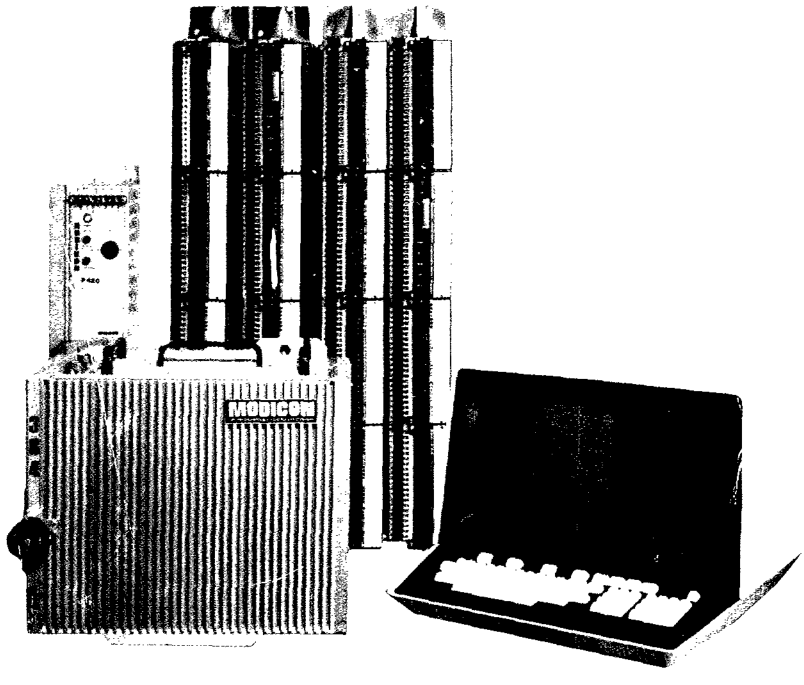
P420
MODICON

GOULD
Modicon Division

184/384
MANUAL

384A

384B - DX ASCII ~~for~~ added functionality

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PREFACE

The MODICON Corporation was founded in 1968 and produced its first Programmable Controller, the 084, in June 1969. The 084 was the first Programmable Controller to utilize core memory in an industrial environment. Over one thousand 084's have been built. Many improvements and expansion of the 084 were identified from its use in a wide variety of applications, which lead to the development of the 184 Programmable Controller in 1972.

The 184 and its high speed version called the 384, represent the most intelligent Programmable Controllers available. Due to the highly sophisticated capabilities available to the user, the 184 or 384 with 4K of core memory, can perform many applications that other programmable controllers require 8K or more memory and a computer would require at least 16K of memory. These Programmable Controllers have also met wide acceptance in a wide variety of industrial uses; over 3000 have already been installed in successful applications. These applications were not concentrated in just one industry; the 184/384 controllers provide a general purpose control device. Some of the installations include the following:

- Power Shedding
- Pollution Abatement
- Pipeline Control
- Weigh Systems
- Polymer Blending and Handling
- Film Coating
- Blast Furnace
- Continuous Casting
- Injection Molding
- Pelletizing
- Burner Control
- Chemical Batch
- Furnace Contol
- Monitoring and Alarm
- Fault Diagnostics
- Analog Control
- Can Plant
- Foundry Molding Machine
- Food Processing
- Textile Processing
- Gas Compressor Control
- Product Testing
- Automated Warehouse
- Packaging Machine
- Instrument Testing
- Machine Tools for:
  - Grinding
  - Milling
  - Boring
  - Assembly
- Tire Building
- Press Monitoring and Control
- Material Handling
- Transfer Machines
- Dial Assembly Machines
- Welding Machines
- Sorting and Classification
- Tracer Lathes
- Stacker Cranes
- Balancing Machines
- Conveyor Systems
- Power and Free Conveyors

In June 1977, the MODICON Corporation became an operating division of GOULD Inc. This division operates independent of the many other divisions of GOULD Inc. and produces only Programmable Controllers. There are no other sideline products such as relays, solid state electronics, or computers to dilute our efforts; the MODICON Division of GOULD Inc. concentrates on making the best programmable controller available. Since its first controller in 1969, MODICON has been the recognized leader in developing new and practical innovations. New features, peripherals, and I/O equipment are constantly being developed. Contact the nearest sales office listed inside the rear cover to obtain the latest details.

In addition to the 184/384 controller, MODICON also produces a 284, 484, and a 1084 Programmable Controller. The 284 controller is a small (80 input/40 output), fast (5 mSec scan), inexpensive machine, ideal for applications previously requiring 15-100 relays. The 484 is slightly larger (256 inputs/256 outputs), with scan times from 4 to 20 mSec, and combines the low cost of the 284 with some of the sophistications of the 184. The 1084 is a large (15,360 input/15,360 output), parallel processing (20 mSec scan, up to ten processors), machine that is fully ASCII compatible and can utilize up to 40K of core memory. For details on any of these Programmable Controllers, also contact the nearest MODICON sales office.

WARRANTIES

A. MATERIAL AND WORKMANSHIP: Gould Inc. guarantees Purchaser that all equipment manufactured by it shall be free from defects in material and workmanship. Gould Inc. shall at its option replace or repair, free of charge, any equipment covered by this warranty which shall be returned to the original shipping point, transportation charges prepaid, within one year from receipt at destination and which upon examination proves to be defective in material or workmanship.

B. PATENTS: Gould Inc. will defend Purchaser and pay any award of damages assessed against Purchaser in any suit or proceeding, so far as same is based on any claim that the equipment or any part thereof furnished hereunder (except for equipment basically of Purchaser's specifications) shall in design or construction infringe any United States patent provided Purchaser gives Gould Inc. prompt notice in writing of such claim and permits Gould Inc. to contest same through its counsel or, at its option, to settle same by securing for Purchaser the right to use such equipment, or by modifying it to avoid infringement or by reclaiming it and replacing it with non-infringing equipment or by reclaiming it and reimbursing Purchaser the sum paid therefor; and provided Purchaser gives Gould Inc. all necessary authority and assistance, at Gould Inc.'s expense, to enable Gould Inc. to do so.

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MAJOR TEXT REVISIONS SINCE LAST ISSUE (DEC 1977)

1. Increased Remote I/O to 5,000 feet.
2. Added 10-60 Vdc I/O Modules B248/B275 and Analog Mux Modules B256/B258
3. Added D285 discussion to paragraph 3.6.
4. Appendix A, J340 Communicator
5. Appendix F, Added new TEF Configurations

SECTION I
INTRODUCTION

GENERAL

A Programmable Controller (P.C.) is a solid-state device designed to perform logical decision making for control applications in the industrial environment. In other words, the P.C. is the modern way to perform industrial control functions that formerly required relays, solid-state electronics, or a mini-computer. The Programmable Controller is a unique device in that its capabilities were not available until the last few years.

Features that are unique with programmable controllers, and in particular, the MODICON Models 184/384 are as follows:

- Solid-state device throughout.
- Designed specifically to operate in the industrial environment *without* special protection such as fans, air conditioning, and electrical filtering.
- Programmed with a light-weight, rugged programming panel connected directly to the Controller.
- Simple to program. The programming language is a relay ladder concept very similar to magnetic relay circuitry. Thus engineers, technicians, and electricians can readily learn to program the Controller without extensive training or experience.

A block diagram of a typical industrial control system is shown in Figure 1. Before the advent of the P.C., the sequencing logic or logic decision-making for nearly all automated industrial systems was accomplished with relays, solid-state electronics, or mini-computers; Figure 2 shows typical installations for industrial control using antiquated techniques. The MODICON 184/384 Programmable Controllers (Figure 3) are universal logic decision-making devices that replace relays, solid-state electronics, and in some cases mini-computers.

The benefits compared to previous devices afforded by the MODICON 184/384 Programmable Controller are as follows:

Compared to Relays:

- Changes accomplished quickly and, in most cases, without hardware modifications to Controller.
- Solid-state reliability provided by Controller.
- Controller is reusable.
- Indicator lights provided on Controller at major diagnostic points to assist in troubleshooting.

Compared to Solid-State Electronics:

- Changes accomplished quickly and, in most cases, without hardware modifications to Controller.
- Controller is reusable.
- Maintenance is very easy on Controller.
- Controller is designed for industrial environment.

Compared to Mini-Computer:

- Controller is simple to program and install in industrial environment.
- Maintenance is very easy on Controllers.
- Controller is designed for industrial environment.

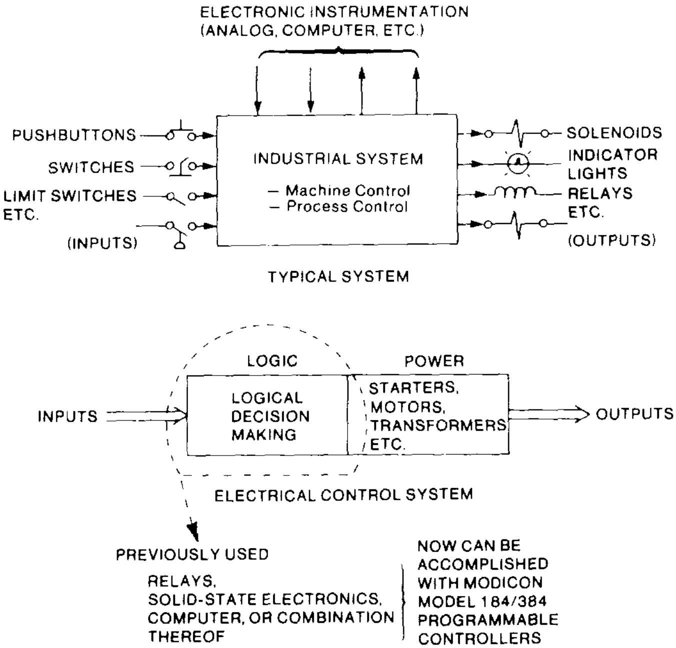


Figure 1. Typical Industrial Control System, Block Diagram

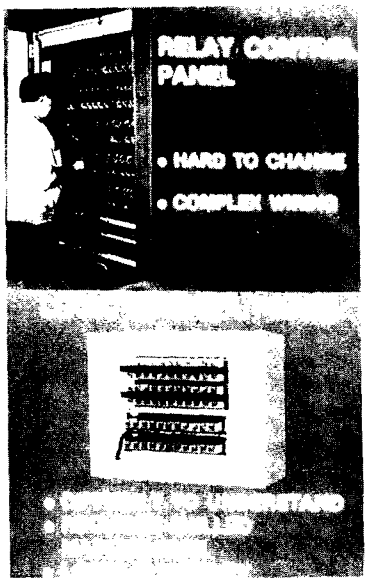


Figure 2. Typical Relay and Solid State Electronics Installations for Industrial Control

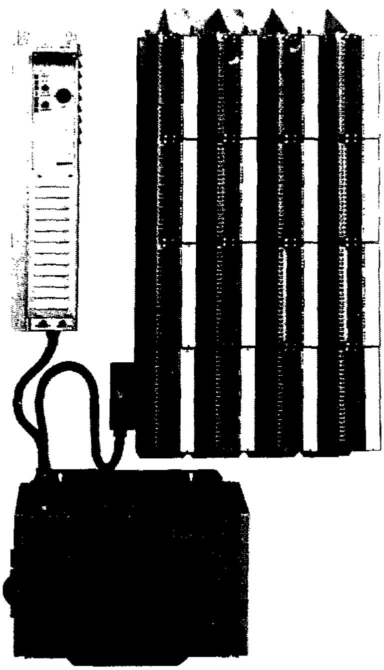


Figure 3. MODICON 184/384 Programmable Controller

A typical Programmable Controller can be divided into three components as shown in Figure 4. These components are a Processor, Power Supply, and an Input/Output (I/O) Section.

PROCESSOR

The Processor (the "brain" of the system) is a completely solid-state device designed to perform a wide variety of production, machine tool, and process-control functions. In the past, these functions could only be performed by conventional electromechanical devices, relays, and their associated wiring. However, the sophisticated and compact circuitry contained in the Processor can not only provide these functions, but also a much wider scope and variety of control functions than conventional relay circuitry, with minimal effort.

The Processor operates on DC power (±5V) which is supplied by the Power Supply. Internal DC power is also routed through the Processor to operate a portion of the I/O and devices connected to the service port. Once the ladder-diagram program is entered into the Processor, it remains resident until deliberately changed by the user with one of the programming devices. The program is unaltered through power failure or power off conditions.

The Processor, in addition to the cables that connect it to the Power Supply and the I/O Section, has an access port on the left side which is used for entering instructions and data. The most common method of entering data or programs into the Processor through this port is with the Programming Panel (Figure 5).

Other devices that could also connect to the port are a Tape Loader, a Computer Interface, CRT, or for diagnostics or troubleshooting, a Telephone Interface providing communications to MODICON's Service Center.

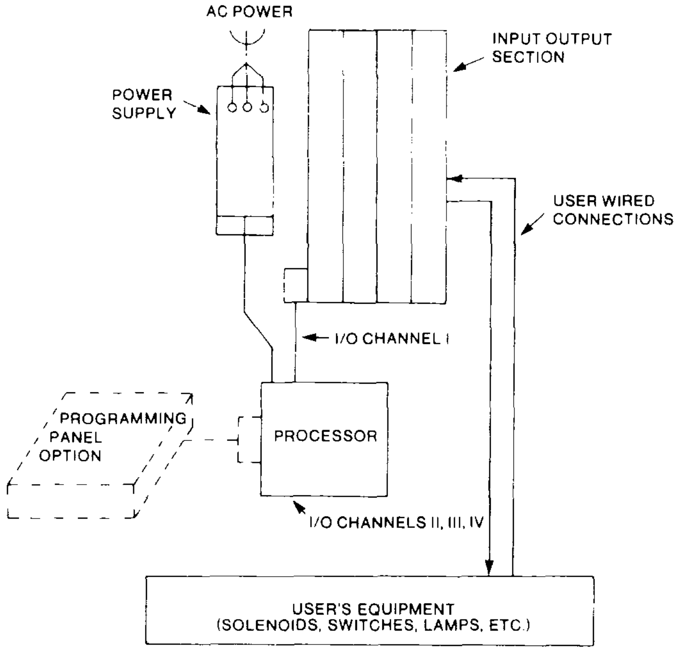


Figure 4. Basic System Configuration

POWER SUPPLY

The MODICON 184/384 Controller system operates on standard 115 Vac power, either 50 Hz or 60 Hz or 230 Vac 50 Hz (not interchangeable). The Main Power Supply is connected to the Processor through a single cable with keyed plug-in connector, and is contained within a heavy-duty finned case. No adjustments or maintenance are required. Lamps are provided to indicate operational power-ready status. No external cooling is required; however, free-air circulation should be provided. Auxiliary power supplies are also required on some expanded I/O systems.

INPUT/OUTPUT SECTION

A major characteristic of the 184/384 Controller is that the input and output control devices are directly connected to the Controller. User wiring to and from the Controller is accomplished through heavy-duty housings. Each housing is designed to contain four I/O modules, and each module contains 16 circuits — either input or output. Each housing is provided with a wiring conduit enabling easy access to bare-wiring clamp terminals. In addition, the cover of the wire conduit has flexible fasteners permitting the user to remove it for easier installation and routing of wires. Each terminal is capable of accepting either one AWG No. 12 or two AWG No. 14 wires.

NOTE

An optional I/O housing (Model B241) is also available that accommodates two I/O modules and is approximately half as tall as the standard housing (Model B240).

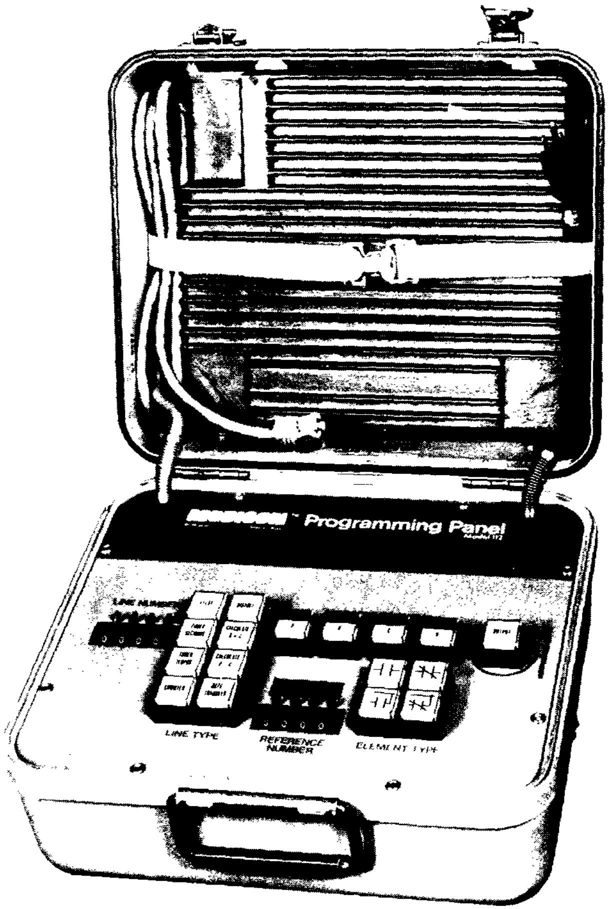


Figure 5. Programming Panel

MODICON offers a variety of I/O modules, designed either to be output-driving or input-handling circuits. Appendix B contains specifications for available I/O modules and their circuitry. The input and output modules are solidly constructed units easily removed or plugged into their housings. Once inserted, electrical contact is automatically made through plated spring connectors. I/O modules can be removed and replaced without removing power either on the field or internal logic; there is no requirement to shut down the system to replace I/O modules.

NOTE

When an input or output module is removed, all 16 circuits on the modules will be disconnected.

All input and output circuits are individually isolated with either transformer coupling or photo diodes to prevent transients on the field wiring from affecting the internal logic. No periodic maintenance is required. Indicator lamps are provided on each module to indicate the field power status, ac output fuse condition, and operational status of the module.

A summary of 184/384 Controller specifications is provided in Table 1.

Table 1. Basic Modicon 184/384 Controller Specifications

Power Requirements:	
Standard	115 Vac ±15%, 50/60 Hz, 300 Volt amps (Max) 7 amp peak start-up transient
Optional	230 Vac ±15% 50Hz 300 Volt Amps (Max) 3 amp peak start-up transient
Environmental Requirements:	
Ambient temperature	0°C to 60°C
Humidity	0% to 95% (non-condensing)
Dimensions:	**(WxHxD)**
Processor (184)	22 in. x 12 in. x 13 in.
Processor (384)	22 in. x 15 1/2 in. x 13 in.
Power Supply (115V)	7 in. x 25 1/2 in. x 13 in.
Power Supply (230V)	7 in. x 29 1/2 in. x 13 in.
Single I/O Housing	5 in. x 41 in. x 13 1/2 in.
Four Housings (One Channel)	20 in. x 41 in. x 13 1/2 in.
Weight:	
Processor (184)	40 lbs.
Processor (384)	45 lbs.
Power Supply (115 Vac)	40 lbs.
Power Supply (230 Vac)	45 lbs.
I/O Module	5 lbs.
Single I/O Housing	13 lbs.
Four Housings (One Channel)	52 lbs.

PROGRAMMING PANEL (Models 102 and 112)

The MODICON 184/384 system Programming Panels (Figure 5) are small, suitcase-size units which plug into the Processor and enable the user to easily "program" the Processor with all desired logic and control information. The two available options differ only in that Model 102 is limited to relay, timer, and counter capabilities; the Model 112 permits arithmetic computation and data transfers in addition to the Model 102 capabilities.

With only 17 illuminated pushbuttons and 2 sets of thumbwheels (4 digits each), the Programming Panel represents a simple control panel enabling the electrician to program the Processor from his ladder diagram. The "language" used to program the Controller is familiar relay symbology; there are no requirements to learn a new programming language.

The Programming Panel is a rugged, easily transportable unit, ideally suited for use in an industrial environment. It is designed to operate in locations where electromagnetic noise, high temperature, humidity, mechanical shock, etc., are prevelant.

Additional 115 Vac power is required for the Programming Panel lamps. This power is normally supplied by the convenience outlet on the main power supply.

For additional details on the Programming Panel, see Appendix A.

CRT PROGRAMMING PANEL (Models 140 and 145)

The CRT Programming Panels utilize the same format and references as the "hard-hat" programming panels (Models 102 and 112). These units allow programming in either the standard four element logic lines as well as a multi-node (10X7) format. In the four element display mode, up to fourteen lines can be displayed simultaneously, in any numerical order; or with these logic lines, any mix of registers, inputs, or latches (up to 40) can be displayed. In multi-node, up to seven coils can be programmed on the screen.

All programs are entered in real time and any line can display its real time power flow/register content. Ladder diagrams can be printed out locally from the CRT as an option. Up to sixteen controllers can be simultaneously connected to the CRT Programmer at a total accumulated distance of up to 3 miles. Special features such as Search, Trace, Cross-References, etc. are also available as standard on all models. Model 140 is a portable CRT with a 9" screen; Model 145 has the same feature except that it is packaged in a desk top version with a 12" screen. For additional details see Appendix A.

SECTION II
CONFIGURATION

SYSTEM REQUIREMENTS

Each 184/384 Controller system requires a main power supply, a Processor (the mainframe), and a variable number of I/O modules. The 184 Processor is available in four different models, 184-1, 184-2, 184-3, and 184-4. Each 184 model is physically the same; the only difference is the size of the core memory provided with the Processor. Any Controller can be changed to any model number by merely replacing the memory printed circuit card. The 384 Processor is available only with 4K of core memory. Criteria for the proper selection of the specific model number is provided as part of the Basic Principles, Section III. In designing a hardware configuration, most of the considerations should be applied to the I/O configuration and its various options.

All 184/384 Controllers have the hardware capability to communicate to a maximum of 512 input points and 512 output points. These are separate limitations; inputs cannot be traded for outputs nor outputs for inputs. The I/O capability is divided into four channels, each channel can contain up to 128 input and 128 output points. Again, these are separate limits. A channel is thus defined merely as a subdivision representing 25% of the total I/O capability to simplify the communications between the Processor and the I/O.

The specific I/O circuitry required to convert the various field voltages to signal levels compatible with the Processor is provided on modules. I/O modules are either totally input or totally output with 16 circuits on each module (see Figure 6); combining input and outputs on one module is NOT possible.

NOTE

If isolated AC I/O modules are to be used, see Appendix B for special conditions applying to these modules.

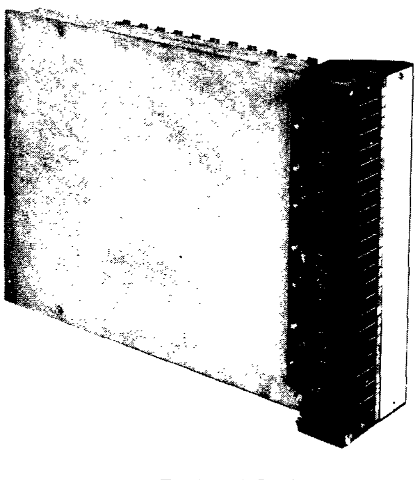


Figure 6. Typical I/O Module

The I/O modules are installed into I/O housings; each housing is capable of receiving up to four I/O modules. Normally, four housings are connected together to form a complete channel of I/O (up to 128 inputs and 128 outputs), which allows up to eight input modules and eight output modules to be installed in each channel. Since each channel is separately connected to the Processor, only those I/O modules required in each channel need be installed.

NOTE

Certain terms such as I/O, channel, etc., are being defined and will be used throughout this manual relative to the Controller. Appendix D summarizes unique terms and their definitions.

Standard MODICON cables are used to connect each I/O channel separately to the Processor. These cables are heavy duty, multiple conductor, double-shielded cables available in a variety of lengths as shown in Table 2. Since the connector for channel I (top of Processor) is different and not interchangeable with the connectors for channels II-IV (bottom of Processor), there are two sets of cables, one for channel I and the other for channels II-IV. Interchanging cables between channels II-IV is possible. Cables provided for connections from the Processor to either auxiliary power supplies or remote drivers are permanently attached to those units.

Table 2. Processor to I/O Cable Options

From Processor To:	Via		
	Directly	Aux Pwr Supply	Remote Driver
Channel I	W600-003,006	W602-012,025, 050,075	W604-006,012
Channels II-IV	W601-006,012	W606-012,025, 050,075	W603-006,012

NOTE

Last three digits of cable number represent the maximum cable lengths in feet; except W600-003 which is 30" long.

Figure 7 is an illustrative example of an expanded 184/384 system. Directly above the Processor is the main power supply and channel I with three housings (maximum 12 I/O modules). In this example, the main power supply is providing internal DC power for the Processor, channel I, and channel II; channel II is only one housing with four I/O modules installed, shown to the left of the main power supply. Both channels I and II are shown without auxiliary power supplies and use direct cables to the Processor (W600 type for channel I and W601 for channel II). A completed channel III is shown to the right of channel I, powered with an auxiliary power supply, and connected to the Processor via this auxiliary power supply with cable type W606.

Referring to Figure 7, channel IV is driven from a remote driver, shown to the right of the Processor. This option is used when a channel is located greater than 75 feet from the Processor. The remote driver is connected to the Processor with cable type W603. Channel IV is divided into two remote subchannels, both shown to the right of channel III; each subchannel can be located 2000 feet from the Processor in different directions. The subchannels are each powered by an auxiliary power supply equipped with an I430 interface (see Figure 8). The connection between the remote driver and each interface is via two twin-conductor shielded cables, one carrying communications to the remote channel and the other communication back to the driver. These cables are NOT supplied with the remote system; Belden type 8227 or equivalent is recommended.

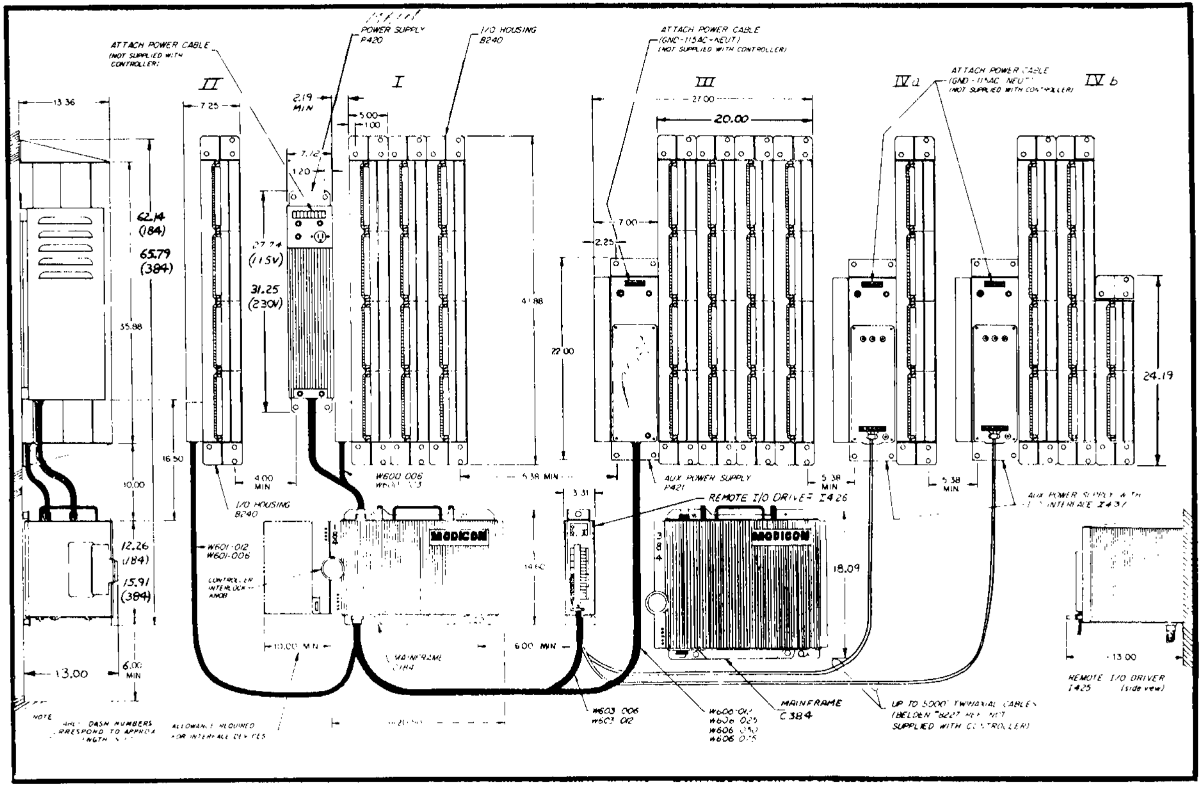


Figure 7. Expanded 184/384 System

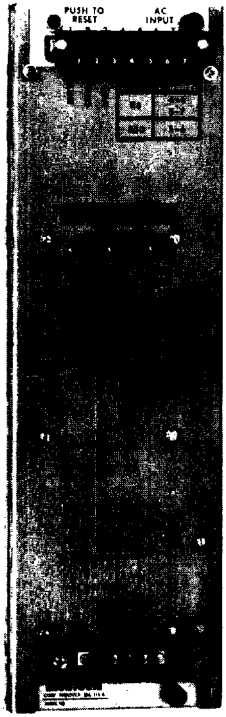


Figure 8. Auxiliary Power Supply and Remote Interface

The remote driver (I425) provides the capability of remoting an entire channel (128 input and 128 output points) to four (or less) locations each up to 5000 feet from the Processor. Any portion, including the entire channel, can be located at each subchannel. However, under no circumstances, can the number of unique input and output points exceed the basic limits of 128 each per channel. Remote I/O allows the I/O to be placed near the machine or process under control; thus replacing all field wires over a long distance with just two twin-conductor cables.

Any channel can be remoted, each into four subchannels (total of 16 possible locations per Processor), located up to 5000 feet from the Processor. See Appendix A for additional details on remote driver.

Appendix B provides detailed specifications on the operation and wiring of all available I/O modules. However, relative to the overall system design, each standard 16-circuit output module requires twice as much internal 5 Vdc power as does the standard 16-circuit input module. Thus, a "unit" of I/O load has been defined by MODICON as the power required by one 16-circuit input module; each 16-circuit output module represents two "units" of I/O load. To drive a complete channel of input/outputs (8 standard 16-circuit input modules and 8 output modules) requires 24 units of I/O power. The main power supply and each auxiliary power supply is capable of supplying 27 units of I/O power. Table 3 summarizes the loading for each type of I/O module available for the 184/384 Controller.

Table 3. Internal I/O Power Loads

Unit	Type	Load (per module)
B230	115 Vac Outputs	2 Units
B231	115 Vac Inputs	1 Unit
B232	24 Vdc Outputs	2 Units
B233	24 Vdc Inputs	1 Unit
B234	220 Vac Outputs	2 Units
B235	220 Vac Inputs	1 Unit
B236	5V TTL Outputs	2 Units
B237	5V TTL Inputs	1 Unit
B238	24 Vdc Outputs, High Current	2 Units
B239	Hi Speed Counter	3 Units
B243	Analog Inputs	6 Units
B244	220 Vac Outputs, Isolated	2 Units
B245	220 Vac Inputs, Isolated	1 Unit
B246	115 Vac Outputs, Isolated	2 Units
B247	115 Vac Inputs, Isolated	1 Unit
B248	10-60 Vdc Outputs	2 Units
B256/258	Analog MUX	2 Units
B260	Analog Voltage Outputs	2 Units
B262	Analog Current Outputs	2 Units
B266	Reed Relay Output	2 Units
B270	48 Vac Outputs	2 Units
B271	48 Vac Inputs	1 Unit
B275	10-60 Vdc Inputs	1 Unit
B680	ASCII I/O	3 Units
J146	CRT Interface	0 Units
J340	I/O Communicator	1 Unit
J342	I/O Comm. with Switchover	2 Units
J540	500 Series Adapter	3 Units
J540/B5XX	Adapter with One I/O Channel	13 Units
J670	1084 Interface	1 Unit
I425	Remote Driver	5 Units
I646	Computer Interface	0 Units
2802	Programming Panel Interface	3 Units

NOTE

Include I425's (Remote Driver) as well as J670 and 2802 Interfaces' load on main power supply at all times. The main power supply and auxiliary power supplies each have 27 units of I/O power available

Normally, channel I is powered from the main power supply's I/O capacity, and auxiliary power supplies are required for channels II-IV. These power supplies provide 5 Vdc internal power to operate the circuitry in the MODICON system; no power is provided to operate external devices, this must be provided by the user. However, under some special conditions, auxiliary power supplies are not required for channels II-IV. If all I/O power is not used by channel I, the unused I/O power can be "borrowed" from the main power supply and provided to channels II-IV. The first condition is that the distance from the Processor to the I/O channel must not be greater than 12 feet. Secondly, the entire channel must not present greater than 10 units of load if one channel is to be supplied by "borrowed" power. If more than one channel is to be supplied by "borrowed" power (e.g., channels II and IV), then each channel cannot represent more than 8 units of load. The last condition is that sufficient I/O power must be available from the main power supply for the total load applied.

If all three conditions (distance, load limit, and available capacity) are satisfied, that channel or channels can be operated without an auxiliary power supply. If channel I is located further than 12 feet from the Processor, it will require an auxiliary power supply. Include the I/O load of each remote driver (if any are used) in the load for channel I; if the load exceeds 27 units, a portion of the I/O should be placed in channel II or an auxiliary power supply used for channel I.

Any I/O channel can receive DC power for internal operation only from one source, either the main power supply or an auxiliary power supply. Borrowing I/O power is possible only from the main power supply. More than four I/O housings can be utilized on any channel as long as the I/O modules do not overload the power supply, nor are there more than eight unique input or output addresses.

As a final check, a review of the load on the I/O portion of the main power supply of Figure 7 can be conducted. Assume that the 12 I/O modules in channel I are 8 input modules and 4 output modules, and channel II contains 4 input modules. The I/O load on the main power supply is 25 units of load consisting of 12 input modules (12 units), 4 output modules (8 units), and 1 remote driver (5 units).

HARDWARE CONFIGURATION

System

Figure 9 is a typical system layout, providing mounting dimensions for all major components.

NOTE

A full-size mylar template is available for location of the mounting dimensions as shown in Figure 9. If use of this template is desired, request Dwg. No. SK-C184-200 from your nearest MODICON sales office or the factory.

This illustration is recommended for layout only; relocation of units relative to the Processor is possible, limited by the cable lengths available. For proper heat flow, all units should be oriented vertically. This will allow fullest removal of heat via the heavy-duty housing fins. Keyhole-type mounting holes are provided on the top of all power supplies and the Processor, to assist in mounting these units.

Processor

The Processor is provided with two mounting brackets that should be used to mount the unit to the panel, providing rear clearance for connection to the optional interface units. Complete installation and checkout procedures are given in Section V.

Install the Processor brackets with the longer one (having two hex-head silver screws) on top, and the other on the bottom. Two mounting screws (24-6 by 3/4 in.) are required but are not furnished with the lower bracket. The screws on the upper bracket are flanged to prevent their inadvertent removal, thus preventing accidental release of the Processor from its mounting structure.

With the bottom screws removed and the upper screws loosened, the Processor can be lifted from its mounting brackets. Since the Processor can easily be removed from its mounting with or without disconnecting external wiring, clearance is not required on the right side for removal of the end plate and access to the printed circuit boards. If access to these is required, the Processor can be removed rapidly, disconnected from its cables and then taken to the work area — or the Processor can be unmounted, rotated 90° clockwise, and supported while access to the end plate is obtained without removing the cables.

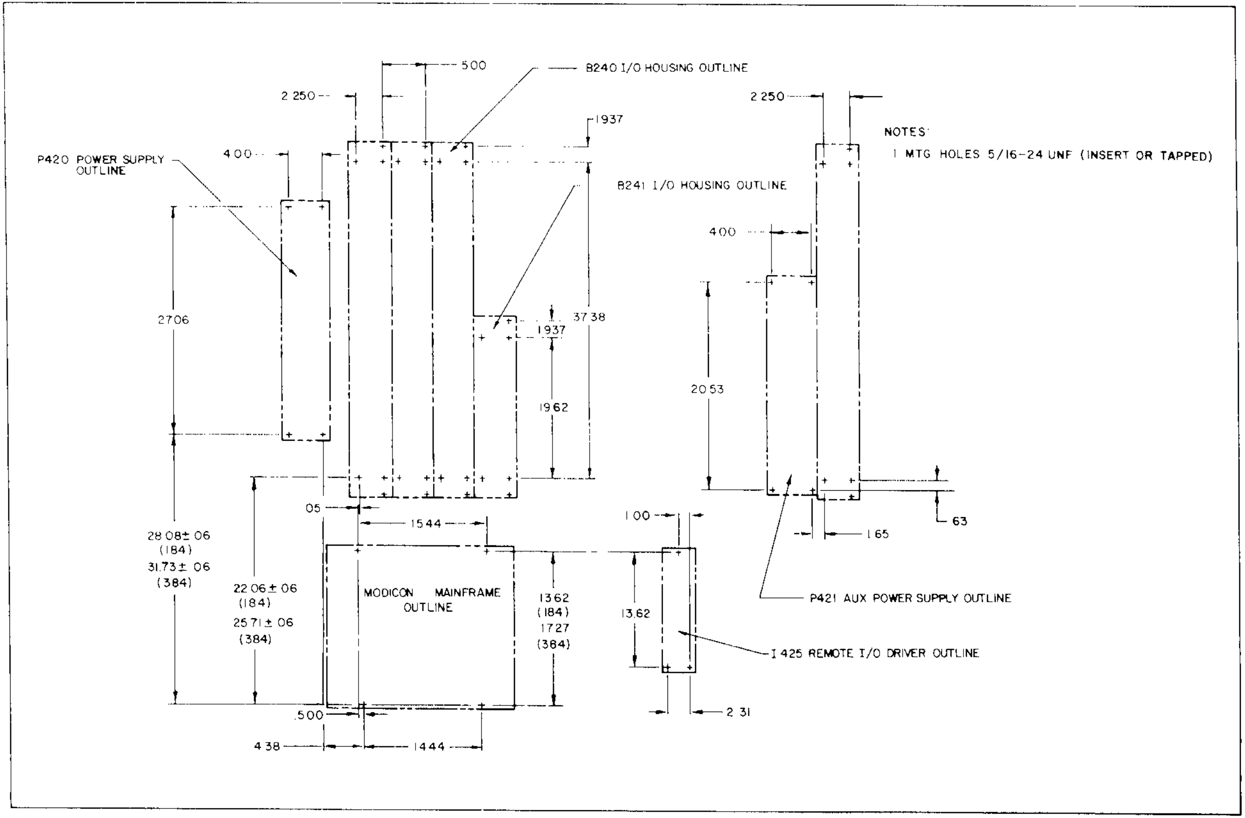


Figure 9. Typical Mounting Plan

The Processor has five indicator lights at the lower left, beneath the interlock knob (see Figure 10a):

RUN	
CHANNEL I	CHANNEL III
CHANNEL II	CHANNEL IV

The Run light indicates power has been applied to the Processor, its logic is being examined, and the I/O is being serviced. The Run light will normally be ON steady.

The Channel lights will be ON when a channel is connected to the Processor and is being serviced by the system. The channel indicators will normally be blinking at a rapid (watchdog timer) rate.

Referring to Figure 10, each Processor is equipped with a male receptacle on top, into which the cable from the main power supply is connected. Also, located on top is a female receptacle to which channel I is connected and a key lock (memory protect) switch which prevents alteration of the user's logic when the switch is placed to the ON position. On the bottom are three female connectors to which channels II-IV (front to rear) are connected. Cables for channels II-IV can be interchanged between themselves; however, they are not interchangeable with channel I cables.

On the left side of the Processor are two connectors to which the auxiliary units are interfaced to the Processor. If not used, these connectors must be covered by the hinged metallic flap provided. A magnetic switch prevents operation of the Processor unless either an interface for an auxiliary unit or the flap is covering the connectors.

A large black knob on the front of the Processor controls the locking of an interface or flap and also turns the Processor ON. The Processor must be turned OFF if an interface is to be removed or inserted.

Internal to each Processor are three large printed-circuit boards, each in its own separate chamber. One controls the processing of data, the second is the core memory, and the third controls I/O processing.

The 184 memory boards are provided with core memory of 1K, 2K, 3K, or 4K (Models 184-1, 184-2, 184-3, or 184-4, respectively). In this core memory is stored a specific MODICON Operating System (MOPS) which allocates the memory into logic lines, storage locations (registers), types of inputs/outputs (i.e., discrete or numerical), and capability (line types). The MOPS installed in memory is as important as hardware selection. For details on MOPS capabilities, see Section III, Basic Principles. Any available MOPS can be installed in a 184 Controller from the Service Center via the Telephone Interface or by the Tape Loader. There are no software costs related to the operation or capabilities of the 184 Controller.

The 384 Controller is provided with a 4K core memory. Into this memory is stored a specific TEF (Three Eighty Four) which performs all the functions discussed above that a MOPS provides for the 184 Controller.

Power Supplies

The main power supply (see Figure 11) provides DC power (±5 Vdc) required for the internal operation of the Processor and one complete channnel of I/O modules. The power supply is also provided with a multi-conductor cable required to connect to the Processor. This cable is permanently connected to the power supply and is 20 inches long. Indicator lights are provided to indicate availability of both control and main power as well as output of dc power to the Processor and the I/O channel. AC power per Table 4 must be applied to the main and control terminals, see Figure 12. When power has been properly supplied, the Main and Control indicators of the Power Supply should light.

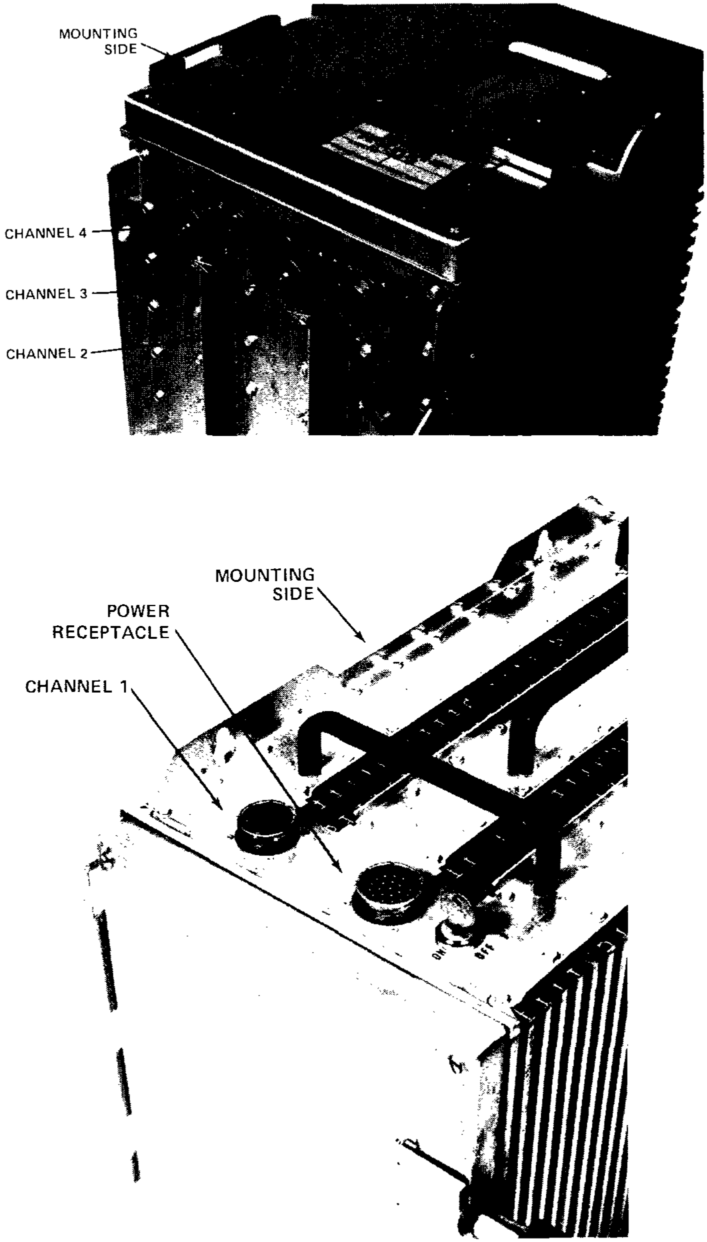


Figure 10. Processor, Showing Cable Connections

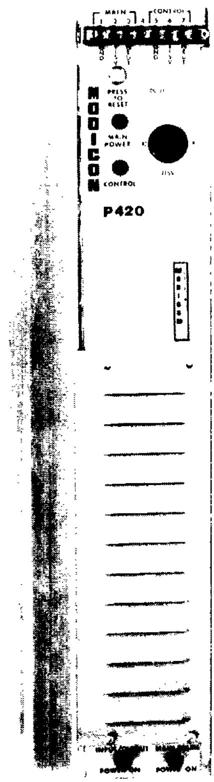


Figure 11. Main Power Supply (Model P420)

NOTE

Verify power connections to main power supply prior to connecting AC power. Proper terminal identifications are provided on each power supply.

The main power activates the Processor electronics; the control power causes the Processor to begin to process data. To ensure maximum reliability when de-energizing the control system, main power should be maintained. A typical system power wiring is illustrated in Figure 13.

Voltage-sensing circuitry is provided in the main power supply to detect out-of-tolerance line voltages and signal the Processor when a power failure has been detected. There is sufficient power stored in the large electrolytic capacitors to ensure uninterrupted operation if the AC power is lost for up to 17 ms; if power is not restored, the Processor ceases operation, forces all outputs to the OFF condition, and turns its run light OFF.

Operation will be automatically restored when AC power (both main and control) is within tolerance as specified in Table 4; there will be a 500 ms delay in restoration of Processor operation after a power failure while the Processor goes through its power-up sequence.

Table 4. Summary of Required AC Power

P420 MAIN POWER SUPPLY

Normal Voltage:	
Standard:	115V RMS ±15% (100-130V RMS)
Optional:	230V RMS ±15% (187-265V RMS)
Transient Voltage (Standard)	
Max. 10 Seconds:	115V RMS ±30% (80-150V RMS)
Max. 17 ms:	115V RMS ±100% (0-200V RMS)
Transient Voltage (Optional)	
Max. 10 seconds:	230V RMS ±30% (160-300V RMS)
Max. 17 ms:	230V RMS ±100% (0-400V RMS)
Line Spikes:	1000V max. (500 μs duration. 0.5% max. duty cycle)
Frequency	
Standard:	60 Hz ±5% (57-63 Hz)
Optional:	50 Hz ±5% (47.5-52.5 Hz)
Normal Load	
*Main:	110 Volt-amps min. 240 Volt-amps max. (7 amp peak ON transient)
Control:	50 Volt-amps (3 amp peak ON transient)
Recommended Transformer Distribution:	1000 Volt-amps (fuse secondary at 7 amps)

P421 AUXILIARY POWER SUPPLY

Normal Voltage	
Standard:	115V RMS ±15% (100-130V RMS)
Optional:	230V RMS ±15% (187-265V RMS)
Transient Voltage (Standard)	
Max. 10 seconds:	115V RMS ±30% (80-150V RMS)
Max. 17 ms:	115V RMS ±100% (0-200V RMS)
Transient Voltage (Optional)	
Max. 10 seconds:	230V RMS ±30% (160-300V RMS)
Max. 17 ms:	230V RMS ±100% (0-400V RMS)
Line Spikes:	1000V max. (500 μs duration, 0.5% max. duty cycle)
Frequency	
Standard:	60 Hz ±5% (57-63 Hz)
Optional:	50 Hz ±5% (47.5-52.5 Hz)
*Normal Load:	10 Volt-amps min. 100 Volt-amps max. (4 amp peak ON Transient)
Recommended Distribution Transformer:	350 Volt-amps (fuse secondary at 3 amps)

*NOTE: P421 and P420 main loads depend on I/O and peripherals connected; minimum and maximum steady state load are as indicated above.

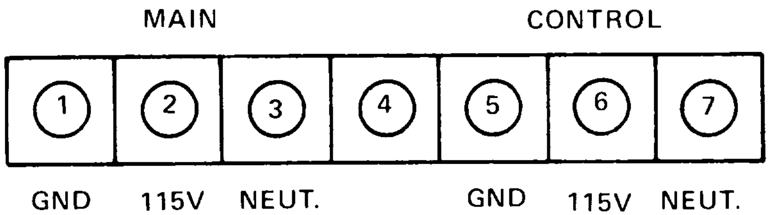


Figure 12. Connections to Main Power Supply

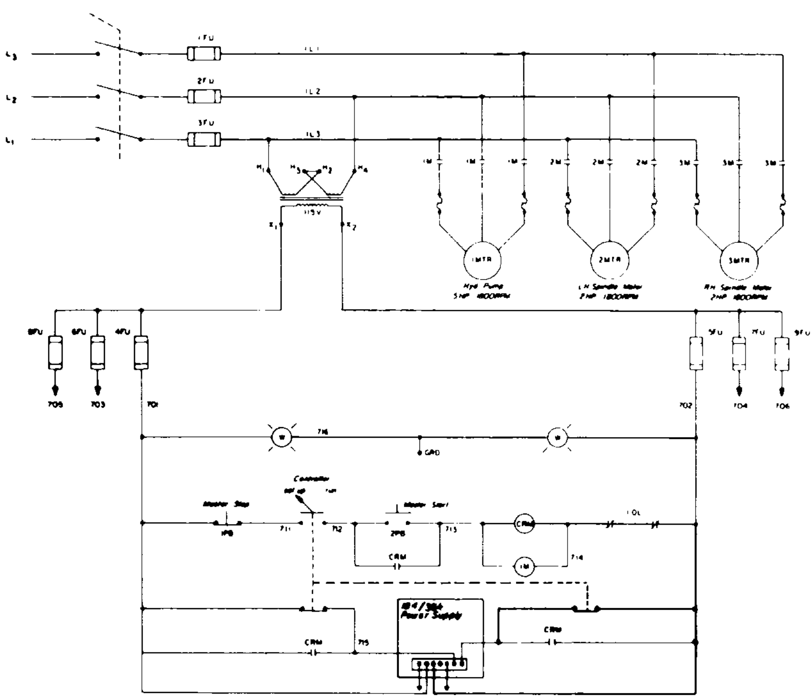


Figure 13. Model 184/384 Controller
Typical Power Connections

WARNING

Proper power shutdown and power-up sequences will not be performed if the Processor is disconnected from the main power supply while operating. The cable between the power supply and the Processor should NOT be disconnected while the Processor is running.

A convenience outlet is provided on the main power supply to power auxiliary units used with the Processor.

The 230V 50Hz version has two convenience outlets, one supplying 230Vac and the other 115 Vac.

Auxiliary power supplies (see Figure 14) are required to power the internal operation of the I/O modules if there is insufficient power capacity in the main power supply, or if the I/O modules are located an excessive distance from the Processor. A single AC power source is required per Table 4 to the auxiliary power supply; indicator lights are provided to indicate the availability of the ac power and the outputting of DC voltage. The selection of either standard 115V or optional 230V auxiliary power supply operation

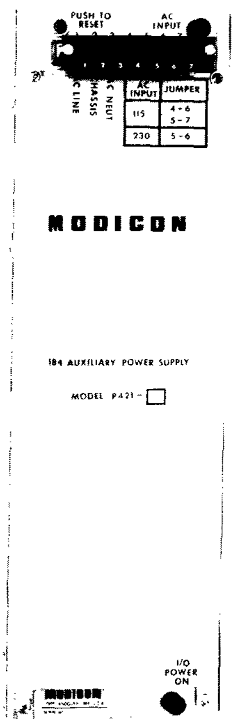


Figure 14. Auxiliary Power Supply (Model P421)

is made by connecting external jumpers as follows:

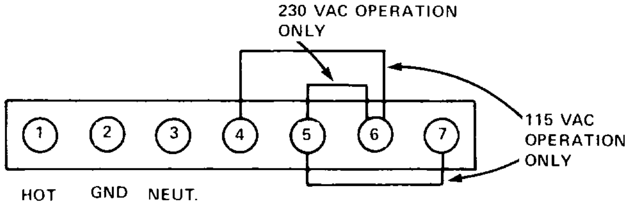


Figure 15. Connections to Auxiliary Power Supply

Each auxiliary supply is capable of providing internal power for one complete channel of I/O modules (maximum 27 units of I/O load). The auxiliary power supply is connected to the Processor via a cable that is permanently connected to the power supply. DC voltages are not transferred via this cable; only input/output status is transferred to the Processor from the I/O modules connected to, and powered by, the auxiliary power supply.

Input/Output

On the backplane of each housing are address index pins, one for each I/O module location. These pins are used to identify which of the eight possible input or output modules is being placed in a particular location. The identification relative to input vs output modules is accomplished automatically by the module. These index pins must be adjusted prior to installing the module. (See Figures 16 and 17.)

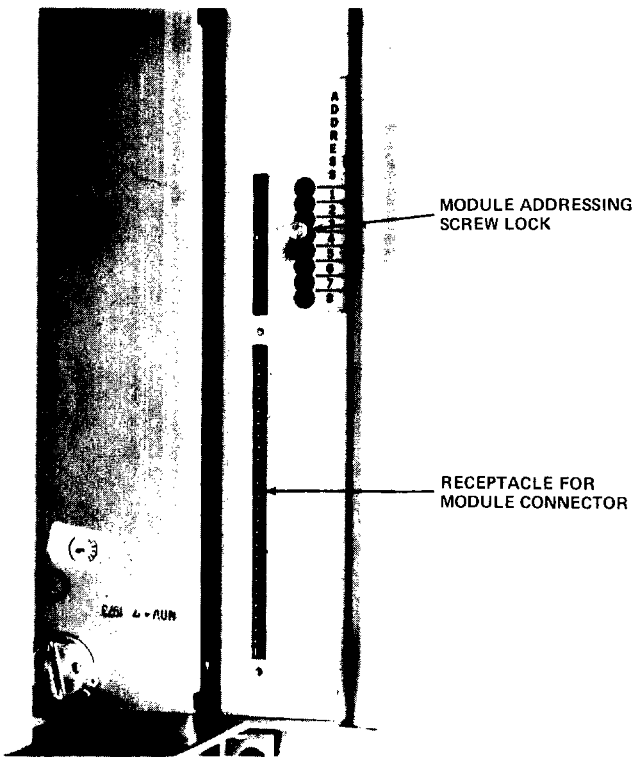


Figure 16. I/O Housing, Showing Module Address Selection

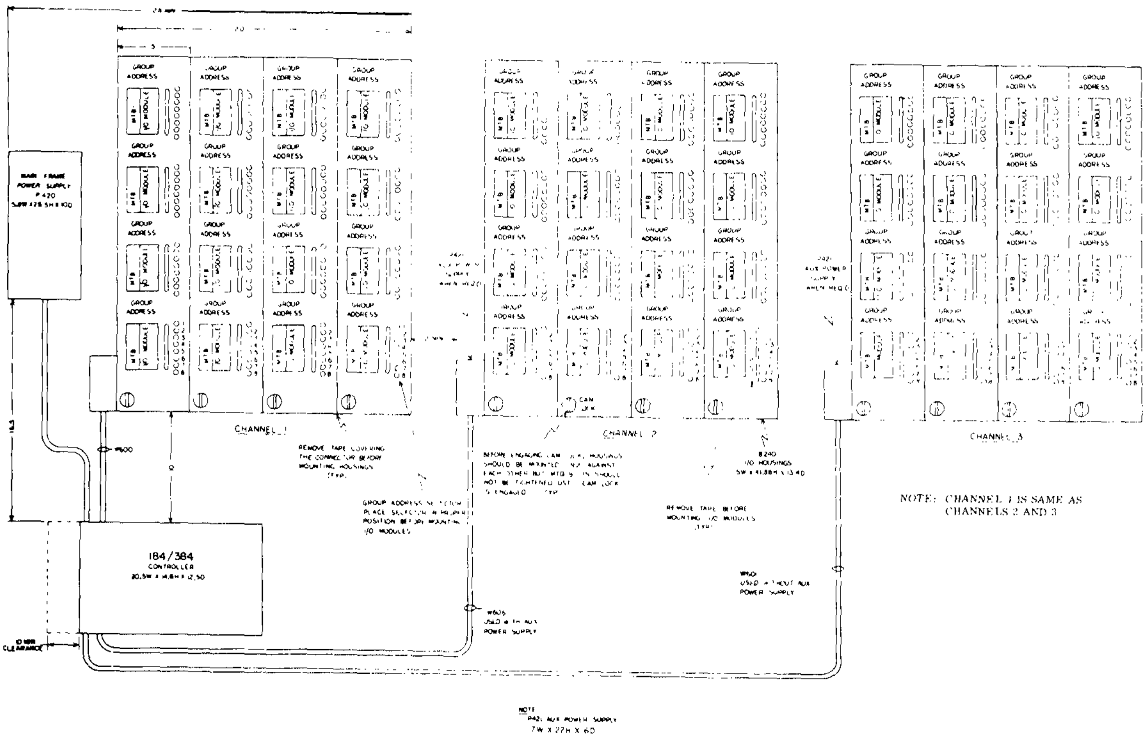


Figure 17. I/O Housing Overview, Showing Module Index Pins

Since the specific input or output identification is not established by the physical placement of the module, but rather by the index pins, any convenient physical arrangement of I/O modules in a channel is possible. All inputs can be placed on the top and all outputs on the bottom, or all inputs on the left and all outputs on the right, or they can be alternated (an input then an output, etc.). The index pin allows the designer complete flexibility to install as many I/O modules as required, in any mix up to the limit of the channel, and in any arrangement that is most appropriate for his application.

Each I/O housing has a male printed-circuit connector on the lower left side and a female receptacle on the lower right side. The male connector is normally retracted within the housing and is extended by rotating a cam, driven by a large screw head on the lower section of the backplane. Rotating this screw head 180° clockwise extends the male connector; rotating it 180° counterclockwise retracts the male connector. This connector is used to connect the housing to either another housing, a cable to the Processor, or an auxiliary power supply. See Section V for additional details on installing I/O housings.

When delivered, each housing has its male and female connectors as well as its module backplane connectors covered by a protective tape. This tape must be removed prior to using the connector. However, if the connector is not to be used (no module inserted or last housing in channel), the tape should be retained to ensure noise shielding and protect against entry of foreign matter.

Field wiring (see Figure 18) can be installed on the I/O housings either before or after the I/O modules are installed. However, the address index pin must be positioned prior to installation of the I/O module. It is recommended that both the field wiring and the index pin be installed prior to installing the I/O modules. Color-coded adhesive strips (Figure 19) are available to identify the 21 field-wiring terminals opposite each I/O module, terminal 1 (top) to 21 (bottom). These strips are color-coded to match the color of the module to be installed; this aids in preventing a module being installed in a location not properly wired for that module type. These strips are available for each I/O module type and are installed by the user in accordance with his particular input/output configuration. The color codes are given in Table 5. Also provided with each I/O module is a white plastic plate so that the user can add his own unique identification for each I/O circuit. This plate is reversible; both sides can be engraved.

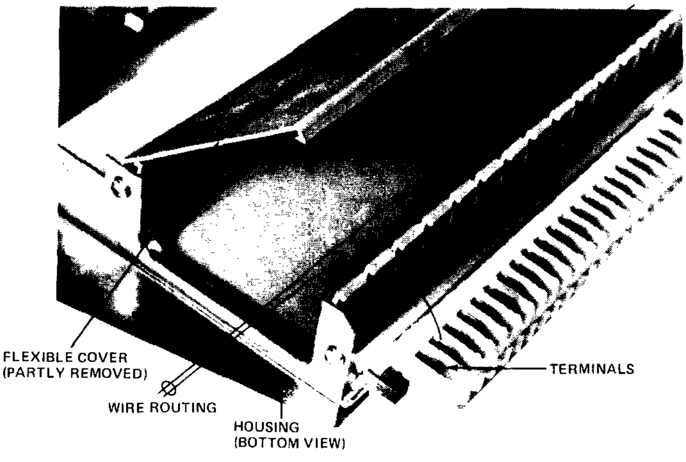


Figure 18. I/O Housing, Showing Conduit and Terminals for Wiring

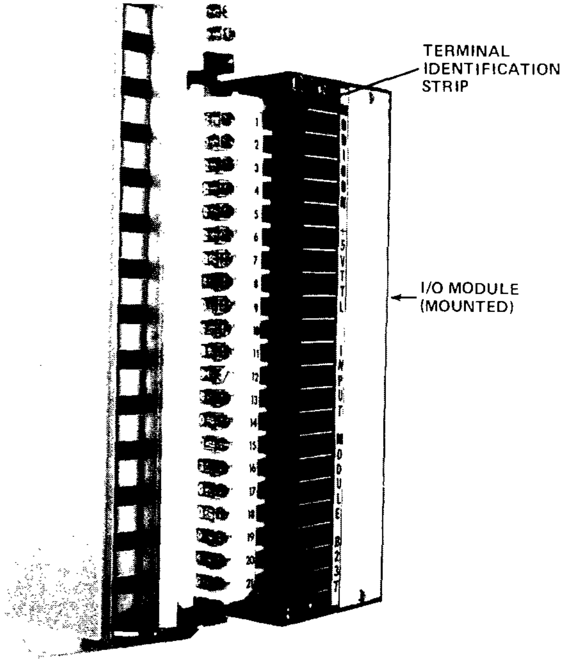


Figure 19. I/O Housing, Showing Relationship Between Terminals and I/O Module Terminal Identification Strip

Table 5. Input/Output Module Color Codes

Module	Type	PMS* Code	Color
B230	115 Vac Output	199	Red
B231	115 Vac Input	197	Pink
B232	24 Vdc Output	286	Dark Blue
B233	24 Vdc Input	284	Light Blue
B234	220 Vac Output	151	Orange
B235	220 Vac Input	149	Melon
B236	5V TTL Output	259	Violet
B237	5V TTL Input	264	Light Purple
B238	24 Vdc Output, 2.5A	354	Green
B239	Dual Hi-Speed Counter	515	Blue
B243	Analog Input	109	Yellow
B244	220 Vac Output, Isolated	463	Brown
B245	220 Vac Input, Isolated	465	Light Brown
B246	115 Vac Output, Isolated	233	Rhodamine Red
B247	115 Vac Input, Isolated	231	Dark Pink
B248	10-60 Vdc Output	347	Green
B256	Analog MUX (Dry)	102	Yellow
B258	Analog MUX (Mercury)	101	Yellow
B260	Analog Output (Voltage)	380	Light Green
B262	Analog Output (4-20 ma)	382	Green
B266	Reed Relay Output	298	Silver Blue
B270	48 Vac Outputs	207	Dark Red
B271	48 Vac Inputs	204	Dark Rubine Red
B275	10-60 Vdc Input	314	Blue

* Pantone Matching System.

Maintenance Aids

Indicator lamps are provided to indicate proper operation of each major function of the Controller (see Figure 20). On the power supplies, indicators show when AC power is available and when DC power is being produced. On the Processor, lamps indicate when data is being processed (RUN lamp) and when communications are being maintained with each I/ O channel. Remote drivers have one indicator (Data Out) that indicates when data is available to all subchannels and separate indicators (Data In) on each subchannel indicating when data is being received from that subchannel. The remote interface has three indicators: one indicating data being sent to the driver, a second for data received from the driver, and the third if it is in the test mode.

Each I/O module has an indicator (active light) which is ON when the module is properly communicating with the Processor, and each individual input circuit has an indicator which will be ON if the external terminal receives an ON signal. Each individual AC output circuit has two indicators; one indicating the output is ON (output in ON condition) and the other indicating if an output fuse has blown. Each individual DC output circuit has an indicator which will be ON if the output is ON. Input and output wiring can be verified by using the "disable" capability of the Programming Panel as discussed in Section III, Basic Principles.

NOTE

> With AC output modules (except B230-1, B234-1, B244-1, and B246-1), an unloaded AC output will have its indicator ON regardless of output status. If an output indicator is always energized, the field wiring should be examined to verify there is continuity to the load device.

Fuses used on modules where field replacement is possible are listed in Table 6. To replace a fuse, remove the module from its housing. There is an opening (approximately 1 in. x 8 in.) on the terminal side of the module through which access to the fuses can be obtained (see Figure 6). All fuses are oriented in accordance with the output terminals such that the top fuse is for the No. 1 output on the module and the bottom fuse is for the No. 16 output; except for the B238, whose top fuse is for the common indicator supply, and the B244 and B246, whose orientation is per Figure 21.

Table 6. Fuse Requirements

Module	Standard Size Pico Fuse	Littlefuse Part No. or Equivalent	Quantity per Module
B230	5 amps	275-005	16
B232	7 amps	275-007	1
B234	5 amps	275-005	16
B236	2 amps	275-002	1
B238*	3 amps	275-003	17
B243	1/4 amp	275-250	8
B244*	7 amps	275-007	8
	1/4 amp	275-250	1
B246*	7 amps	275-007	8
	1/4 amp	275-250	1
B248	3 amps	275-003	16
B256/B258	1/2 amp	276-500	1
B266	3 amps	212-003	8
B270	5 amps	275-005	16
B680	1/4 amp	313-015	1

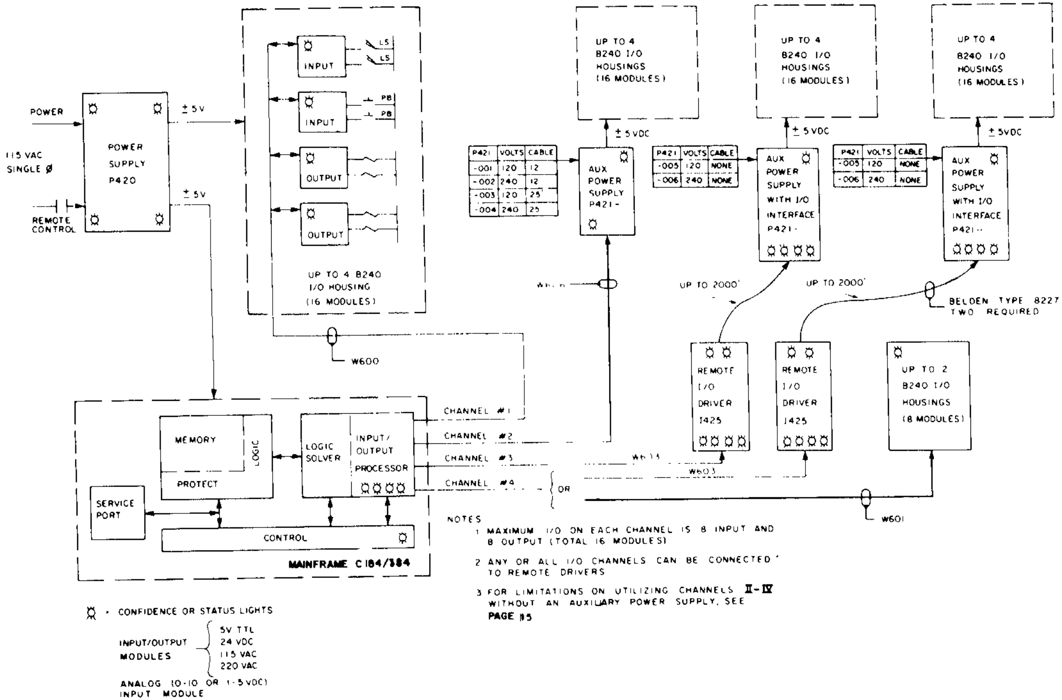


Figure 20. MODICON 184/384 System Block Diagram

NOTE

Those modules indicated by an asterisk (*) are provided with one fuse for each output circuit plus one fuse for separate indicator lamp supply.

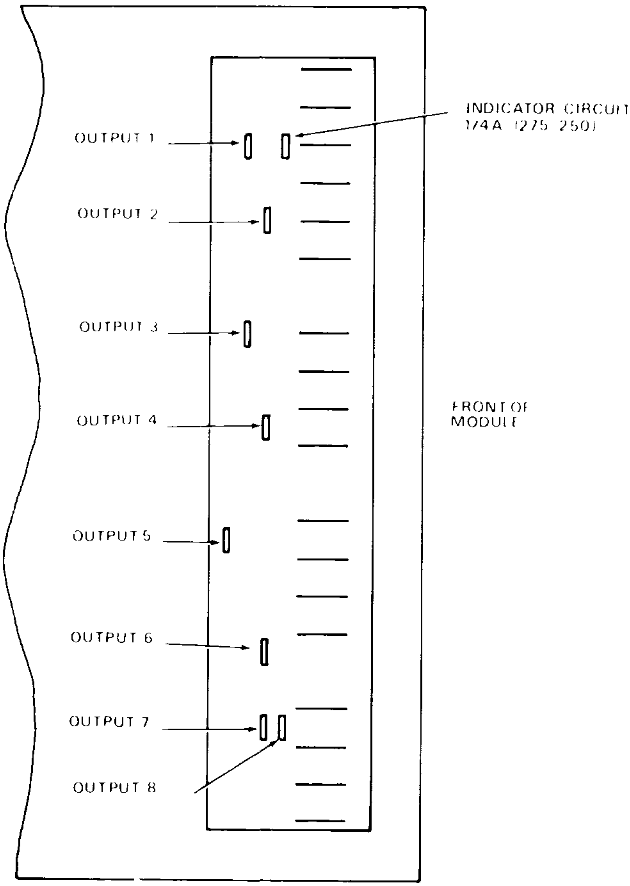


Figure 21. Location of Fuses on B244 and B246 Isolated Output Modules

SECTION III
BASIC CONTROL DESIGN

This section includes the following information:

1. Important machine concepts which, without describing detailed internal circuitry or design, will enable the reader to better understand subsequent descriptions of the MODICON 184/384 Controller functions.
2. A brief description of the physical actions using the Programming Panel required for entering and altering stored logic and data.
3. A detailed discussion of each of the three major functions (basic logic, calculate, and data transfer) available with the MODICON 184/384 Controller (depending on MOPS/TEF options). These discussions include
   a. Detailed description of how the function operates within the Controller configuration.
   b. Step-by-step instructions on how to enter each line type using the Programming Panel.
   c. Several examples of entry of typical ladder diagram logic for the function.
   d. Complete example illustrating an application of the logic just discussed. If these examples are understood, comprehension of the subject matter can be assured.
4. A discussion of the P500 Printer option, in detail, including its various character and control formats.
5. A detailed discussion of new Data Transfer capabilities available only with 384A Controllers.

3.1 IMPORTANT MACHINE CONCEPTS

3.1.1 Controller Reference Numbers

Throughout the programming of any Model 184/384 Controller, four-digit reference numbers are utilized to build the user's logic. These references are divided into two broad categories: discretes and registers. Discrete references are used for individual items that can be either ON or OFF, such as limit switches, pushbuttons, relay contacts, etc. Register references are used to store numerical values such as counts or times; all register references are four BCD digits long (maximum value 9999). Since there are four bits per BCD digit, registers can also be 16 bits of data.

Only five types of references are required to program the 184/384 Controller. Any specific reference can be used as many times as required by the particular application; there are no limitations on the number of times a reference is used. References are defined as follows:

0xxx — logic line numbers/discrete outputs
1xxx — discrete inputs
2xxx — latches
30xx — input register
4xxx — holding register/output register

The address index previously discussed as part of the I/O configuration is very important in establishing proper references. A typical I/O allocation as shown in Table 7, provides 352 discrete inputs and 352 discrete outputs; the maximum number of inputs and outputs can vary as discussed in Section 3.3.2. The output module placed in channel I and indexed as number 1, will output (or copy) the status of the coils associated with logic lines 1-16; output module 2 in channel I will reflect the status of lines 17-32, etc. Inputs are numbered starting with input 1001.

Table 7. Typical I/O Configuration — 352 Discrete I/O

	SLOT	INPUT	OUTPUT
CHAN. I	1	1001–1016	0001–0016
	2	1017–1032	0017–0032
	3	1033–1048	0033–0048
	4	1049–1064	0049–0064
	5	1065–1080	0065–0080
	6	1081–1096	0081–0096
	7	1097–1112	0097–0112
	8	1113–1128	0113–0128
CHAN. II	1	1129–1144	0129–0144
	2	1145–1160	0145–0160
	3	1161–1176	0161–0176
	4	1177–1192	0177–0192
	5	1193–1208	0193–0208
	6	1209–1224	0209–0224
	7	1225–1240	0225–0240
	8	1241–1256	0241–0256
CHAN. III	1	1257–1272	0257–0272
	2	1273–1288	0273–0288
	3	1289–1304	0289–0304
	4	1305–1320	0305–0320
	5	1321–1336	0321–0336
	6	1337–1352	0337–0352

The input module placed in channel I and indexed as number 1 will provide the Processor with status of the first 16 discrete inputs (1001-1016) per the devices connected to its 16 input circuits; input module 2 in channel I will provide the status of the inputs 1017-1032, etc. The circuits at the top of the I/O module (low terminal numbers) utilize the lower-numbered references, and those circuits at the bottom are assigned to the higher reference numbers allotted to that module. See Appendix B for additional details.

Since the I/O reference numbers are established by the index pin, and NOT the physical location of the I/O module, the I/O modules can be placed in any location provided they are properly indexed. Only those references required need be placed in the I/O configuration; inputs do not have to start at 1001, nor do outputs have to begin at line 1. Different types of I/O modules can be intermixed in any channel without regard to the voltage type.

3.1.2 The MODICON Ladder Line

As previously discussed, the MODICON 184/384 Controller controls the user's equipment by a program stored in the Processor's core memory and operating with the I/O. In block diagram form this can be illustrated as shown in Figure 22. All 184/384 Controllers have a program loaded by MODICON into a small portion of the Processor's memory. This program, which is inaccessible to the Programming Panel, is referred to as the executive or 184 MOPS (MODICON Operating System)/384 TEF (Three Eighty Four). The remaining portion of memory is referred to as the user area. It is in this section that the user enters his control program with the Programming Panel or another auxiliary device.

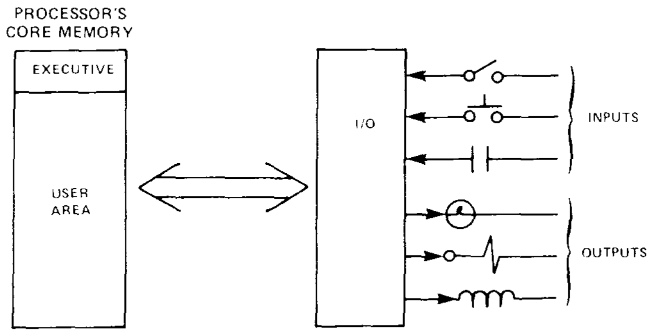


Figure 22. Block Diagram, Operation of I/O with Core Memory

All user programs are entered in a four-element line format as follows:

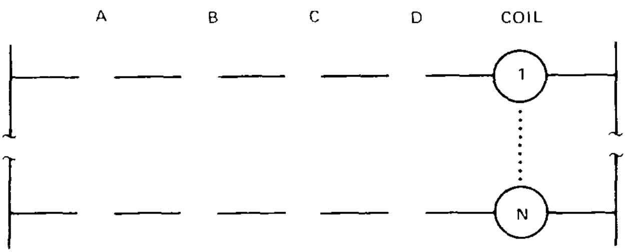


Figure 23. General Four Element Line Format

The number of lines depends on the core memory size and the specific executive installed. All lines are solved one at a time in a very short time, such that, as far as the control system is concerned, all lines are solved simultaneously. The operation of solving all lines sequentially is referred to by several terms such as scanning, scan rate, sweep time, etc.

Any single four-element line may do a number of things. It may be used to specify common relay logic functions; a timing or counting function; an arithmetic operation such as addition, subtraction, or comparison of two numbers; or a number of data manipulations covering a wide spectrum of control and data handling operations.

The type of line being entered into the Processor must therefore be identified as it is entered. Logic lines can be envisioned as rungs on a conventional ladder diagram; each rung having four elements or positions and one coil.

Utilizing the Programming Panel, the sequence for entering any one line is as follows:

1. Number (identify) the line (coil No.);
2. Select (identify) the type of line it is;
3. Enter the four elements desired.

It should be pointed out that the word "element" may not only specify a single relay contact type (e.g., a series or parallel relay contact), but may also mean entering a number — either for timing, counting, or another purpose. Any line can be converted to any valid function provided by the executive program installed. Figure 24 shows the typical MODICON Ladder Line.

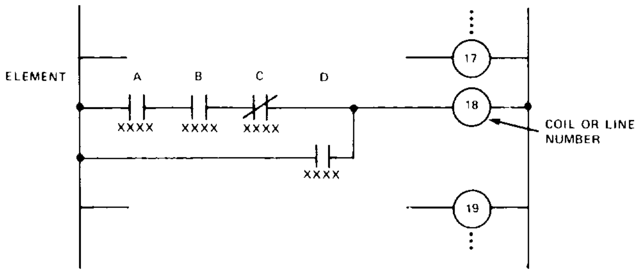


Figure 24. Typical MODICON Ladder Line

It should be noted that any line will always require four elements, even if one or two of these is not needed. (In this case, provision is made to simply duplicate an element as will be explained later.) Logic lines are defined as having exactly four elements and one coil; Their quantity does *not* depend upon number of parallel paths to a coil.

The x's shown below each element are important. Each element is associated with a reference number which must be entered into the processor along with the element. For example, it is seen in the illustration that element A is normally-open series contact. But what input or line activates it? If an input activates a contact, it is specified by a number of the form 1xxx, which the user enters *before* pushing the button which identifies the element type. Pushing the element type enters the reference and the contact type into the Controller's memory.

Figure 25 shows the MODICON Programming Panel with its pushbutton and thumbwheel switches. Referring to the sample ladder line shown previously, and to the Panel keyboard, the complete sequence of operations is as follows:

NOTE

The flow of operations proceeds logically from left to right.

1. Using the thumbwheel switches under LINE NUMBER, enter the number of the line, shown within the relay coil symbol of Figure 24 (which will also represent the output of the line).
2. Push one of the function-select pushbuttons next to the thumbwheels. This will automatically cause the Controller to know what function the line is to accomplish.

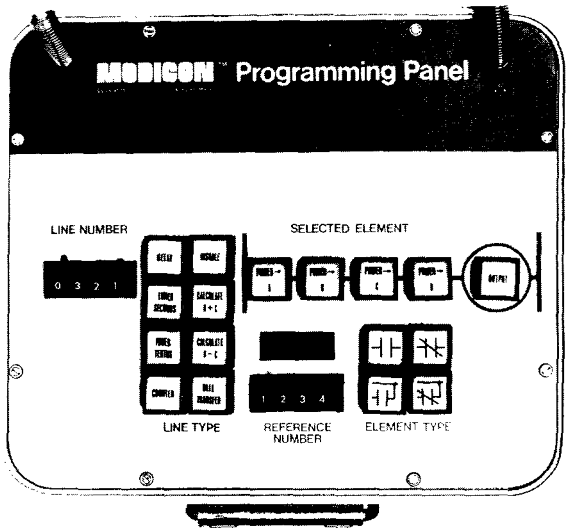


Figure 25. MODICON 184/384 Controller Programming Panel

3. Next, begin the sequence of four-element entries by depressing the pushbutton associated with the element to be programmed. It will light, indicating that the element has been selected and displayed. Elements do NOT have to be programmed in sequence.
4. Using the REFERENCE NUMBER thumbwheel switches, enter the number needed for that particular element's function. This could be either an input or output identifying number, or — in the case of timing or counting functions — the number required for counting, calculating, etc.
5. Push one of the ELEMENT TYPE pushbuttons. This will enter the information (contact type for relay contacts and reference number) into the Processor. At the same time, the number entered into the thumbwheels will show on the illuminated display directly above the REFERENCE NUMBER switches so that the user can observe that it is correct.

NOTE

Errors are easily corrected.

6. Repeat steps 3, 4, and 5 for each of the remaining three elements.

The Programming Panel error checks the line number entries and, when a contact type is depressed, the reference number. Invalid data is ignored and an error code is displayed in the reference number display. Possible error codes are listed in Table 8.

Table 8. Error Codes

⊔11⊔	**MEMORY PROTECT ON**
⊔22⊔	**INVALID LINE NO.**
⊔33⊔	**INVALID REFERENCE**
⊔44⊔	**ILLEGAL LINE TYPE**
⊔55⊔	**INVALID CONTACT**
⊔66⊔	**DATA TRANSFER ILLEGAL REFERENCE**
⊔77⊔	**DATA TRANSFER ILLEGAL TYPE**

With the entry of the last element, the procedure is complete, and the user may go on to the next line.

NOTE

Whenever data is being entered into the Controller with the Programming Panel (line type, references, contact type, disable status, etc.), this data is entered directly into the core memory of the Controller. If power should be interrupted prior to completion of the programming, whatever data has been entered will be retained. No additional processing is required, such as further assembling of data; whatever data the user enters is the data stored for use by the controller.

One of the valuable aspects of the MODICON Ladder Line Concept is that the coil number of any one line may be used (when entering element thumbwheel data) as a reference for any relay contact element. In other words, the output of one line may be used to control or operate an element or contact in another line, without regard for the number of times it is used.

Lines may be changed (either in whole or in part) at any time, using the Programming Panel, and any line may be tested by simulating inputs and outputs. The OUTPUT pushbutton is lighted when the coil is ON.

Once all lines are entered into the Processor, it is ready for a final checkout. For a complete description and specifications for the Programming Panel, see Auxiliary Units, Appendix A.

3.1.3 Scan

The MODICON 184/384 Controller examines (solves) each logic line in numerical sequence. Line one is the first line to be solved on each scan, followed by line two, three, etc., until all available logic lines are solved. Then the Controller goes back and solves line one again. This fixed scanning occurs at a very rapid rate from the time power is applied to the Processor until power is removed.

Since the scanning rate is very fast, it appears to an operator that all logic lines are solved simultaneously. The result of each logic line is immediately available to subsequent lines, regardless of whether this result is a change in coil state or a change in stored numerical value.

All inputs and outputs are updated once per scan concurrent with the line solving. The time from solving any individual line on one scan until that line is again solved on the next scan is defined as the "scan time" of the Controller.

3.1.4 Memory Protect

The MODICON 184/384 Controller is provided with a Memory Protect hardware feature designed to prevent accidental or unauthorized changes to part of the core memory. When the Memory Protect keylock switch (see Figure 10a) is placed in the ON position, neither the user's logic nor the executive can be altered by any external device, such as the Programming Panel, Tape Loader, Telephone Interface, or Computer Interface. The executive or logic data can be examined; but it cannot be altered. Thus, by placing Memory Protect ON and removing the key, maintenance personnel can use the Programming Panel to monitor the system, but they cannot make unauthorized changes. Only specific personnel who are provided access to the key can change the system.

Note that the Memory Protect feature protects the executive and the user's logic, but does not protect those elements that normally change — such as registers and I/O status.

3.1.5 Disable/Enable

To simplify the checkout and maintenance of a control system using the 184/384 Controller, a special feature is incorporated into all Controllers. This feature is called the Disable function. The Disable feature is operational only if Memory Protect is OFF. Any logic line can be examined by using the Programming Panel as discussed previously in Section 3.1.2. When a logic line has been selected (i.e., line number entered on line number thumbwheels), its coil status can be disconnected from the logic entered in elements A-D by depressing the DISABLE pushbutton on the Programming Panel. If the coil was OFF when the pushbutton was depressed, it will remain OFF; if it was ON, it will remain ON. The coil is no longer controlled by the program in the Controller; but is now controlled by the OUTPUT (i.e., coil) pushbutton on the Programming Panel. To change the coil state (e.g., from OFF to ON or from ON to OFF), the OUTPUT pushbutton is depressed once for each change.

When disabled, the logic line's coil, all references to this line in the ladder diagram, and any outputs driven from this coil via properly indexed output modules, will be affected solely by the OUTPUT pushbutton. The internally programmed logic still remains in the Controller and will re-establish control when the line is enabled; but this internal logic has been completely bypassed for this line by the disable function. The disable status of any logic line is permanent until altered by the Programming Panel. The line number can be altered, other lines disabled, power interrupted, memory protect turned ON, or any other change made to the system without affecting the disable status of any lines; any line disabled either ON or OFF will retain that state until changed by the Programming Panel.

The disable status of any line can be examined by entering the line number on the appropriate thumbwheels of the Programming Panel. The DISABLE pushbutton will light if the line is disabled, and be OFF if the line is enabled. If disabled, the OUTPUT (coil) pushbutton will light if the line is disabled ON and not light if the line is disabled OFF. A logic line can be enabled such that control is returned to the Controller's stored logic if the DISABLE pushbutton is depressed a second time. The disable light should go OFF if the line is successfully enabled. Memory protect must be OFF to enable lines; only the line currently being displayed will be enabled.

In addition to the logic lines, discrete inputs can also be disabled in a manner similar to the logic lines. The input to be disabled is entered on the Programming Panel's line number thumbwheels as if it were a logic line. The DISABLE pushbutton is depressed; this removes control of that input from the "real world" and assigns that control to the OUTPUT (coil) pushbutton on the Programming Panel. The input can now be forced either ON or OFF by depressing the OUTPUT pushbutton. All logic lines that use this discrete input will now respond to the disable status and not the real world. The disable status is permanent and can be altered only by the Programming Panel with the memory protect OFF. At any one time, as many logic lines and discrete inputs as desired can be disabled either ON or OFF.

NOTE

Since the disable status is permanent, a record should be maintained of all disabled lines and inputs, so that they can be enabled at a later date. A ladder listing will show the disable state of any line or input.

In checking out a system, the disable function can be used to verify the proper wiring and operation of all discrete outputs. Each output is entered as a line number on the Programming Panel and then disabled. The OUTPUT (coil) pushbutton can be cycled ON-OFF-ON-OFF, etc., and proper operation of the discrete device observed. It is recommended that the line be enabled before the next output is tested to prevent undesirable disable statuses from occurring.

If an input such as a limitswitch fails to operate properly, its effect can be temporarily simulated by disabling the input and forcing it to the required state (ON or OFF). This is particularly useful if the input is on a remote (e.g., 2000 feet away), and the improper signal is preventing the control system from functioning. However, since the disable feature for either inputs or outputs is a very powerful function and can cause catastrophic results if improperly used, the keylock memory protect can be used to ensure changes of the disable states are made only by qualified and authorized personnel.

3.2 BASIC PROGRAMMING

All Controllers are provided with the capability to program or simulate the function of relays, timers, and counters. Any available logic line can be converted to a relay, timer, or counter line by selecting the appropriate pushbutton on the Programming Panel. There are basically three executives that provide only relay, timers, and counters designed for 184 core memory sizes 1K, 2K, and 3K, whose characteristics are as follows:

Program	No. of Lines	No. of Holding Registers	Discrete I/O (Channel)	Latches	Min. Core Size
MOPS 1 Mod 1	224	32	224/I 224/O (1,2)	224 2001- 2224	1K
MOPS 1 Mod 2	464	100	256/I 256/O (1,2)	304 2001- 2304	2K
MOPS 1 Mod 3	640	100	352/I 352/O (1,2,3)	32 2001- 2032	3K

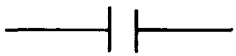
NOTE

Similar executives are available for the 384 Controller; these are called TEF programs — see Appendix F.

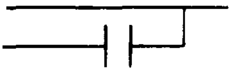
As can be seen, the input, output, and logic line capacity is a function of memory size. The previous discussion has defined inputs, outputs, and logic lines in a general sense; the following description will cover the programming of relays, latch relays, timers, and counters in detail. The 2K program, MOPS 1 Mod 2, will be used to illustrate the programming techniques.

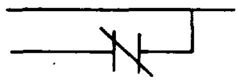
3.2.1 Relays

Control logic for the 184/384 Controller is very similar to a conventional relay schematic, as shown previously. Four contact types are used:


Normally-Open Series Contact


Normally-Closed Series Contact


Normally-Open Parallel Contact


Normally-Closed Parallel Contact

Parallel contacts must *always* return to the left-hand leg. The B, C, and D positions can be any contact type, but the A position (for any function) must *always* be a series contact.

Since discrete inputs from user equipment are always coded 1xxx, the user may have his inputs to the Processor so labeled for ease in installation and wiring.

Coil outputs (0xxx) may be used directly to drive output circuits, or indirectly as contacts in other lines, or both. Line coils can be outputs if they are within the limits established by the MOPS and if an output module is addressed to respond to their status.

Example Relay Logic

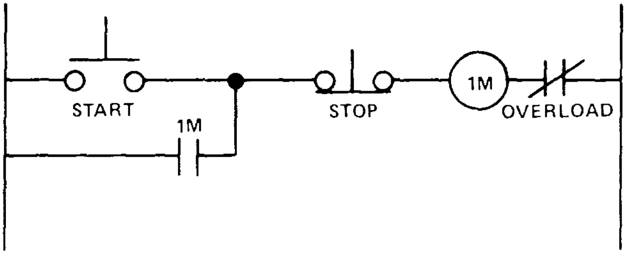


Figure 26. Sample Relay Logic

If the logic in Figure 26 were to be implemented in the 184 or 384 Controller, the control elements must be connected to the input circuits in the I/O configuration and outputs assigned. Any available inputs of the proper voltage level can be used; for this example assume the START pushbutton is wired to input 1001, the STOP pushbutton to input 1002, and the overload detection to input 1006. Output number 1 is assigned to drive the motor starter (M1). The resultant internal logic to be programmed by the user is shown in Figure 27.

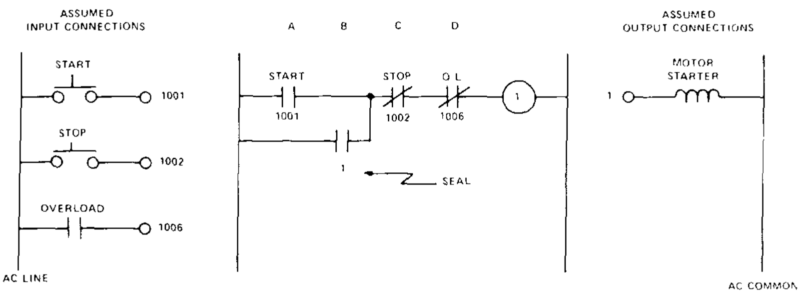


Figure 27. Sample Relay Program

NOTE

If the STOP pushbutton is wired normally closed to the input module, such that the input is normally energized, the C element of line 1 should be programmed with a normally-open contact. The normally energized reference (1002) will close the normally-open contact and allow the motor to start, unless the STOP pushbutton is depressed.

When the START pushbutton is depressed, input 1001 is energized and output 1 will be turned ON, unless the STOP pushbutton is depressed, energizing 1002 and opening the C element contact or if an overload is detected, energizing 1006 and opening the D element contact.

NOTE

Since logic lines are solved from left to right (A to D element), the C or D element, if series, will override the affect of the A and B elements. Thus, if both the START and STOP pushbuttons are energized, the STOP will take precedence and coil 1 will not be energized.

Once coil 1 is energized, the parallel B element will allow the START pushbutton to be released without de-energizing coil 1; thus the B element becomes a "seal" on input 1001. In the event of a power failure or energizing of the C or D reference, the seal will drop out and the circuit will not energize until the A element once again is energized.

NOTE

Seals are not retentive upon power failure; latches are retentive.

As previously defined, MOPS 1 Mod 2 provides 464 logic lines, 256 outputs. The 464 logic lines can be considered as two types of lines — output lines and internal lines — as follows:

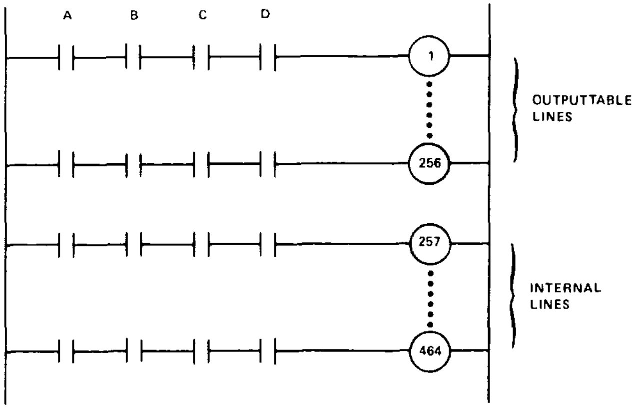


Figure 28. Definition of Output and Internal Logic Lines

Any logic lines in the range 1-256 can directly operate outputs if an output module is installed and properly indexed in the I/O section. Logic lines 257-464 cannot directly control an output and thus are used for internal control. Any logic line coil not used to control an external output can still be used to perform internal control functions. If the maximum number of outputs (including future requirements) is 200, lines 1-200 can be designated for external output control, and lines 201-464 for internal logic.

Extended Logic

If more than four elements are required in a relay line, an internal line is used to extend the number of elements that effectively control an output. As an example, assume the control logic in Figure 29 is to be implemented:

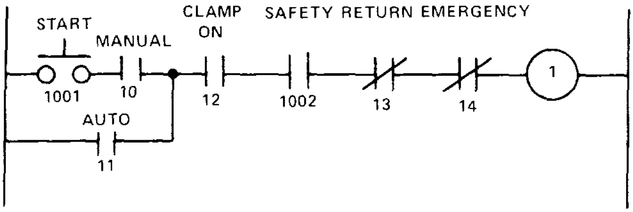


Figure 29. Sample Extended Relay Logic

Typical logic within the Controller to implement the above function would be as shown in Figure 30.

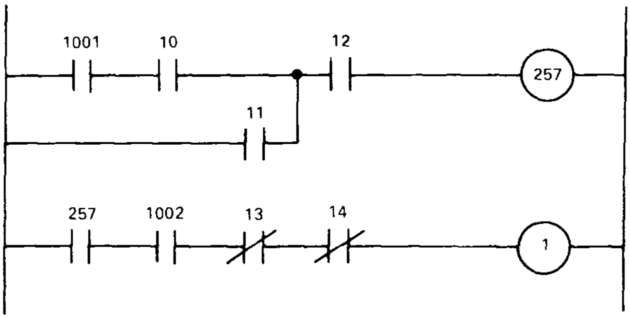


Figure 30. Sample Extended Relay Program

Latches

To build a latch circuit, the contact for a seal is normally entered at the B position. The C position is normally reserved to provide a latch contact.

The latches are designed to retain the state of a line to which they are referenced in the event of power failure. Such contacts are codes with the numbers 2xxx, where the line to which they are referenced is inserted in place of the xxx's. These latches are controlled and subject to logical changes in a similar manner as other discrete references, but permit conditions prior to the power loss to be reinstated on restoration of power.

The latch will return a line to the state it held prior to the power failure, provided that the D element contact is closed upon power-up. Latches must be programmed to be effective.

NOTE

Only specific lines are latchable as provided by the executive. For example, referring to the MOPS summary previously provided under 3.2, MOPS 1 Mod 2 provides 304 latches, specifically 2001-2304; thus lines 1-304 only are latchable.

For example, refer to Figure 31. If line 1 was energized prior to a power failure, when power is restored line 1 will automatically be energized provided the stop input is not energized. The D element contact, since it is in series, will override even the latch upon power-up. If line 1 was de-energized upon power failure, no action is taken by the latch upon restoration of power.

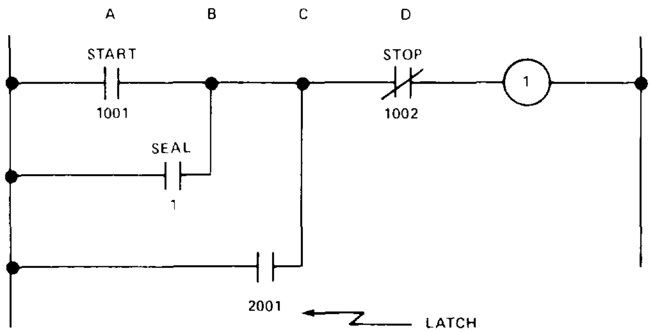
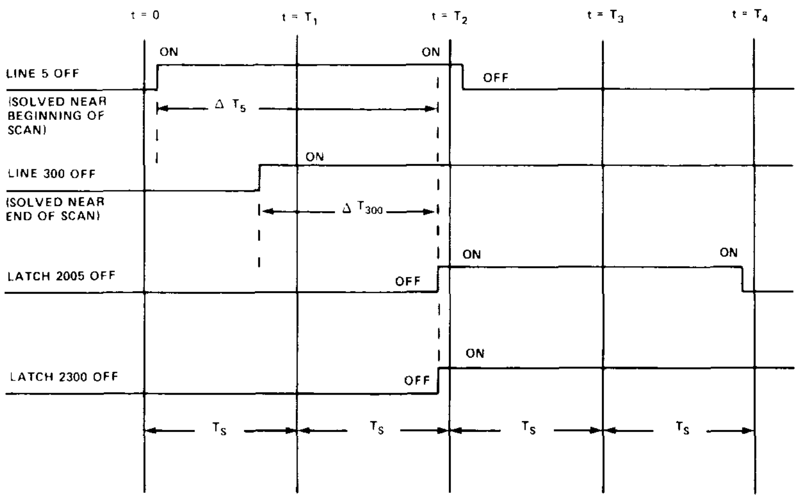


Figure 31. Sample Latch Program

Since latches are updated slightly delayed from the lines to which they are referenced, they are also called "delayed outputs." All latches are updated at the end of each scan, with the status of the lines to which they are referenced as the lines were at the *beginning* of the scan. Figure 32 will illustrate the exact time delay for lines 5 and 300, assuming there are 464 lines in the system and the MOPS allow these lines to be latchable.



NOTES:
1. T_1, T_2, T_3, T_4, etc., are the times at the end of scans 1, 2, 3, 4, etc.
2. T_S is the scan time.
3. ΔT_5 and ΔT_{300} is the delay in updating latches 2005 and 2300, respectively.
4. ΔT_n is always greater than T_S and less than $2T_S$, with latches referenced to lower-numbered lines (e.g., 2005) approaching $2T_S$ and latches on higher-numbered lines (e.g., 2300) approaching T_S.

Figure 32. Latch Timing Diagram

If the A element reference of line 1 in the previous example is guaranteed to always be ON for more than two scans, so that the latch will have time to set, the seal in the B element is not required. Normally, how long a pushbutton is depressed cannot be guaranteed; thus, it is good practice to program both the seal and the latch reference.

WARNING

If an output is only latched (not sealed and latched), and the A element contact is closed for less than two scans, the output can oscillate at the scan rate continuously until the stop is depressed.

Redundant Contacts

If, in the previous example, the overload sensor as well as the latch were required, an internal line could be used and referenced in the output line (see Figure 33). This effectively uses the internal line as a carry and increases the number of available control elements in the output line to seven.

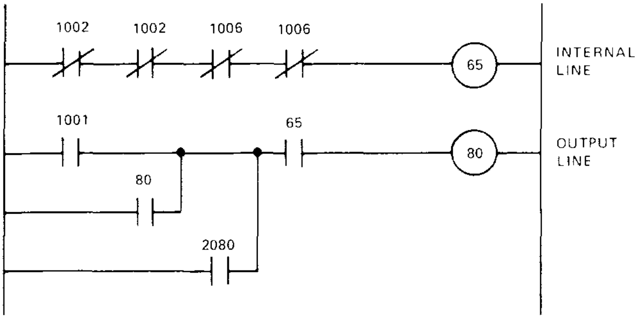


Figure 33. Sample Redundant Contacts

Note that the references for the STOP pushbutton (1002) and the overload detector (1006) are duplicated to fill in all four element positions. Every logic line must have exactly four elements; redundant contacts are used if necessary to complete the logic line.

Watchdog Timer Line

The last line of every MOPS or TEF is a relay line programmed as a Watchdog Timer (WDT) line by the executive; it cannot be altered by the user. The WDT line is four normally-closed contacts in series and referenced to itself as shown in Figure 34.

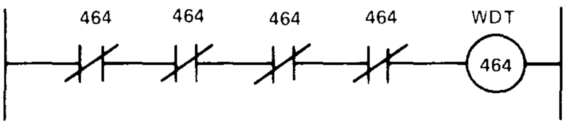


Figure 34. Sample Watchdog Timer Line

This line is a multivibrator or square-wave generator. It is ON for one scan, OFF for one scan, ON for one scan, OFF for one scan, etc., as long as the Controller is running. It takes two scans for the WDT to complete a full cycle (ON-OFF-ON); this coil reference can be used in logic lines when a square-wave generator is required to turn elements ON-OFF-ON-OFF-ON (blink error lights, etc.).

NOTE

When an executive program is listed as providing n lines (e.g., 464 lines), the user can use n−1 lines (e.g., 463 lines); the WDT is the nth (e.g., 464th) line and CANNOT be altered, only referenced.

The hardware in the Processor monitors the WDT line and is designed such that if the WDT does not change states every 200 ms, the Controller is shut down (outputs OFF, run light OFF). This ensures that if there is a hardware failure, and the Controller cannot solve a line or stops scanning, a known state will be reached (i.e., simulated power failure) with all outputs OFF and the RUN light extinguished.

Processor Fault Indications

If an external indication is required when the Processor shuts down, one output line should be programmed with the WDT references as shown in Figure 35.

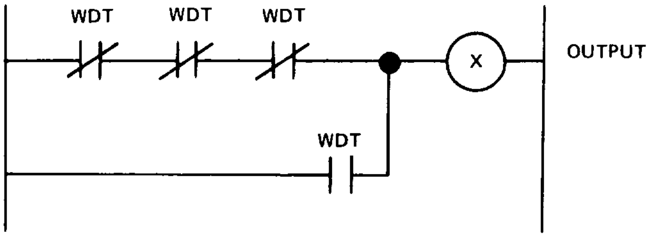


Figure 35. Sample Fault Indicator

This output will be ON as long as the Processor is running and OFF if AC power is removed or if a Processor error has been detected and shut-down accomplished. Note that this output will also be OFF if only the output module fails.

Critical output modules can be monitored by connecting an always ON output on that module to an input circuit; the input will always be ON unless either the output or input module fails. Critical input modules can be monitored by wiring an input on that module directly to power; the input will always be ON unless the input module fails.

Null Data

When a Controller is shipped from the MODICON factory, or if a new executive is loaded from the Service Center, all logic lines (except the WDT lines) are coded as relay lines with null data and all registers contain the value zero, Null data is exactly as shown in Figure 36.

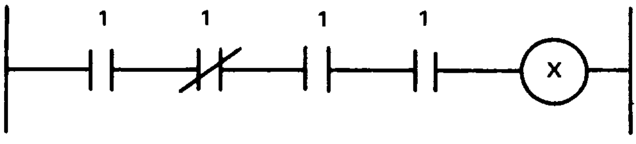


Figure 36. Null Data

NOTE

Any deviation from this line, either in references or contact types, whether or not it affects the operation of the line, will not be interpreted as null data.

Using null data, regardless of the state of coil number 1, will guarantee that all lines so coded will never be energized. This ensures that when a controller is placed in a system and power applied, no outputs will be energized until the user installs his program. When a system is "dumped" into the MODICON Service Center and a ladder listing made of the program, all lines coded as null data will be printed as a blank line. Thus, if all unused lines are coded with null data, spare lines are readily identifiable from the ladder diagram.

One-Shots

The unique timing for latches can be used to great advantage. Relay lines that are valid for exactly one scan are useful to control shift registers, various data transfer functions, some calculate applications, etc. They are called one-shots and can be built as illustrated in Figure 37 in one line using latches.

When line 57 goes from OFF to ON (scan No. 1), line 42 is not affected since this line has already been solved. On the next scan (scan No. 2), line 42 is energized and, at the end of scan No. 2, latch 2057 gets set; on the following scan (scan No. 3), line 42 is de-energized by the setting of latch 2057 on the previous scan, and remains de-energized until line 57 goes from OFF to ON again. The ON to OFF transition of line 57 does not affect the one-shot. Thus line 42 is energized for exactly one scan, from the time it is solved during scan No. 2 until line 42 is again solved on the next scan (No. 3).

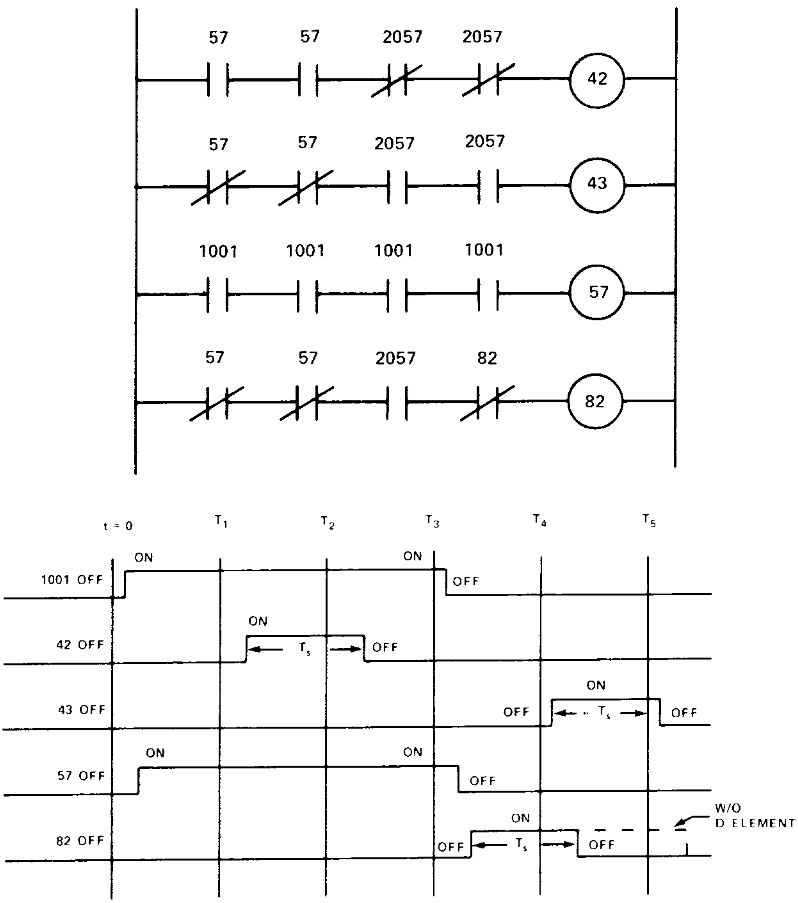


Figure 37. Typical One-Shots

The order of solution (assigment of line numbers) is very important since if line 57 were solved before the one-shot, the one-shot would be valid for two successive scans. Line 43 of Figure 37 is a one-shot triggered when line 57 goes from ON to OFF; line 82 is a one-shot triggered when line 57 goes from ON to OFF and is located after line 57. The normally-closed D element contact of line 82 ensures that this line will be valid for just one scan.

The input references (1001) in line 57 are used only to provide ON/OFF control of this line for illustrative purposes. If a one-shot is desired when an internal line goes from either OFF to ON or ON to OFF, and that line is latchable, there is no requirement to copy its status into another line; use this line and its latch as shown in either lines 42, 43, or 82.

First Scan Indicator

In some applications, actions must be taken following a power failure to clear registers, outputs, etc., but only on the first scan following a power failure. After the first scan, the elements that were cleared are controlled by other logic lines — the clear control is eliminated. The line illustrated in Figure 38 should be programmed after all clear operations have been performed. For the first scan only, all coil references are assumed to be OFF until their respective lines are solved; normally-closed references to line 420 will pass power only on the first scan.

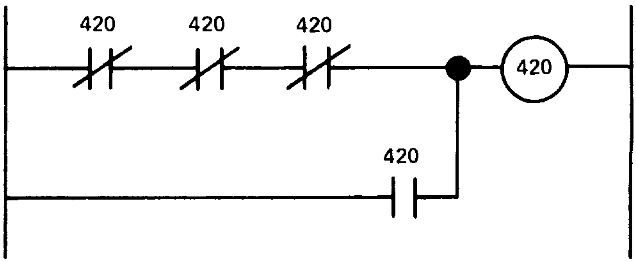


Figure 38. Sample First Scan Indicator

Entering a RELAY Line with the P112 Programming Panel

1. Set the line number on the LINE NUMBER switches.
2. Put the Controller MEMORY PROTECT switch in the OFF position.
3. Press the RELAY pushbutton. It will light and all other line type lights will go OFF.
4. Press the A element pushbutton. It will light and the B, C, and D lights will be OFF.
5. Set, on the REFERENCE NUMBER switches, the line number, input number, or latch that is to control the A position contact.
6. Press the desired ELEMENT TYPE pushbuttons to designate the type of contact to be used in the A position. The ELEMENT TYPE pushbutton will light, and the REFERENCE NUMBER display will show the reference number that has been entered.
7. Repeat steps 4, 5, and 6 for the B, C, and D element positions.
8. If the DISABLE pushbutton is lit, and not specifically desired, press it to enable the line.

NOTE

The elements of any logic line can be programmed in any order.

Programming Example (Memory Protect OFF)

Entry of a Relay Line (see Figure 39).

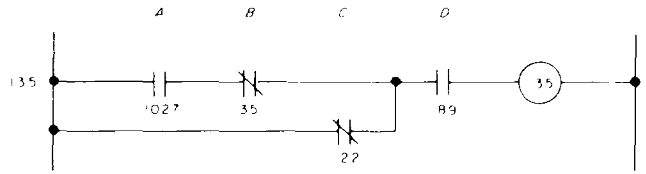


Figure 39. Relay Line Example

1. Set Line Number 135 on LINE NUMBER switches.
2. Press RELAY pushbutton.
3. Press A element pushbutton.
4. Set REFERENCE NUMBER switches to 1027
5. Press Normally-Open Series ELEMENT TYPE pushbutton.
6. Press B element pushbutton.
7. Set REFERENCE NUMBER switches to 0035.
8. Press Normally-Closed Series ELEMENT TYPE pushbutton.
9. Press C element pushbutton.
10. Set REFERENCE NUMBER switches to 0122.
11. Press Parallel Normally-Closed ELEMENT TYPE pushbutton.
12. Press D element pushbutton.
13. Set REFERENCE NUMBER switches to 0189
14. Press Normally-Open Series ELEMENT TYPE pushbutton.
15. If the DISABLE light is lit, press it to turn it OFF unless the line is to be left disabled.

EXAMPLE I — Shift Register

As a review of relay logic, a shift register can be constructed (see Figure 40), and its operation analyzed. Line 201 is basically a one-shot energized when line 202 is transitioned from OFF to ON; line 202 is controlled solely by input 1001, the shift command. Data is entered into stage one (line 200) from input 1003 and is shifted up to lower-numbered lines every time the shift command is cycled OFF to ON.

Each stage of the shift register is basically the same; reload strobe (A element), data (B element), seal (C element), and clear strobe (D element). When a shift has been commanded, line 201 becomes energized for exactly one scan; this clears the contents of all stages of the shift register via their D elements. Refer to Figure 41 for exact timing information, assuming stage 3 was ON and stage 4 was OFF prior to the shift command.

The latch reference to line 201 is utilized as the reload strobe (A element) since it is delayed from coil 201, but is also a one-shot. Thus, immediately after the one-shot (line 201) is fired, the reload strobe is energized; each stage can be reloaded since line 201 is no longer energized (it is a one-shot) and the D elements have returned to their de-energized state (closed).

The first stage (line 200) will be loaded with new data available from input 1003. The remaining stages are loaded with the data that *was* in their previous stages; latch references are used in the B elements, since the previous stages have been cleared, but their latches have not, and will still contain the previous stage's data. The C element seals in and holds the data once entered into the stage, since data entry is accomplished with one-shots.

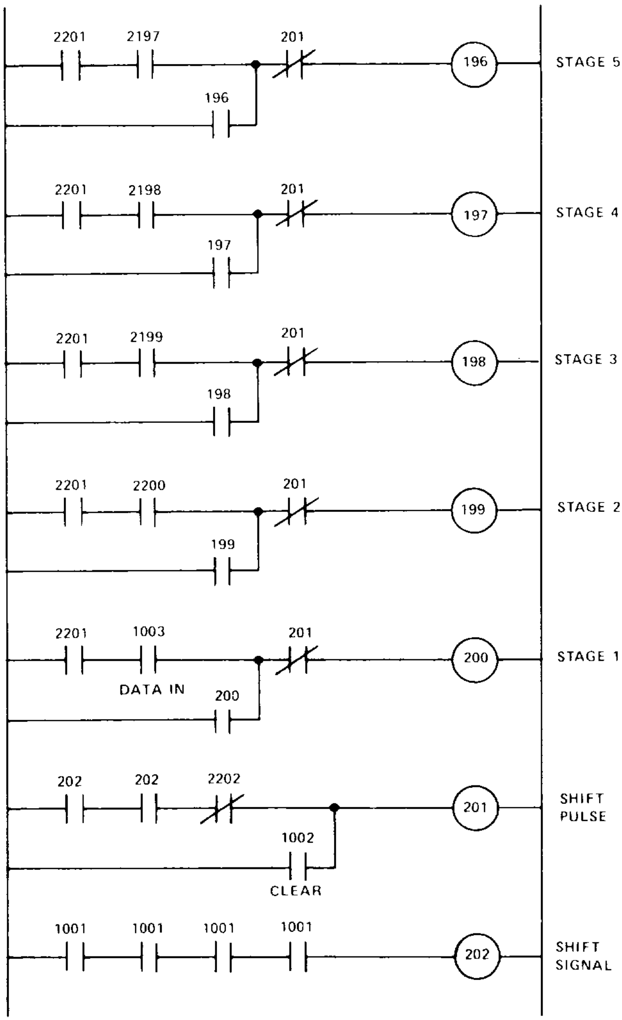
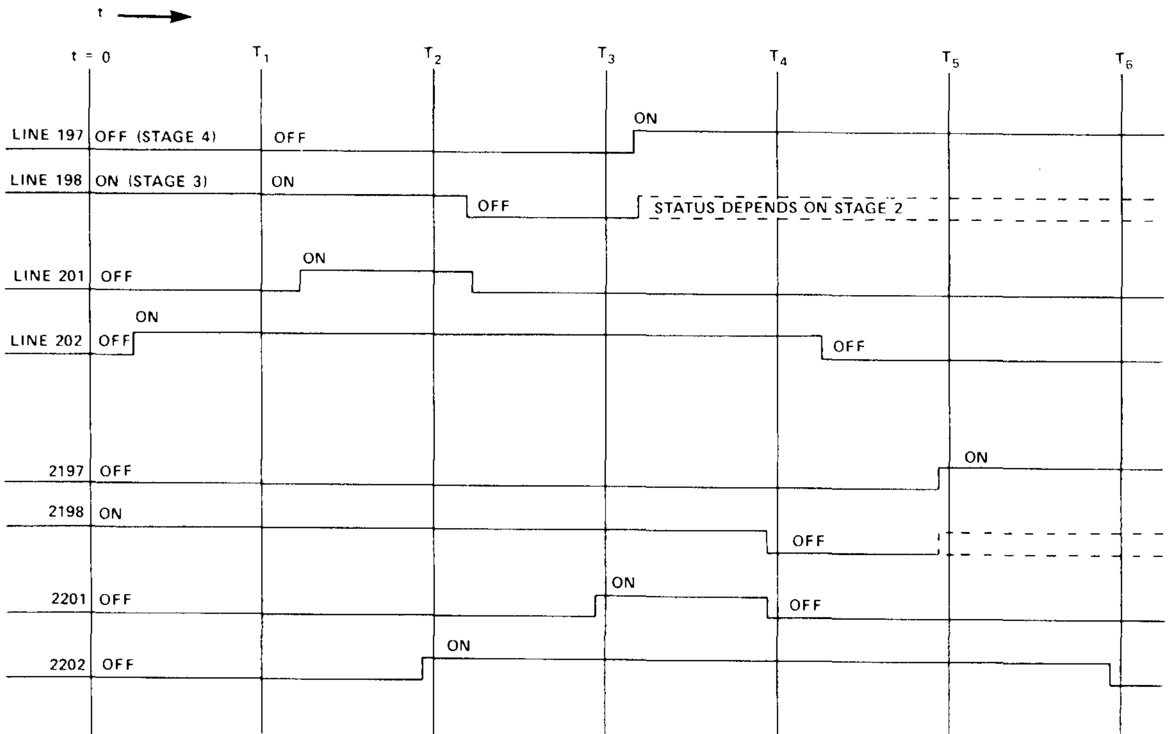


Figure 40. Example: Shift Register

Input 1002 in the D element of line 201 is used as a master clear to force all stages of the shift register to zero (OFF). When this input energized, the D elements of all stages are opened to clear the stages. Since this input will be energized for more than one scan, the stages' latches are also cleared. When input 1002 is turned OFF, stage one will be loaded with the contents of 1003 and all other stages will be OFF.

Additional stages can be added using only one latchable line per stage, following the format of lines 196-200. Since seals are utilized in all stages, if a power failure occurs, all stages will be cleared to zero (OFF). If a retentive shift register is required, either two lines per stage are required or a matrix shift register can be utilized (see EXAMPLE VI).



NOTE: T_1, T_2, T_3 etc., indicates time at end of scans 1, 2, 3, etc.

Figure 41. Timing Diagram for Shift Register

3.2.2 Timers

The 184 Controller is provided with its own internal clock which is able to generate pulses in seconds or tenths of seconds. This clock operates from the line frequency (50 or 60 Hz) of the power source connected to the main power supply. A minor change to the MOPS is required to convert from a 60 Hz to a 50 Hz executive, and vice-versa.

NOTE

The 384 Controller utilizes a crystal controlled clock for its timing signals; no changes to the TEF are required for 60 or 50 Hz operation.

Any logic line can be made a timing line (seconds or tenths of seconds) by pressing the appropriate button on the Programming Panel.

NOTE

The basic accuracy of each timer is its time increment (seconds or tenths of seconds) minus one scan time.

A typical timer line is illustrated in Figure 42.

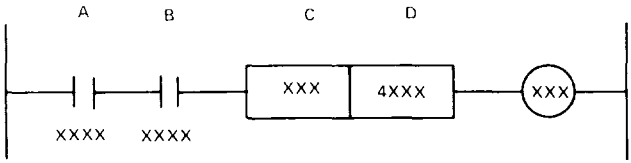


Figure 42. Typical Timer Line

The A element position specifies the series contact to be used to activate the line. The B position is used to specify what signal will reset the timer to zero; the timer is enabled when B closes and resets when B is open. The C position contains the preset time which can be 0-999 seconds for timers incrementing in units of seconds, or 0-99.9 seconds for timers incrementing in tenths of seconds. The D position specifies a storage location within the Controller where the current time is retained.

The coil of the timer line will be energized when the accumulated time is equal to the preset vale. The coil will be de-energized and the accumulated time set to zero whenever the contact in the B element is opened. No further timing is possible if the coil is energized.

With the B element closed, the timer accumulates time whenever the A element closes. If A should open when B is closed, the amount of time accumulated will be stored in the Processor so that time is not lost. Time will continue to be accumulated from its previous value when the A contact is again closed. Whenever the B element opens, regardless of the condition of the A element, or the current time or the coil state, the current time is forced to zero and will remain at that value until the B element is again closed.

NOTE

The relay contacts in the A and B element can be either normally-open or normally-closed; however, they both must be series contacts.

Specifying Time

The C element position is reserved for entering the desired amount of time, in seconds or tenths of seconds, to which the timer is to time. The lowest number to be entered on the thumbwheels will be on the right-most thumbwheel. Whether it will specify up to 9 seconds or 0.9 seconds will depend on which function button was pushed when selecting the line type. If the tenths of seconds timer is selected and a fixed preset utilized, the decimal point will appear in the reference display of the Programming Panel.

When the C element button is pushed, all the contact type lights will come ON. Once the desired time limit (preset) has been entered on the REFERENCE NUMBER thumbwheel switches, pushing *any* of the relay buttons will cause the number to be entered and the user may proceed to the next element.

Storing Time

The number to be entered in the D position, however, is always a storage register (4xxx).

To explain the concept of registers, it is appropriate to again examine the core memory in block diagram format:

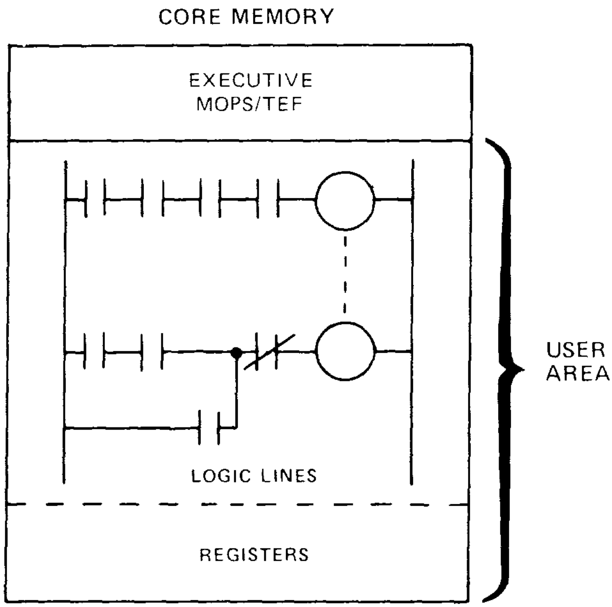


Figure 43. User Area of Core Memory

Registers are locations in the user's area of memory where numbers, up to four digits (9999), are stored; each register is a 16-bit word. However, a simple definition would be a "mailbox" or "bucket" where information (in this case, time) is permanently stored. The registers are referred to or named by reference numbers beginning with 4001 and continuing consecutively to the maximum established by the executive (4100 for MOPS 1 Mod 2).

NOTE

Holding Registers are inherently retentive upon power failure.

The storage location numbers always begin with the reference number 4 and (depending on the executive option) may include as many as 999 such locations. In general, however, all such locations will not be used to store timing information, since these locations are useful for a great many other purposes, as will be seen later. The contents of any storage location may easily be examined (see Section 3.3.3).

Again, as with the C element procedure, the reference number is entered on the thumbwheels. When the D element is selected, all of the relay buttons will light, and the user need only push one (any) contact type to enter the reference number for the storage location, which is then displayed in the readout.

NOTE

> If any element selected by the Programming Panel is a register, its contents can be displayed by holding the selected element pushbutton down. The contents can be altered by entering the new value onto the reference thumbwheels and depressing any contact type while holding the selected pushbutton down.

If the D element register number appears in the Programming Panel readout, with decimal points between each digit, the register location is also being used in the D element of another logic line. This is only a warning to the user that the contents of this register can be altered by more than one operation; it is accepted as a valid reference. Approximately 2 to 5 seconds may be required for these decimal points to appear.

Figure 44 shows an example timing line:

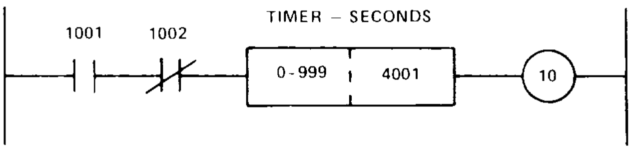


Figure 44. Example Timing Line

When 1001 is energized while 1002 is not energized (B element passing power), the timer will operate and increment the current time in register (or mailbox) 4001 at the rate of one increment every second that 1001 is closed. When the elapsed time in register 4001 equals the preset time in the C element, the line coil (No. 10) will come ON and the timer stops timing. The coil will remain ON (including after a power failure) until power through the B element is interrupted by energizing input 1002. Once the coil is energized, the status of the A element will have no effect on the coil.

The following examples illustrate various ways the basic timer line (either seconds or tenths of seconds — they are completely interchangeable) can be programmed to provide different results.

ON-Delay Energizing Timer

Referring to Figure 45, when line 83 is energized, both the A and B elements of line 101 are closed (i.e., passing power), and the timer begins accumulating time. After 15 seconds (the preset time entered into the C element of this example), coil 101 is energized and remains energized until line 83 is de-energized. If line 83 is de-energized any time prior to the timer reaching its preset, coil 101 will not come ON and the timer is reset to zero. The timer type (seconds or tenths of seconds), the preset time (15 seconds in this example), and the method of starting the timer (another logic line coil, or an input, or a latch) were all selected above for illustrative purposes only and can be altered if desired to suit other applications.

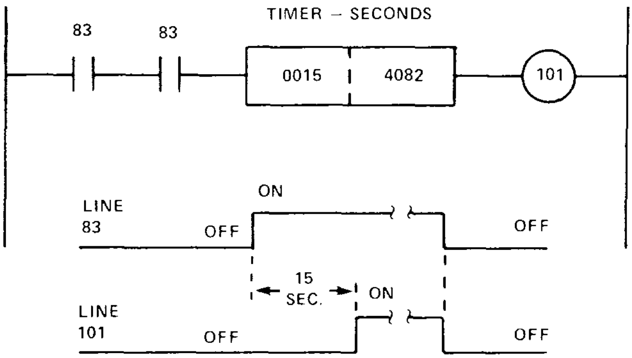


Figure 45. ON-Delay Energizing Timer

ON-Delay De-energizing Timer

The timer (Figure 46) operates similar to the previous timer, except that it is controlled by an input and operates upon one-tenth of a second intervals. The additional relay line (line 103) inverts the effect of the timer to produce the de-energizing affect. As long as the timer is OFF, line 103 will be ON; 25.6 seconds after input 1053 is energized, the timer reaches its preset and energizes its coil, causing line 103 to be de-energized. As soon as input 1053 is de-energized, the timer is reset to zero turning its coil OFF, thus allowing line 103 to be energized again. As an option, other logic control can be placed in line 103 in place of three of the normally-closed contacts referenced to the timer, line 102.

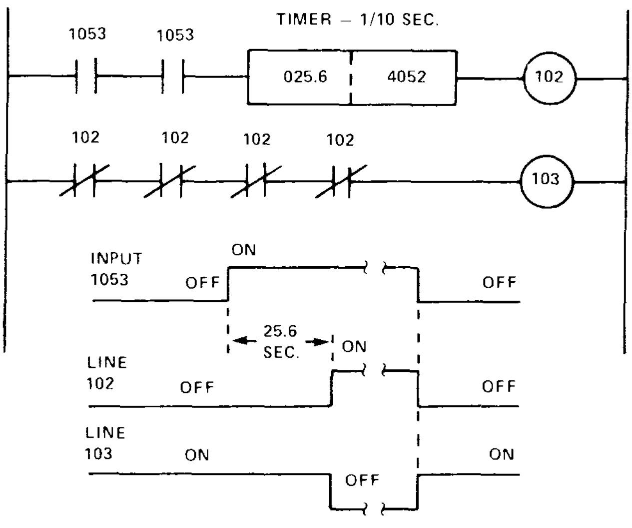


Figure 46. ON-Delay De-Energizing Timer

OFF-Delay Energizing Timer

The ON-delay energizing timer previously discussed can be converted to an OFF-delay timer by merely using normally-closed contacts as shown in Figure 47

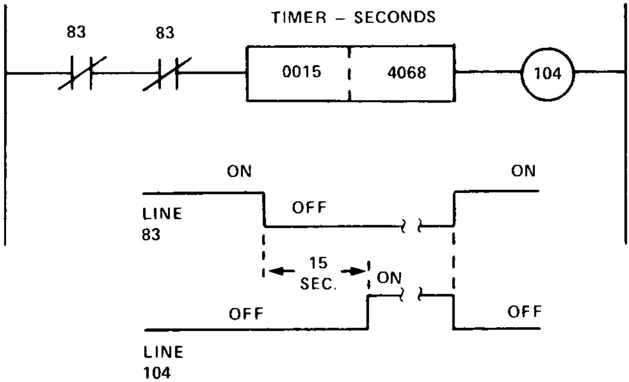


Figure 47. OFF-Delay Energizing Timer

The only difference in operation is that when line 83 is *de-energized,* the timer begins to increment time. The timer line 104 will energize its coil 15 seconds after line 83 is de-energized. Whenever line 83 is energized (opening the B element contact), the timer is reset to zero and its coil is turned OFF.

OFF-Delay De-energizing Timer

Similarly, the ON-delay de-energizing timer previously discussed can be converted to an OFF-delay timer as illustrated in Figure 48.

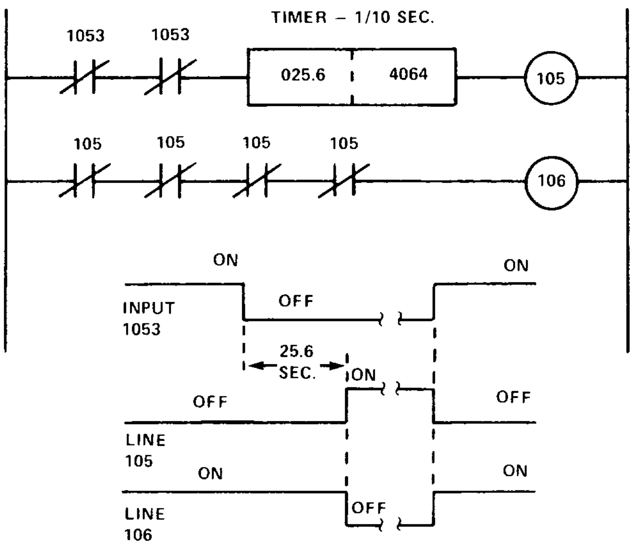


Figure 48. OFF-Delay De-Energizing Timer

When input 1053 is *de-energized*, the timer begins to accumulate time and 25.6 seconds later energizes its coil, causing line 106 to be turned OFF. Whenever input 1053 is energized (opening the B element contact), the timer is reset to zero, its coil turned OFF, and line 106 energized.

Accumulator Timer

In the previous examples, the same reference was used in both the A and B elements of the timers. This caused the timer to be reset to zero whenever it stopped timing. However, the flexibility of the timer line allows it to be converted to a timer that accumulates time by only using different references in the A and B elements as shown in Figure 49.

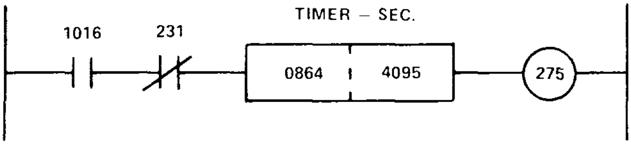


Figure 49. Accumulator Timer

As long as input 1016 is energized, the timer will accumulate time up to its preset of 864 seconds (14.4 minutes). Whenever input 1016 is de-energized, the timer stops timing but will retain its current time stored in register 4095. When input 1016 is again energized, the time begins to accumulate from the previously retained value. Thus, input 1016 can be cycled ON-OFF-ON many times, and the timer will accumulate only the time it is energized until its preset value is reached, at which time the timer stops timing and energizes its coil. The current time is retained even through power failures and is reset to zero only by opening the B element contact (energizing line 231 in this example). Every time line 231 is energized, the contents of register 4095 will be forced to zero and remain at zero until line 231 is de-energized, again closing the B element.

Self-Resetting Timers (Oscillators)

In Figure 50, the timer is programmed to reset itself by using its coil references as the control on the normally-closed B element contact. As long as coil 99 remains energized (closing the A element) the timer will accumulate time in tenths of seconds up to its preset of 18.5 seconds. When the preset is reached, the coil is energized and, on the *next* scan, the B element is opened, resetting the timer to zero and turning its coil OFF. The timer is thus re-enabled and begins to accumulate time from zero. The coil of this timer line (coil 111 of Figure 50) thus is energized for exactly one scan every 18.5 seconds that coil 99 is energized. This output can be considered a series of pulses, each one scan wide, separated by the preset time.

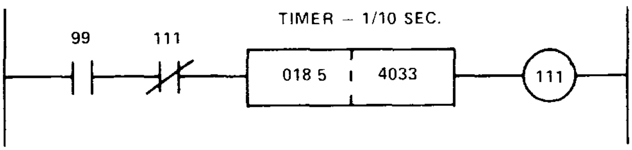


Figure 50. Self-Resetting Timer

3.2.3 Counters

A counter line operates in the same manner as a timer, and Figure 42 describes both. However, instead of pushing one of the two timer buttons on the Programming Panel, the COUNTER button is pushed after the line is identified on the LINE NUMBER thumbwheels.

As with timers, the event to be counted is received through the A position contact, and the counter is reset to zero through the B position contact.

NOTE

> The counter is incremented by one when the A element contact is transitioned from open (not passing power) to closed (passing power) state provided the B element is closed.

The number of events to be counted (up to 999) is entered through the REFERENCE NUMBER thumbwheels when specifying the C position. Entry of data via the C and D positions is like that for timers, any contact type button can be pushed.

Also, as with timers, the number of events counted is stored in the Processor at a storage location whose reference number is 4xxx. This register must be entered at position D. Completion of the full count will cause the coil output to be energized and counting stopped.

Cascaded Counters

The information stored in the 4xxx locations is available for different functions. Also, the coil of a timer line might be used as the A contact for a counter, and the accumulated count used to reset both timer and counter. This technique can be utilized to extend the range of timers and counters by cascading them. The example in Figure 51 is of two counters cascaded to provide a preset of 25,000 (50 X 500) plus a timer and two counters to provide time in seconds (4051), minutes (4052), and hours (4053).

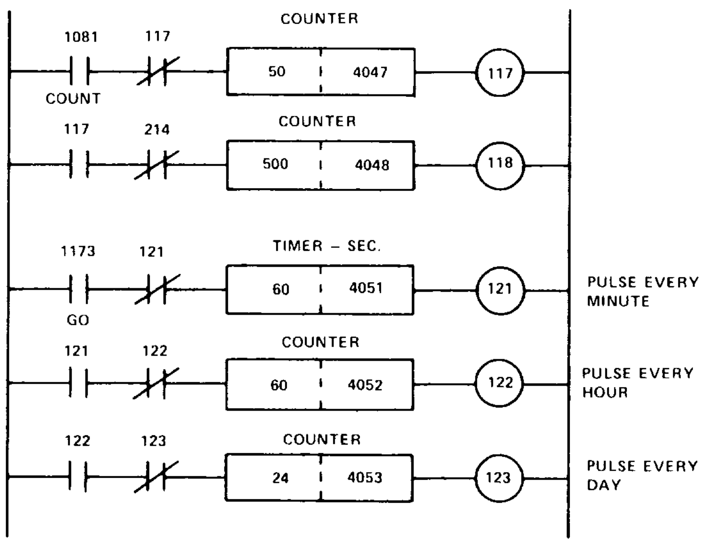


Figure 51. Cascaded Counters

Entering a Timer or a Counter Line

1. Set the line number on the LINE NUMBER switches.
2. Put the Controller MEMORY PROTECT switch in the OFF position.
3. Press either the TIMER SECONDS or TIMER TENTHS or COUNTER pushbuttons as desired. It will light and all other line type lights will go out.
4. Press the A element pushbutton. The A lamp will light and the B, C, and D lights will be OFF.
5. Dial on the REFERENCE NUMBER switches the line number, input number, or latch that is to operate the contact in the A position.
6. Press either the Normally-Open or Normally-Closed ELEMENT TYPE pushbutton. The ELEMENT TYPE pushbutton that is pressed will light, and the REFERENCE NUMBER display will show the number that has been entered.
7. Repeat steps 5 and 6 for the B element position.
8. Press the C element button. It will light and B will go out, and all four ELEMENT TYPE pushbuttons will light.
9. Set on the REFERENCE NUMBER switches the preset time or count value and press any one of the ELEMENT TYPE pushbuttons. Maximum value is 999.
10. Press the D element position. Select on the REFERENCE NUMBER switches the location where the accumulated time or count will be stored. Press any ELEMENT TYPE pushbutton.
11. If the DISABLE pushbutton is lit, and not specifically desired, press it to enable the line.

Example of a Timer Line 53 (see Figure 52)

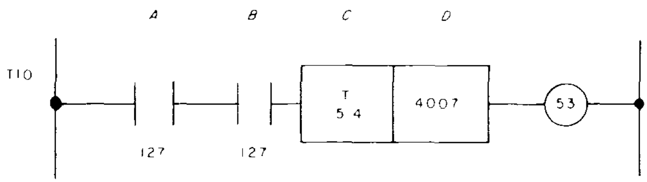


Figure 52. Timer Line

1. Set Line Number 53 on LINE NUMBER switches.
2. Press TIMER TENTHS pushbutton.
3. Press A element pushbutton.
4. Set REFERENCE NUMBER switches to 0127.
5. Press Normally-Open Series ELEMENT TYPE pushbutton.
6. Press B element pushbutton.
7. Leave REFERENCE NUMBER switches set to 0127.
8. Press Normally-Open Series ELEMENT TYPE pushbutton.
9. Press C element pushbutton.
10. Set REFERENCE NUMBER switches to 0054.
11. Press any one of the ELEMENT TYPE pushbuttons.
12. Press D element pushbutton.
13. Set REFERENCE NUMBER switches to 4007 and press any element type.

14. If the DISABLE lamp is lit, press it to turn it OFF, unless the line is to be left disabled.

Example of a Counter Line (see Figure 53)

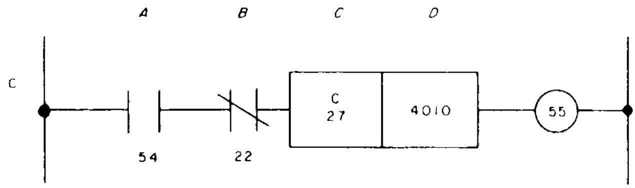


Figure 53. Counter Line

1. Set the Line Number 55 on LINE NUMBER switches.
2. Press COUNTER pushbutton.
3. Press A element pushbutton.
4. Set REFERENCE NUMBER switches to 0054.
5. Press Normally-Open Series ELEMENT TYPE pushbutton.
6. Press B element pushbutton.
7. Set REFERENCE NUMBER switches to 0022.
8. Press Normally-Closed Series ELEMENT TYPE pushbutton.
9. Press C element pushbutton.
10. Set REFERENCE NUMBER switches to 0027.
11. Press any of the ELEMENT TYPE pushbuttons.
12. Press the D element pushbutton.
13. Dial 4010 in the REFERENCE NUMBER switches and press any element type.
14. If the DISABLE light is lit, press it to turn it OFF, unless the line is to be left disabled.

EXAMPLE II — Scan Time Evaluator

As a review of timers and counters, a circuit can be built to evaluate the average scan time of a Controller while it is operating (see Figure 54). These lines can be added to an operating system to evaluate its scan time and then removed when the final system is delivered. Any convenient spare lines can be used; they do not have to be consecutive. However, they should be programmed in the order provided. Any convenient two spare registers can be used for the D element of the counter and timer.

Line 100 is a one-shot fired when line 101 is transitioned from OFF to ON; line 101 is basically controlled by input 1001. An input is not required, just a control signal that can be turned OFF to ON; another line or an input can be disabled OFF to ON to control the one-shot. As soon as the one-shot is fired, line 102 is energized and sealed. The normally-closed D element contact in line 101 ensures that once line 102 is energized, the one-shot cannot be fired a second time. As soon as line 102 is turned ON, line 103 begins to pulse exactly as the Watchdog Timer (WDT) line cycles ON-OFF-ON.

The counter (line 104) counts these controlled pulses from line 103 until 500 pulses are detected. When the counter's preset is reached, coil 104 is energized, dropping the seal on line 102, stopping the pulses, and resetting the counter to zero. Since it takes two scans for the WDT to cycle ON-OFF-

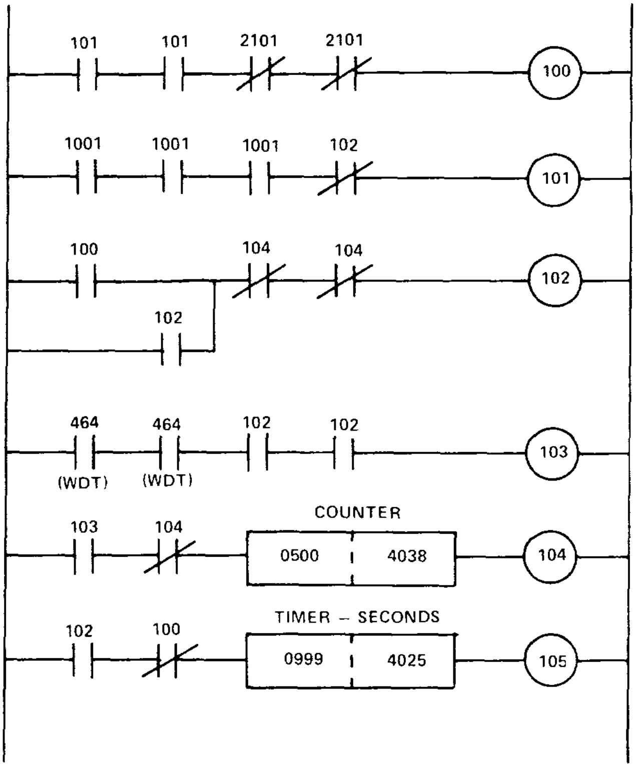


Figure 54. Example: Scan Time Evaluator

ON (which the counter counts as one count), it will take 1000 scans for 500 counts to be detected. The timer starts timing as soon as line 102 is energized (start of pulses), and stops when line 102 is de-energized (1000 scans have been detected). Thus, the contents of register 4025 (D element of line 105) will be the time in seconds it took the Controller to go through 1000 scans, or the average scan time in milliseconds for each of these 1000 scans. The timer is reset to zero only at the start of the evaluation; thus the value in register 4025 will be available any time after completion of the evaluation. The preset in line 105 is established as high as possible since the timer should stop only when line 102 is de-energized, and not at any specific value.

The one-shot is optional since the control reference (e.g., input 1001) can be used directly in the A element of line 102 and the B element of line 105, provided it is very short in duration. As long as this reference is ON, or if it is energized a second time, the timer is reset to zero but the counter continues to count. Thus, to reduce error, a short duration reference, i.e., a one-shot, must be used. The D element of line 101 ensures that the timer cannot be reset to zero while the scan evaluation is in progress (i.e., line 102 ON).

Summary

One of the major advantages of the 184/384 Programmable Controller is the flexibility the executive program provides. Since this program is in core memory, it can be altered to change the Controller's characteristics without modifying the hardware. The three basic MOPS programs listed at the beginning of this section have been modified to suit various customer applications; this has resulted in a number of available MOPS as listed in Table 9.

NOTE

See Appendix F for list of 384 executive (TEF) programs.

Any program listed can be supplied with any 184/384 Controller that has sufficient core memory. These programs can also be loaded via the Telephone Interface or Tape Loader. Additional MOPS/TEF programs are periodically developed based on customer requirements and, once developed, are made available to any 184/384 Controller user.

Table 9. Model 184 Controller Executive Program

MOPS 1: Relays, Timers, and Counter

Model	No. of Lines	No. of Holding Registers	Discrete I/O (Channel)	Latches	Min. Core Size	Special Functions
1	224	32	224 I 224 O (1,2)	224 2001- 2224	1K	
2	464	100	256 I 256 O (1,2)	304 2001- 2304	2K	
3	640	100	352 I 352 O (1,2,3)	32 2001- 2032	3K	
4	736	100	256 I 256 O (1,2)	32 2001- 2032	3K	
5	464	100	256 I 256 O (1,2)	304 2001- 2304	2K	Timers: 1/100 and 1/10 sec. divide panel timer labels by 10.
6	512	78	256 I 256 O (1,2)	256 2001- 2256	2K	
7	736	100	128 I 128 O (1)	160 2065- 2224	3K	
8	640	500	352 I 352 O (1,2,3)	32 2001- 2032	3K	Timers: 1/100 and 1/10 sec divide panel timer labels by 10.

3.3 ADVANCED CONCEPTS

3.3.1 Registers

The MODICON 184/384 Controller accepts, stores, performs operations on, and outputs data using state-of-the-art processing hardware and software. The degree to which a Controller can manipulate this data and produce the various outputs is determined by its own executive program. As described previously, the 184 MOPS programs can be modified to suit various applications. In addition to modifying the number of discrete I/O, logic lines, and latches, the MOPS can be modified to provide numerical inputs and outputs.

An example of input registers would be to connect a four-digit BCD thumbwheel from an operator's panel to an input module. Thus, by proper programming, the operator can be provided with control over the logic by adjusting the thumbwheels. An output register can be similarly used to provide numerical information to the operator via a four-digit BCD display.

In all cases, each register I/O is provided with up to four digits. Since each BCD digit requires four wires, a complete 16-circuit I/O module is used for each register I/O. The same type of I/O modules are used for registers as are used for discrete I/O; the selection of the specific I/O modules depends on the equipment to which the module is to be connected. See Appendix B for a summary of the available I/O modules.

When used as register I/O, reference numbers of the form 30xx identify input registers and 40xx identify output registers. Typically channels III and IV are dedicated to providing register I/O when the MOPS has been modified to provide this capability; channels I and II remain for discrete I/O (see Table 7).

Depending on the MOPS selected, there are a number of options to the reference numbers for channels III and IV as shown in Table 10. All 384 TEF programs provide register I/O (see Appendix F). The three examples shown in this table are for the executives currently written; most executives provide 256 discrete I/O and 16 register I/O.

Normally, I/O registers are assumed to be coded BCD; however, with a minor change to the MOPS, any register (input or output) can be coded binary. Binary registers are useful if the register is connected to discrete devices in groups of 16 in lieu of numerical devices. The same I/O modules are used for registers (either BCD or binary) as are used for discrete, one module for each register. Registers, either input or output, are wired as shown in Figure 55; power terminals 1, 2, 7, 12, and 17 are connected to reference power depending on the type of I/O module used.

NOTE

On DC modules, terminals 7, 12, and 17 are internally connected to dc common (terminal 2), and do not require external connections.

Output registers that are not used for outputting data can be used to store internal data, along with the remaining holding registers. References to logic lines, discrete inputs, latches, input registers, or holding registers can be made as many times as necessary; there are no limitations on how many times any reference is used.

As can be seen from Table 10, up to 16 input registers and 16 output registers can be provided by standard executives. Figure 56 is a block diagram of the Controller's memory, illustrating how these registers relate to the total system.

Internally, up to 999 holding registers (4001-4999), depending on the executive selected, are available to store numerical data. All holding registers can store up to four digits (maximum value 9999); the value in registers 4001-4016 can also be supplied to the real world and as such are a special type of holding registers, referred to as output registers. Holding registers are inherently retentive on power failure; unless some positive action is taken, they will permanently retain their content.

3.3.2 184 Executive Program (MOPS)

Two groups of MOPS have been developed that provide register I/O; these are MOPS 2 and MOPS 3. The MOPS 1 family has been previously discussed and provides logic lines that simulate the effect of relays, timers, and counters with discrete I/O only. The MOPS 2 family provides, in addition

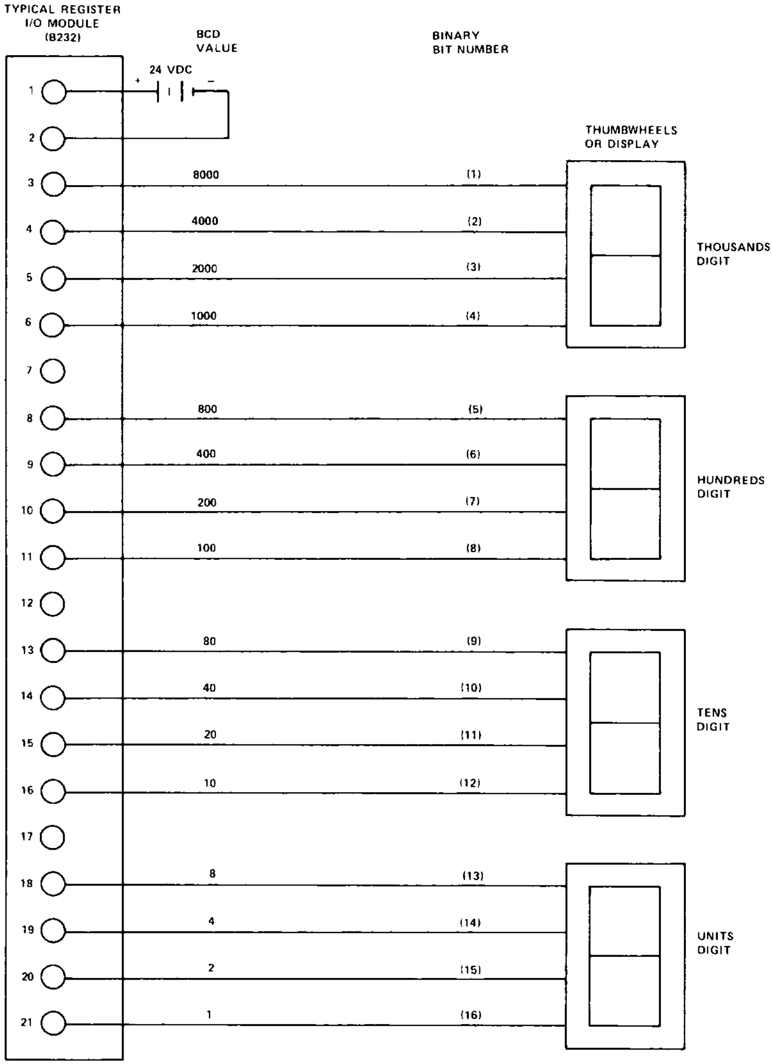


Figure 55. Wiring of Input/Output Registers

to register I/O, the calculate capability and remote set of timers and counters (see Section 3.4) as well as the relay, timing, and counting features of the MOPS 1 level. Finally, the MOPS 3 family provides all the capabilities of the MOPS 2 plus the Data Transfer features (see Section 3.5).

Each MODICON Operation System (MOPS) is designed for a specific size of core memory. This is the minimum core size required; larger core size can accommodate MOPS designed for small core memories.

NOTE

See Appendix F for list of 384 executive programs (TEF).

Table 10. I/O Channels III & IV, Optional Register Assignments

Channel III Index	256 Discrete & 16 Register Input	256 Discrete & 16 Register Output	320 Discrete & 12 Register Input	320 Discrete & 12 Register Output	352 Discrete & 10 Register Input	352 Discrete & 10 Register Output
1	3001	4001	1257-1272	257-272	1257-1272	257-272
2	3002	4002	1273-1288	273-288	1273-1288	273-288
3	3003	4003	1289-1304	289-304	1289-1304	289-304
4	3004	4004	1305-1320	305-320	1305-1320	305-320
5	3005	4005	3001	4001	1321-1336	321-336
6	3006	4006	3002	4002	1337-1352	337-352
7	3007	4007	3003	4003	3001	4001
8	3008	4008	3004	4004	3002	4002
Channel IV Index						
1	3009	4009	3005	4005	3003	4003
2	3010	4010	3006	4006	3004	4004
3	3011	4011	3007	4007	3005	4005
4	3012	4012	3008	4008	3006	4006
5	3013	4013	3009	4009	3007	4007
6	3014	4014	3010	4010	3008	4008
7	3015	4015	3011	4011	3009	4009
8	3016	4016	3012	4012	3010	4010

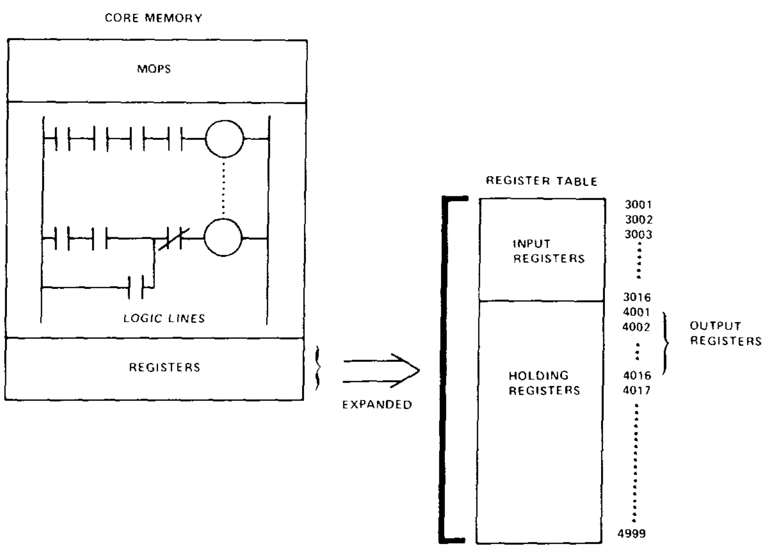


Figure 56. Block Diagram of Core Memory

Each executive resides in core memory and allocates the core memory into areas for storage of the user's logic, registers, and I/O status (see Figure 57). This allocation defines how many logic lines and registers are provided, what type of I/O is assumed, and which lines are latchable. The coil status of all lines are referred to by reference numbers beginning with the digit zero (0xxx). This reference begins at 0001 for the first line and extends to the last line provided by the MOPS. The lower-numbered lines are outputtable and the higher-numbered lines are internal.

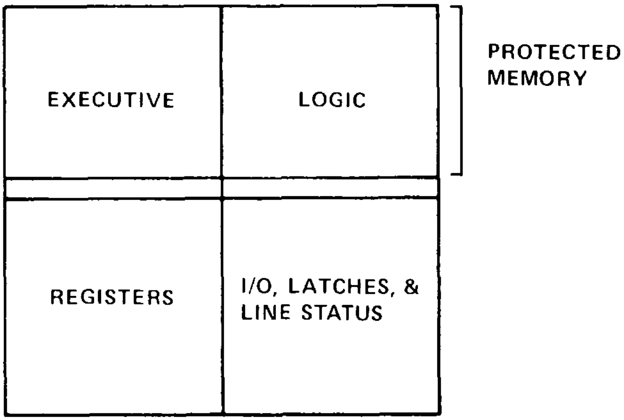


Figure 57. Core Memory Allocation

NOTE

These executive programs are constantly being generated, adding additional capabilities and features. Contact nearest MODICON sales office for latest information.

3.3.3 Additional Programming Panel Features

The Programming Panel (see Figure 25) can be utilized not only to enter logic line data and control disable status of line coils and discrete inputs (see Section 3.1.5), but also provides the ability to monitor other references used in the logic program. The line number thumbwheels are used to determine which reference is being displayed.

At any time, any logic line can be examined by entering the line number (0xxx) on the thumbwheels. The upper half of the selected element pushbutton will light to indicate power flow through relay contacts from left to right; the coil light will be ON if the line's coil is energized. Each element of the line can be examined for proper programming by selecting the element (A, B, C, or D) and observing the reference number display and contact type that is lit. Again, changes can be made only with memory protect OFF; however, monitoring can occur at any time.

If the status of a discrete input is required, the input reference (1xxx) is entered as if it was a line number on the LINE NUMBER thumbwheels. The output coil will be ON if the input is energized, and OFF if the input is de-energized; disregard the element power lights. Similarly, any latch can be examined by entering its reference (2xxx) on the LINE NUMBER thumbwheels and observing the output coil. The contents of the input registers or holding registers can be examined by entering their reference (30xx or 4xxx) on the LINE NUMBER thumbwheels and observing the reference number display. The contents of a register is displayed as a four-BCD-digit magnitude.

If a holding register (4xxx) is being displayed, all four relay contact types will light to indicate that the contents of this register can be altered if desired; input registers (30xx) obtain their contents from the outside world and cannot be altered by the Controller. New contents for a register is entered onto the REFERENCE NUMBER thumbwheels, and any contact type may be depressed to cause this data to be loaded into the holding register.

NOTE

Memory Protect does *not* have to be OFF to change the contents of the holding registers.

If a logic line in the Controller is forcing a number into the register or limiting its value, the manual load of this register will be only temporary; the reference display will indicate the acceptance of the value and then the result of the operation on it by the logic line. The manual load takes place at the end of the scan when the Programming Panel is serviced (see Table 20) and its value remains in the register until the logic line that affects the value is solved.

There are two methods of loading holding registers; one by entering the register reference on the LINE NUMBER thumbwheels as discussed above; the other indirectly through the logic line where the register is referenced, as discussed in Section 3.2.2. In the D element of any non relay line, if decimal points appear to the left of each digit of the reference (total four decimal points), this indicates that the holding register is used in the D element of another logic line. The reference is accepted as a valid reference, but the user is cautioned that the contents of this register may be altered by more than one logic line.

If values are entered on the LINE NUMBER thumbwheels that exceed the limits established by the executive, an error code (⊔22⊔) will be shown on the REFERENCE NUMBER display. Thus, if line number 740 or latch 2512 is entered on the LINE NUMBER thumbwheels, and only 640 lines and 128 latches (2001-2128) are provided, all panel lights will be extinguished and the reference number display will contain a ⊔22⊔.

This feature can be used to determine which executive is in the Controller. Increase the line display by hundreds from zero (e.g., 0100, 0200, 0300, etc.) until a ⊔22⊔ appears; reduce the line number by one hundred to extinguish this display and begin incrementing the line number by tens (e.g., 0600, 0610, 0620, etc.). When the ⊔22⊔ reappears, reduce the line number by ten and begin incrementing by units. When the last valid line is determined, add one to it for the WDT line and this is the number of lines the executive provides. A similar operation can be performed to determine how many holding registers (4xxx) are provided; no incrementing of the result is required similar to that accomplished for the WDT line. Using these two parameters (number of lines and number of registers), available executives in Tables 9, 11, and 12 (for 184 controllers) or Appendix F (for 384 Controllers) can be scanned to determine possible executives. To determine which specific executive is installed, the differences between the possibilities are determined (i.e., location of latches, number of discrete inputs, etc.), and these references examined to determine which set of references are valid.

3.4 REMOTE SET AND CALCULATE CAPABILITY

3.4.1 Remote Set Timers and Counters

Since all MOPS 2, MOPS 3 and TEF level executives are provided with register I/O, their timer or counter logic lines can have their preset adjusted by the contents of either holding or input registers. A typical remote set timer or counter line is shown in Figure 58.

Table 11. Model 184 Controller Executive Program

MOPS 2: Relays, Timers, Counters, and Calculators

Model	No. of Lines	No. of Holding Registers	Discrete I/O (Channel)	Register I/O (Channel)	Latches	Min. Core Size	B+C Coil Option, ON When B = C	Special Functions
1	400	100	256 I 256 O (1,2)	16 I 16 O (3,4)	368 2001- 2368	2K		
2	672	999	256 I 256 O (1,2)	16 I 16 O (3,4)	80 2001- 2080	4K		
3	400	100	256 I 256 O (1,2)	16 I 16 O (3,4)	368 2001- 2368	2K	X	
4	672	999	256 I 256 O (1,2)	16 I 16 O (3,4)	80 2001- 2080	4K	X	
5	672	999	256 I 256 O (1,2)	16 I 16 O (3,4)	80 2593- 2672	4K	X	
6	592	999	352 I 352 O (1,2,3)	8 I 8 O (4)	80 2513- 2592	4K		Seconds Timer Replaced by Down Counter
7	592	999	352 I 352 O (1,2,3)	8 I 8 O (4)	80 2513- 2592	4K	X	Seconds Timer Replaced by Down Counter
8	400	989	256 I 256 O (1,2)	16 I 16 O (3,4)	368 2001- 2368	4K	X	Seconds Timer Replaced by Down Counter
9	800	300	224 I 224 O (1,2)	8 I 8 O (3)	0	4K		
10	672	999	320 I 320 O (1,2,3)	12 I 12 O (3,4)	32 2001- 2032	4K	X	
11	768	300	256 I 256 O (1,2)	8 I 8 O (3)	0	4K	X	K112 Compatible
12	672	999	352 I 352 O (1,2,3)	10 I 10 O (3,4)	0	4K	X	

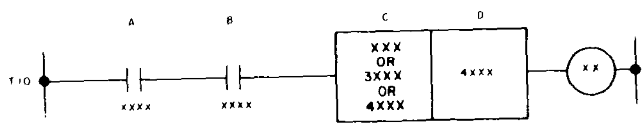


Figure 58. Typical Remote Set

The operation of these logic lines is the same as previously discussed, except for the preset value. The preset in the C element can still be a fixed quantity up to 999; but now it can also be the contents of an input register (30xx) or a holding register (4xxx). Thus, if a preset greater than 999 is required, the value up to 9999 can be placed in a holding register and that register referred to as the preset in the C element of any timer or counter line.

Example of a Remote Set Timer (see Figure 59)

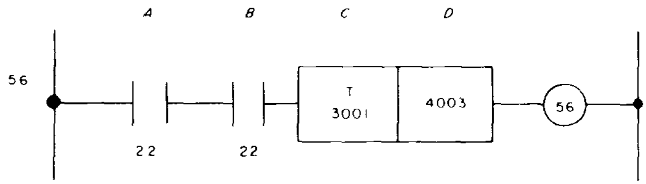


Figure 59. Remote Set Timer Line

1. Set Line Number 56 on LINE NUMBER switches.
2. Select range by pressing TIMER TENTHS or TIMER SECONDS.
3. Press A element pushbutton.
4. Set REFERENCE NUMBER switches to 0022.
5. Press Normally-Open Series ELEMENT TYPE pushbutton.
6. Press B element pushbutton.
7. Leave REFERENCE NUMBER switches set to 0022.
8. Press Normally-Open Series ELEMENT TYPE pushbutton.
9. Press C element pushbutton.
10. Set REFERENCE NUMBER switch to 3001.
11. Press any of the ELEMENT TYPE pushbuttons.
12. Press D element pushbutton.
13. Dial 4003 into REFERENCE NUMBER switches and press any element type.
14. If the DISABLE light is lit, press it to turn it OFF, unless the line is to be left disabled.

Example of a Remote Set Counter (see Figure 60)

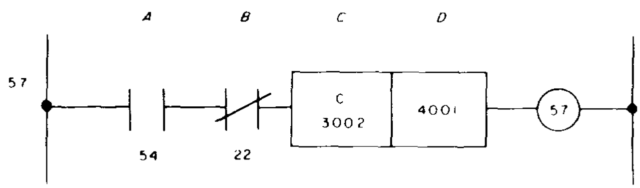


Figure 60. Remote Set Counter Line

1. Set Line Number 57 on LINE NUMBER switches.
2. Press COUNTER pushbutton.
3. Press A element pushbutton.
4. Set REFERENCE NUMBER switches to 0054.
5. Press Normally-Open Series ELEMENT TYPE pushbutton.
6. Press B element pushbutton.

7. Set REFERENCE NUMBER switches to 0022.
8. Press Normally-Closed Series ELEMENT TYPE pushbutton.
9. Press C element pushbutton.
10. Set REFERENCE NUMBER switches to 3002.
11. Press any one of the ELEMENT TYPE pushbuttons.
12. Press D element pushbutton.
13. Dial 4001 on the REFERENCE NUMBER switches and press any element type.
14. If the DISABLE light is lit, press it to turn if OFF, unless the line is to be left disabled.

3.4.2 Addition (B+C) and Subtraction (B−C)

The MOPS 2, MOPS 3, and TEF level executives are all provided with the calculate capability. Any legal line can be converted to a calculate line (B+C or B−C) by selecting the appropriate pushbutton on the Programming Panel. Table 11 lists the currently available executives (MOPS 2) that provide relay, timer, counter, and calculate lines; MOPS 3 programs are listed in Table 12. See Appendix F for list of available 384 TEF Programs.

The usefulness of the holding registers described previously is most apparent when using the Controller's calculate capabilities. Such registers (4xxx) may contain numbers which the user can add to or subtract from each other. Figure 61 is a typical calculate logic line.

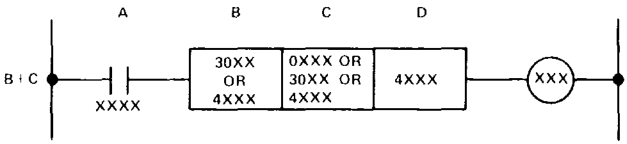


Figure 61. Typical Arithmetic Line

A single series contact (A position) is used to control the operation; this contact may be either normally-open or normally-closed. The B position then requires the entry of a register location (input or holding) – the one to which another number is to be added or from which one is to be subtracted. The C position then requires entry of a fixed number or register (input or holding) location being added or subtracted. The constant value entered into the C position may range from 0 to 999. Finally, in the D position, the holding register (a 4xxx reference) is specified where the result is to be stored.

NOTE

The values in the B and C element register are not altered by the calculate line; the value in the D element register will be replaced with the results of this line. The calculate function is accomplished every scan the A element is closed (passing power).

Again, as with any element having data (box symbol) in a line, no relay information is to be specified; all relay contact types will light and pushing any one will enter thumbwheel data from the reference number into the element selected.

In most cases, the numbers entered in both B and C positions will be 30xx and 4xxx register references rather than real numbers. This makes it much easier and more flexible for handling various functions. The Controller automatically finds the number(s) kept in the specified locations and adds or subtracts them as commanded.

Coil Activation

While the operation of the calculate line — when the A contact is closed — will take place continuously (adding, subtracting, and storing numbers), the energizing of the output coil will only occur selectively.

1. Energize if: in subtraction, the number in B is greater than or equal to the number in C (i.e., result positive, zero being a positive number).

2. Energize if: in addition, the sum of B and C is greater than 9999. (Calculation range has been exceeded.) This is a standard option.

NOTE

If the resultant sum is greater than 10,000 the amount of difference (over 10,000) will be placed in the storage location specified by the D element. For example, if 4999 is added to 6000, then the coil will be energized, and the value 0999 will be stored in the location specified by D.

3. Energize if: in addition, B exactly equals C. This is the B=C coil option (see Table 11, Special Functions). Of course, the addition is still accomplished even if B exactly equals C.

As with other functions, the data stored in the location specified by 4xxx is available for other purposes.

*2 and 3 are mutually-exclusive depending on executive program selected. Any MOPS will have only one B+C coil option. See Tables 11 and 12; unless otherwise indicated, the B+C calculate line will have the standard option.

NOTE

See Appendix F for discussion of B+C coil options available with 384 TEF executives.

Set Points (Compare)

To perform comparison of two numbers, the subtraction capability is useful as shown in Figure 62.

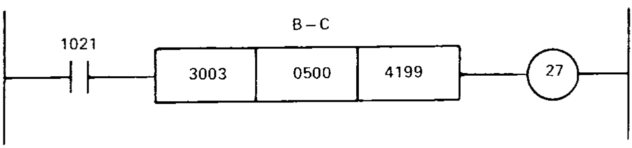


Figure 62. Sample Set Points

The variable data from an input or holding register is addressed in element B, and the set point is loaded into element C. The D element register is loaded with the result of the subtraction and can be used to indicate how close the variable data is to the set point. If the number addressed by element B becomes equal to or greater than the set point in element C, the coil output is energized.

In this example, monitoring begins as soon as input 1021 is energized. With this input energized, whenever the value in input register 3003 becomes equal to or greater than 500 (the set point), coil 27 is energized. The contents of register 4199 represents how close the variable data is to the set point (500).

As many set points as desired can be established on any single input signal, multiple inputs, or internal data, limited only by the number of logic lines available. Set points can be fixed (up to 999), under operator control (input registers up to 9999), or stored internally (holding registers up to 9999). The coil state can be reversed (ON below or at set point and OFF above set point) by placing the set point in the B element register and the variable data in the C element.

Register-to-Register Move

The Calculate B+C logic line can be used as a register-to-register move as illustrated in Figure 63.

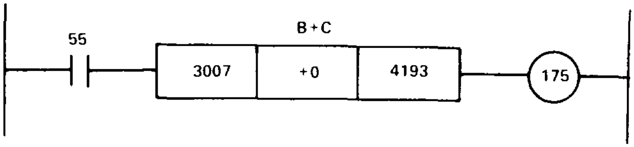


Figure 63. Sample Register to Register Move

Whenever line 55 is energized, the contents of 3007 is copied into register 4193. If line 55 is a one-shot, the contents of 3007 is sampled and held in register 4193 until the next strobing (energizing) of line 55 causes a new sample to be taken. This technique is useful when sampling of register contents is required or if a register is to be loaded with a fixed value stored in the Controller (e.g., forcing pointers to values such as 4, 10, 17, etc.).

Clearing a Register to Zero

The Calculate B−C logic line can be used to clear a register to zero as illustrated in Figure 64.

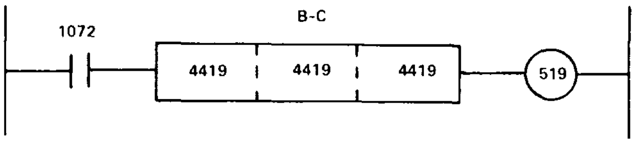


Figure 64. Sample Clearing of a Register

Whenever input 1072 is energized, the contents of 4419 is subtracted from itself, the result will always be zero, and the zero is placed into register 4419. As long as input 1072 is energized, register 4419 will be forced to zero by line 19 every scan; there is no other use for a B−C logic line with the above format. This technique is useful to clear accumulators to zero, force pointers to start of a table, clear displays, etc.

Double-Precision Add

If an executive has the standard coil option for the B+C logic lines (coil ON if sum exeeds 9999), a double-precision add can be developed as shown in Figure 65.

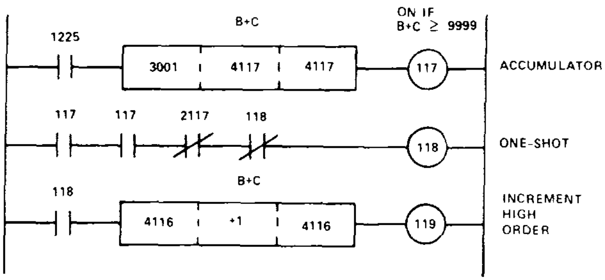


Figure 65. Sample Double-Precision Add

Whenever input 1225 is energized, the contents of 3001 is added to the contents of register 4117, and the sum stored in 4117. The contents of 4117 will continue to accumulate unless cleared to zero by a B−C logic line elsewhere in the logic. If 1225 remains closed for more than one scan, the contents of 3001 will be added to 4117 more than once. Whenever the summation accomplished by line 117 exceeds 9999, the coil is energized and line 118 fires a one-shot. Line 119 adds one to the high-order accumulator (register 4116) whenever the one-shot fires, i.e., whenever line 117 overflows. The one-shot ensures that the high-order accumulator is incremented only once on each overflow; it is not required if the A element reference in the accumulator line (i.e., input 1225) is a one-shot itself, or if continuous adding is accomplished and two successive overflows are possible. When clearing the accumulator to zero, both the high-order (register 4116) and the low-order (register 4117) values must be set to zero.

Detecting Equality with B+C Overflow Coil Option

If an executive is designed with the standard B+C coil option (i.e., coil ON with overflow, NOT when B=C), and detection of exact equality is required, two B−C logic lines can be used as illustrated in Figure 66.

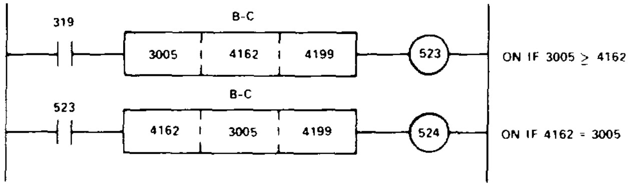


Figure 66. Sample Detection of Equality with B+C Overflow Coil Option

When line 319 is energized, line 523 will subtract the contents of register 4162 from 3005; if the contents of 3005 are equal to or greater than the contents of 4162, coil 523 will be energized and line 524 accomplished. If, and only if, the contents of 4162 exactly equal 3005, will coil 524 come ON; if the contents of 3005 are greater than the contents of 4162, coil 524 will be OFF.

To further illustrate this technique, assume values for the contents of 3005 and 4162 for the three cases: 3005 > 4162, 3005 < 4162, and 3005=4162. Assume the value in 3005 is 100, and the contents of 4162 is 80 (case 1). Line 523 subtracts 80 from 100, resulting in a positive 20 in 4199 and coil 523 is turned ON. Line 524 then subtracts 100 from 80, resulting in a negative 20 in 4199 and coil 524 is OFF. If 3005 contains 100, and 4162 contains 125 (case 2), line 523 subtracts 125 from 100, resulting in a negative 25 in 4199 and coil 523 is OFF. Line 524 is not accomplished and its coil will be OFF. If 3005 contains 100 and 4162 contains 100 (case 3), line 523 subtracts 100 from 100, the result being a positive zero in 4199, and coil 523 is energized. Line 524 subtracts 100 from 100 and the result is also a positive zero in 4199, and coil 524 will be ON. Coil 524 will come ON only if the contents of 3005 exactly equal the contents of 4162. Note that the difference, i.e., how close they are to being equal as an absolute number, is available from 4199.

Detecting Overflow with B+C Equal Coil Option

If an executive is designed with the optional B=C coil status for B+C logic lines, and detection of overflow is required, a B−C logic line and a relay line can provide this signal as illustated in Figure 67.

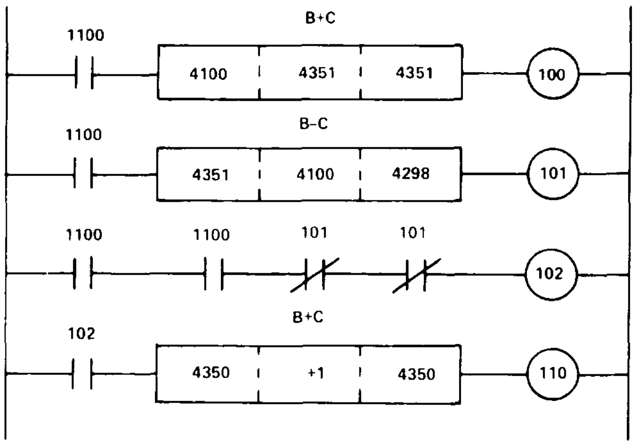


Figure 67. Sample Detection of Overflow with B+C Equal Coil Option

The B+C calculate line (100) is used to accumulate, in 4351, the values in 4100 whenever input 1100 closes. Line 101 checks to ensure the sum is always greater than or equal to the incremented quantity in 4100. If the accumulator (4351) becomes less than the incremental value, i.e., overflow just occurred and the less-significant portion is in 4351, coil 101 will *not* be energized and coil 102 will be energized to indicate overflow. If the accumlator is equal to the incremental value, i.e., accumulation just started and this is the first summation performed after 4351 was reset to zero, coil 101 will be energized and no overflow indicated. The overflow indication can be used to form a double-precision add, as is accomplished by line 110.

Entering a Calculate Line

1. Set the Line Number on the LINE NUMBER switches.
2. Put the Controller MEMORY PROTECT switch in the OFF position.

3. Press either Calculate B+C or Calculate B−C pushbutton as desired. It will light and all other LINE TYPE lights will go out.
4. Press the A element pushbutton. The A element lamp will light and the B, C, and D lights will be OFF.
5. Set the REFERENCE NUMBER thumbwheel switches to the line number, input number, or latch that is to operate the contact in the A position.
6. Press either the Normally-Open or Normally-Closed Series ELEMENT TYPE pushbutton. The ELEMENT TYPE pushbutton that is pressed will light and the REFERENCE NUMBER display will show the number that has been entered.
7. Select the B element position. It will light and the A will go out, and all four ELEMENT TYPE pushbuttons will light.
8. Enter, on the REFERENCE NUMBER switches, the data location for the B element. Depress any contact type pushbutton.
9. Repeat steps 7 and 8 for the C and D positions.

NOTE

Either an input register (30xx), or holding register (4xxx) can be used in either the B or C element. In addition, a constant value of from 0 to 999 may be entered in the C element rather than a remote data (register) location number. A holding register (4xxx) must be placed in the D element.

10. If the DISABLE pushbutton is lit, and not specifically desired, press it to turn if OFF.

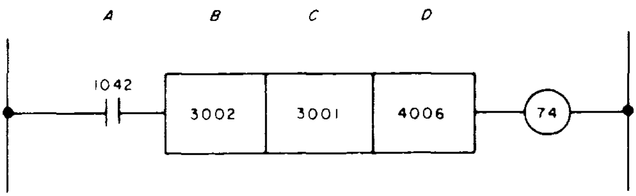
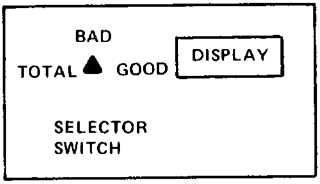


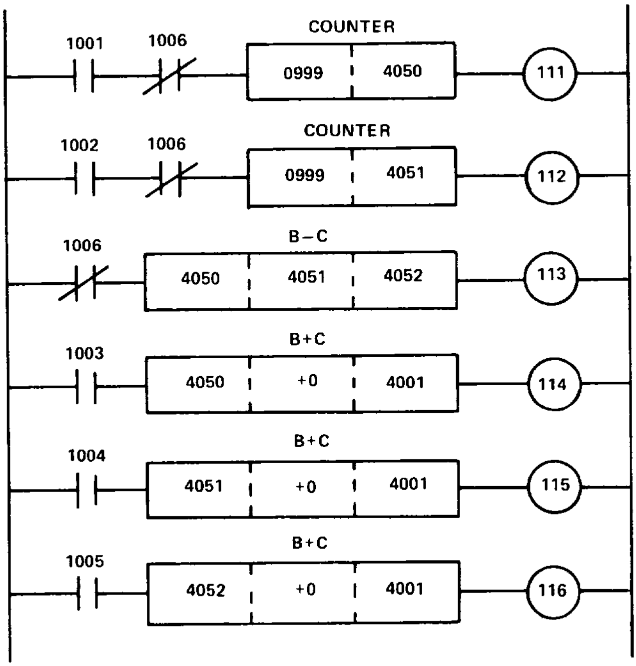
Figure 68. Calculate B+C Line

Entry of a B+C Calculate (Figure 68)

1. Set Line Number switches to 0074.
2. Press Calculate B+C pushbutton.
3. Press A element pushbutton.
4. Set REFERENCE NUMBER switches to 1042.
5. Press Normally-Open Series ELEMENT TYPE pushbutton.
6. Press B element pushbutton.
7. Set REFERENCE NUMBER switches to 3002. Press any ELEMENT TYPE pushbutton.
8. Repeat steps 6 and 7 for C element 3001, and D element 4006.
9. If the DISABLE line is lit, and not specifically desired, press it to turn it OFF.



OPERATOR'S PANEL



INPUT ASSIGNMENTS

1001 = PARTS PRODUCED
1002 = BAD PARTS DETECTED
1003 = DISPLAY TOTAL PARTS
1004 = DISPLAY BAD PARTS
1005 = DISPLAY GOOD PARTS
1006 = CLEAR ALL COUNTS TO ZERO

REGISTER UTILIZATION

4001 = DISPLAY

4050 = # OF TOTAL PARTS
4051 = # OF BAD PARTS
4052 = # OF GOOD PARTS

Figure 69. Example of Time Shared Display

EXAMPLE III. Time-Shared Display

As a review of the calculate capability, a method of time-sharing an output register that is connected to a display can be developed (see Figure 69). This will allow displaying many groups of data via a single output register. Assume input 1001 is energized every time a part is processed by a machine; input 1002 is energized every time a bad part is detected. The operator must be able to select either total parts, good parts, or bad parts for displaying; only one parameter will be displayed at a time.

Line 111 counts the number of total parts and line 112 counts the number of bad parts. Line 113 takes the difference between total parts and bad parts and places the result (good parts) into register 4052. When the selector switch is placed in the total position, input 1003 is energized, causing line 114 to move the current total count (stored in register 4050) into the display, driven from register 4001. When the selector switch is placed in the bad position, input 1003 is de-energized, and input 1004 is energized. This input causes line 115 to move the number of bad parts stored in register 4051 into the display via register 4001; line 114 will not move any data since input 1003 is not energized. Similarly, line 116 moves the number of good parts from register 4052 into the display.

If additional data is to be displayed (e.g., machine-up time), another position of the selector switch must be provided, with another input, and another calculate line similar to lines 114-116. Additional logic (e.g., a timer) must be included to develop the additional parameter to be measured. For other more sophisticated methods of driving display, see EXAMPLE IV.

3.5 DATA TRANSFER

In addition to the usual relay contact circuits described previously, and the counting, timing, and arithmetic functions, the storage location concept allows the MODICON 184/384 Controller another versatile capability: the manipulation of the contents of such storage registers, either in whole or in part, under the control of other logic. These data transfer functions are still controlled by relay logic.

The data transfer function capability provides the designer with the ability to move or transfer data in large blocks, perform extended arithmetic operations, and bit manipulations within the Controller utilizing only one line of logic. This capability is provided in the 184 Controller only by MOPS 3 level executive program (see Table 12) written for 4K memory systems. At present, the data transfer (DX) capability is divided into four groups:

Code	Function
1YXX	Move
2YXX	Matrix Handling
3YXX	Extended Arithmetic
4YXX	Printer

Each function group is provided as software (programmed) subroutines within the executive. All executive programs at the MOPS 3 level include various combinations of these function groups; the Move capability is very basic and is included in all MOPS 3 executives.

Since executives with data transfer functions occupy a portion of the available core memory and are larger than the less sophisticated MOPS, the quantity of logic lines and holding registers can be somewhat reduced. However, the reduced number of lines resulting from a larger executive are more than compensated for by the added power capability of the DX lines.

NOTE

See Section 3.6 for complete discussion of the Printer DX line function.

NOTE

All 384 Controllers are provided with all DX capabilities except PID without effect on logic line or register quantity. See Appendix F.

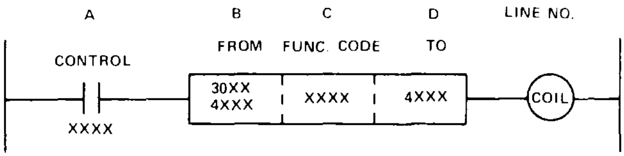


Figure 70. Typical DX Line

A typical Data Transfer (DX) logic line is shown in Figure 70. The contact in the A element activates the DX line; no operation is performed until this contact is closed (passing power through the A element). Either series-open or series-closed contacts, with any legal discrete reference can be utilized in the A element. The B element specifies where the data is to be obtained; any valid input register, output register, or holding register can be utilized in the B element. Data is copied from the location specified in the B element; the contents of the B element register are not altered.

The C element is a functional code; it is *not* a register, storage address, latch, or input. Valid functional codes are provided below as part of the discussion of each functional group.

The D element register specifies where the data or action is to be received or take place. Any valid output or holding register can be utilized in the D element. Since the data transfer into the register specified in the D element is destructive (i.e., the old data is lost and the new data retained), input registers whose contents are controlled by an external device cannot be used in the D element. The status of the coil varies within the functional groups and thus will be discussed separately as part of each group. These coil status are important in the design of supporting relay logic control.

Registers in the B and D elements can refer by inference to more than one register. In these cases, the additional registers will be in sequence following the register specified by the DX line. For example, registers 3001, 3002, and 3003 can be referred to by the appropriate functional code when register 3001 is specified in the B element. How many registers and under what conditions they are referred to is discussed as part of each functional code. The above discussion should be assumed to be applicable to each functional code unless specifically exempted.

It is important that these general concepts be understood prior to discussing the specific functional codes. Since all registers affected by the DX function are not always referred to in the logic line, it is desirable to prepare a map of register utilization to ensure the overlapping of registers does not occur unless desired by the user.

3.5.1 MOVE (Group 1YXX)

This function group allows tables of data to be built in consecutively numbered registers. The length of the table is always specified in the last two digits (XX) of the functional code (C element); thus, the maximum length of any table is 99 registers. Data can be moved from a register to a table, from a table to a register, or from a table to a table.

NOTE

Minimum table length is two registers, except 384 TEF programs which allow function codes 1001 and 1101 — see Appendix F.

Table 12. Model 184 Controller Executive Programs

MOPS 3: Relays, Timers, Counters, Calculators, and DX Functions

Model	No. of Lines	No. of Holding Registers	Discrete I/O (Channel)	Register I/O (Channel)	Latches	B+C Coil Option, ON When B=C	Move	Basic Matrix	Mult./ Divide	P500 Printer	Special Functions
4	640	931	256 I 256 O (1,2)	16 I 16 O (3,4)	128 2001- 2128		X				
8	512	900	256 I 256 O (1,2)	16 I 16 O (3,4)	240 2001- 2240		X			X	
9	704	240	256 I 256 O (1,2)	16 I 16 O (3,4)	64 2001- 2064		X			X	Extended Sweep
10	640	795	256 I 256 O (1,2)	16 I 16 O (3,4)	128 2001- 2128		X	X			
11	608	300	256 I 256 O (1,2)	16 I 16 O (3,4)	160 2449- 2608	X	X			X	
12	592	865	256 I 256 O (1,2)	16 I 16 O (3,4)	176 2001- 2176	X	X		X	X	
13	432	999	256 I 256 O (1,2)	16 I 16 O (3,4)	336 2001- 2336	X	X		X	X	
14	496	500	256 I 256 O (1,2)	16 I 16 O (3,4)	272 2001- 2272		X			X	
15	592	841	352 I 352 O (1,2,3)	10 I 10 O (3,4)	80 2513- 2592	X	X		X		
16	640	795	256 I 256 O (1,2)	16 I 16 O (3,4)	128 2513- 2640	X	X	X			

Table 12. Model 184 Controller Executive Programs (continued)

MOPS 3: Relays, Timers, Counters, Calculators, and DX Functions

Model	No. of Lines	No. of Holding Registers	Discrete I/O (Channel)	Register I/O (Channel)	Latches	B+C Coil Option, ON When B=C	Move	Basic Matrix	Mult./ Divide	P500 Printer	Special Functions
17	640	931	256 I 256 O (1,2)	16 I 16 O (3,4)	128 2001- 2128	X	X				Extended Sweep
18	608	300	320 I 320 O (1,2,3)	12 I 12 O (3,4)	96 2513- 2608	X	X			X	K112 Compatible
20	512	950	256 I 256 O (1,2)	16 I 16 O (3,4)	256 2001- 2256	X	X	X	X		
21	592	486	256 I 256 O (1,2)	16 I 16 O (3,4)	176 2001- 2176	X	X	X	X		Extended Sweep
22	720	700	256 I 256 O (1,2)	16 I 16 O (3,4)	48 2001- 2048	X	X				
23	688	624	320 I 320 O (1,2,3)	12 I 12 O (3,4)	16 2001- 2016	X	X		X		
24	640	795	256 I 256 O (1,2)	16 I 16 O (3,4)	128 2001- 2128		X	X			Extended Sweep
25	608	788	256 I 256 O (1,2)	16 I 16 O (3,4)	128 2481- 2608		X	X			Improved Matrix Additional 30XX References
26	704	195	256 I 256 O (1,2)	16 I 16 O (3,4)	64 2225- 2288	X	X		X	X	
27	624	300	352 I 352 O (1,2,3)	10 I 10 O (3,4)	48 2577- 2624	X	X			X	K112 Compatible

Table 12. *Model 184 Controller Executive Programs (continued)*

MOPS 3: Relays, Timers, Counters, Calculators, and DX Functions

Model	No. of Lines	No. of Holding Registers	Discrete I/O (Channel)	Register I/O (Channel)	Latches	B+C Coil Option, ON When B=C	Move	Basic Matrix	Mult./ Divide	P500 Printer	Special Functions
28	512	930	256 I 256 O (1,2)	16 I 16 O (3,4)	256 2001- 2256	X	X	X	X		
29	640	795	256 I 256 O (1,2)	16 I 16 O (3,4)	128 2001- 2128		X	X			Additional 30XX References
30	720	689	256 I 256 O (1,2)	16 I 16 O (3,4)	48 2001- 2048	X	X				Extended Sweep
31	640	795	256 I 256 O (1,2)	16 I 16 O (3,4)	128 2001- 2128		X	X			Extended Sweep Additional 30XX References
32	464	700	256 I 256 O (1,2)	16 I 16 O (3,4)	128 2001- 2128	X	X	X		X	Improved Matrix Extended Sweep Additional 30XX References
33	320	950	256 I 256 O (1,2)	16 I 16 O (3,4)	320 2001- 2320	X	X		X	X	Extended Sweep PID
34	800	439	224 I 256 O (1,2)	16 I 16 O (3,4)	0	X	X				Extended Sweep
35	432	999	256 I 256 O (1,2)	16 I 16 O (3,4)	336 2001 - 2336		X		X	X	
36	416	999	256 I 256 O (1,2)	16 I 16 O (3,4)	352 2001 - 2352	X	X		X	X	Checksum
37	512	900	256 I 256 O (1,2)	16 I 16 O (3,4)	240 2001 - 2240		X			X	Extended Sweep

Table 12. Model 184 Controller Executive Programs (continued)

Model	No. of Lines	No. of Holding Registers	Discrete I/O (Channel)	Register I/O (Channel)	Latches	B+C Coil Option, ON When B=C	Move	Basic Matrix	Mult./ Divide	P500 Printer	Special Functions
38	432	989	256 I 256 O (1,2)	16 I 16 O (3,4)	336 2001 - 2336	X	X		X	X	K112 Compatible
39	592	850	352 I 352 O (1,2,3)	10 I 10 O (3,4)	80 2001 - 2080	X	X	X			Improved Matrix Standard I/O is 256 discrete, 16 register.
40	640	795	256 I 256 O (1,2)	16 I 16 O (3,4)	128 2001 - 2128	X	X	X			
41	592	513	256 I 256 O (1,2)	16 I 16 O (3,4)	176 2001 - 2176	X	X	X	X		Additional 30XX References
42	512	944	256 I 256 O (1,2)	16 I 16 O (3,4)	256 2257 - 2512	X	X	X	X		Improved Matrix Additional 30XX References
43	288	950	256 I 256 O (1,2)	16 I 16 O (3,4)	288 2001 - 2288	X	X		X	X	PID, Guarded Lines
44	704	795	320 I 320 O (1,2,3)	12 I 12 O (3,4)	0	X	X	X			
45	400	951	256 I 256 O (1,2)	16 I 16 O (3,4)	240 2001 - 2240	X	X	X	X		Sequencer (DX Code 29XX), 128 steps (2241-2368)

NOTES: 1. All MOPS 3 executives require 4K core size.
2. Executive programs marked "Extended Sweep" allow the processor to have a scan time greater than 200 ms and service I/O twice a scan

In all functional codes, except 16XX, the register specified in the D element will contain a pointer indicating where in the table(s) the *last* operation occurred. If this pointer is a zero, no operation has occurred; if it is a one, the first register in the table has been operated on and the next operation will be accomplished on the second register. The contents of the pointer will be automatically incremented by one at the completion of an individual move.

The coil will be energized when the A element is closed (passing power) *and* the contents of the pointer register equals the length of the table as specified in the functional code. When the A element is opened (not passing power) *after* the coil has been energized, the coil will be de-energized and the pointer set to zero.

Since the pointer is stored in a register, it can be altered by other logic lines, such as calculate lines, to force the move to occur on specific registers within the table without operating on previous registers. To accomplish this, the pointer should be forced to the desired location in the table *minus* one.

For example, if the operation is to be done on the fifth register of a table, the pointer should be forced to four. If the pointer is forced to a value equal to or greater than the table length, and the A element is closed, the coil will come ON and no action will take place, except to force the pointer to the maximum length of the table.

The following discussion assumes that no operation other than the move is performed on each table. In some cases, a register-to-register move without pointer is desired. In these cases, a calculate (B+C) line is used where the B element contains the source of the data, the C element a zero, and the D element the receiving location.

NOTE

Do not use a calculate line to move data whose magnitude is greater than 9999 (e.g., binary information), unless the 384 Binary B+C option is selected — See Appendix F.

10XX — Table-to-Register Move (Incremental)

NOTE

The table-to-register moves (10XX and 11XX) are useful to change the preset on timer/counter lines as the operation sequences through finite steps, drive devices in groups of 16 wired to output registers, search a table by its contents, or to simulate a drum programmer.

This code causes one register in a table of registers to be copied into a specified register upon closure of the A element contact. To transfer the next register in the table, the A element contact must be opened and then closed again. As an example, refer to Figure 71.

Assume that input 1054 is not energized and register 4200 contains a zero. On the first scan that input 1054 is energized, the contents of register 4100 will be transferred to register 4201 and the contents of register 4200 incremented by one to 1. The values in the table (4100- 4149) will not be altered; however, the previous contents of 4201 will be lost.

On subsequent scans, no operation will be performed until 1054 is de-energized and then re-energized. If register 4200 contained the number 49 and 1054 was energized, the contents of register 4149 would be copied into register 4201, the contents of register 4200 would be incremented to 50, and the coil would be ON. The coil would remain ON until 1054 is de-energized, at which time register 4200 would be cleared to zero and the coil turned OFF; the contents of 4201 are not altered when the pointer (4200) is cleared to zero. Note that the B element reference (register 4100) actually refers to 50 sequential registers (4100-4149) since the table length is coded in the function code as 50, and the D element reference (register 4200) refers to two sequential registers (4200 and 4201).

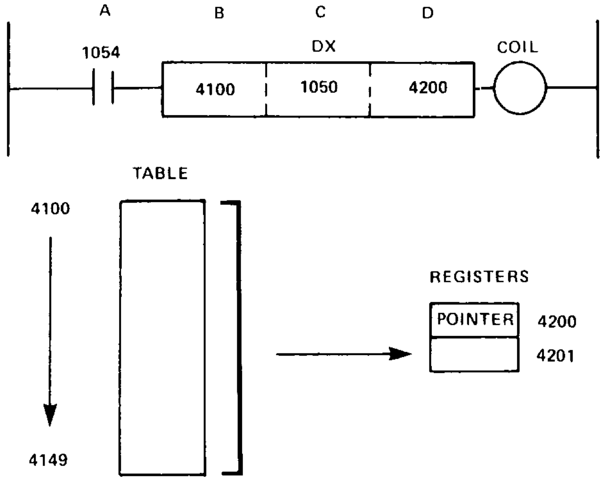


Figure 71. Sample Table to Register Move

11XX — Table-To-Register Move (Continuous)

This code causes one register in a table of registers to be copied into a specific register at the rate of one register per scan as long as the A element contact is closed (passing power). The operation of this function is very similar to code 10XX discussed above, except that the A element does not have to be cycled ON-OFF-ON.

For example, assume that Figure 71 has a functional code of 1150 and a 32 in register 4200. On the first scan that input 1054 is energized, register 4132 will be copied into register 4201 and the contents of register 4200 incremented by one to 33. On the next scan, assuming input 1054 remains energized, register 4133 will be copied into register 4201 and the contents of register 4200 incremented to 34. This operation will continue until either input 1054 is de-energized or the end of the table is reached. If, after 10 scans, input 1054 is de-energized, the number 42 will be in register 4200 and register 4201 will contain the contents of register 4141. When input 1054 is re-energized, the move will commence from where it was and copy register 4142 into 4201, incrementing the contents of 4200 to 43.

Once the end of the table is reached, register 4200 will contain a 50, the contents of register 4201 will be the same as register 4149, and the coil will be ON. Only after input 1054 is de-energized will the coil be OFF and register 4200 cleared to zero; register 4201 will still contain the contents of register 4149 until another move is performed.

12XX — Register-to-Table Move (Incremental)

NOTE

The register-to-table moves (12XX and 13XX) are useful to load tables with new data, retain multiplexed input data, or store error information for future use.

This code causes the contents of one register to be copied into a table of registers upon closure of the A element contact. To load the next register of the table in sequence, the A element contact must be opened and closed again. As an example, refer to Figure 72.

Assume that input 1034 is not energized and register 4001 contains the number 11. On the first scan that input 1034 is energized, the contents of register 3001 will be copied into register 4013 and the contents of register 4001 will be incremented by one to 12.

On subsequent scans, no operation will be performed until 1034 is de-energized and then re-energized. If register 4001 contained the number 14 and 1034 was energized, the contents of register 3001 would be copied into register 4016, the contents of register 4001 would be incremented by one to 15, and the coil would come ON. The coil will remain ON until output 1034 is de-energized, at which time register 4001 would be cleared to zero, and the coil turned OFF.

Note that the B element refers to only one register and the D element refers to 16 sequential registers, one for the pointer and the table of length 15 immediately following the pointer.

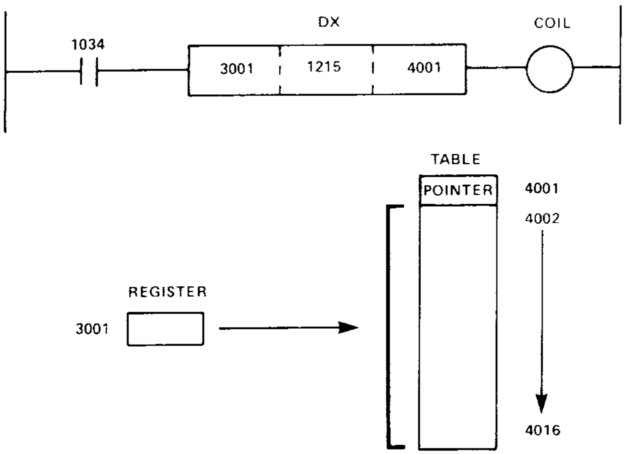


Figure 72. Sample Register to Table Move

13XX — Register-to-Table Move (Continuous)

This code causes a register to be copied into a table of registers at the rate of one register per scan as long as the A element contact is closed (passing power). The operation of this function is very similar to code 12XX discussed above except that the A element contact does not have to be cycled ON-OFF-ON.

For example, assume that Figure 72 has a functional code of 1315 and a 5 in register 4001. On the first scan that input 1034 is energized, register 3001 will be copied into register 4007 and the contents of the register 4001 is incremented to 6.

This operation will continue loading the table from register 3001 until either input 1034 is de-energized to halt operation where it is, or the end of the table is reached. Once the end of the table is reached, register 4001 will contain a 15, register 3001 would have been copied into register 4016, and the coil will be ON. No further moves are possible until input 1034 is de-energized to clear register 4001 to zero and turn the coil OFF.

14XX — Table-to-Table Move (Incremental)

NOTE

The table-to-table moves (14XX and 17XX) are useful to load working registers with various recipe-type data or drive outputs in multiple groups of 16 devices, each group wired to a register output.

This code causes the contents of a register in a table of registers to be copied into a corresponding register of another table upon closure of the A element contact. To transfer the next register in the table, the A element must be opened and then closed again. As an example, refer to Figure 73.

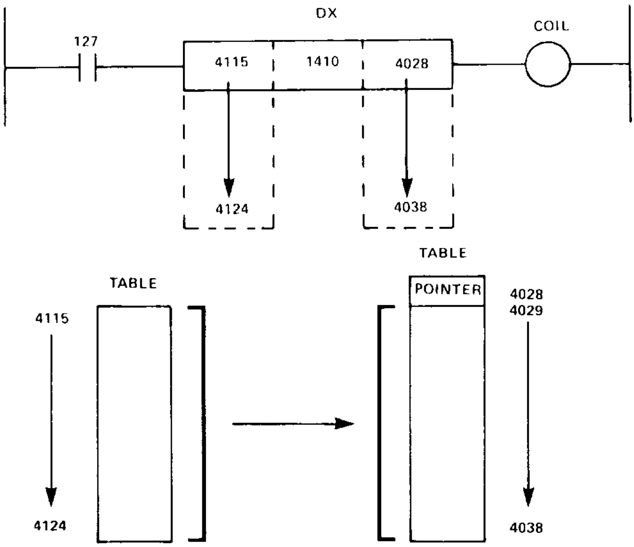


Figure 73. Sample Table to Table Move

NOTE

In Figure 73, the tables are symbolically appended to the DX line, elements B and D. Many designers use this technique to document DX moves. However, it is to be emphasized that only the first register of each table is actually entered into the DX line.

Assume that line 127 is not energized and register 4028 contains the number 2. On the first scan that line 127 is energized, the contents of the third register of the table starting at 4115 (i.e., register 4117) will be copied into the third register of the table starting at 4029 (i.e., register 4031) and the contents of register 4028 will be incremented by one to 3. Since there is only one pointer register, transfers will always take place into table locations with the same element number as the source.

If it was desired that the transfer be offset in the example of Figure 73 so that the third element of table 4115 be transferred into the first element of table 4029, the B element register should be changed to 4117 and the functional code changed to 1408 (table length of eight). A similar alteration of the receiver table is not possible without additional operations, since the pointer location would also change. Thus, if it were desired to transfer the first element of table 4115 into the third element of table 4029, a functional code of 1408 and D element register of 4030 would result in the pointer (value 0-8) being written over the second element of table 4028. In this case, the contents of 4030 should be saved before the move and restored after the move is completed.

Note that the B element refers to 10 sequential registers and the D element to 11 sequential registers where a functional code of 1410 is utilized. The coil will be energized when the pointer equals the specified table length and the A element contact is closed (passing power). The pointer is cleared to zero and the coil de-energized after it was energized if the A element contact is opened when the end of the table is reached.

17XX — Table-to-Table Move (Continuous)

This code causes the content of one register in a table of registers to be copied into the corresponding register of another table at the rate of one register per scan as long as the A element contact is closed (passing power). The operation of this function is very similar to code 14XX discussed above except that the A element does not have to be cycled ON-OFF-ON.

For example, assume that Figure 73 has a functional code of 1710 and a four in register 4028. On the first scan that line 127 is energized, register 4119 will be copied into 4033 and the contents of register 4028 incremented by one to 5. On the next scan, assuming line 127 remains energized, register 4120 will be copied into register 4034 and the contents of register 4028 incremented to 6. This operation will continue until either line 127 is de-energized or the end of the table is reached. Once the end of the table is reached, register 4028 will contain a 10; table 4115 will be completely copied into table 4029, and the coil will be ON. Only after line 127 is de-energized will the coil be OFF and register 4028 cleared to zero.

15XX — First In, First Out (FIFO) Load

NOTE

> The FIFO moves (15XX and 16XX) are useful to temporarily store data that may occur in large groups and provide it in a slower more continuous rate or to move data associated with equipment synchronized to the external movement of a conveyor or tranfer system (e.g., a 99-stage shift register with 16 bits available in each stage).

This code causes the contents of a register to be copied into the last available register of a table when the A element contact is closed; the new data is thus immediately stacked above any existing data. For subsequent moves, the A element contact must be opened and then closed again. The coil will come ON after the last available register in the table is utilized (table full) and will be OFF only after data is removed from the table by 16XX function; the coil status is not affected by the condition of the A element contact. For example, refer to Figure 74, line 316.

Assume that line 275 is not energized and there are still three previous entries in the FIFO stack; thus the pointing register (4100) will contain the number 3. On the first scan that line 275 is energized, the contents of register 4011 will be copied into the FIFO table immediately above the existing thee entries, thus into register 4117 (4100 + 20 − 3) and the contents of register 4100 will be incremented by one to indicate four valid entries now in the table.

The data in register 4011 will be retained and the previous contents of register 4117 destroyed. If register 4100 contained the number 19 before the move, after the move the coil for line 316 would be ON and the number 20 would be in register 4100. The coil would remain ON regardless of the condition of the A element contact and all future moves into this table would be ignored until the contents of register 4100 was reduced to less than 20.

Note that the B element reference is to a single register and that the D element is to 21 registers.

16XX — First In, First Out (FIFO) Remove

This code, upon closure of the A element contact, causes the contents of the last register in a table to be copied into a specific register, and the contents of all remaining registers in the table containing valid data are moved down by one to their next registers. For subsequent moves, the A element contact must be opened and then closed again. The coil will come ON after the last valid entry in the table is removed (table empty) and will be OFF only after data is entered into the table by a 15XX function; the coil status is not affected by the condition of the A element contact. For example, refer to Figure 74, line 317.

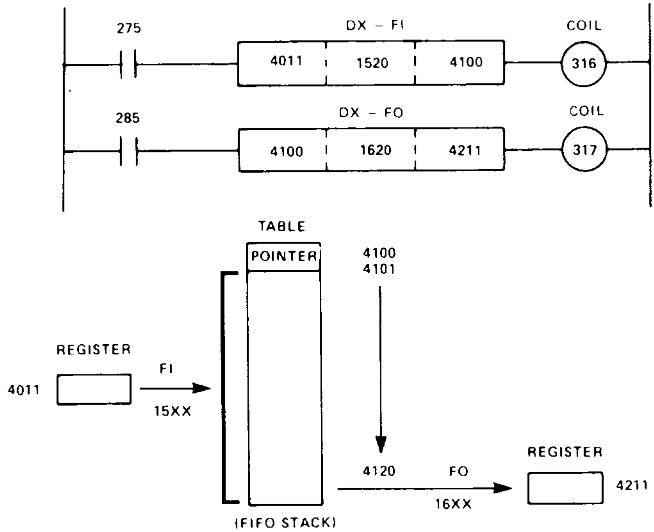


Figure 74. Sample FIFO Stack

Assume that line 285 is not energized and register 4100 contains a 7, indicating that there are seven valid entries in the FIFO stack. On the first scan that line 285 is energized, the contents of register 4120 will be transferred to register 4211, the six remaining valid registers will be copied into their following registers (i.e., 4119 into 4120, 4118 into 4119, etc.), and register 4100 will be decremented by one to 6. If register 4100 contained a one before the move, after the move the coil for line 317 would be ON regardless of the condition of the A element contact and all future moves out of this table would be ignored, until the contents of register 4100 was increased above zero.

Note that the B element refers to 21 registers and the D element to 1. This function is the only one wherein the B element reference is to a pointer. Since the pointer reference keeps track of how many valid registers there are in the FIFO stack, it must be shared between the 15XX and 16XX functional codes.

When data is removed from the FIFO stack, the uppermost register containing valid data is copied into a lower register, but its contents will remain in the previous register. Since the pointer is decremented by one, the uppermost register that contained valid data, and now contains invalid data, will be rewritten on the next load (15XX) move.

NOTE

Function code 17XX is discussed after function code 14XX.

NOTE

Function codes 18XX and 19XX (384A and 384B only) are discussed in section 3.7.

EXAMPLE IV — Operator Monitor and Change of Registers

In many cases, the operator must be provided with the capability of monitoring and possible altering the contents of a large number of registers within the Controller without using the Programming Panel. These registers can be presets on timer/counter lines, current time or counts, set points for compares, recipe data, etc. The quantity of registers that are to be altered can be the same as or fewer than the monitored registers. A typical operator's panel and logic lines are shown in Figure 75.

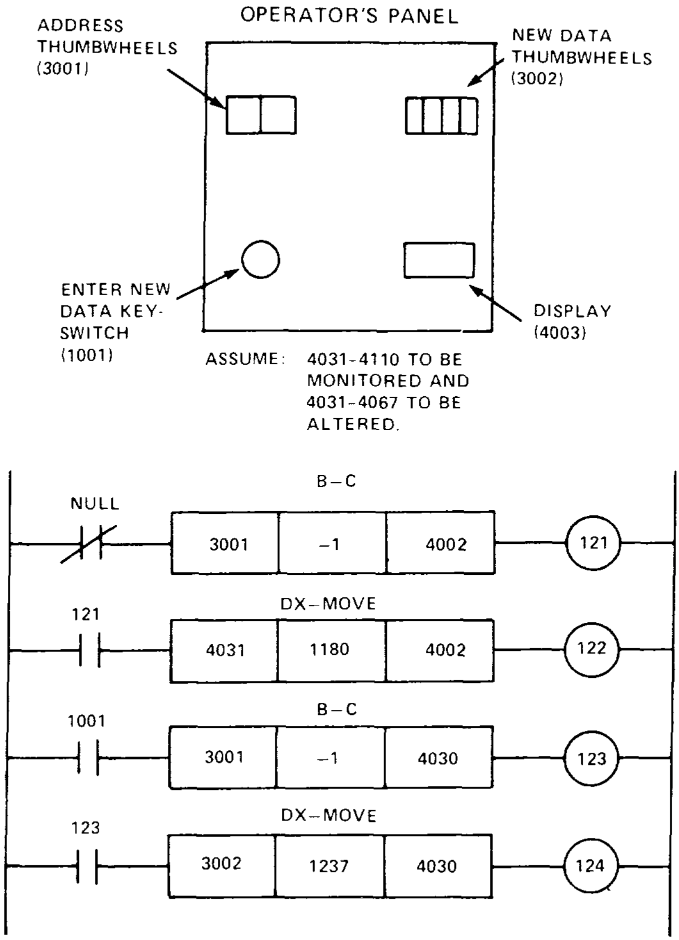


Figure 75. Example: Operator Monitor and Change of Registers

The operator's panel contains two sets of thumbwheels; in this example one set of two digits (0-99) wired to input register 3001 and the other of four digits (0-9999) wired to input register 3002. A single BCD display of four digits is wired to output register 4003, and a keylock switch to provide security is wired to discrete input 1001. If more than 99 registers are to be monitored, the thumbwheels connected to 3001 can be increased to three digits (0-999).

In this example, numerical data is placed in registers 4031-4110. If these registers contained binary status used to drive outputs, or with matrices, input register 3002 should be coded binary and connected to 16 separate toggle switches; output register 4003 should also be coded binary and connected to 16 separate status lamps.

Since the A element of line 121 is referenced to a coil that is never energized (i.e., null data relay line, input that is not wired up, etc.), line 121 always obtains the contents of 3001, subtracts 1 from it, and forces the pointer register 4002 to that value. Line 122, every scan that the A element is closed, obtains from the table of length 80 (starting with 4031), the element referred to by the pointer and places it in 4003 for display. Line 122 is inhibited from progressing through the table at one element per scan as it normally would, since line 121 is always forcing the pointer back to its required value. However, every time a new value is entered into 3001, the corresponding element is automatically extracted from the table; no action is required by the operator, other than to change the value on the thumbwheel connected to 3001. If the thumbwheels are set to zero, no action is desired since there are no elements in the table with the number or address of zero. Line 121 will still take the zero on 3001, subtract one from it, and place the result (a 1) into 4002. However, since this is a *negative* one, its coil does not come ON and no move is performed by line 122; whatever value was in the display remains there. If the value on 3001 exceeds 80 (the length of the table which the operator is allowed to monitor), no moves are performed since the pointer will be forced to 80 or greater, and line 122 is limited by the DX code to 80 registers.

Altering the data is performed in a similar manner. The operator enters on 3001 the element he would like to change, views its current contents on 4003, enters the new value on 3002, and closes the keylock switch. If he does not have a key, he cannot make changes. When the keylock switch (input 1001) is closed, line 123 forces the pointer and line 124 moves the data from 3002 into the table; the display will automatically verify entry of the new data. Again, entry of data into element zero is prevented by coil 123 used in the A element of line 124 and entry of data into registers beyond 4067 (table length 37) is inhibited by the DX function code.

This monitoring capability requires only four logic lines and provides monitoring/altering capability for up to 99 consecutive registers. If more than 99 registers are required, additional capacity can be added at the rate of five logic lines per additional 99 registers or fraction thereof. This monitoring scheme does not in any way affect the use of these registers as presets (C element) in timers/counters, set points (C element) of calculate lines, current times or counts (D element), etc. They can and should be used by other logic lines in the program as required. To be fully confident in this example, select some values between 1 and 80 and test the effects of these logic lines.

Compare the efficiency of this method using Data Transfer with Example III where calculate lines are utilized. These four logic lines using DX provide monitoring and altering of up to 99 registers; 99 calculate lines provide monitoring only of 99 registers.

3.5.2 Matrix Handling (Group 2YXX)

These codes provide the capability to manipulate data as binary bits, either in large segments or as individual bits. The following functions are available with this group:

Basic		**Improved**	
20XX	Logical AND	25XX	Complement
21XX	Logical OR (Inclusive)	26XX	Logical OR (Exclusive)
22XX	Matrix Compare	27XX	Rotate Left
23XX	Clear Bit or Sense Bit	28XX	Rotate Right
24XX	Set Bit or Sense Bit	29XX	Sequencer Move

NOTE

All 184 Controllers with matrix provide the basic capability; only those executives specifically noted in Table 12 as having the improved capability provide codes 25XX-28XX. All 384 Controllers are provided with both Basic and Improved Matrix capabilities regardless of TEF selected. Only 384A and 384B Controllers can utilize code 29XX, unless specifically noted in Table 12.

Matrices are defined as sequential registers, each of 16 bits, up to a maximum of 99 registers (1584 bits). The size of the matrix in registers is defined by the XX digits of the functional codes. The individual bits of a matrix are numbered 1 through 1584 depending on their location in the matrix. The numbering begins at the high-order bit of the first register and continues left to right, as one would read lines of a page in a book, until the low-order bit of the last register is reached. The last bit of each matrix will be evenly divisible by 16.

For example, Figure 76 illustrates the numbering of a 5-register (80-bit) matrix. The quantity of bits in any matrix is always mutiples of 16; the smallest matrix is one register (16 bits) in length. A bit can be described as ON, ENERGIZED, VALID, SET, or TRUE if its numberical value is one (1); OFF, DE-ENERGIZE, INVALID, CLEAR, or FALSE can be used to describe a bit whose numerical value is zero (0).

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	FIRST REGISTER
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	#2 REGISTER
33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	#3 REGISTER
49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	#4 REGISTER
65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	#5 REGISTER

Figure 76. Typical Matrix Bit Numbering

When receiving binary data via input registers (30XX), including analog inputs, these registers must be coded in the I/O Allocation Table (part of the executive) as binary registers. If they are not coded as binary register, the data obtained from the input modules will first have its bits interpreted as a BCD number. See 4.1.4 for additional details. A similar modification must be made to provide binary (NOT BCD) data to the output modules from holding registers (40XX). Figure 77 provides two examples of outputting binary data from register 4208 via a BCD coded register (4006).

Note that if the resultant magnitude of the 16 bits in any register is greater than 9999, an incorrect BCD display will occur. Also viewing a binary register from the Programming Panel results in a binary-to-BCD conversion. Table 13 summarizes the resultant BCD display for various bit configuration. If output register 4006 of Figure 77 was coded as binary in the I/O Allocation Table, the bit pattern in 4208 would be copied into 4006 without change.

All Matrix operations are accomplished in their entirety every scan the A element is closed (passing power), regardless of the length of the matrices.

Table 13. P112 Hexadecimal Symbols

Bit Configuration	Display	
0000	0	
0001	1	
0010	2	
0011	3	
0100	4	
0101	5	
0110	6	
0111	7	
1000	8	
1001	9	
1010	⊏	(10)
1011	⊐	(11)
1100	⊔	(12)
1101	⊑	(13)
1110	Ŀ	(14)
1111	(blank)	(15)

20XX — Logical AND of Two Matrices

NOTE

The Matrix AND and OR operations are useful to construct masks within the Controller as well as to move blocks of data in one scan.

This code, when the A element is closed, causes the contents of the matrix referred to in the B element to be logically ANDed with the contents of the matrix referred to in the D element and the result stored in the D element matrix. This operation is accomplished on a bit-by-bit basis and is done every scan as long as the A element is passing power; the entire AND operation is done once each scan. The contents of the B element matrix is retained and the previous content of the D element matrix is destroyed and replaced with the result of the AND operation.

For a one (1) to appear in the D element matrix after the AND operation, a one (1) must appear in both the B element matrix and the previous D element matrix; in all other cases, a zero (0) will appear in the resulting D element matrix. The coil has no significance, and is OFF in all cases. As an example, refer to Figure 78.

The B element refers to three consecutive registers (4166-4168) as does the D element (4009-4011) since the functional code has defined each matrix as three registers in length. In all cases, matrix AND will be accomplished on matrices of equal length. For this example, on the first scan that input 1021 is energized, a bit-by-bit AND will be performed between registers 4166-4168 and registers 4009-4011, and the result stored

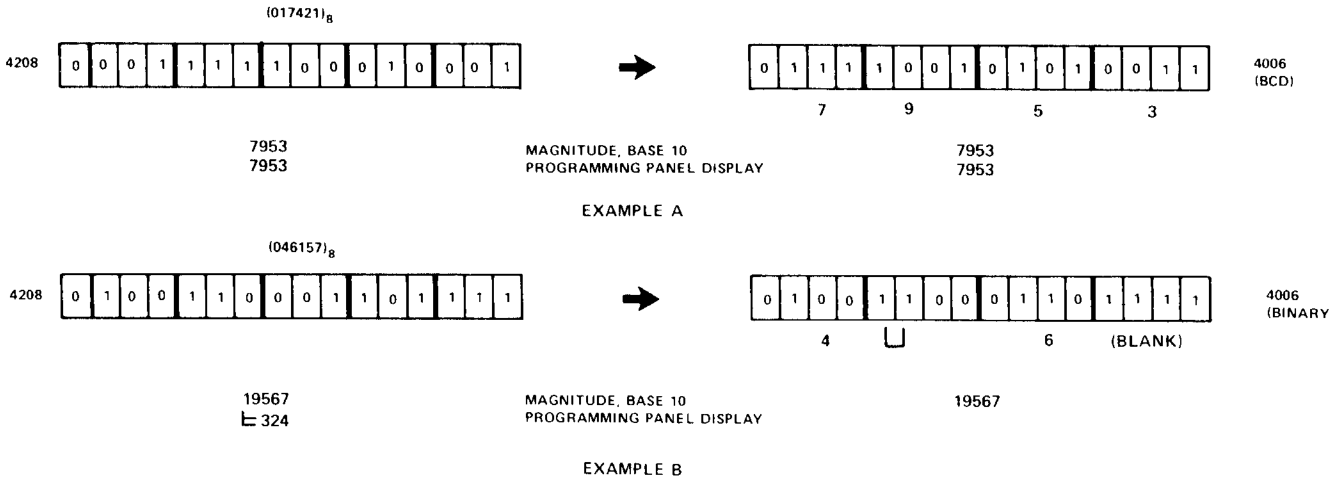


Figure 77. Programming Panel Display of Binary Data

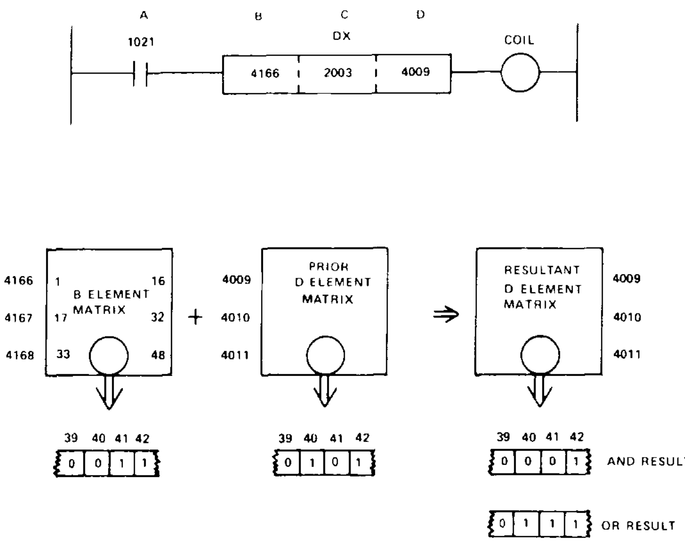


Figure 78. Sample Matrix AND and OR

in registers 4009-4011 assuming these output registers are coded for binary data. All bits in the matrices will be ANDed each scan the A element is passing power.

On subsequent scans, an AND operation is performed between the B element matrix and the resultant D element matrix; as long as the B element matrix does not change, the resultant D element matrix will not be altered.

If a one (1) in the B element matrix is changed to zero (0), the D element matrix will have a zero (0) in that location, even if the bit in the B element matrix is changed back to a one (1). Specific examples are provided by observing the operation of bits 39-42. Since there is a zero (0) in the B or previous D element matrices (or both) for bits 39-41, the resultant D element matrix contains a zero (0) for these bits. Only bit 42 has a one (1) in both matrices and thus has a one (1) in the resultant matrix. At no time will the coil be energized.

21XX — Logical OR (Inclusive) of Two Matrices

This code, when the A element is closed, causes the contents of the matrix referred to in the B element to be logically ORed with the contents of the matrix referred to in the D element, and the result stored in the D element matrix. This function operates similar to code 20XX discussed previously, except that a logical OR is performed between the two matrices. As an example, assume that the functional code of Figure 78 was 2103. The only difference in operation would be the specific results; bits 39-42 of the resultant D element matrix would contain a 0, 1, 1, 1, respectively.

Since only bit 39 has a zero (0) in both the B element matrix and the prior D element matrix, it is the only bit to contain a zero in the resultant matrix; all other bits are set to one (1). Thus, the logical OR will result in a one (1) if either matrix contains a one (1); it will result in a zero (0) only if *both* matrices contains a zero (0). Note that since this is an *inclusive* OR, a bit that is one (1) in both matrices will be a one (1) in the resultant matrix. Again the coil will be OFF in all cases. On subsequent scans, if the B element matrix has a zero changed to a one, the D element matrix will have a one in that location, even if the bit in the B element matrix is changed back to a zero.

22XX — Matrix Compare of Two Matrices

NOTE

The matrix compare is useful to monitor the status of large numbers of inputs or states as well as to detect changes in bit status. It is a very useful function.

This code, when the A element is closed, causes the contents of two matrices to be compared on a bit-by-bit basis. The compare operation will continue until a miscompare is observed, which will cause the coil to be energized and the compare terminated, or until the end of the matrices is reached. If the matrices compare exactly, the coil remains OFF and the next line of logic is performed.

The B element register refers to the first register of one matrix; the remaining registers of this matrix must follow this reference in ascending order. The functional code in the C element defines both the operation and the length in registers (XX) of each matrix. The D element register refers to a pointer register where the bit number that is currently being compared is stored; registers for the second matrix of the compare must follow this pointer register in consecutive order. Thus the B element register refers to XX registers and the D element register refers to XX+1 registers.

The contents of the pointer register is incremented by one before a compare is accomplished and will not be changed when a miscompare is encountered. Thus the bit number causing the miscompare is available from this pointer register after completion of a compare with coil ON; if no miscompare was detected (coil OFF), the pointer register will contain the bit number of the last bit in the matrix plus one.

NOTE

If more than one miscompare occurs in a matrix, the coil will remain ON for successive scans until the end of the matrix is reached, and the pointer register will contain (for one scan) each successive bit number that miscompares.

The compare is always begun at the bit referred to by the contents of the pointer register *plus* one (1), unless this value exceeds the number of bits in the matrix, in which case the comparison begins with the first bit of each matrix. The contents of the pointer register will exceed the number of bits in the matrix if the compare is restarted after a successful compare (i.e., next scan, if A element contact remains closed), since the pointer register would contain the bit number of the last bit in the matrix plus one, and that value would be incremented by one at the start of the next compare; or the pointer register could be forced to any value by other logic lines. The contents of either matrix are *not* altered by this function; only the pointer and coil status change.

As an example, refer to Figure 79 and assume register 4372 contains a zero. When input 1056 is turned ON, the comparison will begin with bit one (1) and continue until either a miscompare or the end of the matrix is encountered. Assume that at bit 23, a miscompare occurs; either a one (1) is in the B element matrix and a zero (0) in the D element matrix or vice-versa. The coil will be energized and the scan continued with the next line of logic; the pointer register will retain the value 23.

If input 1056 remains ON, and the contents of register 4372 has not been altered, on the next scan the comparison will be restarted from where it was last terminated, by comparing bit 24. If the second miscompare was encountered at bit 56, for example, the compare will be terminated a second time, the coil will remain energized, and register 4372 will contain the value 56.

Note that the location of the first miscompare is lost unless it is copied to another location (e.g., register-to-table move, continuous, controlled by the compare coil) before the line is solved again. If no miscompares are located, register 4372 will contain the value 81 and the coil will be OFF.

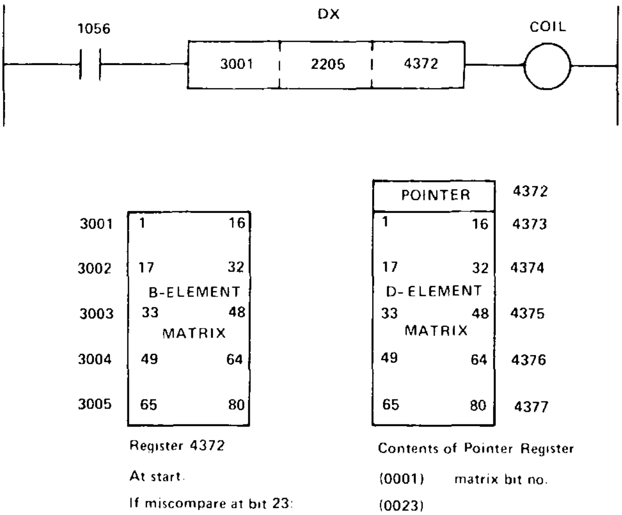


Figure 79. Sample Matrix Compare

On the next scan, assuming input 1056 is still energized, register 4372 will be incremented to 82 and, since this exceeds the size of the matrix as defined by the functional code, it will be reset to one (1) and a comparison will begin again at the first bit.

Note that, in general, either matrix of the compare can be referred to by either the B or D element; however, since the holding register whose value this code alters is associated with the D element, input registers must be referred to only by the B element.

If the last bit of the matrices miscompares, the next compare will be accomplished starting at the beginning of the matrices. Thus the end of the matrices (coil OFF) will not be detected between compares. Using the previous example, if only bit 80 miscompares, the holding register will always contain an 80 and the coil will be ON; the coil will not oscillate between ON (miscompare) and OFF (end of matrix). A calculate line can be used to detect when the pointer is equal to or greater than the number of bits in the matrix; this indicates the compare is at the end of the matrix.

If all bits agree, the entire matrices will be compared (monitored) every scan that the A element is closed regardless of the length of the matrices (maximum 1584 points).

23XX — Clear Bit or Sense Bit

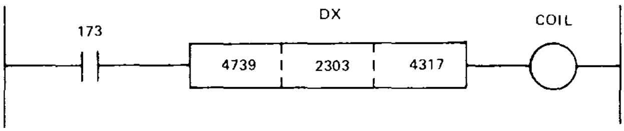
NOTE

The matrix clear and set operations are useful to build matrices within the Controller as well as examine individual bits of any matrix and provide a coil reference for use as a control element in relay symbology.

This code, when the A element is closed, causes a single bit in a matrix to be cleared to zero (0) regardless of its previous value (either a 1 or a 0). The bit number is contained in the B element register, the matrix length in registers is defined by XX of the functional code, and the specific matrix location starts with the D element register.

The operation is performed continuously upon closure of the A element contact; a series of bits can be cleared by changing the value in the B element register with a table-to-register move or by using an input register in the B element. If the A element contact is NOT closed, this line will sense the state of the bit referred to by the contents of the B element register, but not alter it. The coil will be ON if it is a one (1) and OFF it it is a zero (0); the coil will *always* reflect the status of the B element bit, regardless of the state of the A element contact.

The coil status prior to closure of the A element contact will be that of the bit to be operated on and, after closure of the A element contact, the coil will be OFF (since the bit is to be cleared). When utilized as a sense line, an input register can be placed in the D element, since no alteration of this register is required. If an input register is utilized in the D element, closure of the A element contact will have no affect on either the coil status or the matrix contents. The B element register refers just to itself, and the D element register to XX registers — the size of the matrix. As an example, refer to Figure 80.



Bit: 1..........5 6.........10 11...........16

																REGISTER
1	1	0	1	1	0	0	0	1	1	0	1	0	1	1	0	4317
0	1	0	0	1	1	1	1	0	0	1	0	0	1	1	0	4318
1	0	0	1	0	0	1	0	0	1	1	0	1	1	0	1	4319

Bit: 33.......................................48

Figure 80. Sample Matrix Clear Line

Assume that line 173 is OFF and register 4739 contains the value 5. The coil will be ON, sensing the one (1) in the matrix at bit 5. When line 173 is ON, this bit in register 4317 will be cleared to zero (0) and the coil will be OFF. If the value in register 4739 is changed to 10, the tenth bit will be cleared to zero (0).

CAUTION

If an input register is to be used in the B element and is connected to thumbwheel switches, intermediate bits between 5 and 10 could be cleared if the A element contact remains closed while the input register is changed.

If the A element contact is referenced to a null data line, an input that is not utilized, or to an AND or OR logic line (i.e., some reference that will never be energized), this function can be used as a sense line. If line 173 of Figure 80 is an OR logic line (DX line with a 21XX functional code), and register 4739 contains a 23, the coil will be ON and no clearing operation is possible; if register 4739 contains a 44, the coil will be OFF.

If the contents of the B element register exceeds the number of bits in the matrix as defined by the functional code (or is zero), no operation is performed and the coil will be OFF regardless of the state of the A element contact.

24XX — Sense Bit or Set Bit

This code, when the A element is closed, causes a single bit in a matrix to be set to one (1) regardless of its prior value. Its operation is very similar to the 23XX clear function discussed above, except that the bits are set to one (1) in lieu of zero (0). Either functional codes, 23XX or 24XX, provide exactly the same sense functions.

For example, assume the functional code of Figure 80 is 2403, line 173 is OFF, and register 4739 contains the value 6. Initially, the coil will be OFF reflecting the status of the referenced bit. When line 173 becomes valid, bit 6 in register 4317 will be set to one (1) and the coil energized, again reflecting the status of the bit. If the value in register 4739 is changed to 11, bit 11 in register 4317 will also be set to one (1).

If the A element is referenced to a line or input that will not be energized, and register 4739 contains a 23, the coil will be ON and no setting operation is possible; if register 4739 contains a 44, the coil will be OFF.

25XX — Matrix Complement

NOTE

The complement capability is useful to prepare data for comparison when the data is exactly reversed from the source data (e.g., output matrix driving valves, compared to limitswitch inputs from valves, which close when the valve is de-energized).

This code, when the A element is closed, causes the contents of the matrix referred to in the B element to be complemented and the result placed in the D element matrix. Every bit in the B element matrix has its value reversed, zeros replaced with ones and ones replaced with zeros, and the result placed in the D element matrix. The entire matrix is complemented every scan that the A element is closed (passing power). The contents of the B element matrix is retained and the previous contents of the D element matrix is destroyed and replaced with the result of the complement operation. The coil has no significance, and is OFF in all cases.

It is possible to specify the same matrix in both B and D elements, resulting in the complement replacing the source matrix. However, if this is desired, the A element should be referenced to a one-shot to prevent the matrix from being complemented a second time during the next scan. As an example, refer to Figure 81.

The B element refers to three consecutive registers (4134-4136) as does the D element (4479-4481), since the function code has defined each

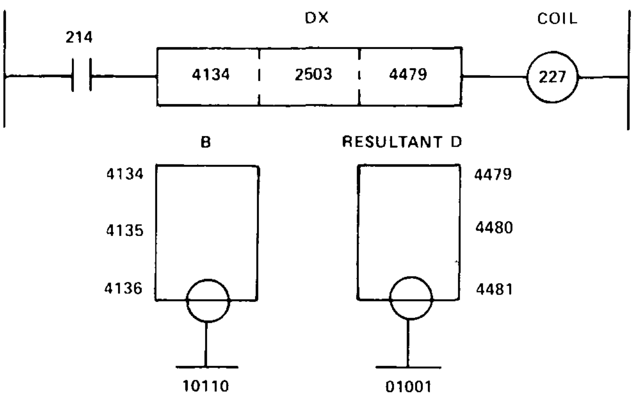


Figure 81. Sample Matrix Complement

matrix as three registers in length. In all cases, matrix COMPLEMENT will be accomplished on matrices of equal length. For this example, on the first scan that line 214 is energized, all bits in registers 4134-4136 will be complemented, and the result placed in registers 4479-4481. The contents in registers 4134-4136 will not be altered and the previous contents in 4479-4481 will be destroyed and replaced with the result of the complement operation. On subsequent scans, the complement operation will be performed as long as the A element passes power. As long as the B element matrix is not altered, the results in the D element matrix will not be altered from its initial value. Note the illustrated effect of five bits in register 4136 and their corresponding results in register 4481.

If the D element reference was changed to 4134 (same matrix referred to in both the B and D matrices), on the first scan 214 was energized, the 10110 in register 4136 will be replaced with 01001. On the next scan, assuming 214 remains energized, 4136 is again complemented, and 10110 (the original value) is placed in register 4136. Thus, every scan, the bits in each register will oscillate between ones and zeros; the result when 214 is de-energized cannot be guaranteed. To prevent this oscillation when using the same matrix in the B and D elements, the A element should be referred to a one-shot that is valid for exactly one scan. In all cases, the coil will not be energized.

26XX — Logical Exclusive OR of Two Matrices

NOTE

The exclusive OR is useful to compare two matrices in one scan and allow specific identification of those bits that miscompared at some future time. After an exclusive OR is performed, a one indicates a miscompare and a zero a compare. These miscompares can be located by comparing (22XX code) the result with a zero matrix (a matrix containing all zeros).

This code, when the A element is closed, causes the contents of the matrix referred to in the B element to be logically ORed (exclusively) with the contents of the matrix referred to in the D element, and the result stored in the D element matrix. This function operates similar to code 20XX and 21XX discussed previously, except the logical Exclusive OR is performed between the two matrices. Since an Exclusive OR is accomplished every scan the A element remains closed, oscillations can occur wherever the B matrix bits are ones; thus the A element references should *always* be to a one-shot. As an example, refer to Figure 82.

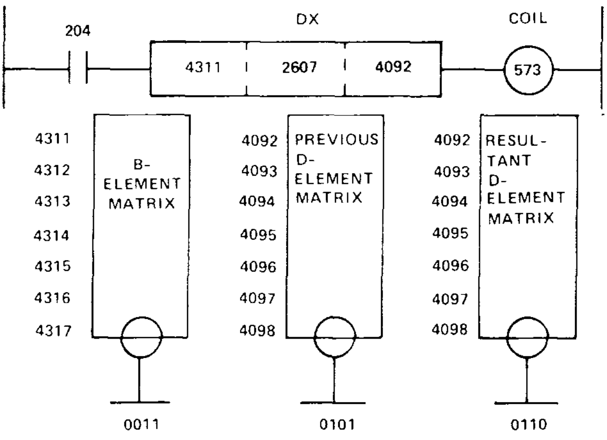


Figure 82. Sample Matrix Exclusive OR

The B element refers to seven consecutive registers (4311-4317) as does the D element (4092-4098), since the function code has defined each matrix as seven registers in length. In all cases, matrix Exclusive OR will be accomplished on matrices of equal length. For this example, on the first scan that line 204 is energized, a bit-by-bit Exclusive OR will be performed between registers 4311-4317 and registers 4092-4098. Note the specific example of four bits provided in registers 4317 and 4098. The result is a one only if there is a one in either the B element matrix or the D element matrix, but not (excluding) if they are both ones.

If line 204 remains energized on the next scan, another Exclusive OR is performed between the retained (not changed) contents of the B element matrix and the new D element matrix. The four bits in register 4097 will become 0101, the original values; to prevent this, line 204 should be a one-shot valid for exactly one scan. The coil on line 573 has no significance and is never energized.

27XX — Rotate Left

NOTE

The Rotate Left and Rotate Right are both useful to form single-bit retentive shift registers or to shift data as required for reformatting.

This code, when the A element is closed, causes the contents of the matrix referred to by the B element to be rotated one position to the left and the result placed in the D element matrix. All bits are shifted down one position, e.g., the status of bit 30 is placed in bit 29, 29 in 28, 17 in 16, 2 in 1, etc. The status of bit 1 is carried around (true rotate not just shift) and placed in the last bit of the matrix. The coil reflects the status of this bit carried around; the coil will be ON if the bit is a one, and OFF if the bit is a zero. For example, refer to Figure 83.

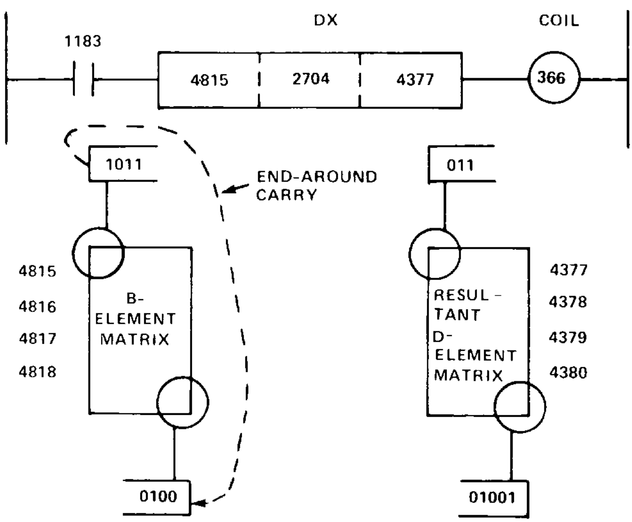


Figure 83. Sample Matrix Rotate Left

The B element refers to four consecutive registers (4815-4818) as does the D element (4377-4380), since the function code has defined each matrix as four registers in length. In all cases, matrix Rotate will utilize matrices of equal length. For this example, during the first scan input 1183 is energized, the contents of registers 4815-4818 will be rotated one position to the left and the result placed in registers 4377-4380; the contents of the B element matrix is not altered and the previous contents of the D element matrix is destroyed and replaced by the result of the rotate. The coil will be ON since the end-around carry bit was a one.

As long as input 1183 remains closed, the rotate will be performed and the coil status not altered, since on every scan the rotate goes back to the B matrix for its initial data. Note the specific status of bits 1-4 and 61-64 of the B element matrix. Bits 61-64 are shifted down to 60-63 and placed in the D element matrix; bit 1 of the B element matrix is placed in bit 64 of the D element matrix; bits 2-4 of the B element matrix are placed in bits 1-3 of the D element matrix.

28XX — Rotate Right

This code, when the A element is closed, causes the contents of the matrix referred to in the B element to be rotated one position to the right and the result placed in the D element matrix. This function operates similar to code 27XX except that the bits are shifted up, status of bit 1 into bit 2, 2 into 3, 16 into 17, 25 into 26, 32 into 33, etc., and the last bit end-around carried to bit 1. The coil is still set to the status of this end-around carried bit.

As an example, assume the function code in Figure 83 is 2804; the only difference in operation would be the specific results. Bits 2-5 of the resultant D element matrix would be 1011; bits 62-64 would be 010; bit 1 would be zero (obtained from bit 64 of the B element matrix); and the coil would be OFF.

A continuous rotate can also be obtained if the same matrix is referred to in the B and D elements of a 27XX or 28XX code. A calculate line can be used to control how long the rotate is performed, and thus how many bits are rotated.

NOTE

Function Code 29XX (384A and 384B only) is discussed in Section 3.7.

Additional 30XX References

Some of the executives that provide matrix capabilities also provide a capability referred to as Additional 30XX References. Input registers normally start at channel III and up to 16 are provided with any executive (3001-3016). However, it is possible to develop and executive that provides input registers in all four channels, maximum 32 input registers (3001-3032). Thus these additional references start at 3033, which has no possible meaning relative to the hardware I/O.

The contents of 3033 are controlled by the coil status of logic lines 1-16. If the coil of line one is ON, bit one in register 3033 will be a 1; if coil one is OFF, bit one will be a 0. The same technique is used to determine that status of bits 2-16 from coils 2-16. These additional references continue at 16 lines per register, until the last logic line is used. For example, if the MOPS provides 608 lines, the additional references used for coil status will be 3033-3070; bit 16 of register 3070 is controlled by line 608, the WDT line.

With additional references, the logic to drive discrete outputs (e.g., lines 1-256) can be built with simple relay logic; but their status is also available in registers 3033-3048 for monitoring by matrix compare lines. The additional references bridge the gap between discretes and registers.

The next additional reference after the logic lines (e.g., 3071) reflects the status of inputs 1001-1016. If input 1001 is energized, bit one in register 3071 is a 1; if 1001 is de-energized, bit one is a 0. These references continue at 16 inputs per reference until the limit of discrete inputs is reached (e.g., 3071-3086 if 256 inputs are provided). Discrete inputs are thus available as discrete references and as a bit in a register for matrix operations. For an example of additional references, see Table 14 which assumes 608 lines and 256 discrete inputs.

EXAMPLE V — Monitoring of Discrete Inputs Versus Outputs

Assume discrete outputs 81-160 are used to drive 80 solenoid valves with standard relay logic. On each valve is a limitswitch that closes when the valve goes to the energized position. A monitoring system is required that constantly compares the outputs against the limitswitches to ensure all energized valves go to their proper position and that, when de-energized, the valves do not remain in the energized positions.

Table 14. Example Additional 30XX References (608 Lines, 256 Discrete Inputs)

Register	Contents Controlled by Lines	Register	Contents Controlled by Lines	Register	Contents Controlled by Inputs
3033	1-16	3052	305-320	3071	1001-1016
3034	17-32	3053	321-336	3072	1017-1032
3035	33-48	3054	337-352	3073	1033-1048
3036	49-64	3055	353-368	3074	1049-1064
3037	65-80	3056	369-384	3075	1065-1080
3038	81-96	3057	385-400	3076	1081-1096
3039	97-112	3058	401-416	3077	1097-1112
3040	113-128	3059	417-432	3078	1113-1128
3041	129-144	3060	433-448	3079	1129-1144
3042	145-160	3061	449-464	3080	1145-1160
3043	161-176	3062	465-480	3081	1161-1176
3044	177-192	3063	481-496	3082	1177-1192
3045	193-208	3064	497-512	3083	1193-1208
3046	209-224	3065	513-528	3084	1209-1224
3047	225-240	3066	529-544	3085	1225-1240
3048	241-256	3067	545-560	3086	1241-1256
3049	257-272	3068	561-576		
3050	273-288	3069	577-592		
3051	289-304	3070	593-608		

Assuming the limitswitches are connected to discrete inputs 1129-1208 for use in the relay logic, Figure 84 is an example of the logic that will perform this monitoring. Referring to Table 14, discrete outputs 81-160 control the contents of registers 3038-3042 and discrete inputs 1129-1208 control registers 3079-3083. Line 325 clears all five registers in the compare matrix (4487-4491) to zero every scan by ANDing them with zero. The zero matrix is loaded initially with zero, and never altered; thus it always contains known zeros unless action is taken to alter its contents. Line 326 moves the contents of registers 3079-3083 (inputs 1129-1208) into the compare matrix by ORing them with a known zero placed in the matrix by line 325. This is required since an input register (3079-3038) cannot be placed in the D element of a DX compare line. Line 327 does the actual comparing between the outputs (3038-3042) and the inputs (loaded into 4487-4491). Coil 327 will be ON if any miscompares are detected and the contents of 4486 will be the bit number (valve) that caused the miscompare.

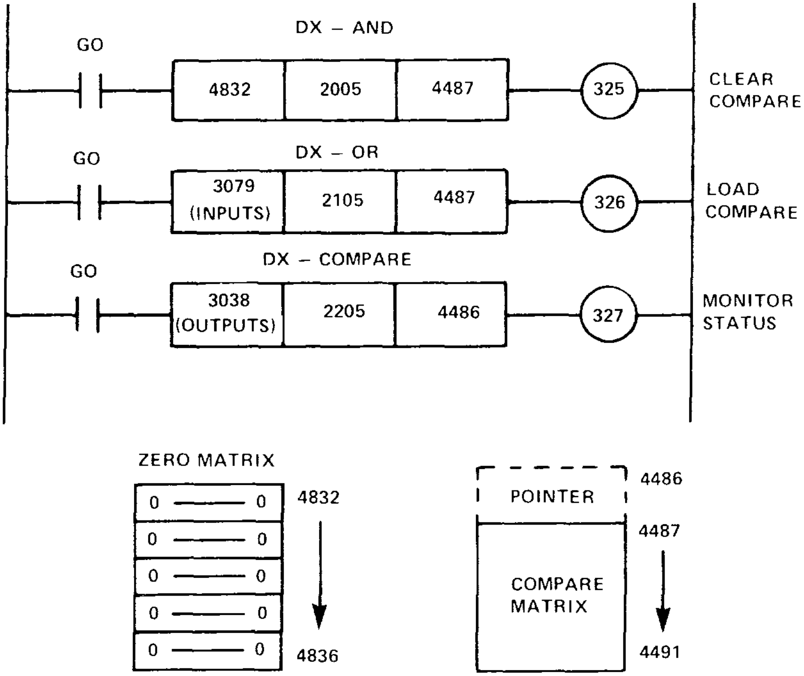


Figure 84. Example: Monitoring of Discretes

Since the matrix operations are accomplished every scan in their entirety, all inputs are compared once a scan until a miscompare is detected; one miscompare is detected every scan. The GO contact controls when the compare is enabled and can be a normally-closed contact reference to null data if constant comparisons are required. Note that the comparison is not affected by whether the output is energized or de-energized; if it does not compare (i.e., energized output and open limitswitch, or de-energized output and closed limitswitch) coil 327 will be ON. Timers can be incorporated such that a miscompare must be detected for a continuous time period (e.g., 0.5 seconds, 2.0 seconds, etc.) before action is taken. If more or less valves or other devices are to be monitored, the only action required is to change the DX function codes to adjust the size of the matrices; these three logic lines (9 words of core memory) perform the monitoring function for one to 99 registers of data (16 to 1584 devices).

If a second limitswitch is incorporated on each valve that is closed when the solenoid valve is de-energized, and open when it is energized, another comparison can be made to detect valves that "hang up" between limits. Lines 325 and 326 are duplicated with a single complement line (25XX) that will take these limitswitch inputs, complement their status, and place the result into a COMPARE matrix. A complement is required so that direct comparisons can be made to the output lines. For example, if an output is energized, a one is placed into the matrix starting at 3038; however, since these new limitswitches are open when the valve is energized (opposite of first limitswitches), a zero is placed into their input matrix. Direct comparisons will result in a miscompare whenever the valves are operating properly. To correct this, the inputs from these new limitswitches are first complemented, then direct comparisons are made and miscompares only occur when malfunctions are detected.

Various actions are possible when a miscompare is detected, as with a fault diagnostic system. The malfunction can be printed on the P500 Printer; operator alerted by lights, bells, displays, etc.; process shut down or next step not allowed; machine forced to a safe condition; etc. Which action is selected depends upon the specific application and system design requirements. Two items are available to support whatever action is taken; the compare coil (e.g., line 327) will be energized and the pointer (e.g., register 4486) will contain the bit number (related to the specific valve) that caused the miscompare.

EXAMPLE VI — Matrix Retentive Shift Register

The matrix rotate capability can be utilized to develop a retentive shift register, driven by basically three logic lines (9 words of core memory), up to 1584 stages. Either rotate function (27XX-left or 28XX-right) can be used with equal efficiency; Figure 85 illustrates a shift register built using the 2803 DX line to form a 48-station shift register. Line 497 shifts the contents of the three-register matrix, which starts at register 4757, one position to the right and places the result back into the same registers. To ensure that only one shift is made, the shift input should be a one-shot. Since the rotate function also takes the status of the last bit (e.g., 48th bit) and places it into the first bit, line 498 will always clear the first bit whenever the end-around carry is a one (coil 497 energized). Line 499 places one in the first stage of the shift register whenever commanded by the input signal. If a one is not placed in this stage by the time the next shift is performed, a zero is shifted into the shift register.

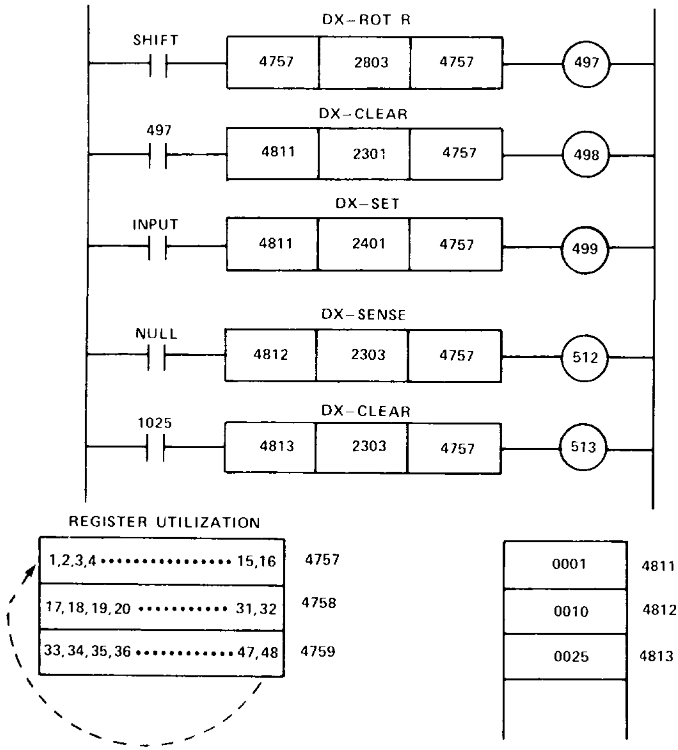


Figure 85. Example: Matrix Shift Register

Coil 497 can represent the output of the shift register if this output is required for only one scan. Otherwise, a sense line similar to line 512 can be utilized for continuous output status. In addition, a sense line can be provided to obtain the status of any stage of the shift register. Line 512 currently provides the status of the tenth stage since register 4812 contains a ten; if register 4812 contents are altered, another stage's status is obtained. Coil 512 is ON for a one in the stage and OFF for a zero. Parallel entry of any stage can also be provided with clear and set lines similar to line 513. This line is currently designed to clear stage number 25 when input 1025 is energized, since register 4813 contains a 25; a similar line with a 2403 code can be utilized to set any stage to a one. It is to be noted that lines 497-499 are the basic drive for this shift register; lines similar to 512 and 513 can be added if the application requires. If more than 48 stages are required, the DX code in line 497 is increased to provide 16 stages per additional register; a DX code of 2899 provides 1584 stages. Since the shift register is built in holding registers, it is retentive upon power failure.

3.5.3 Extended Arithmetic (Group 3YXX)

These codes provide the extended arithmetic capability so that multiplication, division, and other special functions can be accomplished. The resultant product of a multiply operation and the dividend prior to a divide operation are stored and referred to within memory as double-precision. This implies that the magnitude may exceed the capability of one register and thus two registers are allotted to store this value; one register contains the four high-order digits (tens of millions through tens of thousands) and the next register in sequence contains the four low-order digits (thousands through units). This concept is important since the result of a multiply must be evaluated from the contents of both registers, and preparation for division must include loading two registers.

When either a multiply or divide operation is performed, the coil will come ON to indicate successful accomplishment. The following are valid functional codes currently available with the extended arithmetic capability. All 184 executives with this capability are provided with the four multiply/divide codes; only selected executives also provide the special functions (see Table 12). All 384 controllers are provided with the four multiply/divide codes; the 384A and 384B are provided with all eight codes (Basic plus Special).

	Basic		**Special**
3000	General Multiply	34XX	PID (Seconds)
3100	General Divide	35XX	PID (Minutes)
32XX	Multiply by XX	36XX	SORT (Ascending)
33XX	Divide by XX	37XX	SORT (Descending)

The multiply/divide functions are performed only once on closure of the A element contact and are completed prior to commencing operation on the next line of logic.

3000 — General Multiply

This code causes the contents of the B element register to be multiplied by the contents of the register immediately following the B element register, and the resultant product deposited as a double-precision number in the D element registers. The multiply is accomplished only on transition of the A element from OFF to ON; the coil will come on at the completion of this line. Both the B element and the D element refer to two consecutive registers; their contents are entered and read as four BCD digits.

For example, refer to Figure 86 and assume input 1035 is not energized.

If the input registers contain the values 976 and 42 as illustrated, on the first scan that input 1035 is energized, the product (40,992) of 976 and 42

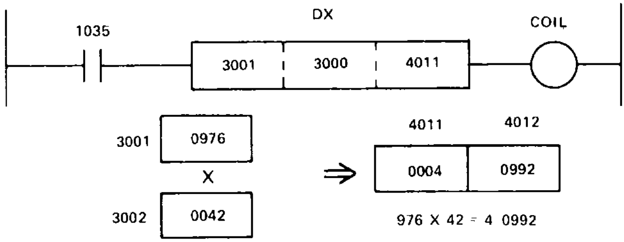


Figure 86. Sample Multiply

will be deposited into registers 4011 and 4012 as a double-precision number, and the coil energized. Note that the resulting product is separated with the four low-order digits being placed in the low-order product register (D element reference plus one) and the high-order digits (with leading zeros) placed in the high-order product register (D element reference). If the input registers change their values, input 1035 must be cycled ON-OFF-ON to produce a new product. The coil will be ON after the product is available and will remain ON until input 1035 is de-energized. Either or both B element registers can be zero.

NOTE

> There are no conditions under which the coil of a multiply will not come ON as long as the A element contact is closed (passing power).

3100 — General Divide

This code causes the contents of the B element registers (double-precision) to be divided by the contents of the register referred to by the B element plus 2. The resultant quotient is stored in the D element register, with any remainder stored in the D element register plus 1. The divide operation is performed only when the A element contact is closed; its results are available prior to commencing the following line of logic.

The B element register refers to three consecutive registers and the D element register to two consecutive registers; their contents are entered and displayed as four BCD digits. The coil will come ON only if the operation is successful. Division by zero (0) or a resultant quotient too large (greater than 9999) to be stored in one register are both valid reasons for the coil to remain OFF; if the coil is not ON, the contents of any register will not be altered.

For example, refer to Figure 87 and assume line 413 is not ON.

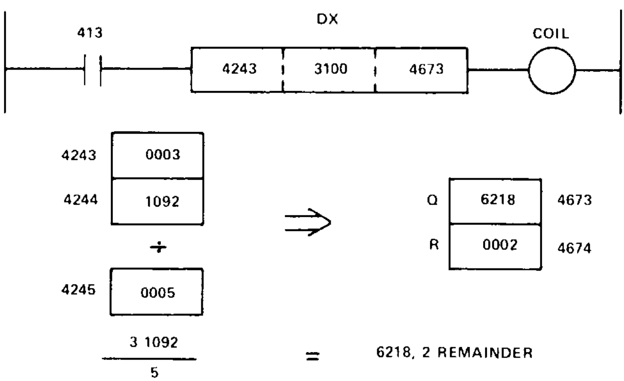


Figure 87. Sample Divide

If registers 4243 through 4245 are preloaded as indicated, on the first scan that line 413 is on, the double-precision number (31,092) in registers 4243 and 4244 will be divided by the contents (5) in register 4245. The resultant quotient (6218) will be stored in register 4673 and any remainder (2) in register 4674; the coil will be ON until line 413 is turned OFF.

If the divisor in register 4245 was a 3, the resultant quotient would be 10,364 which is too large to fit into one register; thus the coil would be OFF and the contents of all registers retained. If registers 4243-4245 change their values, a new division will take place only after line 413 is cycled ON-OFF-ON.

32XX — Fixed Multiply

This code causes the contents of the B element register to be multipied by a fixed quantity (XX), which is part of the functional code, and the resultant product is stored as a double-precision number in the registers referred to by the D element reference. The operation of this code is very similar in all respects (including coil status) to the general multiply functional code 3000 discussed previously, except the second B element register is replaced by the last two digits of the functional code.

Two limitations should be clearly understood; the multiplier must be only two digits in magnitude (99 or less excluding zero) and the multiplier cannot be altered by other logic operations. If either of these features are required, the general multiply code (3000) must be used.

For example, if the functional code of Figure 86 was 3242, the same result would be stored in registers 4011 and 4012; register 3002 is not required and can be used for another operation. Note that, for the 32XX code, the B element refers to only one register and the D element to two registers.

33XX — Fixed Divide

This code causes the double-precision contents of the B element registers to be divided by a fixed quantity (XX) which is part of the functional code, and the quotient stored in the D element register, with the remainder in the D element register plus 1. The operation of this code is very similar in all respects (including coil status) to the general divide functional code (3100) discussed above, except that the third B element register is replaced by the last two digits of the functional code.

There are two limitations. The divisor must be magnitude 99 or less, but not zero, and it cannot be altered by other logic lines. If either or both of these features is required, the general divide instruction (3100) must be used. For example, if the functional code of Figure 87 was 3305, the same results would be stored in registers 4673 and 4674; register 4245 is not required. Note that, for the 33XX code, both the B and D element refer to two registers.

3400 — PID (Proportional, Integral, Derivative) Control

This type of control is normally used for temperature, pressure, pH, etc., and other variables usually controlled by analog controls. In addition, positioning and servo loops are also ideal applications for this type of control.

The controller solves the following equation to provide the control action desired:

$$P = K_1 e + K_2 \int_0^t e\,dt + K_3 \frac{de}{dt} + K_4$$

where,

$P =$ Output

$K_1 =$ Gain (00.01→99.99) – proportional band is equal to $1/K_1$

$K_2 =$ integral rate, or reset rate (0.001→9.999) repeats per *second*

$K_3 =$ derivative time or the rate time (0001→9999) *seconds*

$K_4 =$ Initial starting point

$e =$ error = input minus set point

PROGRAMMING PID CONTROL

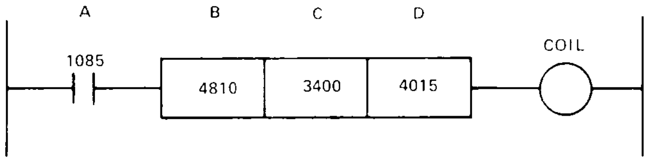


Figure 88. Sample PID Logic Line

A: Starts control when closes.

B: First register in input table (see below for input data).

C: 3400 is function code for PID control.

NOTE

Function codes 3401, 3500, and 3501 (PID-384A and 384B only) are discussed in section 3.7.

D: First register in output table (see below for output data table).

Input Table Description

Register Number (Typical)	Value in Register (Typical)	Description
4810	0517	Input (i.e., could be 517°F)
4811	0525	Set Point (i.e., could be 525°F)
4812	0025	K_1 – Gain
4813	0.050	K_2 – integral rate in repeats per *second*
4814	0000	K_3 – derivative time in *seconds* (derivative action not wanted so zeros used).
4815	0550	High limit of 550°F
4816	0500	Low limit of 500°F

NOTE

Seven sequential registers starting with the register used in the B element are set aside for PID operations when code 3400 is used. Therefore, do not use those register numbers for other functions.

Output Table (6 Registers)

Register 4015 contains the output values which can be used to position control valves or servos, etc. This output is a four-digit numerical quantity that will vary between limits established by 4815 and 4816 in this example. Maximum range of output is 0000 to 9999.

NOTE

Five register numbers following the register used in D (in this example 4016→4020) are used for internal use in PID control in the controller and cannot be used anywhere else in your program.

Additional Application Notes

1. This PID control is *direct acting*. If *reverse acting* is desired, a (B−C) calculate line can be used.
2. *Profile Control* (predetermine a non linear set point program): Can be very easily done by using a table to register DX move, storing up to 99 different set points. Linear ramp control of set points can be done in the same manner.
3. *Cascade Control:* The output of one PID line in the Controller can be the input to another PID line within the Controller by using a (B+C) calculate line to move the output value in the output register (in this example 4015) to the input register in another PID line.
4. *Adaptive Control:* The gain, reset rate and derivative time can each or all be changed at will by (B+C) calculate lines or DX transfer operations. Therefore, adaptive control can be used with no extra hardware by simply using additional programs in the controller.
5. *Feed Forward Control:* Can be accomplished very similar to adaptive control discussed above with additional programmed techniques to do the arithmetics required.
6. *High-Low Limits:* The coil of the PID line will be on when the limits are exceeded.

NOTE

Function codes 36XX and 37XX (384A and 384B only) are discussed in section 3.7.

3.5.4 Entering a Data Transfer Line

1. Set the Line Number on the LINE NUMBER switches.
2. Put the Controller MEMORY PROTECT switch in the OFF position.
3. Press the DATA TRANSFER pushbutton. It will light and all other LINE TYPE lights will go out.
4. Press the A element pushbutton. The A element lamp will light and the B, C, and D lights will be OFF.
5. Set the REFERENCE NUMBER switches to the line number, input number, or latch that is to operate the contact in the A position.
6. Press either the Normally-Open or Normally-Closed Series ELEMENT TYPE pushbutton. The ELEMENT TYPE pushbutton that is pressed will light and the REFERENCE DISPLAY will show the number that has been entered.

NOTE

On 184 controllers, the Data Transfer lines can be programmed in any element order. However, the 384 controller requires the Function Code (C element) to be entered prior to programming either the B or D elements to establish proper error checking. This requirement is for DX lines only.

7. Select the B element position and enter on the REFERENCE NUMBER thumbwheels the register which is the location of the SOURCE data. Press any ELEMENT TYPE pushbutton. The REFERENCE DISPLAY will show the register that has been entered.
8. Select the C element position and enter on the REFERENCE NUMBER thumbwheels the FUNCTION CODE. Press any ELEMENT TYPE pushbutton. The REFERENCE DISPLAY will show the code that has been entered.
9. Select D element position and enter on REFERENCE NUMBER thumbwheels the register which is the DESTINATION of the data.
10. Press any ELEMENT TYPE pushbuttons. The REFERENCE DISPLAY will show the register that has been entered.
11. If the DISABLE pushbutton is lit, and not specifically desired, press it to turn it OFF.

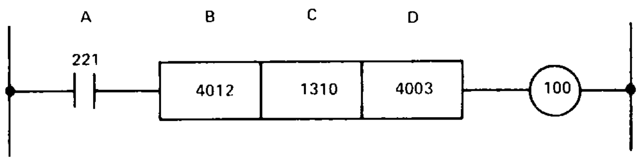


Figure 89. Data Transfer (Move) Line

1. Set Line Number switches to 0100.
2. Press DATA TRANSFER pushbutton.
3. Press A element pushbutton.
4. Set REFERENCE NUMBER switches to 0221.
5. Press Normally-Open Series ELEMENT TYPE pushbutton.
6. Press B element pushbutton.
7. Set REFERENCE NUMBER switches to 4012. Press any ELEMENT TYPE pushbutton.
8. Repeat steps 6 and 7 for the C element (1310), and D element (4003).
9. If the DISABLE Light is lit, and not specifically desired, press it to turn it OFF.

3.6 P500 PRINTER/D285 DISPLAY UNIT

3.6.1 Introduction

The P500 Printer (see Figure 90) is an industrial-environment hardcopy printer designed to provide data on the plant floor. It is capable of printing out management information such as number of parts produced, up times, efficiencies, recipe contents, etc.; or operator information such as error messages, batch completed notation, manual operations required, etc. The P500 Printer is not designed to document the user's program with ladder diagrams; this support is available from the Service Center (see 4.2.2).

The paper used in the P500 is pressure sensitive; thus the printer does not require carbon paper or ink and the associated maintenance problems. The paper is 3½ inches wide, each page approximately 5½ inches long— a convenient size to place in shirt pockets. Each page can contain up to 20 lines, each line 21 characters (see Figure 91). A summary of P500 specifications are provided in Table 15.

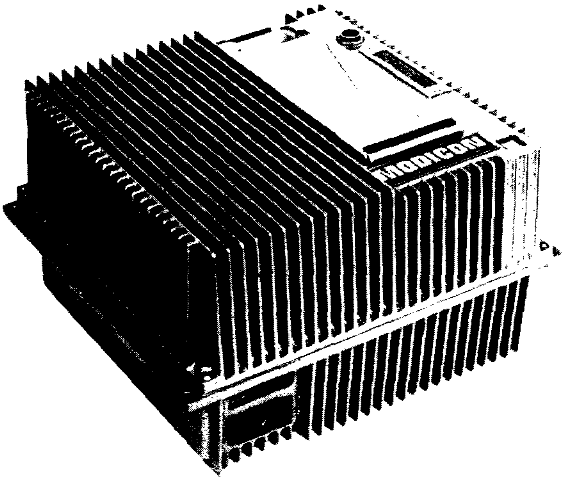


Figure 90. Programmable Printer

SAMPLE

387621 14 783 9342

DOWN TIME REPORT

PARTS THIS SHIFT 5673
EFFICIENCY 92.9%

STATUS OF MACHINE #17
SEQUENCE COMPLETE

FAILURE OF CARRIAGE
TO ELEVATE DURING
LOAD

CHECK I/O & LIGHTS

CHARACTER SET

ABCDEFGHIJKLMNOPQRSTU
VWXYZ 0123456789 [\ ] (
- ! " # $ % & ' ( ) * + ^ , . / : ; < = >
@ ?

Figure 91. Sample Printout

Table 15. P500 Printer Specifications

Power Requirements	115 Vac ±20%, 60 Hz (Standard) 115 Vac±20%, 50 Hz (Optional) 250 Volt-amps
Environmental:	
Ambient Temperature Humidity	0°C to 60°C 10% to 70% (non-condensing)
Dimensions:	19 in. x 11 in. x 17½ in.
Weight:	60 lb. (approx.)
Read-Only Memory:	108 lines of stored messages; each line contains 21 characters
Print Speed:	2 lines per second
Paper:	3½ in. wide, pressure-sensitive, fan-fold: 20 lines per page; approx. 1600 pages per box
Control I/O Level:	115 Vac or 24 Vdc
I/O Cable (supplied with P500):	25-wire, standard 12-feet long (Type W500)
Optional -Interfaces:	Parallel BCD or ASCII Serial, EIA RS-232C compatible
Model Variations:	P500-100 (115 Vac I/O, 60 Hz power) P500-200 (115 Vac I/O, 50 Hz power) P500-300 (24 Vdc I/O, 60 Hz power) P500-400 (24 Vdc I/O, 50 Hz power)
Mounting:	Standard horizontal (table-top) or optional vertical (wall-mounting)

Within the printer is a Programmable Read-Only Memory (PROM). This PROM is capable of storing 108 lines of preformatted alpha-numeric messages. These messages are programmed in accordance with the user's specification provided at the time of manufacture. The PROM can be changed by the MODICON factory. Changes are made on an exchange basis; a new message sheet is provided to MODICON, and a revised PROM (either just one chip or the entire memory) is sent to the customer. After installation, the old memory must be returned to the factory for reuse.

The P500 Printer is a general-purpose industrial unit capable of being driven from a computer, relay panel, or another controller as well as the MODICON 184/384 Controller if properly interfaced. When connected to the 184/384 Controller, the overhead control required to establish and store messages awaiting servicing by the printer, as well as providing numerical data to the printer, is all automatically handled by the DX Print capabilities.

Up to 16 printers can be connected to one 184/384 controller through the I/O and any number of logic lines can be used to drive separate messages to these printers. One printer is serviced at a time with messages in the real-time order they were energized within the Controller. Each printer connected to a 184/384 Controller requires an output register to provide data and commands to the printer, and two individual inputs to accept signals (Busy and Form Busy) from the printer. All data provided to the printer requires a positive response from the printer before another command or number is provided. This technique requires communication both ways and is called "handshaking" between the Controller and the printer.

The printer requires 115 Vac power locally to drive the print head, paper advance, DC power supply, etc., in addition to a 25-wire cable to connect to controller I/O. The AC power can be either 50 or 60 Hz and the I/O can be either 115 Vac or 24 Vdc, thus there are four models of printer available (see Table 15).

Table 16. Standard Character Set

A	Q	5	+
B	R	6	,
C	S	7	—
D	T	8	.
E	U	9	/
F	V		:
G	W	!	;
H	X	"	<
I	Y		=
J	Z	$	>
K		%	?
L	0	&	†
M	1	'	[
N	2	(	\
O	3	)	]
P	4	*	

Control Codes

Eb End of Block — indicates end of message to be printed.

Ff Form Feed — advance paper to next page; will always be executed prior to printing line in which Ff is located, regardless of Ff location in line.

Lf Line Feed — prints blank line; must be first character of a blank line in the PROM; nothing else can be programmed into this blank line.

Vd Variable Data — blanks to be filled in by data from the controller; one digit per blank.

The D285 Display Unit provides CRT display of messages using exactly the same handshaking as the P500 Printer. Any 184 or 384 controller that communicates to a P500 Printer can also control the D285 Display Unit.

3.6.2 Formatting Messages

Each printer's PROM is loaded with messages in accordance with each customer's requirements. Table 16 is a list of characters available with the standard P500. Each of the 108 lines (numbered 0 to 107 in the PROM) has space for 21 characters; Figure 92 provides a sample form completed to indicate a portion of one customer's requirements. Figure 93 shows sample forms that can be used to specify the contents of the printer PROM.

All print commands are originated within the Controller by Data Transfer (DX) logic lines. When these commands specify a message stored within the printer's PROM, they utilize the first line of the message as the identification for that message. The printer begins at the line specified and will continue printing until an End-of-Block (Eb) character is detected, which terminates the print of that message. All 21 characters in a line are printed simultaneously.

The location of the Eb characters is determined by the customer when completing the PROM specification (Figure 93); they are used to combine lines forming messages of multiple lines in length. Since only lines 0 to 99 are individually addressable, line 100 through 107 are used as a single continuation of a message that began earlier. Thus, typically, the longest message is placed at the end of the PROM to make maximum use of these continuation lines.

Message Address	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
72																						P
73																						R
74																						O
75																						M
76																						
77																						6
78																						
79																						
80																						
81																						
82																						
83																						
84																						
85																						
86																						
87			P	R	O	D	U	C	T	I	O	N		S	U	M	M	A	R	Y		P
88				Vd	Vd	Vd	Vd		Vd	Vd	Vd	Vd		1	9	7	4					R
89				T	I	M	E		Vd	Vd	Vd	Vd	H	Vd	Vd	Vd	Vd	Vd	M	I	N	O
90				S	H	I	F	T		N	O		Vd									M
91	Lf																					
92	M	A	C	H	I	N	E		N	O		Vd	Vd									7
93	P	A	R	T	S		T	H	I	S		S	H	I	F	T		Vd	Vd	Vd	Vd	
94	E	F	F	I	C	I	E	N	C	Y		%			Vd	Vd		Vd	Vd		Eb	
95																						
96																						
97	Ff			D	O	W	N	T	I	M	E		S	U	M	M	A	R	Y			
98	T	Y	P	E			O	C	C	U	R			M	I	N	U	T	E	S		
99													C	U	M			W	A	I	T	P
100	T		C	H	G			Vd	Vd	Vd	Vd		Vd	Vd	Vd	Vd		Vd	Vd	Vd	Vd	R
101	M	--	R	E	P			Vd	Vd	Vd	Vd		Vd	Vd	Vd	Vd		Vd	Vd	Vd	Vd	O
102	E	L	E	C				Vd	Vd	Vd	Vd		Vd	Vd	Vd	Vd		Vd	Vd	Vd	Vd	M
103	L	O	A	D				Vd	Vd	Vd	Vd		Vd	Vd	Vd	Vd		Vd	Vd	Vd	Vd	
104	U	N	L	O	A	D		Vd	Vd	Vd	Vd		Vd	Vd	Vd	Vd		Vd	Vd	Vd	Vd	8
105								–	–	..	–		.	–	--	.				.		
106	T	O	T	A	L	S		Vd	Vd	Vd	Vd		Vd	Vd	Vd	Vd		Vd	Vd	Vd	Vd	
107	Ff	Eb																				

Figure 92. Sample P500 PROM Specification

Message Address	COLUMNS																				
00																					P
01																					R
02																					O
03																					M
04																					
05																					0
06																					
07																					
08																					
09																					
10																					
11																					
12																					P
13																					R
14																					O
15																					M
16																					
17																					1
18																					
19																					
20																					
21																					
22																					
23																					
24																					P
25																					R
26																					O
27																					M
28																					
29																					2
30																					
31																					
32																					
33																					
34																					
35																					

Figure 93. Blanks for Specifying P500 PROM Messages

Message Address	COLUMNS																					
36																						P
37																						R
38																						O
39																						M
40																						
41																						3
42																						
43																						
44																						
45																						
46																						
47																						
48																						P
49																						R
50																						O
51																						M
52																						
53																						4
54																						
55																						
56																						
57																						
58																						
59																						
60																						P
61																						R
62																						O
63																						M
64																						
65																						5
66																						
67																						
68																						
69																						
70																						
71																						

Figure 93. Blanks for Specifying P500 PROM Messages (Cont)

Message Address	COLUMNS																					
72																						P
73																						R
74																						O
75																						M
76																						
77																						6
78																						
79																						
80																						
81																						
82																						
83																						
84																						P
85																						R
86																						O
87																						M
88																						
89																						7
90																						
91																						
92																						
93																						
94																						
95																						
96																						P
97																						R
98																						O
99																						M
N/A																						
N/A																						8
N/A																						
N/A																						
N/A																						
N/A																						
N/A																						
N/A																						

Figure 93. Blanks for Specifying P500 PROM Messages (Cont)

In many applications, blanks are required in the message format where numerical data from the Controller's memory is to be placed. These blanks are indicated by a special character called Variable Data (Vd) and can be used to indicate where the number of parts produced, efficiencies, up times, machine identification for diagnostics, etc., are to be printed. The location of these blanks are again per the customer's specifications (Figure 93). When the printer detects a Vd character, it requests the numerical digit (0-9) from the Controller. The Controller obtains the numerical data from registers specified in the DX print command.

Since the high-order digit (thousands digit) is provided to the printer first, most variable data blanks are left in groups of four (one register's content) to prevent restructuring of the data prior to transmission to the printer. For example, assume a blank is left for a machine number whose magnitude will be 1 to 20 (two digits maximum) and a blank is only two digits wide. If a counter is providing the machine number, the magnitude 0001 through 0020 is available in a register. However, when this register is used to fill in the blanks, the first two characters will always be zero, since the thousands and hundreds digits from the register are utilized first. This problem can be solved by either leaving four blanks so that the entire register's content is printed, or to count by hundreds with a calculate line in lieu of units as a counter does.

Two other special codes are available. The first is Line Feed (Lf), which causes a blank line to be printed (a line is skipped); Lf must be the first character of a blank line in the PROM. No other characters such as Eb, Ff, A, B, C, 3, 4, or another Lf can follow this first character. The second is a Form Feed (Ff), which causes the paper to be advanced to the top of the next page *prior* to printing the line in which Ff appears. Ff can be used to start a message on the top of a new page or force the paper up for removal after a message has been printed. Ff can occur at any character location in line; it is still executed prior to that line being printed.

All control codes occupy only one character of the 21 characters in a line, although it requires two letters to specify each code. Codes Eb, Lf, and Ff are replaced by blanks when the line is actually printed.

3.6.3 Programming DX Lines

This section applies to the Data Transfer Print capability available with some 184 MOPS 3 level execitives; see Table 12 for a list of MOPS 3 executives that provide print capabilities. All 384 controllers have DX print capabilities. These DX lines provide a simple method of outputting alpha-numeric data via the P500 Printer from the Controller. The general form of a DX line is still applicable (see Figure 70).

The A element, when closed, activates the print line and places the message in the print queue; this element has to be closed for only one scan. If the A element is cycled ON-OFF-ON while that particular print line is still in the queue (not completed at the printer), the second command will be ignored. If the A element remains closed, no additional commands will be generated when the print is complete; the A element must be cycled OFF-ON to enter a second print command after the previous print is completed.

The B element is a register, either holding or input, in which is placed the data to be printed if variable data is required by the print command. If more than four characters are required, the registers following the B element register will be used in sequence until sufficient characters are obtained.

NOTE

Characters are taken from the high-order digit first.

The C element is the DX code starting with the digit 4 (4YXX type); each code is discussed later in this section. The D element is *the* output register to which the printer is connected.

NOTE

Output registers programmed in the D element of a DX print line will automatically be permanently coded binary in the I/O Allocation Table, unless the Table is modified (see 4.1.4).

The coil on DX print lines will be energized as soon as the A element is closed (print command entered into the queue) and remains ON until the message is completed at the printer. The status of the coil is not affected by the condition of the A element, only by the status of the message in this print queue. Data in the B element table should be loaded prior to closing the A element, and not changed until the coil is de-energized. The following are discussions of the specific DX print codes available.

40PL — Print Numerical Data

NOTE

The Numerical Print capability is useful to print out report data in columns with the 41XX code providing the title and headings of the report. Do not waste PROM storage to specify format of purely numerical data.

This code causes only numerical data stored within the Controller to be printed in a specific format when the A element contact is closed. The B element register is the source of the data to be printed; if more than four digits are required by the format specified, successive registers will be utilized until the required data has been obtained. Data is supplied to the printer with the most-significant digits first.

The data format is specified in the functional code by the characters PL; P for page definition, and L for line content — see Table 17. The register in the D element identifies which output register the printer is connected to. The coil will be energized when the print line is activated and remain energized until the data is printed. As an example, see Figure 94.

Assume registers 4032-4035 contain the values 1234, 5678, 9012, and 3456, respectively. When input 1132 is energized, the printer will print one line of data and then one line feed (per page format 1 of Table 17); the line will contain four registers of data (per line format 4 of Table 17). The coil will be energized and remain ON until the print is accomplished regardless of the status of the A element contact; additional print commands of this line, while the coil is energized, will be ignored. If the data in the storage registers is changed after the A element is closed, but prior to the print being completed, the revised data may or may not be printed. Note that the B element register refers to four registers, depending on the page and line format specified in the functional code. The D element register refers only to itself.

41XX Print Specified Stored Message

NOTE

The Stored Message print capability is useful to provide report data or messages to the operator.

This code causes a message contained within the printer to be printed on closure of the A element contact. The B element register contains the numerical data (if any) to be printed in locations specified by the code Vd (variable data) in the message format; if more than four digits are required, the next register immediately after the B element register will be used. Data will be utilized with the most-significant digit first. Thus, if only one Vd code is placed in the message, the thousands digit of the register will be used. To simplify programming, whenever possible, blanks in the message should be designed as four digits in length.

The message number to be printed is specified by the last two digits (XX) of the functional code; these messages can be 00 to 99 inclusive. The message to be printed will begin at the line number specified (XX) and continue until an end-of-block (Eb) code is reached within the PROM. The D element register is the output register to which the printer is connected. The coil will remain ON until the complete message has been printed.

Table 17. P500 Printer Data Format

40PL

P = Page Format:

0 = Print 1 line

1 = Print 1 line, line feed

2 = 12 Line feeds, print 1 line, Form feed

3 = 11 lines, print 2 lines, Form feed

4 = 10 Line feeds, print 3 lines, Form feed

5 = 9 Line feeds, print 4 lines, Form feed

6 = 10 Line feeds, print 1 line, Line feed, print 1 line, Form feed

7 = 8 Line feeds, print 2 lines, Line feed, print 2 lines, Form feed

L = Line Format:

1 = XXXX

2 = XXXX XXXX

3 = XXXX XXXX XXXX

4 = XXXX XXXX XXXX XXXX

5 = XXXXXXXX XXXX

6 = XXXXXXXX XXXXXXXX

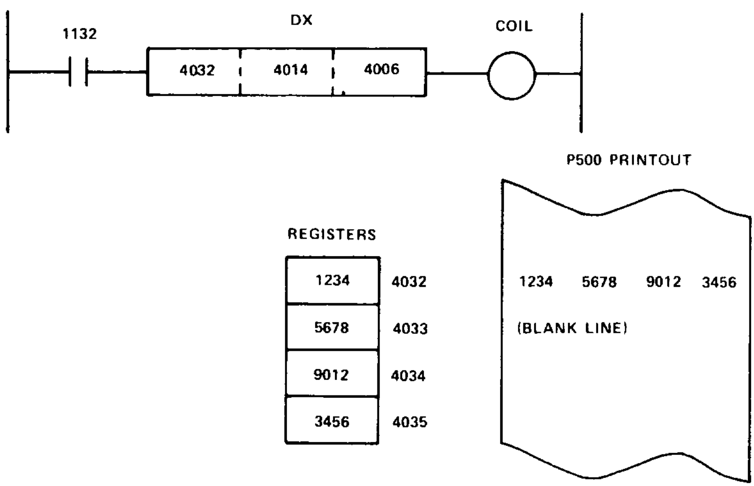


Figure 94. Sample Fixed Format Print

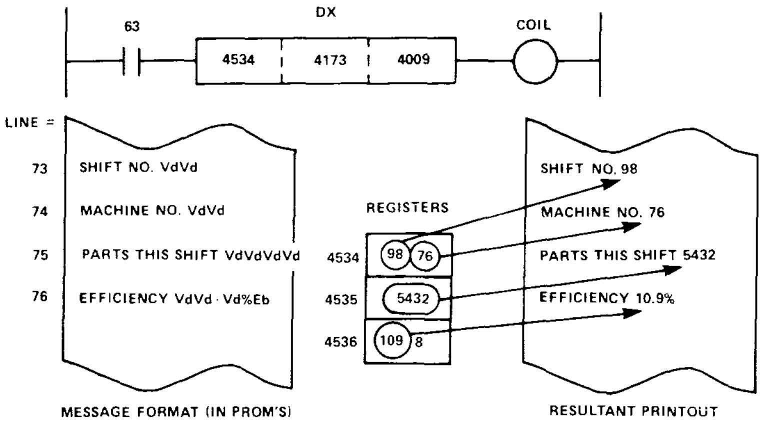


Figure 95. Sample PROM Format Print

As an example, refer to Figure 95. If registers 4534-4536 contain the data specified, when logic line 63 comes ON, message 73 will be printed with variable data blanks replaced by the contents of these registers. The coil will be ON until the message is actually printed out. If another line specified printing message 74, the printout will begin with line 74 (Machine No.) and continue to line 76. If logic line 63 remains ON at the completion of message 73, a second printing will NOT be commanded.

Note that the B element register refers to as many sequential registers as necessary to complete the variable data required by the message specified by the functional code and that the D element register refers only to itself.

4200 — Print Variable Stored Message

NOTE

The Variable Message Print capability is useful to print out error messages calculated by the Controller or messages whose addresses vary (e.g., dates printed out).

This code causes a message number contained in the B element register to be printed on the closure of the A element contact. This code operates very similar to the 41XX functional code previously discussed, except that the B element register contains, in the two least-significant digits, the message to be printed. Variable data, if any, will be obtained from the registers immediately following the B element register.

For example, assume Figure 95 contained, in the B and C elements of the logic line, the register 4533 and the functional code 4200, respectively. If register 4533 contained the value YY73 (where YY are ignored), message 73 will be printed with the data obtained from registers 4534 through 4536. By utilizing this instruction, the Controller can calculate and control both the message number and variable data to be printed.

NOTE

Procedures for entering Data Transfer lines, including DX Print lines, are provided in Section 3.5.4.

3.6.4 Connecting Printer to 184/384 Controller

Each printer connected to a Controller requires an output register and two single inputs (discrete or register) to provide communications both ways. The connections are made via a 25-wire cable (type W500, standard length 12 feet). This cable is plugged into the printer and has each of its wires on the opposite end (Controller end) labeled with a number from 1 to 25. Table 18 summarizes the functions and connections for these wires when used with the 184/384 Controller.

The Busy and Form Busy signals are very important since they are the only method the printer has of communicating to the Controller. Whenever the printer is busy performing a function (manual paper advance, printing numbers, printing messages, etc.), the Busy signal is ON. When the printer is using its PROM for formatted messages, the Form Busy signal is ON.

If numerical data is required by the printer to complete its format (e.g., variable data blanks detected in the PROM), the Form Feed remains ON and the Busy is turned OFF.

Table 18. Printer Output Register Connections

Wire No.	Function	Printer Pin	B230 or B232 Terminal		
1	Form Select 00	A	11		NOTE: On B230 Output Module only, add jumpers between terminals 2 & 7, 7 & 12, and 12 & 17. Apply power to terminals 1 & 2 as indicated. Terminal 14 is NOT connected. Output will always be lit for B230 only.
2	Form Select 01	B	10		
3	Form Select 02	C	9		
4	Form Select 03	D	8		
5	Form Select 04	E	6		
6	Form Select 05	F	5		
7	Form Select 06	H	4		
8	Form Select 07	J	3		
9	Space	K	20		
10	Motor Turn ON	L	15		
11	Print	M	21		
12	Load Buffer	N	16		
13	Start Form	R	18		
14	Form Feed	S	19		
25	Clear	P	13		
			B230	B232	
23	115 Vac Hot/24 Vdc Hi (+)	EE/BB	2	1	
24	115 Vac Neut/24 Vdc Rtn (–)	HH/CC	1	2	
18	Busy	u	Connect to B231 or B233 Input Module. See Figures 96–98.		
19	Form Busy	v			
15	BCD/ASCII	T	Unconnected or connect to neutral/return for BCD; connect to Hi for ASCII.		
16	Orientation	U	Unconnected or connect to neutral/return for normal printing; connect to Hi for inverted printing.		
17	Paper Out	t	Remote indication of paper out.		
20	Motor ON	w	Remote indication of motor ON.		
21	DC Power ON	x	Remote indication of dc power ON.		
22	Bell	y	Drives external bell when Printer receives bell character.		

When the character is accepted by the printer, the Busy is turned ON. If additional characters are required, the printer cycles the Busy signal OFF-ON-OFF as many times as necessary, transferring one character at a time to the printer until the format is completed. Characters are transmitted at the rate of one character every two scans of the Controller.

3.6.5 D285 Connections and Programming

The D285 CRT Display Unit connects via a W280 cable and requires one output module and two input circuits. The connections are very similar to the P500 Printer and are shown in Table 18A. There are four models of D285 Display Unit offering a variety of power sources (50 or 60 Hz) and I/O voltage levels (115V or 24 Vdc). As an option, this display unit can be equipped with an I/O device section which includes: one 4-digit thumbwheels, one 4-digit LED display, three 24 Vdc lamps, two pushbuttons, one snap switch, and one key lock switch. These devices are wired into the controller's I/O section via two W280 cables (see Table 18A for connections), separately from the W280 cable that drives the CRT.

Within the D285 display unit, messages can be stored in PROM loaded by the factory. These messages are similar to the P500 PROM messages, except they are 64 characters wide. Up to 32K ASCII characters can be stored within the D285 memory depending upon model number ordered (minimum 8K memory providing 7K ASCII characters); addressing is provided for 496 unique messages (numbered 1 to 496). Messages can be of any length, limited only by amount of memory available; messages do not have to be one "line" long nor do they have to be even increments of 64 ASCII characters. Special characters are available to control message format and are used as follows:

Eb End of Block — indicates end of message to be displayed

Ff Form Feed — clears bottom of screen (ignored when used with 40PL DX code)

Lf Line Feed — displays a blank line for each line feed encountered

Vd Variable Data — blanks to be filled in by BCD data from the controller; one digit per blank

Bl Blink Text — begins flashing all characters until Sb or Eb is encountered; replaced by a space when displayed

Sb Stop Blink — stops flashing message characters; no effect if not already flashing. Replaced by a space when displayed.

Ts Top of Screen — place message at top of screen and begin schrolling down. Normal entry is at bottom schrolling up.

Tb Blink Top — place message at top of screen and begin flashing.

The 12" CRT screen provides excellent clearity to view messages up to ten feet away. Up to 16 lines, each of 64 characters, can be displayed at one time. Messages can be entered at the bottom and schrolled up or at the top and schrolled down. As an option, an ASCII port can be added to provide the messages to another device (such as ASCII compatible line printer, remote CRT, or magnetic tape recorder) as they are placed on the CRT screen. The controller can select messages for CRT screen only or for both CRT and optional device. When this option is selected, user must specify baud rate and ASCII type (RS-232 or 20 ma loop) at time of order.

Table 18A. D285 Connections Via W280 Cables

Connector Pin	Wire Color	Functions: D285 Control Cable	Functions: I/O Option Cables, Upper	Functions: I/O Option Cables, Lower
A	Wht/Blk/Grn	Load Buffer	TW BCD 1	Display BCD 1
B	Wht/Blk/Yel	Start Form	TW BCD 2	Display BCD 2
C	Wht/Blk/Orn	Clear	TW BCD 4	Display BCD 4
D	Wht/Blk/Red	SPARE	TW BCD 8	Display BCD 8
E	Wht/Blk/Brn	Space	TW BCD 10	Display BCD 10
F	Wht/Blk/Blk	Print	TW BCD 20	Display BCD 20
G	Wht/Gray	Form Feed	TW BCD 40	Display BCD 40
H	Wht/Violet	Hard Copy	TW BCD 80	Display BCD 80
J	Wht/Blue	Form Select 07	TW BCD 100	Display BCD 100
K	Wht/Green	Form Select 06	TW BCD 200	Display BCD 200
L	Wht/Yellow	Form Select 05	TW BCD 400	Display BCD 400
M	Wht/Orange	Form Select 04	TW BCD 800	Display BCD 800
N	Wht/Red	Form Select 02	TW BCD 1000	Display BCD 1000
P	Brown	Form Select 01	TW BCD 2000	Display BCD 2000
R	White	Form Select 00	TW BCD 4000	Display BCD 4000
S	Blue	Form Select 03	TW BCD 8000	Display BCD 8000
—	Wht/Brown	SPARE	SPARE	SPARE
T	Wht/Black	Form Busy	NO S4 Key Switch PB	Lamp #2
U	Gray	Busy	NO S1 Pushbutton	Lamp #3
V	Violet	Positive/Hi Voltage	NO S2 Pushbutton	Lamp #1
W	Green	Negative/Low Voltage	NC S3 Snap Switch	+24 Vdc Power
X	Yellow	SPARE	NO S3 Snap Switch	-24 Vdc Power
Y	Orange	SPARE	SPARE	Lamp Common
Z	Red	SPARE	SPARE	SPARE

The D285 Display Unit is controlled exactly as the P500 Printer is controlled via DX codes 40PL, 41XX, and 4200. Any controller capable of communicating to a P500 Printer is also capable of controlling the D285; no changes to the controller's hardware or executive program is required. There are only two exceptions unique to the D285 operation. When using DX codes 40PL, all Form Feed (Ff) executions will be ignored by the D285. This prevents the fixed format code from entering numerical data and then clearing the CRT screen, in lieu of advancing the P500's paper. As a maximum, only 21 of the 64 available characters in a D285 CRT line will be utilized by the fixed format DX code.

The second change is message addressing. D285 messages numbers 1-99 are used exactly as the P500 message are via either DX codes 41XX (XX = message number 01 to 99) or DX code 4200. To address messages above 99 (i.e. 100 — 496, since the D285 has 496 messages versus the P500's 100 message capacity), message zero is used as a converter. Within the D285, message zero can not be altered by the user and always has the form: Vd Vd Vd Vd. The content of these four blanks must be filled in by the controller with the message address (0001 — 0496) to be displayed.

For example, DX code 4100 will cause message zero to be addressed. The content of whatever register is entered into the B element of this logic line (all four BCD digits) will now be used as the message to be displayed. If this content is greater than 496 or not assigned within the PROM memory, the D285 Display Unit will display the message "ILLEGAL MESSAGE ADDRESSED". Another method of addressing messages above 99, is to use DX code 4200. The content of the B element register, two least significant digits only (units and tens) are made zero(XX00). The next register in sequence is assumed to contain the four digit address of the message to be displayed.

Other than the fixed format form feed and addressing messages above 99, all other features of DX Printing apply. Messages can be queued up in as many logic lines as necessary. They are serviced basically in logic line numerical order. Variable Data (Vd) will be filled in by BCD digits (0 — 9) from the register specified in the B element of the DX logic lines. All commands to the D285 require an active and positive response from the Display Unit, thus a two-way handshaking is employed. Busy, Form Busy, and Abort inputs must be programmed as discussed in paragraph 3.6.6 to insure proper handshaking capabilities.

If the ASCII port option is selected, to inhibit providing ASCII information to this port, pin H of the W280 cable is connected to a high voltage source. This can be controlled either by the appropriate type output module, or an external switch, or the output module driving the D285. The output module that provides commands and data to the D285 has one spare circuit that can be used via a DX Matrix (bit 10) set/clear operation if this capability is available. Otherwise, any single output circuit of the proper voltage can be used.

See Appendix A for further details on the D285 Display Unit.

3.6.6 Programming Busy, Form Busy, and Abort Inputs

The Busy and Form Busy signals from the printer can be connected to any convenient inputs of the proper voltage, either discrete or register inputs. To inform the Controller of which inputs were selected, special programming must be provided at the end of the ladder diagram. Counting back from the last line of the program (Watchdog Timer line), the WDT-4 coil must reflect the printer's Busy signal, the WDT-3 the Form Busy signal, and the WDT-2 an optional Abort signal generated by the user. Table 19 summarizes the line assignments for these functions with executives of various length.

The Abort signal, when energized, will cause the current message being printed to be aborted and the next message in the queue utilized. Since the Abort signal only works on the OFF-ON transition of the abort coil, if more than one message is being aborted, this coil will be cycled OFF-ON-OFF-ON, (WDT references) as many times as there are messages to be aborted. If the Abort is not used, the WDT-2 line should contain null data to prevent its coil from being energized.

Table 19. Line Assignments for Printer Control Functions

Program Length	Busy	Form Busy	Abort
432	428	429	430
496	492	493	494
512	508	509	510
608	604	605	606

If the Busy, Form Busy, and Abort signals are connected to discrete inputs, Figure 96 illustrates one method of programming the WDT-4 through WDT-2 lines. Whenever the printer is busy, the input signal to the Controller

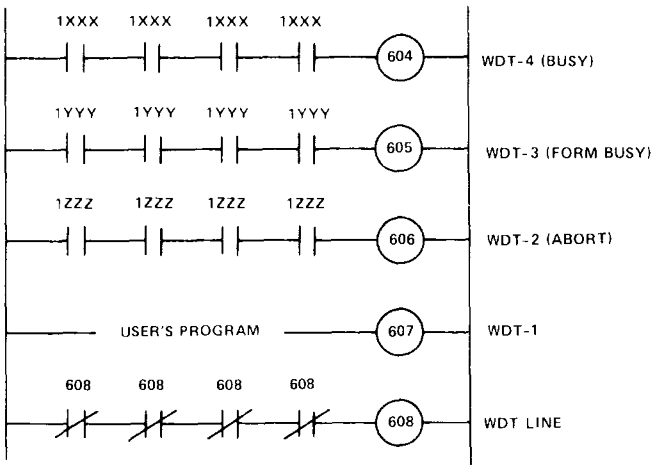


Figure 96. Typical Printer Control Lines using Discrete Inputs

(wire 18 of Table 18) is turned ON, input 1XXX to which this wire is connected becomes energized, and coil 604 is energized. Coil 604 will thus copy the Busy status of the printer via input 1XXX, which can be any discrete input to the Controller. A similar analysis can be performed for the Form Busy (1YYY) and Abort (1ZZZ) signals.

If the Busy, Form Busy, and Abort signals are connected to register inputs, a number of methods can be used to program the WDT-4 through WDT-2 lines. If matrix capabilities are available, the method in Figure 97 can be used. The three sense lines energize their coils only if the bits in the input registers (3014 and 3008) representing Busy, Form Busy, and Abort signals, are turned ON. Registers 4XXX, 4YYY, and 4ZZZ contain the bit numbers to which the Busy, Form Busy, and Abort signals are connected.

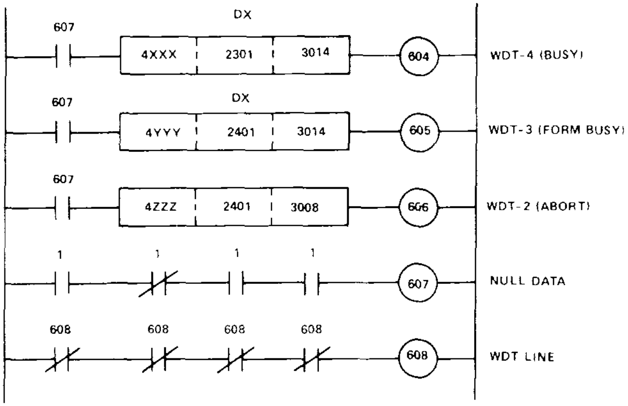


Figure 97. Typical Printer Control Lines using Matrix Register Inputs

If matrix capabilities are not available, subtraction lines similar to those in Figure 98 can be used. As an example, assume the Busy and Form Busy inputs are connected to the one and two lines of the thousands digit of BCD register 3014. The Abort signal is assumed to be a discrete input connected to 1ZZZ. Storage registers 4HHH, 4TTT, 4BBB, and 4MMM contain the values 1000, 2000, 3000, and 4000, respectively; lines 600, 601, 602, and 603 will be ON if, and only if, the contents of register 3014 exceeds or equals the values 1000, 2000, 3000, and 4000 respectively. Thus, the Busy line (604) will be ON if the thousands digit of register 3014 is a one (1) or a three (3) and the Form Busy line (605) will be ON if this digit is a two (2) or three (3).

If more than one printer is connected to the Controller, the Busy and Form Busy signals from each printer should be ORed into WDT-4 and WDT-3 lines. Thus, if any one printer is busy, the WDT-4 coil is energized, and if any printer has its Form Busy ON, the WDT-3 coil is energized. Figure 99 illustrates one method of programming these lines assuming three printers are connected and all inputs are wired to discrete input modules.

3.7 Improved Data Transfer Capabilities (384A)

The following DX functions have been developed and are available as standard features on the 384A and 384B controllers. All of the following functions are provided with these controllers in addition to all the standard DX functions previously discussed. A few 184 executives have been configured with one of these functions; see table 12 for specific details or which functions are available with 184 controllers.

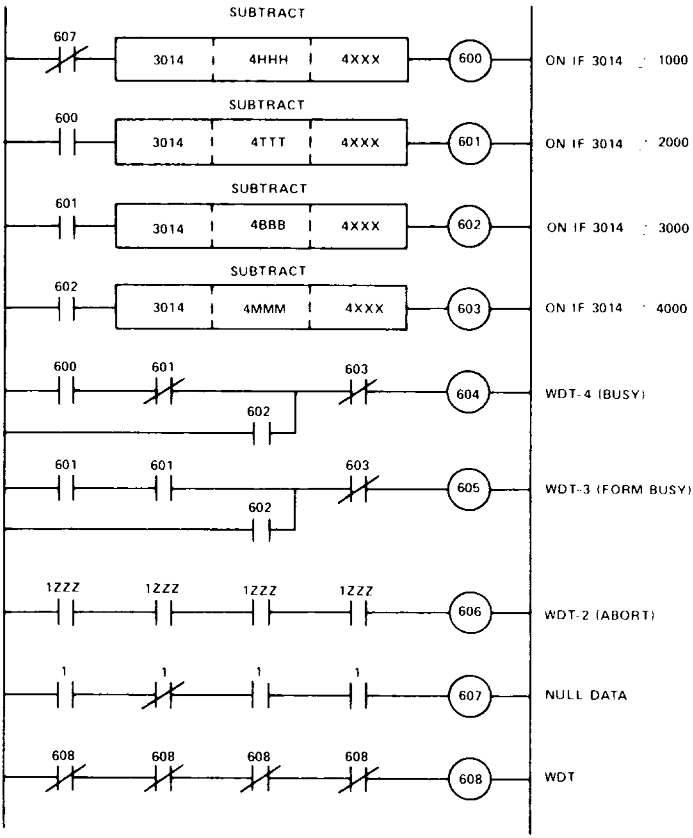
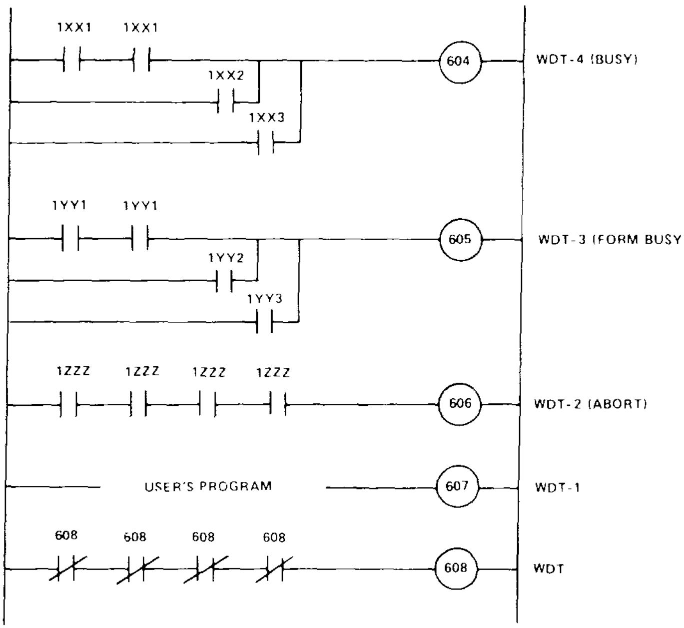


Figure 98. Typical Printer Control Lines using Register Inputs

3.7.1 Privileged Registers (5XXX references)

In many applications, the 384 controller is so efficient in its use of logic lines, that more holding registers are also desired. This is especially true of large monitoring routines and multiple recipe storage. To satisfy these requirements, the concept of "privileged" registers was developed. When memory protect is ON, these registers cannot be altered by the logic, only copied. Thus standards can be entered and used in the logic as required; however, once memory protect is ON, they cannot be altered by the logic. They can be examined at any time using the programming panel; they can never be altered directly from the programming panel regardless of the condition of memory protect. At any time, a computer via the computer interface, can alter these registers.

The privileged registers, (5XXX) are similar to holding registers (4XXX) in that they are retentive on power failure and utilize one word of memory. Thus they can contain four BCD digits (maximum value 9999) or sixteen bits of binary information. However, they can NOT be referenced in the logic as can the holding registers (4XXX). To utilize data contained in the privileged registers, they first must be moved into holding registers. Two Move functions are available for handling privileged registers: 18XX (move into 5XXX) and 19XX (move out of 5XXX).



1XX1 = BUSY PRINTER #1 1YY1 = FORM BUSY PRINTER #1
1XX2 = BUSY PRINTER #2 1YY2 = FORM BUSY PRINTER #2
1XX3 = BUSY PRINTER #3 1YY3 = FORM BUSY PRINTER #3

1ZZZ = USER'S ABORT SIGNAL

Figure 99. Typical Printer Control Lines with Multiple Printers

18XX — *4XXX/30XX to 5XXX Move (Block)*

This code causes the content of a table of input (30XX) or holding (4XXX) registers to be copied into a table of privileged registers (5XXX). This is a block move such that every scan the A element contact is closed and memory protect is OFF, the entire table will be moved. The table length is indicated by the XX of the function code. The coil always reflects the state of memory protect regardless of the condition of the A element; thus the coil will be ON when memory protect is ON, and OFF when memory protect is OFF. This move code (18XX) will not function as long as memory protect is ON. If memory protect is engaged during the block move, the move will be completed and then additional updates inhibited.

Since this is a block move, no pointer is required and all registers in the table will be moved every scan the A element remains closed. Both tables must be of the same length. Since the DX code has only two digits for table length, the maximum size of these tables is 99; the minimum table size is one. As an example, refer to figure 100.

When input 1001 is energized, 35 holding registers (4237-4271) are moved into privileged registers (5106-5140) in one scan. As long as input 1001 remains energized, registers 4237-4271 are copied into registers 5106-5140 thus updating these privileged registers every scan. No pointer is involved since all registers are updated effectively at the same time. The coil of line 731 will be energized whenever memory protect is ON regardless of the condition of the A element. If memory protect is ON, line 731 will *not* affect the contents of registers 5106-5140 even if input 1001 is energized.

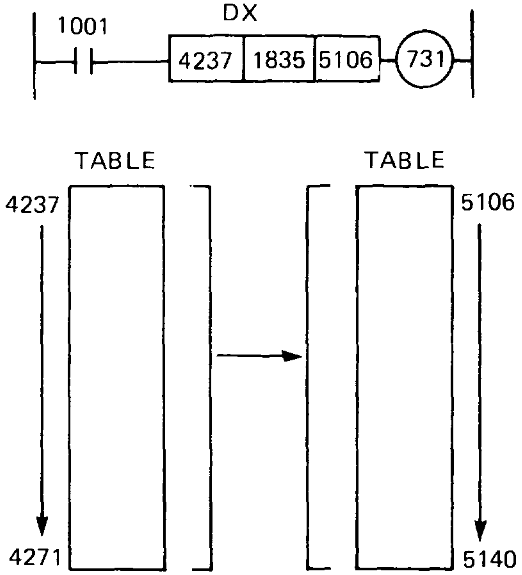


Figure 100. Sample 4XXX to 5XXX Move

19XX — *5XXX to 4XXX Move (Block)*

This code causes the contents of a table of privileged registers (5XXX) to be copied into a table of holding registers (4XXX). This is a block move such that every scan the A elements contact is closed, the entire table will be moved. This move can be accomplished regardless of the condition of memory protect. The coil will be energized when the move has been completed; since the entire table is moved every scan, the coil will be energized whenever the A contact is closed.

This is a block move and thus no pointer is required; all registers in the table will be moved every scan the A element remains closed. Both tables must be of the same length. Since the DX code has only two digits for table length, the maximum size of these tables in 99; the minimum table size is one. As an example, refer to figure 101.

When line 392 energizes its coil, 12 privileged registers (5063-5074) are moved into holding registers (4419-4430) in one scan and the coil will be energized. As long as coil 392 is energized, all 12 privileged registers will be moved into the holding registers and coil 688 will remain ON. No pointer is involved in this move since all registers are moved every scan. This move can take place only into holding registers (4XXX), not input registers (30XX), since it does alter their content.

3.7.2 Matrix Sequencer Move

The additional 30XX references discussed in section 3.5.2 form the bridge between discrete references such as line coils (0XXX) and inputs (1XXX), and register references. The DX function code 29XX forms the bridge in the opposite direction, from registers to discrete references. Inputs (1XXX) have been selected as the discrete references that can be controlled from register contents.

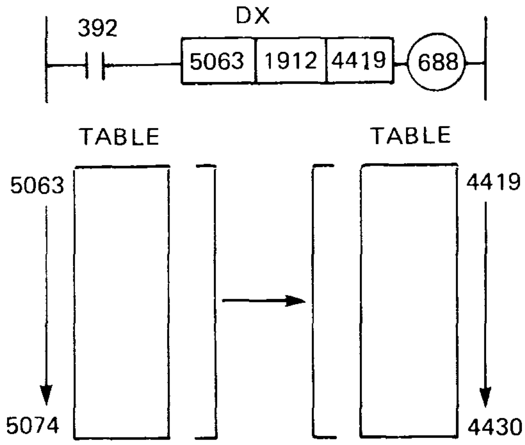


Figure 101. Sample 5XXX to 4XXX Move

These inputs are assigned reference numbers beyond those used in the Input/Output section. Exactly how many sequencer inputs are available is dependent upon the executive or TEF program selected (see Appendix F). However, as an example, assume a TEF was configured for 256 "real" inputs and 128 sequencer steps. The references for discrete inputs would be the conventional 1001-1256 and for the sequencer steps 1257-1384. The sequencer inputs can be dedicated to one sequencer or to a series of independent sequencers depending upon the application and the user's program; however, the total number of sequencer inputs (or steps), can not exceed the quantity established by the executive for this purpose.

NOTE

It is convenient, but not necessary, to assign sequencer inputs to individual sequencers in groups of sixteen.

29XX - Matrix Sequencer Move

This code causes the content of a matrix (B element) to be moved into discrete references, such that each register controls 16 "sequencer" inputs. Matrices can be of holding registers (4XXX) or input registers (30XX). The discrete references are updated every scan the A element is closed.

NOTE

The sequencer will retain this state when the A element is opened and through a power failure. They can only be altered by a 29XX DX logic line.

The XX in the DX code (C element) identifies the size of the matrix in registers and the quantity of sequencer inputs (when multiplied by 16), controlled by that logic line. The minimum size of a matrix is one register, and the maximum is the number of sequencer inputs provided by the TEF divided by 16.

The D element is the first sequencer input to be controlled by this logic line; all other sequencer inputs follow this reference in ascending numerical order. The reference entered in the D element must be a sequencer input such that, when divided by 16, will result in a remainder of exactly one. As an example, refer to figure 102.

NOTE

If an attempt to enter a reference that is not of the proper value is made, the automatic error checking in the 384A or 384B will reduce that value to the next lowest reference that is legal.

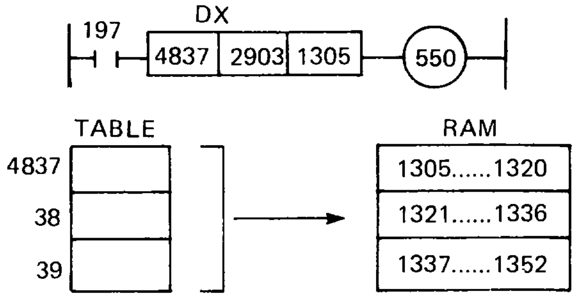


Figure 102. Example Matrix Sequencer Move

When logic line 197 energizes its coil, the content of registers 4837-4839 is moved into the RAM where it establishes the state (ON or OFF) for sequencer inputs 1305-1352. Every scan the A element is closed, these inputs will be updated with the content of registers 4837-4839. If an error is made in the programming of line 550 that the controller cannot correct for, and the A element is closed, coil 550 will be energized. Since the matrix is defined by the DX code as three registers long, it controls the status of 48 sequencer inputs. When the A element is opened, these inputs retain their state even through power failure, and can be altered only by a DX logic line utilizing a 29XX function code.

For example, if the content of the first eight bits of register 4837 was 10011101, then sequencer inputs 1305, 1308, 1309, 1310, and 1312 would be energized since they are opposite one (ON) bits and inputs 1306, 1307, and 1311 would be de-energized since they are opposite zero (OFF) bits. These sequencer inputs can be used anywhere in the user's logic to produce a sequencer or tenor drum effect. How many steps there are in each sequencer depends upon how many matrices are assigned to controlling the sequencer inputs; how many outputs are assigned to each sequencer, depends upon how many sequencer inputs are utilized (i.e., size of DX code XX value).

3.7.3 Improved PID

The basic PID function (DX code 3400) has been altered in two areas to provide a more user-related operation. The first change was to incorporate a PID function with constants in minutes instead of seconds. The second change was to make the derivative term (K_3) a function of rate of change of input and not error. Other than these improvements, the PID function operates the same as discussed for function code 3400 in section 3.5.3. These new capabilities are in addition to the 3400 code; all four PID functions (3400, 3401, 3500, and 3501) are available with the improved PID and are in the fast ROM area of the 384.

35XX — PID (Minutes)

This function operates identical to function code 34XX discussed in section 3.5.3, except that the constants are entered as minutes. The following is the definition of constants used in the seven register input table to the PID function:

first register (e.g. 4810) = Input } Same Units
second register (e.g. 4811) = Set Point }
third register (e.g. 4812) = K_1 (Gain)
fourth register (e.g. 4813) = K_2 (repeats per min. in the form XX.XX, or 00.00-99.99)
fifth register (e.g. 4814) = K_3 (minutes in the form XXX.X, or 000.0-999.9).
sixth register (e.g. 4815) = High Limit
seventh register (e.g. 4816) = Low Limit

3401 and 3501 — *PID with Modified K_3 Term*

This function operates identical to function 3400, except that the derivative term responds to the rate of change of input, not error. The PID equation now becomes:

$$P = K_1 e + K_2 \int_0^t edt + K_3 \frac{di}{dt} + K_4$$

Utilizing this function allows changes to be made to the set point, without affecting the K_3 term of the PID function. The output will still respond to the K_1 (gain) and K_2 (integral) terms; however, the oscillatory effects of K_3 will be eliminated.

3.7.4 Sort

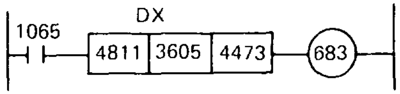
These two DX functions allow a table of registers to be sorted by their numerical contents. The entire table is sorted in one scan upon closure of the A element. The sort is performed only once upon closure of the A element; if additional sorts are required, the A element must be opened and then closed again. The first register of the table to be sorted is entered in the D element; the DX code last two digits indicate the table length. Maximum table length is 99 registers, minimum is 02.

Associated with the D element table is another table of the same length referred to in the B element. At the beginning of the sort, each register in the D element table is paired with a register in the B element table. The first registers in each table are paired together, the second registers, the third registers, etc. The sort is then performed on the D element table by its numerical value. The B element table is also sorted but only to maintain the paired relationship.

For example, if the first register in the D element table becomes the third register after the sort because of its numerical magnitude, the first register in the B element table will become the third register in its table regardless of its magnitude. The B element must be a holding register (4XXX), not an input register (30XX) since its value can be altered. The tables must be equal length and between 02 and 99 registers long. The coil will come ON if no sorting is required when the A element is closed; it remains ON as long as the A element is closed.

36XX — SORT (Ascending order)

This code causes the content of a table to be sorted by their numerical values, resulting in the smallest magnitude on the top, and the largest on the bottom. The sort is performed entirely in one scan upon closure of the A element; the coil will be energized if no sort is required. For example, refer to figure 103.



PRIOR TO SORT				AFTER SORT			
4811	0101	4473	0011	4811	2000	4473	0003
12	0200	74	0007	12	0700	74	0004
13	0400	75	0015	13	0200	75	0007
14	0700	76	0004	14	0101	76	0011
15	2000	77	0003	15	0400	77	0015

Figure 103. Example Sort

When the A element is closed, the content of D element table (registers 4473-4477) are rearranged to placed them in ascending order. The lowest content (value 0003) is placed in the first register, the next to lowest in the second, etc. until the highest magnitude (value 0015) is placed in the last register. A value of zero is considered the lowest magnitude. The coil is energized if the D element table was already in ascending order when the A element was closed.

The B element Table is also rearranged; however, its result depends upon the magnitudes of the D element table. Prior to the sort, the value 0101 (first register in the B element table) is paired with the first register in the D element table (value 0011). After the sort, the value 0011 results in the fourth element of the D table; thus the value 0101 is also placed in the fourth element of the B table to maintain its pairing. All values in the B element table are similarly arranged regardless of their magnitudes.

37XX – SORT (Descending Order)

This code operates exactly the same as function code 36XX except that the D element table is arranged in *descending* order. The highest content is placed in the first register. For example, refer to figure 103 and assume the DX code was 3705. The results would be as follows when the A element is closed:

Register	**Content**	**Register**	**Content**
4811	0400	4473	0015
12	0101	74	0011
13	0200	75	0007
14	0700	76	0004
15	2000	77	0003

3.7.5 Guarded Lines

All 384A and 384B controllers have the capabilities to be configured with logic lines that have additional protection from change beyond Memory Protect. These lines can be located anywhere in the user's logic lines as one contiguous set. Lines are guarded in groups of sixteen, with the first line number, when divided by sixteen, resulting in a remainder of exactly one (e.g. lines 33, 81, 129, 289, 401, etc.) Any number of lines can be guarded, but they must be in consecutive numerical order. Any 384 controller can also be provided with guarded lines, by requesting a TEF 04 executive that includes guarded lines.

Guarded lines can be viewed at any time from various programming devices (P112 Programming Panel, P140/P145 CRT's etc.) to determine their programmed content and power flow. However, if Memory Protect is turned OFF and a change made to any content of these guarded lines (i.e. disable coil, alter reference, change contact type, register address, or fixed preset, etc.) *All* guarded lines will have their coils forced OFF. Removing the change will NOT reenable the coils; the coils can be restored only by reloading the entire program. This restore can be accomplished from either the MODICON Service Center or a L206 Tape Loader. If the guarded line coils are used as normally open contacts in the normal logic as permissives, when changes are attempted to the guarded logic the permissives will be lost and the process/machine operation will stop. If Memory Protect is ON, changes to guarded lines will be inhibited and no loss of guarded coils is possible. After loss of guarded coils, turning Memory Protect ON will cause the RUN lights to go OFF; turning Memory Protect OFF will restore the RUN light.

When a system is received from MODICON, or a reload of the TEF with null data is made, no lines are guarded. The logic to be guarded is entered in the normal manner with any programming device. Once this program is installed and checked-out, the MODICON Service Center is contacted and asked to guard specific line numbers. A special code is added by the Service Center via the T152 Interface to protect the desired lines. The Service Center can also remove the guarding function if additional changes to these lines is desired; however, special identification procedures will be required to validate such a request.

In addition to logic lines, inputs can be also guarded: Once guarded, the disabled state of these inputs cannot be altered. Inputs that are enabled cannot be disabled, nor can disabled inputs be enabled. If a change to a guarded input's disabled state is attempted, all guarded lines will have their coils turned OFF. The system responds exactly the same to changing guarded inputs as it does for guarded lines.

3.7.6 Input/Output Communication Status

Four input registers after the additional 30XX references (see section 3.5.2) are allocated to recording the results of the I/O communications. If the controller is unable to communicate to an I/O module (see section 4.1.2), a one is placed in these registers; if it can communicate without six retransmissions, a zero is placed in these registers. A zero is also placed in the registers if an I/O module is not installed. The first register contains the status of channel I's I/O modules, the second channel II, etc. Within these registers, the first eight bits record the input module statuses (slots 1-8) and the last eight bits the output modules (slots 1-8).

To monitor the I/O module status, a matrix of known zero's is constructed in four holding registers: a DX compare line (2204) compares these input registers with this known standard. If an I/O module malfunctions, the compare line coil is energized and the pointer can be decoded to identify exactly which I/O module. When more than one I/O module malfunctions, the pointer will have more than one value and each can be decoded. If this standard is built in registers 4771-4774, figure 104 illustrates such a compare line for monitoring I/O modules: additional 30XX references are assumed to stop at 3095.

In addition to these four registers, a fifth register is available to indicate the status of the mainframe. Using the assumed references shown in figure 104, this fifth register would be 3100; these exact references always depend upon where the standard 30XX references end and thus the number of logic lines and discrete inputs. Five bits are used in the mainframe status register as follows:

Bit No.	ON (one value) When
1	Memory Protect is ON
2	Last reset caused by memory protect violation
3	Error detected in Logic Solver hardware
4	Programming Panel connected
5	First scan following power failure

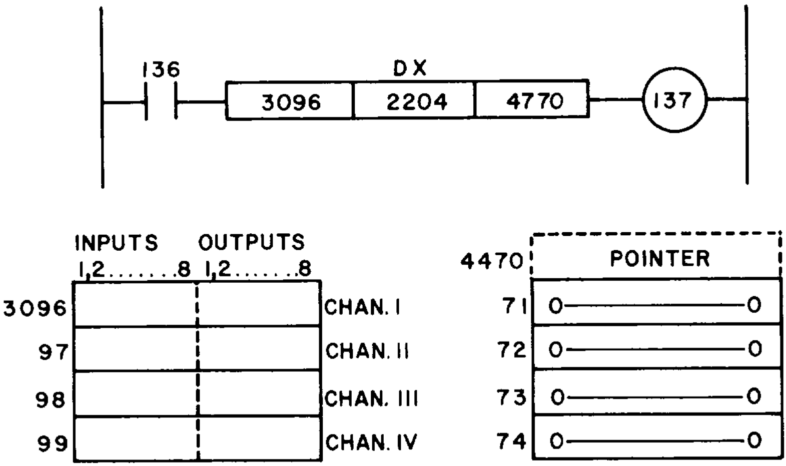


Figure 104. Example I/O Monitoring

3.8 ASCII I/O COMMUNICATIONS (384B)

The 384B Controller has all DX capabilities previously described in paragraphs 3.5, 3.6, and 3.7 for the 184, 384, and 384A Programmable Controllers. In addition, the 384B has the communications capabilities to be utilized with the 1084 Programmable Controller (including 1084 ASCII) as well as its own ASCII driving capability. Refer to the 1084 manual for complete discussion of the 1084 communications. The 384's stand-alone ASCII capability is obtained by adding four DX functions (codes 43XX, 44XX, 45LF and 46XX); these codes are discussed in the following subparagraphs. The 384B's require a TEF10 level executive to utilize the ASCII DX codes; however, they can operate on TEF08 executives if ASCII I/O is not required.

3.8.1 Introduction to ASCII Communications

ASCII I/O is obtained by using the B680 or B684 I/O module (see appendix B). When installed in I/O structure, this B680/B684 requires only one B240 or B241 slot locations. It utilizes two index pin locations, one for input capability and one for output capability, the same location as set by the user. Thus as a maximum, only eight ASCII modules (and no other modules of any type) can be installed in a single I/O channel. If less than eight ASCII modules are installed in a channel, they can be mixed with discrete and/or register I/O. Internally, each ASCII module requires four input registers

(30XX references) and four output registers (40XX references); no other module or I/O slot location should be coded to utilize data in these I/O registers. Thus, if all available register I/O is dedicated to ASCII I/O, up to eight ASCII I/O modules can be accommodated per 384B controller. Traffic cop modifications are required for each I/O slot number into which ASCII I/O modules are to be installed.

Each ASCII module is serviced separately during a 384B scan and thus they all can be active each scan. In addition, separate storage is provided for both input and output transfers, allowing simultaneous transfers (duplex operation) for each ASCII module. These ASCII communications are controlled by DX PRINT logic lines with the DX codes 43XX and 45LF (outputs) or 44XX and 46XX (inputs). As many DX logic lines can be addressed to a single ASCII module as required; however only one input and one output logic line will be actively communicating to an ASCII module at one time.

Similar to the P500 PRINT, when the A element is transistioned from open (not passing power) to closed (passing power), the print line becomes "active" and energizes its coil. If the ASCII module is available, the logic line begins commuication; if the module is already busy with another line, this line's communication is delayed until the module is available. The coil of an ASCII Print line will be energized whenever the A element is closed and de-energized when that ASCII Print operation is complete, regardless of the state of the A element.

NOTE

The A element need be closed for only one scan, and will not restart communications if it remains closed after completion of the line's function.

The first ASCII DX line activated and referenced to an ASCII module will take control of the module. Subsequent lines that are referenced to the same module, will be queued up and serviced by their line number in numerical order following the line that currently controls the ASCII module.

NOTE

Servicing these queued lines begins at the line following the currently controlling line *NOT* Line number one.

Each ASCII module in the I/O structure is provided with four consecutive output registers (40XX) for storing ASCII characters prior to their delivery to the ASCII device, and a similar number of input registers (30XX) for receipt of characters from the ASCII device. These two buffers have completely independent control and storage and can be accessed by any properly programmed logic line in the 384B controller. The only similarity is that the last two digits of the register references will be the same (i.e., 3001-3004 and 4001-4004).

NOTE

Since Traffic Cop modifications are required for all ASCII modules, it is convenient, but not necessary, to leave the normal 30XX and 40XX references to BCD/Binary numerical I/O (i.e., 3001-3016 and 4001-4016), and establish other references for the ASCII modules. Suggested references are:

MODULE	INPUTS	OUTPUTS
1	3017-3020	4017-4020
2	3021-3024	4021-4024
3	3025-3028	4025-4028
4	3029-3032	4029-4032

If more than four ASCII modules are utilized, some (or all) of the normal register I/O will be required.

The input or output buffer (four registers) are utilized in a similar operation as follows:

POINTER		Register 1
Status	Char 1	Register 2
Char 2	Char 3	Register 3
Char 4	Char 5	Register 4

The first register contains the line number which currently controls that ASCII module buffer (either input or output, but not both). A pointer of zero indicates no line has control over the buffer, it is available for use. The remaining three registers are divided in halves, and contain status relative to communication to the ASCII module or characters in the process of being transferred.

NOTE

Upon power failure, all DX ASCII PRINT logic lines have their coils de-energized, and Buffer Pointers set to zero. To abort an ASCII output, bit 1 of register 1 should be set. As long as this bit is set to a one state, all outputs to this ASCII device, will be terminated. ASCII inputs cannot be aborted.

When a properly referenced ASCII DX line is activated, it looks at the pointer (register 1) to determine if the buffer is available. If it is, it places its line number into the pointer, and loads/obtains from the buffer up to five characters. Every scan, the DX line monitors the status area and refills/empties the buffer with up to five characters if the buffer is empty/full. When the DX line has completely transferred its quantity of ASCII characters to/from the buffer, the DX line de-energizes its coil and clears the buffer pointer (register 1) to zero. The next active line referenced to this ASCII module can now take control of the buffer.

When the scan services the I/O slot to which an ASCII module is referenced, up to five characters can be transmitted to/receive from the B680/B684 I/O module. Less than five characters will be transmitted/received if the buffer is only partially full or if the B680/B684 has space for less than five characters. For example, if the scan rate of the 384B controller is 50 msec (20 scans per second), up to 100 characters can be sent/received per second. This converts to 1100 baud at eleven bits per ASCII character, (eight data, two stop, one start bits). This transmission rate is fully duplex and applies to all ASCII devices connected to the 384B controller, since each is serviced independently.

NOTE

Baud rates are a function of scan time which can depend also upon number of ASCII devices active at one time.

3.8.2 Programming DX ASCII Functions

43XX-ASCII Output

This function code copies ASCII characters stored in holding registers and provides them to a single ASCII device. The characters are assumed to be packed two per register and can be any legal ASCII character. Referring to figure 105 (line 167) the A element is a relay contact that controls when the ASCII Output is to be activated. The A element can be referenced to any line coil, discrete input, or latch reference. The B element is a pointer which indicates how many characters (NOT registers) have been provided to the output buffer; the table of registers that contain the ASCII characters must follow this register in ascending order. The B element must be a holding register (4XXX).

NOTE

The contents of the pointer will be reset to zero when the ASCII output is completed.

The C element is the DX code (43XX) where XX is replaced with the number of registers in the B element table (excluding the pointer). Thus, the maximum number of ASCII characters accessed by a 43XX DX line will be twice the XX value. The D element is the output register (40XX) to which the ASCII module is indexed. In all cases, four consecutive output registers starting at the D element register are assigned as this ASCII module's output buffer.

NOTE

No other output modules or I/O slot locations should be addressed to any of these output registers.

The coil indicates this line is busy providing ASCII characters to that particular B680/B684 module. The coil is energized when the A element is closed, and de-energized whenever the transfer to the output buffer is complete. The transfer is complete whenever the end of the table as defined by the DX code is reached or a special delimiter is encountered in the table.

NOTE

The standard delimiter is *LF* and can be altered by a Traffic Cop type change. The delimiter is outputted to the ASCII device.

When the A element of line 167 (see figure 105) is closed, coil 167 is energized. If the output buffer is available (register 4021 contains zero), the line's number is loaded into register 4021 and the first five ASCII characters are loaded from the table starting at register 4371 into the output buffer. If register 4021 did not contain zero, outputting ASCII characters is delayed until all ASCII Outputs prior to line 167 that are addressed to register 4021 are completed. Every scan when line 167 is solved, the output buffer status (bits 1-8 of register 4022) is examined until the buffer is empty. When empty, line 167 transmits the last five ASCII characters into the output buffer, de-energies its coil, and clears register 4021. If the A element is closed when its coil is de-energized, no further outputs will be commanded by line 167.

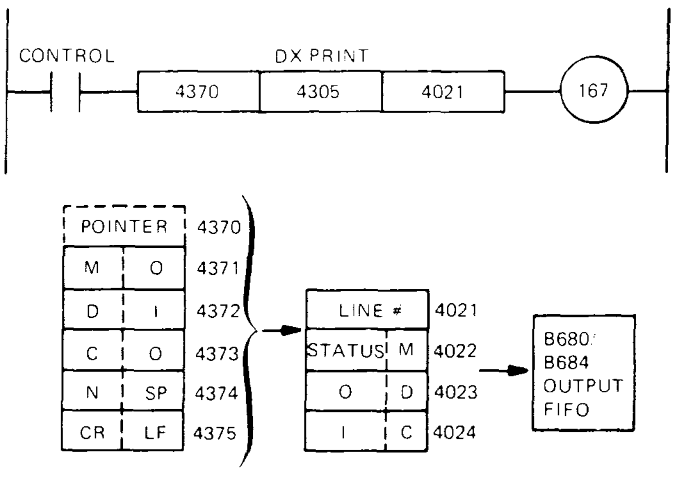


Figure 105a. ASCII Output

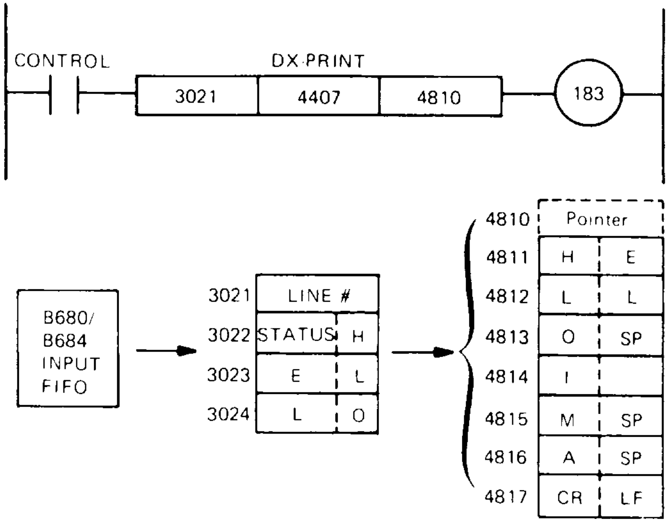


Figure 105b. ASCII Input

NOTE

If the quantity of the last set of ASCII characters loaded into the buffer is less than five (e.g., three), the status area will insure only the new characters are sent to the B680/B684 I/O module.

44XX - ASCII Input

This function code receives ASCII characters from a single ASCII device and stores them in a table of holding registers. The ASCII characters are automatically packed two per register and can be any legal ASCII character. Referring to figure 105, (line 183), the A element is a relay contact that controls when the ASCII Input is to be activated. The A element can be referenced to any line coil, discrete input, or latch reference. The B element is the input register (30XX) to which the ASCII module is indexed. In all cases, four consecutive input registers starting at the B element register are assgned as this ASCII module's input buffer.

NOTE

No other input module or I/O slot locations can be addressed to any of these input registers.

The C element is the DX code (44XX) where XX is replaced with the number of registers in the D element table (excluding the pointer). Thus the maximum number of ASCII characters loaded by a 44XX DX line will be twice the XX value. The D element is a pointer which indicates how many characters (NOT registers) have been loaded from the input buffer; the table of registers that are loaded by this line must follow this register in ascending order. The D element must be a holding register (4XXX).

NOTE

The contents of the pointer will be reset to zero when the ASCII input is completed.

The coil indicates this line is busy receivig ASCII characters from that particular B680/B684 module. The coil is energized when the A element is closed, and de-energized whenever the transfer from the input buffer is complete. The transfer is complete whenever the end of the table as defined by the DX code is reached or a special delimiter is received from the ASCII device.

NOTE

The standard delimiter is *CR* and can be altered by a Traffic Cop type change. The delimiter is stored in the table.

When the A element of line 183 (see figure 105) is closed, coil 183 is energized. If the input buffer is available (register 3021 contains zero), register 3021 is loaded with the line's number (i.e., 183), and any ASCII characters in the buffer (up to five) are loaded into the table starting at register 4811. If register 3021 did not contain zero, receiving ASCII characters is delayed until all ASCII inputs prior to line 183 that are addressed to register 3021 are completed. Every scan when line 183 is solved the input buffer status (bits 1-8 of register 3022) is examined to determine when new input data is available. Up to five ASCII characters are received every scan; the buffer does not have to be full to be acted upon by the DX 44XX logic line. After fourteen characters are received in this particular example (DX code 4407), line 183 will de-energize its coil and clear register 3021. If the A element is closed when its coil is de-energized no further inputs will be commanded by line 183.

45LF-ASCII Numerical Output

This function code operates similar to function code 43XX, except that the data to be outputted is four BCD numerical digits per register. The content of each register of the B element table is automatically converted from binary to BCD, and each resultant BCD digit is provided to the ASCII module as an ASCII character. Digits are provided first from the high order (1000's) digit.

The format of outputting data is controlled by the L and F characters of the DX code. The L character specifies the number of lines to be outputted (1 to 9) each followed by a single carriage return and a line feed. The content of each line is controlled by the F or format character as follows:

F Code	Digits Per Column	Number of Columns	Spaces Between Columns	Registers Per Line	Characters Per Line
0	4	1	0	1	4
1	8	1	0	2	8
2	4	2	8	2	16
3	8	2	8	4	24
4	4	4	8	4	40
5	8	4	4	8	44
6	4	8	4	8	60
7	8	8	2	16	78
8	4	12	2	12	70
9	4	16	1	16	79

NOTE

Sufficient registers must be provided to support the content of the format specified.

If a line quantity of zero is specified, the ASCII output line will provide to the output buffer a single carriage return followed by the number of line feeds specified by the F character (0-9). Any spaces, carriage returns, or line feeds required by the format of numerical ASCII output is automatically generated by DX function and does not require register storage.

NOTE

The B element register is not utilized with DX codes 450F and can be any legal register value.

The first four registers in the table associated with the BCD values to be outputted, are utilized by the ASCII output for internal statuses. These registers are not included in the table length as defined by the L and F digits of the DX code. The first register records the number of registers that have been converted to BCD values and then to ASCII characters. The second register stores various status information about the transfers and when to generate spaces or line feeds. The remaining two registers temporarily store ASCII characters after conversion and prior to their delivery to the output buffer. These registers must be allocated to the ASCII Print line, cannot be used elsewhere in the program, and must not be altered by the user.

As an example, refer to figure 106, line 362. When line 278 energizes its coil, line 362 also energizes its coil and monitors register 4025. If register 4025 contains a zero (buffer available), line 362 takes control of the buffer and begins to output the ASCII data. Since there are three lines required, each with four registers content separated by eight spaces (DX code 4534), a total of 16 (12+4 internals) registers is required in the B element table. Thus, this line provides to the ASCII device the content of registers 4235-4246 separated by appropriate spaces and line feeds. Line 266 of figure 106 will cause a single carriage return and two line feeds to be generated when line coil 283 is energized.

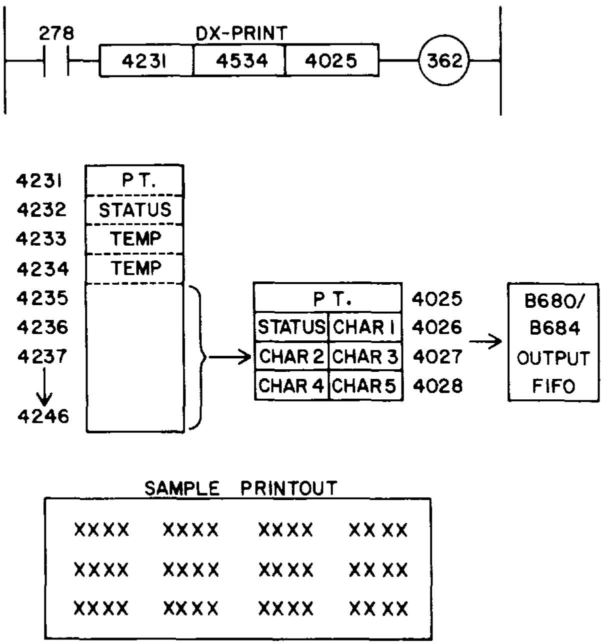
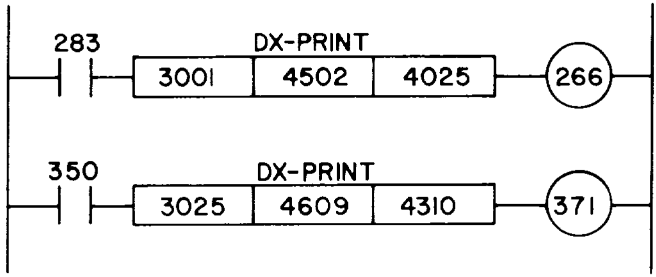


Figure 106a. ASCII Numerical Output



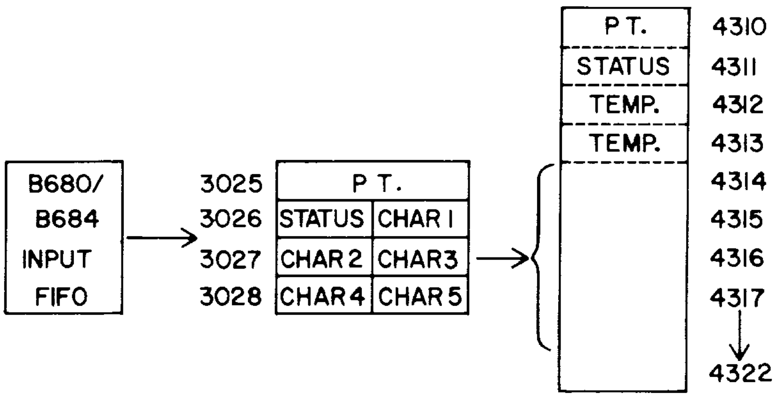


Figure 106b. ASCII Numerical Input

46XX-ASCII Numerical Input

This function code operates similar to function code 44XX except that the data received is packed up to four BCD numerical digits per register. ASCII characters other than numerical values, space, or a delimiter (carriage return) will be ignored and not effect the ASCII inputting via the 46XX code. Digits are stored in registers with each new digit causing previous digits stored in the register to be shifted to left (higher order). After four digits are received, the next register in the D element table is loaded with the next numerical character. If a space character is received after a register contains at least one BCD digit, loading that register is stopped and the next register is accessed. The loading of this table is terminated whenever the end of the table as defined by the XX of the DX code is reached, or if the delimiter is detected (CR).

As an example, refer to line 371 of figure 106. When line 350 energizes its coil, line 371 also energizes its coil and monitors register 3025. If register 3025 contains a zero (buffer available), line 371 takes control of the buffer and begins to input the ASCII data. Since there are nine registers in the D element table (plus 4 internal), up to 36 numerical digits (including zeros), can be received. The pointer in register 4310 contains the number of registers in the table that have been loaded. The content of all registers loaded by this DX line (e.g., 4314-4322) is automatically converted to binary after all digits for that register are received.

Delimiters

There are two separate delimiters in each 384B controller; one operating on ASCII inputs and the other on ASCII outputs. The same delimiters are used for both 1084 ASCII communications as well as DX (stand-alone) ASCII. Each delimiter can be altered from the Service Center similar to changing the Traffic Cop. Unless otherwise requested, delimiters will be a Carriage Return (CR) for inputting and Line Feed (LF) for outputting. Delimiter for numerical ASCII (45LF and 46XX) can NOT be changed.

SECTION IV
INTERNAL PRINCIPLES AND AUXILIARY EQUIPMENT

4.1 THEORY OF OPERATION

4.1.1 Introduction

The power and flexibility of the MODICON 184/384 Controller is provided by its software — or executive — capabilities. The 184/384 Controller has had broad acceptance in a large number of applications, but its potential in terms of a control system, not just relay replacement, has barely been tapped.

The following are descriptions of the system software data base (as of this writing) and includes a description of the I/O allocation tables and conventions designed by MODICON for proper system operation. Also provided is a description of the procedures required to properly integrate the Controller into a data processor system.

This information will normally NOT be required for the designer to program the Controller. The designer enters his program by means of the simple MODICON four-element logic lines. However, when the Controller is to be interfaced to a computer system, this information will assist the user in obtaining the data he requires. The specific core addresses for logic lines, registers, etc., are unique to each MOPS/TEF and are available from the MODICON Service Center.

Designer comments are always welcome, and the MODICON engineering and programming staff are available to aid the user in solving control design problems.

4.1.2 Scan

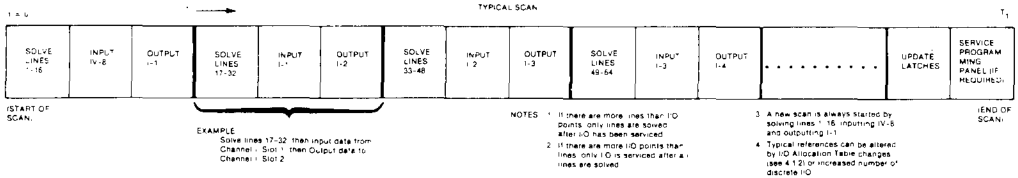
The MODICON 184/384 Controller processes its logic data by solving lines in numerical order, beginning with line 1 and continuing until the last line of the executive is solved. This completes one scan. As soon as one scan is completed, the next scan begins, again with line 1.

Each line is independently solved from element A to element D. The new results from each logic line (either coil status or data in registers) is immediately available for use by the next logic line. The scanning technique is very basic to the operation of the 184/384 Controller and should be understood before proceeding.

During the solving of logic lines, individual input and output modules are serviced by the Processor. Every line is solved once each scan and each I/O module serviced once each scan. The exact time to complete a scan varies from application to application, but depends on the number of logic lines scanned, the number of I/O provided, and the types of logic lines utilized.

NOTE

When power is supplied, a power-up sequence is performed which requires 500 ms. After this sequence, scanning is performed, based on real data (inputs and latches updated), beginning at line 1. If a power failure is detected, scanning is terminated at whichever line is currently being solved and the power-down sequence is initiated, which includes turning all outputs OFF.



SAMPLE SCAN

	INPUT		OUTPUT	
Lines	Channel	Typical Reference	Channel	Typical Reference
1-16	IV-8	3016	I-1	0001-0016
17-32	I-1	1001-1016	I-2	0017-0032
33-48	I-2	1017-1032	I-3	0033-0048
49-64	I-3	1033-1048	I-4	0049-0064
65-80	I-4	1049-1064	I-5	0065-0080
81-96	I-5	1065-1080	I-6	0081-0096
97-112	I-6	1081-1096	I-7	0097-0112
113-128	I-7	1097-1112	I-8	0113-0128
129-144	I-8	1113-1128	II-1	0129-0144
145-160	II-1	1129-1144	II-2	0145-0160
161-176	II-2	1145-1160	II-3	0161-0176
177-192	II-3	1161-1176	II-4	0177-0192
193-208	II-4	1177-1192	II-5	0193-0208
209-224	II-5	1193-1208	II-6	0209-0224
225-240	II-6	1209-1224	II-7	0225-0240
241-256	II-7	1225-1240	II-8	0241-0256
257-272	II-8	1241-1256	III-1	4001
273-288	III-1	3001	III-2	4002
289-304	III-2	3002	III-3	4003
305-320	III-3	3003	III-4	4004
321-336	III-4	3004	III-5	4005
337-352	III-5	3005	III-6	4006
353-368	III-6	3006	III-7	4007
369-384	III-7	3007	III-8	4008
385-400	III-8	3008	IV-1	4009
401-416	IV-1	3009	IV-2	4010
417-432	IV-2	3010	IV-3	4011
433-448	IV-3	3011	IV-4	4012
449-464	IV-4	3012	IV-5	4013
465-480	IV-5	3013	IV-6	4014
481-496	IV-6	3014	IV-7	4015
497-512	IV-7	3015	IV-8	4016
513-528	None	None	None	None
529-544				
545-560				
561-576				
577-592				
593-608				
609-624				
625-640				
641-656				
657-672				
673-688				
689-704				
705-720				
721-736				
737-752				
753-768				
769-784				
785-800	None	None	None	None

Table 20. Sample Scan

Table 20 illustrates the specific order of input/output servicing. After a group of 16 lines is solved, an input module is sampled with its data stored in the I/O status area of core memory, and status is provided to an output module. If, after all the I/O modules are serviced, there are lines to be solved, only the lines are solved and no I/O servicing is done. If there are fewer logic lines than I/O points, then only I/O modules are serviced after all lines are solved. Thus, the solving of lines and the servicing of inputs/outputs are accomplished once per scan, and always starts with lines 1-16, input IV-8, output I-1, etc. If the executive services less than four channels, Table 20 must be modified to delete references to those I/O slots that are not serviced.

Outputtable lines are connected to the real world only when the user installs an output module that is properly indexed. Inputs and outputs are used only in groups of 16 as required. They do not have to be indexed in consecutive order. Tables 7 and 10 define the allocated inputs and outputs for the possible I/O configurations established by the various executives.

The general servicing scheme of line solving, inputting, and then outputting data is then followed until either lines or inputs/ outputs are all serviced. At this time only the remaining category is serviced; thus the synchronization of input/output servicing versus line solving is maintained. Each I/O module is serviced individually with all 16 bits obtained from or provided to the module effectively in parallel, i.e., all at the same instant.

NOTE

If isolated I/O modules are utilized, 8 bits of information are obtained from each module (16 bits from each pair of modules).

When servicing input modules, the Processor requests the status of its 16 circuits twice and compares the two samples. If they agree, the data is stored in the I/O status; if they do not agree, another complete sample is requested and compared to the previously obtained status. This sampling is continued until two consecutive samples agree or until five compares are made. If, after five compares, no two consecutive samples agree, the Processor assumes all inputs are OFF (zero) for that input module and continues to scan. At the input module, if communications from the Processor are not received within 250 ms, the module will turn its active light OFF.

Output modules are provided with new status (all 16 outputs) at least twice each servicing; both transmissions are echoed to the Processor by the output module. The output module compares both sets of received data and, if they agree, uses them to drive its outputs. If they do not agree, the Processor re-transmits the data and a new compare is accomplished by the module between the most-recently received previous data and the new transmission; the re-transmission is initiated by the Processor's compare of the echoed data which will also be faulty. Up to four re-transmissions are accomplished if the echoes do not agree with the transmitted data. If, after a total of five comparisons, a valid compare is not obtained, the outputs retain their previous states and the Processor continues scanning. If the output module does not receive valid data within 250 ms, it will turn its active light OFF and shut all outputs OFF.

An attempt is made to communicate with each I/O module every scan regardless of the previous scan's results. Note that error checking is accomplished individually on all 16 bits provided or obtained from the I/O module. It is not a parity or error code verification.

4.1.3 Data Base

Data Base Description

The data base is composed of sequential words in the Controller memory that contain the information necessary to implement the control functions chosen by the designer for the logic lines of his system. For each logic line, exactly three 16-bit data words exist in the data base. The general format of the three words is as shown in Figure 107.

WORD 1

BIT NO	0	1 2 3	4 5 6 7 8 9 10 11 12 13 14 15
FUNCTION	LINE TYPE	A ELEMENT DATA	B-ELEMENT DATA

WORD 2

BIT NO	0 1 2 3	4 5 6 7 8 9 10 11 12 13 14 15
FUNCTION	A ELEMENT DATA	C ELEMENT DATA

WORD 3

BIT NO	0 1 2 3	4 5 6 7 8 9 10 11 12 13 14 15
FUNCTION	A-ELEMENT DATA	D ELEMENT DATA

Figure 107. General Format of Logic Lines Data Base

The data base is accessed by the logic solver section of the Controller as the line is solved in the scanning process. For each logic line, three associated words are read out of the data base and interpreted.

If the logic line being interrogated is a relay line, the logic solver provides the solution. If the logic line is a non-relay function, the necessary data is passed to the software section of the Controller for the line solution. The logic solver determines the type of line by examining the line type bit (word 1, bit 0 of Figure 107). If the line is not a relay line, two additional bits in the third word are used to further classify the line as one of four other types. In this manner, the logic line is thereby classified as either a relay, counter, timer, calculate, or data transfer line.

The arrangement of data within the A, B, C, and D elements is dependent on the line type. For example, if relay contacts are associated with the A element, the data consists of the contact type and the address where the state of the reference controlling the contact is stored. In the case of a counter line, the element associated with the preset count would contain the constant (if the preset is fixed) or the address of the register that holds the desired preset count (if remote preset is utilized).

The exact contents of the words in the data base are established by the designer when he programs the Controller via the Programming Panel. An external computer can also be used to examine or alter the data base. In this case, the following descriptions provide the information required for interpretation of the codes. The beginning memory address of the data base is variable and dependent on the executive program used by a particular Controller; the specific allocation of core memory within the Controller for any individual MOPS/TEF can be obtained from the Service Center.

Data Base Formats

Detailed word format descriptions are provided in this section for the five types of logic lines that can be programmed: relay, counter, timer, calculate, transfer data. Three types of operands — discrete references, register references, and constants — are used in the data base. Discrete and register references are explained in the following paragraphs and are detailed in the word format descriptions.

Discrete References. Discrete references are addresses of individual data bits within the logic solver RAM (Random Access Memory). The logic solver RAM consists of sixty-four 16-bit words. The relative RAM address refers to a bit location in the RAM as shown in Figure 108.

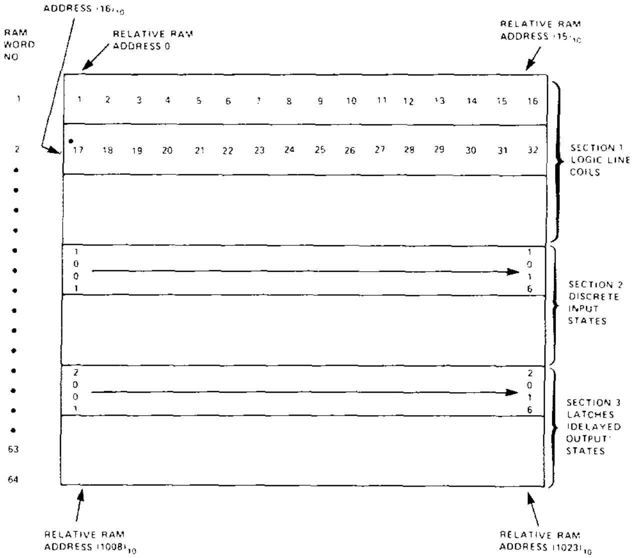


Figure 108. RAM Definition

To associate a relative RAM address with a line number, the configuration of a particular Controller and the three sections of the RAM must be considered. The size of section 1 of the RAM (in core words) consists of the number of Controller logic lines divided by 16. Each bit in a word indicates the state (coil) of one line; for example, bit 0 of word 1 is the state of logic line 0001, bit 1 in word 1 indicates the state of logic line 0002, etc. The state of these bits is controlled by the logic solver and the Controller hardware.

Section 2 of the RAM contains the states of the discrete inputs to the Controller whose address is determined by the Controller's executive. In order to associate a relative RAM address with a discrete input, the size of section 1 must be considered. Section 1 size is determined by the number of logic lines involved, as previously described. Similarly, section 2 consists of the Controller discrete inputs divided by 16 words. For example, consider a Controller with logic lines 0001 through 0224 and discrete inputs 1001 through 1224.

Section 1

Logic Line		**Relative Address**	
0001 – 1	=	0000	First logic line relative RAM address (bit 0 of word 1).
0002 – 1	=	0001	Second logic line relative RAM address (bit 1 of word 1).
↓		↓	
0224 – 1	=	0223	Last logic line relative RAM address (bit 15 of word 14; i.e., 224/16 = 14).

Section 2

L = Last logic line relative RAM address (e.g., 223).

Discrete Input		**Relative Address**	
L + 1	=	224	First discrete input (1001) relative RAM address (bit 0 of word 15).
L + 2	=	225	Second discrete input (1002) relative RAM address (bit 1 of word 15).
↓		↓	
L + 224	=	447	Last discrete input (1224) relative RAM address (bit 15 of word 28; i.e., 14 + 224/16 = 28).

For the example above, valid discrete input relative RAM addresses would fall in the range from 224 through 447.

Section 3 of the RAM contains the states of the latches (delayed outputs) of the Controller. To associate a relative RAM address with a latch, the size of sections 1 and 2 must be considered. To illustrate this, assume a Controller with latch 2001 through 2224 and the logic lines and discrete inputs as previously described. As stated, the last discrete input relative RAM address is 447.

Section 3

K = Last discrete input relative RAM address (e.g., 447).

Latch Number		**Relative Address**	
K + 1	=	448	First latch (2001) relative RAM address (bit 0 of word 29).
K + 2	=	449	Second latch (2002) relative RAM address (bit 1 of word 29).
↓		↓	
K + 224	=	671	Last latch (2224) relative RAM address (bit 15 of word 42; i.e., 28 + 224/16 = 42).

For the above example, valid latch relative RAM addresses are from 448 to 671.

NOTE

Since the logic solver RAM is always 64 words long, the number of lines, plus the number of discrete inputs, plus the number of latches, must be equal to or less than 1024.

Register References. Register references are addresses of words in the register table. The register table is a section of memory designated for input and holding register data. The words in the register table are referenced by the relative register address as shown in Figure 109.

In order to associate a relative register address with a specific input or holding register, the number of input registers for a particular executive program must be considered. For example, consider a Controller with input registers 3001 through 3016:

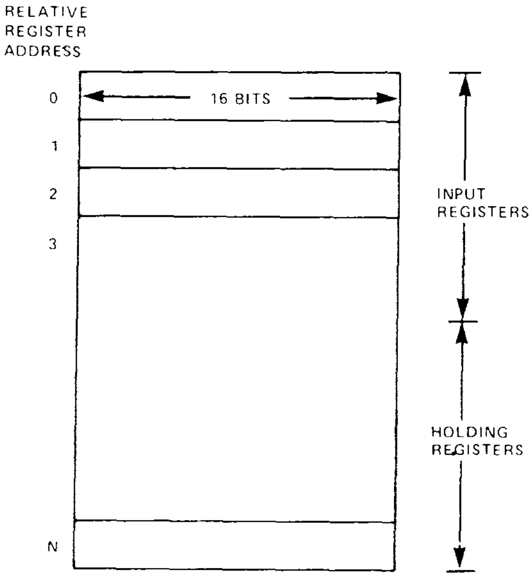


Figure 109. Definition of Register Table.

Input Register	**Relative Register Address**
3001	00
3002	01
↓	↓
3016	15

Holding register data is placed in the table beginning in the next location following the input registers. For the above example, where 15_{10} is the last input register, the holding registers would have relative addresses as follows:

Holding Register	**Relative Register Address**
4001	16
4002	17
↓	↓
4XXX	N

In the above example, N is the last relative register address that is required and is associated with the last holding register, 4XXX.

NOTE

Many executives provide more relative register address for input registers than are used by the standard I/O configuration. Consult the MODICON Service Center for specifics on any executive. These additional input registers can be utilized by I/O Allocation Table changes (typical maximum 32 register input) or to receive data from a monitoring computer.

For Controller configurations with no input registers, the holding registers are moved to the top of the table. Register 4001 would then have relative register address 00.

Word Formats. The five types of word format — relay, counter, timer, calculate, and data transfer — are designated by line type fields contained in data words 1 and 3 as shown in the following table.

	Word 1, Bit 0	**Word 3, Bit 4**	**Word 3, Bit 5**
Relay	0	—	—
Counter	1	0	1
Timer	1	1	0
Calculate	1	0	0
Data Transfer	1	1	1

The five types of formats are illustrated in the word format diagrams which follow (Figures 110, 111, 112, 113, and 114). The associated descriptions detail the data content of each word.

NOTE

The discrete and register references entered by the Programming Panel are automatically converted to relative references prior to their entry into core memory of the Controller.

NOTE

Since ten bits are available on the following diagrams for relative references (both discretes and registers), the number of unique discrete references must be equal to or less than 1024. In addition, the number of unique register references (input and holding) must also be equal to or less than 1024. These are separate limitations; both discrete and register references must be evaluated separately, and both must meet their limitation.

4.1.4 I/O Allocation Table

Table Description

The MODICON 184/384 Controller internally operates based on binary data. Normally, data received from the Programming Panel or input registers is converted from BCD to binary, and data provided to the Programming Panel or output registers is similarly converted from binary to BCD.

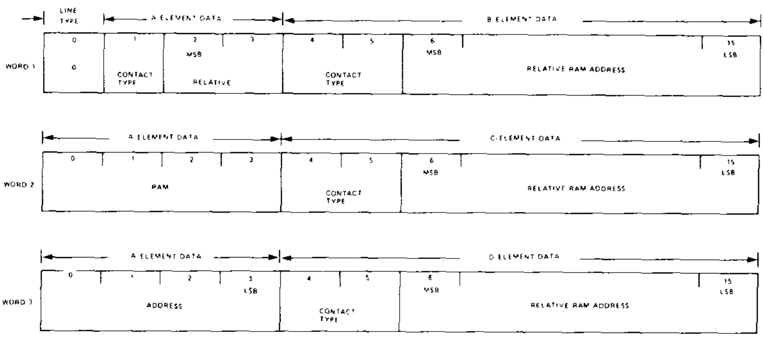
The Input/Output Control System software provides control of the sequence of I/O exchanges (transfers). The hardware ensures the sequences will start with channel I slot 1, and continue numerically to channel IV slot 8. The I/O allocation controls how the data obtained from or provided to the I/O modules is interpreted. *Any* I/O module can be coded for discrete or register data. Register inputs can be selected to be stored "as is" or converted from BCD to binary; register outputs also have the option to be converted from binary to BCD or outputted without conversion (binary outputs). In addition, particular input and output transfer can be inhibited without affecting the remaining I/O exchanges.

The interpretation of I/O exchanges is established by the I/O Allocation Table which is a directory of the relative logic solver RAM and register table addresses (see Figures 108 an 109). This table (see Figure 115) consists of thirty-two 16-bit words in the executive initially programmed by MODICON. Each word controls an I/O exchange to a particular I/O slot number. Bits 0 through 7 of each word control the input transfer while bits 8 through 15 control the output transfer.

NOTE

Because of its functions, the I/O Allocation Table is commonly referred to as the "Traffic Cop."

RELAY LINE



LINE TYPE

Word 1 Bit 0 0 Indicates Relay Line

A ELEMENT DATA

		Contact Type
Word 1 Bit 1	0	Series Normally Open
	1	Series Normally Closed

Word 1	Bit 2	MSB	Relative RAM Address
	Bit 3		
Word 2	Bit 0		
	Bit 1		
	Bit 2		
	Bit 3		
Word 3	Bit 0		
	Bit 1		
	Bit 2		
	Bit 3	LSB	

B, C, D ELEMENT DATA

		Contact Type
0	0	Series Normally Open
0	1	Series Normally Closed
1	0	Parallel Normally Open
1	1	Parallel Normally Closed

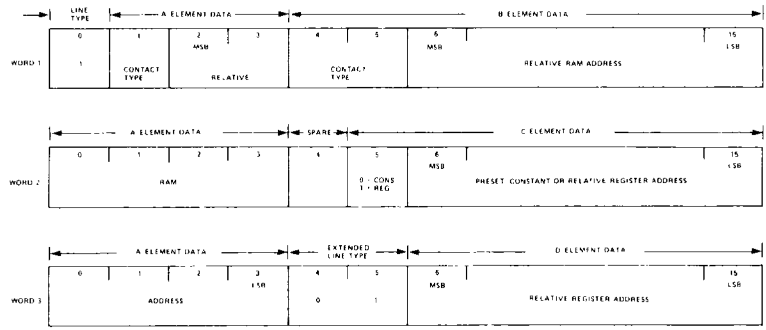
Relative RAM Address

Bit 6 ↓ Bit 15 — MSB to LSB

NOTE MSB = most-significant bit
LSB = least-significant bit

Figure 110. Relay Line Word Format

COUNTER LINE



LINE TYPE

Word 1	Bit 0	1	
Word 3	Bit 4	0	Indicates Counter Line
Word 3	Bit 5	1	

A ELEMENT DATA

			Contact Type
Word 1	Bit 1	0	Series Normally Open
		1	Series Normally Closed

Word 1	Bit 2	MSB	Relative RAM Address
	Bit 3		
Word 2	Bit 0		
	Bit 1		
	Bit 2		
	Bit 3		
Word 3	Bit 0		
	Bit 1		
	Bit 2		
	Bit 3	LSB	

B ELEMENT DATA

		Contact Type
0	0	Series Normally Open
0	1	Series Normally Closed
1	0	Parallel Normally Open
1	1	Parallel Normally Closed

Relative RAM Address

Bit 6 MSB

Bit 15 LSB

C ELEMENT DATA

Constant/Register (Bit 5)

0 Indicates the data in bits 6 through 15 is a constant

1 Indicates the data in bits 6 through 15 is a relative register address

Preset (Bits 6 through 15)

Bit 6 MSB — Constant binary equivalent of 0 to 999. Indicates desired count

Bit 15 LSB — Register Address indicates desired register that contains the desired count (Remote Preset)

D ELEMENT DATA

Relative Register Address

Bit 6 MSB

Bit 15 LSB

Indicates the register in which the accumulated count is to be stored

Figure 111. Counter Line Word Format

TIMER LINE

	LINE TYPE	A-ELEMENT DATA			B-ELEMENT DATA			
	0	1	2 MSB	3	4	5	6 MSB	15 LSB
WORD 1	1	CONTACT TYPE	RELATIVE		CONTACT TYPE		RELATIVE RAM ADDRESS	

	A ELEMENT DATA				TYPE		C ELEMENT DATA	
	0	1	2	3	4	5	6 MSB	15 LSB
WORD 2	RAM				0 = SEC 1 = 1/10 SEC	0 = CONS 1 = REG	PRESET CONSTANT OR RELATIVE REGISTER ADDRESS	

	A ELEMENT DATA				EXTENDED LINE TYPE		D ELEMENT DATA	
	0	1	2	3 LSB	4	5	6 MSB	15 LSB
WORD 3	ADDRESS				1	0	RELATIVE REGISTER ADDRESS	

LINE TYPE

Word 1	Bit 0	1	Identifies Timer Line
Word 3	Bit 4	1	
Word 3	Bit 5	0	

A ELEMENT DATA

Contact Type

Word 1	Bit 1	0	Series Normally Open
		1	Series Normally Closed

Word 1	Bit 2	MSB	Relative RAM Address
	Bit 3		
Word 2	Bit 0		
	Bit 1		
	Bit 2		
	Bit 3		
Word 3	Bit 0		
	Bit 1		
	Bit 2		
	Bit 3	LSB	

B ELEMENT DATA

Contact Type

0 0	Series Normally Open
0 1	Series Normally Closed
1 0	Parallel Normally Open
1 1	Parallel Normally Closed

Relative RAM Address

Bit 6 MSB

↓

Bit 15 LSB

TYPE

Timer Resolution (Bit 4)

0	Indicates data defined by bits 6 through 15 is in seconds
1	Indicates data defined by bits 6 through 15 is in tenths of seconds

C ELEMENT DATA

Constant/Register (Bit 5)

0	Indicates data in bits 6 through 15 is a constant
1	Indicates data in bits 6 through 15 is a relative register address

Preset (Bits 6 through 15)

Bit 6 MSB ↓ Bit 15 LSB

Constant — binary equivalent of 0 to 999. Indicates desired time in seconds if bit 4 is 0, or 1/10 seconds if bit 4 is 1.

Register Address — indicates designated register contains desired time expressed in seconds if bit 4 is 0, or 1/10 seconds if bit 4 is 1.

D ELEMENT DATA

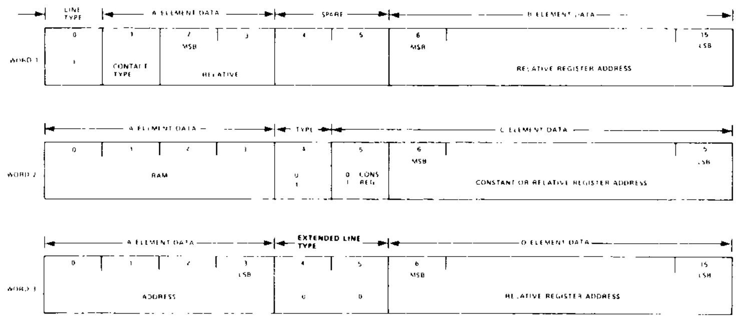
Relative Register Address

Bit 6 MSB ↓ Bit 15 LSB

Indicates the register in which elapsed time is to be stored either in seconds if bit 4 word 2 is a 0, or in 1/10 seconds if bit 4 word 2 is a 1.

Figure 112. Timer Line Word Format

CALCULATE LINE



LINE TYPE

Word 1	Bit 0	1	Identifies Calculate Line
Word 3	Bit 4	0	
Word 3	Bit 5	0	

A ELEMENT TYPE

Contact Type

Word 1	Bit 1	0	Series Normally Open
		1	Series Normally Closed
Word 1	Bit 2	MSB	Relative RAM Address
	Bit 3		
Word 2	Bit 0		
	Bit 1		
	Bit 2		
	Bit 3		
Word 3	Bit 0		
	Bit 1		
	Bit 2		
	Bit 3	LSB	

B ELEMENT DATA

Relative Register Address

Bit 6	MSB	Indicates register in which B portion of calculation is stored
Bit 15	LSB	

TYPE

Add or Subtract (Bit 4)

0	Indicates the calculation is B + C
1	Indicates the calculation is B − C

C ELEMENT DATA

Constant/Register (Bit 5)

0	Indicates data in bits 6 through 15 is a constant
1	Indicates data in bits 6 through 15 is a relative register address

Bits 6 through 15

Bit 6	MSB	Constant — binary equivalent of 0 to 999. Value of C portion of B + C calculation if bit 5 is 0 Register Address — indicates designated register contains C portion of B + C calculation, if bit 5 is 1
Bit 15	LSB	

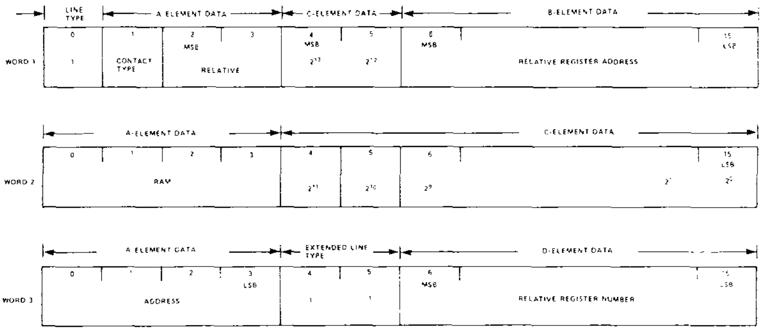
D ELEMENT DATA

Relative Register Address

Bit 6	MSB	Indicates register in which results of B + C calculation is to be stored
Bit 15	LSB	

Figure 113. Calculate Line Word Format

DX LINE



LINE TYPE

Word 1	Bit 0	1	Identifies Data Transfer Line
Word 3	Bit 4	1	
	Bit 5	1	

A ELEMENT DATA

Contact Type

Word 1	Bit 1	0	Series Normally Open
		1	Series Normally Closed
Word 1	Bit 2	MSB	Relative RAM Address
	Bit 3		
Word 2	Bit 0		
	Bit 1		
	Bit 2		
	Bit 3		
Word 3	Bit 0		
	Bit 1		
	Bit 2		
	Bit 3	LSB	

B ELEMENT DATA

Relative Register Address

Bit 6 MSB
↓
Bit 15 LSB

Indicates designated register that contains data to be acted on

C ELEMENT DATA

Word 1	Bit 4	MSB	Function Call Binary equivalent of four digit base 10 number Format of the function call is shown below
	Bit 5		
Word 2	Bit 4		
	Bit 15	LSB	

X X X X

Function Call Identifier Function Call Modifier

Function Call Identifier Code to designate the operation to be performed Examples of the code are

1XXX	Move
2XXX	Matrix
3XXX	Extended Arithmetic
4XXX	Print

Function Call Modifier Code to elaborate upon the function call Examples are

1XXX

210	Move data from a single register into a table 10 registers long every time A contact closes
534	Load a 34-register FIFO (First In First Out) stack

2XXX

005	Logical AND between two matrices each five registers long (80 bits)
212	Matrix compare each scan of two matrices each 12 registers long (192 bits)

3XXX

000	Multiply
100	Divide
400	PID

4XXX

001	Print contents of one register
125	Print form message number 25

D ELEMENT REGISTER

Relative Register Address

Bit 6 MSB
↓
Bit 15 LSB

Indicates designated register where results of transfer are to be placed

Figure 114. Data Transfer Line Word Format

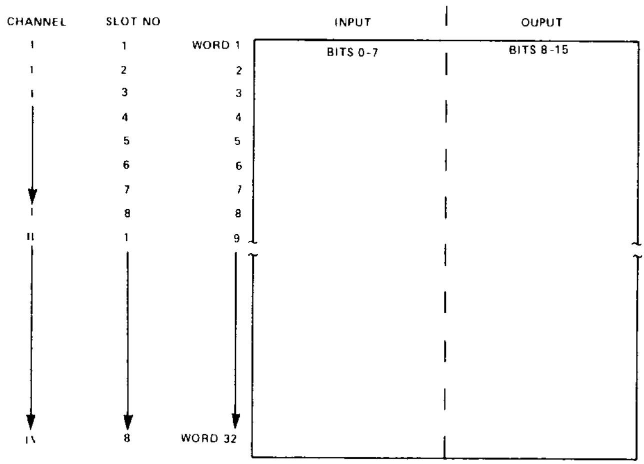


Figure 115. Word Definition in I/O Allocation Table

At the end of each group of 16 line solutions, the I/O control system initiates a transfer. Both the logic solver line solutions and the I/O Allocation Table are sequenced by the same index. The table is sequenced starting at word 1, and for one complete sweep of the executive program all I/O transfers in the table are performed. The desired results of I/O transfers can be obtained by assigning an I/O module to the appropriate location within the I/O structure.

Each word in the I/O table contains a 5-bit input-relative address and a 5-bit output-relative address to direct the I/O data to or from the appropriate memory location (refer to Figure 116). Each input or output group consists of 16 lines of discrete data or 16 bits of register data. Bits are set in the input and output control field of the I/O Allocation Table word to indicate whether the transfer is discrete data or register data and, if register data, is it binary (no conversion) or BCD (conversion to binary required).

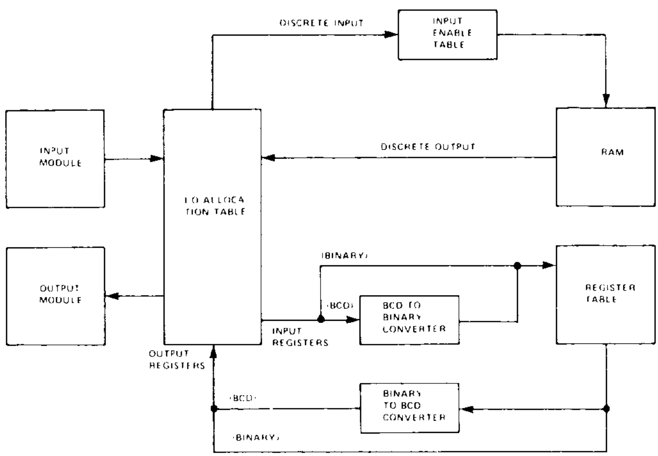


Figure 116. Block Diagram of I/O Transfers

The 16 bits of discrete input are directed by the I/O Allocation Table input-relative address to the assigned storage location within the logic solver RAM. The input is routed to the logic solver RAM through the Input Enable table. Data in the Input Enable table can inhibit transfer of selected discrete inputs if the disable feature has been utilized.

When a discrete output transfer is indicated by the I/O Allocation Table word control field, the relative output address controls where in the logic solver RAM the data is obtained, and directs it to the appropriate output module.

The 16 bits of register input data are directed by the I/O Allocation Table input-relative address to a specified position within the register table. Register input data can either be BCD or binary. If the register data is to be stored "as is" (e.g., already is binary), the I/O Allocation Table routes the input data directly to the register table. However, if the data is BCD, it must be converted to binary prior to being placed in the register table. This is done by setting a bit in the I/O Allocation Table word input control field.

Register output data can also be transferred "as is" to the output module or converted to BCD as controlled by a control bit in the I/O Allocation Table word.

Word Format

The word format for the I/O Allocation Table and a description of the format by field and bit assignments is provided in Figure 117. In addition, an explanation of the relationship of the relative input and output address with respect to memory location within the RAM and register table is provided in the following paragraphs.

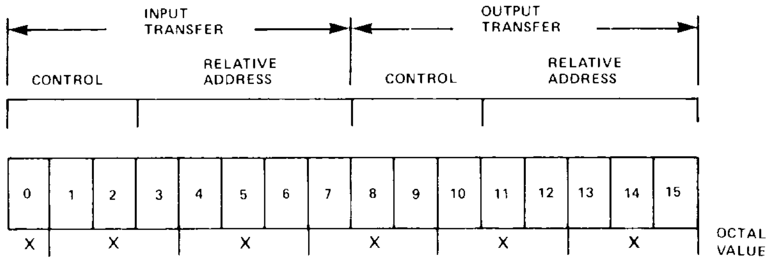
Discrete Data Addresses. The logic solver RAM consists of sixty-four 16-bit words divided into three sections. Section 1 contains the state of line solutions (outputs); section 2 contains the state of the discrete inputs to the Controller; and section 3 contains the latches (delayed outputs). Latches are not addressable by the I/O Allocation Table.

A relative input address selects the appropriate word within section 2 of the logic solver RAM to store the 16 discrete inputs. In section 2, the discrete inputs are stored in numerical sequence as follows: relative input 00 selects discrete inputs 1001 through 1016, relative input address 01 selects discrete inputs 1017 through 1032, etc. The maximum discrete input-relative address is calculated by dividing the number of discrete inputs by 16.

A relative output address selects the appropriate word (16 bits) within section 1 for loading as coil outputs to an output module. In section 1, the coil outputs are stored in numerical sequence starting at word 1 (relative address 00) as follows: relative output 00 selects coil output lines 0001 through 0016, address 01 selects coil outputs 0017 through 0032, etc. The maximum coil output-relative address is calculated by dividing the number of logic lines by 16 not to exceed 32.

Since the I/O Allocation Table provides five bits for relative addressing, the system could load 32 words into the RAM from discrete inputs (maximum 512 discrete inputs) and output 32 words from the RAM for coil outputs (maximum 512 discrete outputs). Such a system would have 512 logic lines and no latches since the RAM is 64 words long. Changes to the I/O Allocation Table cannot be made to provide more discrete outputs than logic lines, nor more discrete inputs than established by the particular executive. The maximum relative addressing (32) is the same as the total number of I/O slots provided with the Controller (8 X 4 = 32).

Register Data Addresses. Relative register input and output addresses are locations in the register table. The register table is a section in memory designated for input and holding register data. The length of the table is determined by the number of input registers plus the number of holding



INPUT CONTROL

Bit 0 Input Word Transfer Inhibit
- 1 Disable: Indicates input data transfer for this input slot not to be performed.
- 0 Enable: Indicates input data transfer for this input slot to be performed.

Bit 1 Discrete Register Identifier
- 1 Register: Indicates input relative address is a register table address.
- 0 Discrete: Indicates input relative address is a logic solver RAM word address.

Bit 2 Register Data Type
- 1 - BCD: Indicates register data is to be converted to binary prior to storing in register table.
- 0 - Binary: Indicates register data is to be stored "as is" in register table.

INPUT RELATIVE ADDRESS

Bits 3-7 Relative Address 0 through 37_8:
Indicates relative RAM word or input register address as determined by the setting of bit 1.

OUTPUT CONTROL

Bit 8 Output Word Transfer Inhibit
- 1 Disable: Indicates output data transfer for this output slot not to be performed.
- 0 Enable: Indicates output data transfer for this output slot to be performed.

Bit 9 Discrete Register Identifier
- 1 Register: Indicates output relative address is a register table address.
- 0 Discrete: Indicates output relative address is a logic solver RAM word address.

Bit 10 Register Data Type
- 1 BCD: Indicates data stored in register table is to be converted to BCD before output transfer.
- 0 Binary: Indicates data stored in register table is to be transferred "as is".

OUTPUT RELATIVE ADDRESS

Bits 11-15 Relative Address 0 through 37_8:
Indicates relative logic solver RAM word or output register table address as determined by setting of bit 9.

Figure 117. Word Format in I/O Allocation Table.

registers for a particular executive program. The first entry in the table, relative input address 00, is input register 3001; the second is 3002, etc. Thus, if an executive program has input register 3001 through 3016, the corresponding relative input addresses in the I/O Allocation Table are 00 through 15. A maximum of 32 input registers can be addressed by the I/O Allocation Table.

The holding registers follow the input registers. In the I/O Allocation Table, only the first 32 holding registers (4001 through 4032) in the register table can be transferred to output modules. For executive program configurations with no input registers, relative output address 00 through 32 would still denote holding registers 4001 through 4032. However, there is no executive currently written that provides only register outputs; whenever register I/O is available, both input and output registers are provided.

The maximum number of register I/O is normally greater than that provided with the basic executives as listed in Tables 11 and 12. Generally up to 32 input registers and 32 output registers, as a maximum, can be provided by altering the standard I/O Allocation Table; the exact limitations on maximum register I/O for each MOPS/TEF is available from the Service Center and should be verified prior to utilizing more than 16 input registers.

Modifications to I/O Allocation Table

Since the I/O Allation Table is part of the executive, changes to it can only be accomplished by a computer interface with the Controller's memory protect OFF. A unique I/O Allocation Table can be designed and loaded into the

Controller at time of shipment, or via a Telephone Interface and the Service Center. The major flexibility of this table allows the designer to make changes as to how the I/O is configured; however, if discrete and register modules are intermixed in the same channel, then identification of each module's function is mandatory in order to minimize maintenance procedures. Thus it is recommended that changes to the I/O Allocation Table be normally limited to reasons of necessity and not convenience. Some valid reasons for altering the standard table provided with the executive are as follows:

1. Make individual register I/O binary instead of BCD (Analog I/O).
2. Increase the number of register I/O (either input or output) at the expense of discretes.
3. Increase the number of discrete outputs (at the expense of register outputs).

NOTE

> Changes to the I/O Allocation Table *cannot* be made that provide more discrete inputs than allowed by the executive.

4. Mixing discrete and register I/O in a channel that is to be remoted (i.e., driven from 1425 Remote Driver).
5. Output any of the first 32 holding registers (4001-4032) or first 512 line coils (in groups of 16) in lieu of standard discrete outputs without changing the total discrete vs register output mix.

4.1.5 Power-Up/Power-Down Sequence

When power is initially applied to the Main Power Supply (P420), it begins to generate dc power ($\pm$5 Vdc) required to operate the logic within the Processor and the I/O. As soon as both of these supplies are within tolerance ($\pm$0.5% on + 5 Vdc and $\pm$ 1.0% on $-$5 Vdc), a power OK signal is sent to the Processor. This power OK signal remains available until the power supply detects a loss of ac power, at which time it removes the power OK signal prior to loss of the $\pm$5 Vdc power.

As soon as the power OK signal is received, the Processor goes through a special power-up sequence. This sequence takes approximately 500 milliseconds and includes clearing the logic solver RAM (see Figure 108), updating the latches with the retained coil status, scanning inputs and updating status (discrete inputs plus input registers), then beginning scanning the logic at line 1.

As part of the power-up sequence, all DX printer lines will be cleared (coil OFF) and lines representing print commands awaiting servicing will be cleared (removed from queue). The A element history table, that represents previous status of discrete references for use with counter and some DX lines, is not altered and retains its previous state.

When scanning begins at line 1, all subsequent line coils will be assumed to be OFF. As the lines are scanned and solved, their coil status will be provided to the RAM for immediate reference by all subsequent lines. The power-up sequence does not alter the status of any registers; their previous contents will be retained unless altered by the logic lines.

Whenever the power OK signal is removed, the Processor goes through a power-down sequence. It completes whatever instruction is currently being operated on; this ensures that data read from core memory is rewritten back into core. Data cannot be lost even if power is shut down during a core read/write operation. The scanning is terminated at whatever line is currently being executed; the Processor does not wait until the end of a scan to stop operation. All outputs are forced to zero (OFF condition) and the run light extinguished. Since the power OK signal is removed prior to actual loss of the dc power, there is sufficient time to ensure an orderly shutdown whenever ac power is removed.

4.2 SERVICE CENTER

4.2.1 Services

The Service Center is an office at MODICON's headquarters in Andover, Massachusetts that is manned 24 hours per day, 365 days a year. This office provides maintenance assistance to MODICON's customers at any time of the day or night. At the Service Center, there are several data telephone lines, support computers, and extensive files on all Controllers manufactured by MODICON. Any data line can be obtained by calling (617)475-1181. If one line is busy, the call is automatically transferred to the next available line. Since the center is always manned, this telephone number should be made available to maintenance personnel as the first option they exercise when assistance is required.

Figure 118. Telephone Interface

To make maximum use of the Service Center's capabilities, a Telephone Interface (Figure 118) should be available. This interface connects to the 184/384 Controller's Processor and allows the support computers to communicate directly to the Controller. Complete operating instructions for this interface are provided in Appendix A, Auxiliary Units. With the interface connected, the computer can:

1. Record the Controller's memory contents onto paper tape for storage at the Service Center.
2. Reload a Controller's memory from previously made paper tape.
3. Generate a ladder diagram of the user's logic, complete with cross-references and optional mnemonic identification.
4. Exercise a Controller with special diagnostic programs to locate hardware faults.
5. Load a Controller's memory with any executive available from MODICON.
6. Makes changes to the I/O Allocation Table (Traffic Cop) — see 4.1.4.

Figure 119. Typical Ladder Diagram Printout

When a Controller's memory content is to be recorded onto paper tape ("dump" into the Service Center), the entire core memory (executive, logic, register contents, and I/O status) is recorded. Thus, if a reload is required, due to operator error (e.g., power supply disconnected while the Controller is running, a wrong program loaded by magnetic tape, or unauthorized changes are made), or a duplicate machine is being programmed, or hardware malfunction, the entire core memory is restored to the status it held at the time of the "dump." Any I/O Allocation Table changes, stored register contents, disable status, etc. will be included in the reload.

Programs are stored by the Controller's serial number, located on the top, forward, right-hand corner of the Processor. This serial number should be referred to whenever the Service Center is contacted for assistance. Upon request, the Service Center can store more than one program under a serial number, provided clear identification is made between programs; or the program can be identified with a "tag" agreed upon between the user and the Service Center, thus allowing the serial number to be ignored.

Also stored by serial number, along with the latest core dump on paper tape, is the manufacturing history of the Controller, a summary of all previous service calls, notations of I/O Allocation Table changes, and identification of executive currently in the Controller. Thus, if a problem occurs

```
I
I                    AUTO                     I LOADER DRIVE TO BSKT INIT LT
I  222      228      129       224            I
I--] [---------*---] [-----] [-----(033)--I
I---------] [-^                               I
I
I
I LS13     PS8&10                             I LOADER DOWN WITH ROOF LIGHT
I  1050     1057     036       224            I NO 35
I--] [-----] [---------*---] [-----(034)--I
I----------------] [-^                        I
I
I
I                                             I BSKT CLEAR TO RAISE LDR LITE
I  019      036      034       034            I
I--] [---------*---] [-----] [-----(035)--I
I---------] [-^                               I
I
I
I                                             I LOADER DRIVE TO M/L INIT LT
I  242      242      243       244            I NO 34, 35, 46, 226, 244
I--] [-----] [-----] [---------*---(036)--I
I-----------------------] [-^                 I
I
I
I                                             I LOADER RDY FOR BODY TRUCK LT
I  254      271      224       224            I
I--] [---------*---] [-----] [-----(037)--I
I---------] [-^                               I
I
I
I                    LS3 NP                   I SYNC ARM EXT TO ENGAGE BODY
I  038      038      1059      224            I NO 38
I--] [-----] [---------*---] [-----(038)--I
I----------------] [-^                        I
I
I
I                    LS5                      I LOADER DOWN 37" OVER M/L LT
I  266      266      1055      267            I NO 40, 231, 235, 267
I--] [-----] [-----] [---------*---(039)--I
I-----------------------] [-^                 I
I
I
I           LS2A&B                            I LOC PINS EXT INTO GATE LITE
I  039      1051     040       224            I NO 40
I--] [-----] [---------*---] [-----(040)--I
I----------------] [-^                        I
I
```

Figure 120. Ladder Diagram with Mnemonics

at 3:30 a.m., the Service Center operator can review previous communic-tions and determine if a change was made at 11:30 a.m. on the previous day that may have some effect on the problem. Diagnostic programs can also be used to exercise the Controller and locate areas of malfunction. In addition to maintenance support, the Service Center can reload executives (MOPS and TEF), make changes to the I/O Allocation Table, or determine which executive is in the Controller.

4.2.2 Ladder Diagram Documentation

Once the program is stored on paper tape, a ladder listing can be generated as illustrated in Figure 119. This listing documents the entire user's program utilizing the same reference numbers that were used to enter the program in all four elements of each logic line. An extensive cross-reference is also provided that indicates where each line coil is referred to in the logic, and whether the reference is to a normally-open or normally-closed contact. In addition, at the end of the listing, a cross-reference is provided indicating where all discrete inputs, latches, and registers (input, output, or holding) are used as well as the contents of *all* registers.

As an optional feature, mnemonic information can be added to each logic line and discrete input. This information can be used to label the logic lines as to where they are wired in the system if they are also discrete outputs, or to indicate the function of the logic line. The discrete inputs can also be labeled as to where they are connected in the system. Figure 120 has the optional mnemonic information added to it. Utilizing this option, documentation and troubleshooting of a control system is extremely simple.

Figure 121 provides a sample form that can be used to provide MODICON with your desired mnemonic information; additional forms are available on request from MODICON. Each logic line or input can be assigned a six-character name (e.g., LS37), which will appear in the ladder diagram above each and every contact referred to this logic line or input. A complete label, up to 28 characters, can be assigned to any and all logic lines; discrete inputs can be labeled with up to 53 characters. These complete labels will appear opposite the coil of the logic line and opposite the cross-reference of discrete inputs at the end of the ladder diagram.

4.2.3 System Maintenance Support

The above services assume a Telephone Interface is available. If this unit is not available at the time the Service Center is contacted, some limited assistance can still be provided. Assuming all or a portion of the control system is malfunctioning, step-by-step maintenance instructions can be provided and the responses analyzed. A typical discussion could be:

Customer (C) *Service Center Operator (O)*

C: My system is down.

O: What type of Controller do you have?

C: I do not know; it's big.

O: Do you know where the Processor is?

C: Yes.

O: What does it look like, just the Processor

C: It is square, about 18 in. long, 12 in. high, and 12 in. deep, gold in color.

O: On the top of the Processor, is there a tag marked 184?

C: Yes.

O: After the 184, what is the dash number?

C: Two.

O: On the top right corner, there is a silver tag. What is the serial number on that tag?

C: 1313.

O: You have a 184 Controller, serial number 1313 with 2K memory. Is your entire control system down?

C: Yes.

O: Above the Processorn generally to the left, is a power supply. Are both lights on the top of this power supply ON?

C: Yes.

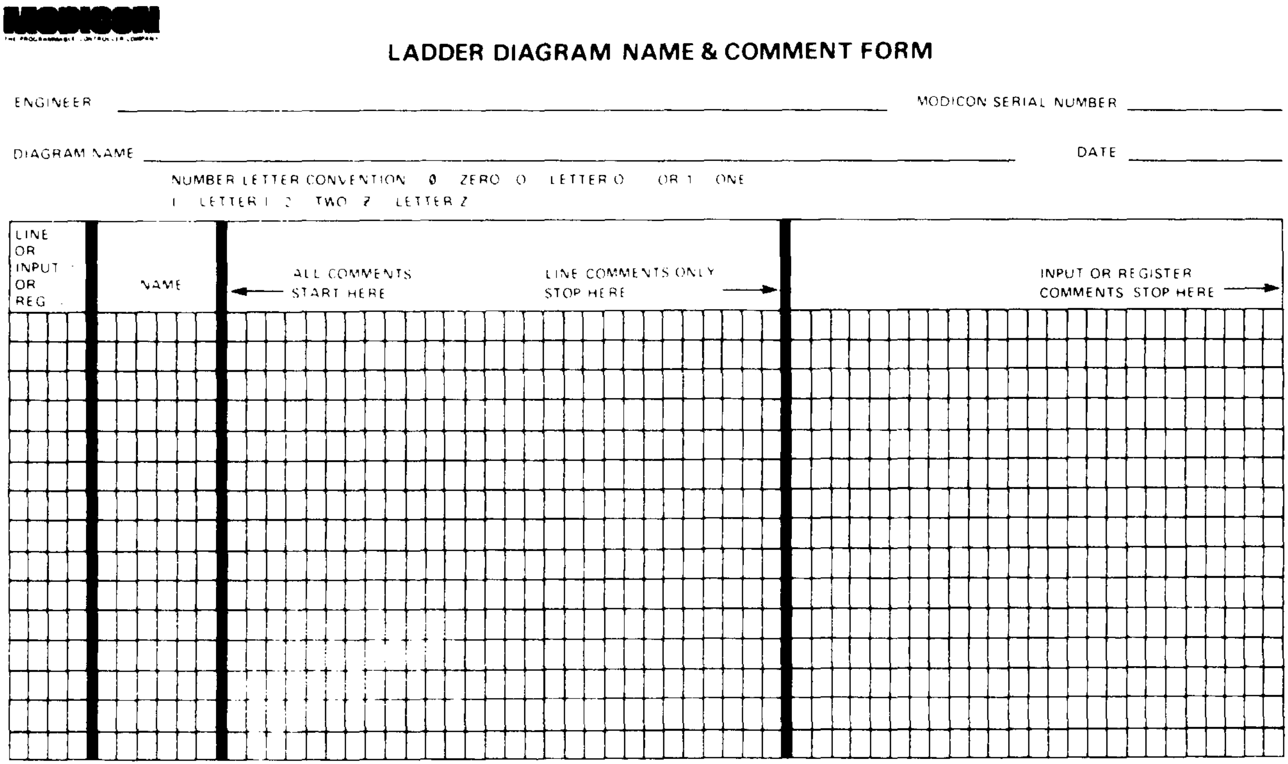
O: At the bottom of the power supply, there are two lights; are they both ON?

C: Yes.

O: On the Processor, below the large black knob on the front are five lights. Is the top one ON?

C: Yes.

O: Are any other lights ON?



MODICON

LADDER DIAGRAM NAME & COMMENT FORM

ENGINEER ______________________ MODICON SERIAL NUMBER ____________

DIAGRAM NAME ______________________ DATE ____________

NUMBER LETTER CONVENTION Ø ZERO O LETTER O OR 1 ONE

I LETTER I 2 TWO Z LETTER Z

Figure 121. Form for Specifying Mnemonics

C: Yes, the first three are blinking; the last one is OFF.

O: On the bottom of the Processor, below these lights, are three receptacles. How many have large black cables connected.?

C: All three.

O: Follow the large black cable connected to the last receptacle, the one closest to the mounting plate. Where does it go?

C: It goes to a large box.

O: What does this box look like?

C: It is about 24 in. tall, 12 in. deep, and 8 in. wide, gold in color, and is connected to other things.

O: That appears to be an auxiliary power supply. At the top should be three wires coming in and some jumpers. Is the light on the top ON?

C: No.

O: It appears that there is no ac power to this auxiliary power supply. Can you check this out with a meter and determine the problem?

C: Yes.

O: Please call me back if restoring ac power does not correct your problem.

If a ladder listing of the program in the Controller has been made, a carbon copy is kept at the Service Center again under the Controller's serial number. When a control system (not just the Controller) malfunctions, the Service Center operator can "walk" the maintenance technician through this logic with the Programming Panel and assist him to determine the cause of the fault. This cause may be a failed limitswitch, solenoid, relay, etc., or could be a failed I/O module or Processor. Whatever the cause, the Service Center is interested in solving your problems, whatever they are, at any time day or night, without having to obtain the services (3:30 a.m.!!) of the control engineers or maintenance supervisors. However, assistance provided can only be as reliable as the data previously provided to the Service Center. If changes are made to the program after a "dump" has been made, they should be clearly documented or another "dump" made into the Service Center to update its data.

4.3 COMMUNICATIONS WITH A COMPUTER

Introduction

As an option, the 184/384 Controller can be equipped with a Computer interface (Figure 122). This interface provides an EIA specification number RS-232C (Type E) data port to the Controller; RS-232C interfaces are recognized industrial standards. The hardware considerations of this Computer Interface (I646) are discussed in Appendix A. This section describes the operations and software considerations required to provide reliable communications to a computer.

The computer must be equipped with RS-232C matching data port, normally a standard hardware option with most computer manufacturers. The MODICON Computer Interface standard baud rates are: 300, 2400, 4800, and 9600; optional rates on special order are: 150, 200, 600, 900, 1200, 1800, 3600, and 7200. Once installed, the interface can provide the computer with full access to the Controller's core memory. Only one computer can be connected via the Computer Interface to the Controller at a time; however, the Controller can communicate to both a computer and the Programming Panel at the same time.

RS-232C Details of Operation

The RS-232C interface is an asynchronous, full-duplex, serial communication device. Figure 123 illustrates the basic format of this serial transmission. Each character is defined as eleven bits; one start bit, eight

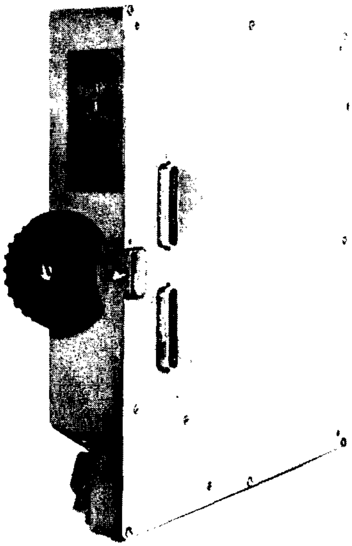


Figure 122. Computer Interface.

data bits, and two stop bits. As soon as one character has been sent, a second and subsequent characters can follow immediately in serial format there is no requirement to delay between character transmission. The length of time to transmit a character depends on the baud rate of the Computer Interface. Table 21 summarizes the minimum time to transmit a character and a single bit for the available baud rates. Since the 184/384 Controller is a 16-bit machine, it requires two RS-232C character transmissions to convey the information in one word of the Controller's memory (see Figure 124). The least-significant bit is the first bit to be transmitted.

NOTE

The computer interface will operate with either one or two (or more) stop bits; it echos back whatever format it receives. Two stop bits will be utilized for illustrative purposes here.

Table 21. Minimum Times for Single Character or Bit Transmissions

BAUD RATE (Bits per Second)	TIME (ms) REQUIRED FOR:	
	One RS-232C Character	One Bit
150	73.3	6.67
200	55.0	5.00
300	36.7	3.33
600	18.3	1.67
900	12.2	1.11
1200	9.2	0.83
1800	6.1	0.5
2400	4.6	0.42
3600	3.0	0.28
4800	2.3	0.21
7200	1.5	0.14
9600	1.1	0.10

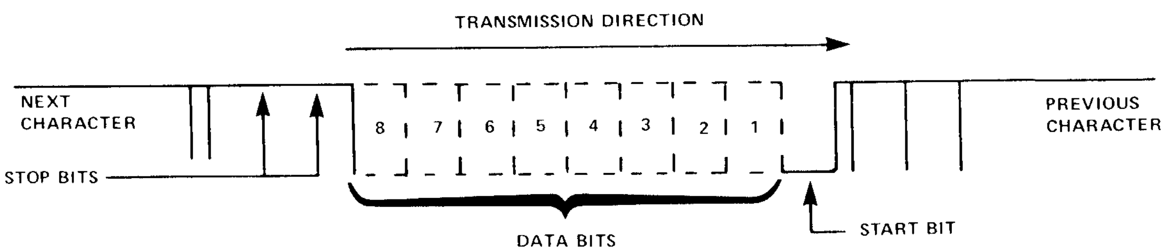


Figure 123. Format of RS-232C Serial Transmission

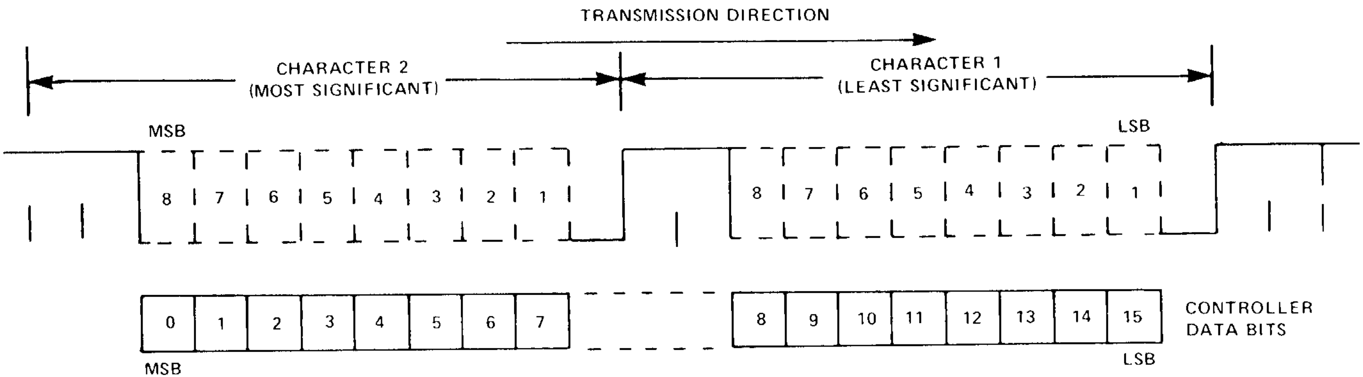


Figure 124. Format of Controller's 16-Bit Word Transmission

Communications

When power is first applied to the Computer Interface, it will assume the idle state. In order to activate the interface, the computer must provide, to the interface, a special code that establishes the mode of operation, either "TO" or "FROM" the CONTROLLER. This special code includes the core address in the Controller where the transmission is to start; transmissions continue from that address each time being automatically incremented by one (e.g., 0160, 0161, 0162, etc.) until the transmission is terminated by the computer. To terminate a transmission, the computer merely stops sending characters for the time normally required to transmit 3½ characters (3.9 ms minimum at 9600 baud). Once terminated, the transmission must be re-initiated with a special "TO" or "FROM" code. To provide error checking, whenever these special codes are utilized, the complete transmission (code and starting address) must be sent twice.

TO Mode

To establish a "TO" mode of operation, wherein data is to be sent to the Controller for storage in its core memory, the code 0101 is utilized. In addition to the code, the starting address *minus 2* must also be provided. Table 22 lists some example values of desired starting location and the actual value to be transmitted. Since the maximum core memory size in the 184/384 Controller is 4K (4096 words), 12 bits are required to address any core location. Thus, with four bits added for the special direction code, 16 data bits must be sent to establish a TO transmission starting at a particular core address. Each time these 16 bits are transmitted, they must be sent twice. Following these two transmissions (each of two 11-bit characters), the data to be placed in memory is provided (two 11-bit characters per word to be loaded). The following is an example of transmission into core location 2000-2007:

DATA SENT

OCTAL	BINARY		First bit sent
$\boxed{0\ 5}$ 1 7 7 6	$\underline{0\ 1\ 0\ 1}$ 0 0 1 1	1 1 1 1 1 1 1 0	Establish TO mode, desired
$\boxed{0\ 5}$ 1 7 7 6	$\underline{0\ 1\ 0\ 1}$ 0 0 1 1	1 1 1 1 1 1 1 0	starting address $(1776)_8 + 2$
0 4 0 1 0 0	0 1 0 0 0 0 0 0	0 1 0 0 0 0 0 0	Load 2000 with $(040100)_8$
0 4 0 5 0 1	0 1 0 0 0 0 0 1	0 1 0 0 0 0 0 1	Load 2001 with $(040501)_8$
0 4 1 1 0 2	0 1 0 0 0 0 1 0	0 1 0 0 0 0 1 0	Load 2002 with $(041102)_8$
0 4 1 5 0 3	0 1 0 0 0 0 1 1	0 1 0 0 0 0 1 1	Load 2003 with $(041503)_8$
0 0 0 1 0 4	0 0 0 0 0 0 0 0	0 1 0 0 0 1 0 0	Load 2004 with $(000104)_8$
0 0 0 5 0 5	0 0 0 0 0 0 0 1	0 1 0 0 0 1 0 1	Load 2005 with $(000505)_8$
0 4 4 1 0 6	0 1 0 0 1 0 0 0	0 1 0 0 0 1 1 0	Load 2006 with $(044106)_8$
0 4 4 5 0 7	0 1 0 0 1 0 0 1	0 1 0 0 0 1 1 1	Load 2007 with $(044507)_8$
X X X X		X X X X X X X X	
Transmission terminated by lack of data from computer for at least 3½ characters	Second character sent	First character sent	

Each bit transmitted is echoed back to the computer for error checking via the duplexed communications. The bit will be sent back or echoed slightly delayed from its reception; this delay is one-half of the time it takes a bit to be transmitted (0.05 ms at 9600 baud). These bits can be compared by the computer to the data transmitted if the proper software is written, and any errors detected. This error checking is not accomplished using a parity or some other error checking code, but rather by an entire retransmission and complete compare. If an error is detected, the transmission can be terminated and re-started at an earlier error-free location. Data is actually loaded into the core memory after the next RS-232C character (11 bits) is received. Thus, on the previous example, one character of any eight data bits (represented by X's) is sent to force the last word received (044507) into location 2007 prior to terminating the transmission.

Table 22. Starting Addresses vs. Address Sent

Desired Starting Address (Octal)	Actual Value Transmitted (Octal)
0	7776
1	7777
2	0000
777	0775
1230	1226
2000	1776
2037	2035
3777	3775
5325	5323
7775	7773
7777	7775

FROM Mode

To establish a FROM mode of operation, wherein data is to be sent FROM the Controller, the code 0010 is utilized. Data is copied out of its core memory (non-destructive, retentive copying). In addition to the code, the starting address *minus 2* must also be provided (see Table 22). Again, a 16-bit transmission (4 bits for code, 12 bits for address) is sent to establish a FROM transmission and must be sent twice. These 16-bit transmissions are accomplished in two 11-bit characters; the following is an example of transmissions from core locations 5325-5331:

DATA SENT

OCTAL	BINARY (Second character sent)	BINARY (First character sent) — First bit sent at right	
0 2 5 3 2 3	0 0 1 0 1 0 1 0	1 1 0 1 0 0 1 1	Establish FROM mode, desired
0 2 5 3 2 3	0 0 1 0 1 0 1 0	1 1 0 1 0 0 1 1	starting address $(5323)_8 + 2$
X X X X X X	1 1 1 1 X X X X	X X X X X X X X	Echo* Starting Address − 1
X X X X X X	X X X X X X X X	X X X X X X X X	Echo Content of 5325_8
X X X X X X	X X X X X X X X	X X X X X X X X	Echo Content of 5326_8
X X X X X X	X X X X X X X X	X X X X X X X X	Echo Content of 5327_8
X X X X X X	X X X X X X X X	X X X X X X X X	Echo Content of 5330_8
X X X X X X	X X X X X X X X	X X X X X X X X	Echo Content of 5331_8
Transmission terminated by lack of data from computer at least 3½ character times.	Second character sent	First character sent.	*With four high-order bits set to ONE.

Each bit in the special code will be echoed when received (total four characters). These echoes can be used to verify that the proper mode and address has been established. After two control transmissions, any bit pattern can be sent since they will be used only to force data out of memory (FROM mode only). The first two arbitrary 11-bit characters after the control codes (characters 5 and 6) cause the desired starting address minus one to be echoed. Since addresses are only 12 bits long, the remaining four bits (high order end of second character), where the control code is normally found, will be replaced by all one's. In the above example, the echo after the two control code transmissions will be 175324. This echo can also be used to verify that the proper starting address has been established. The next dummy character sent (character 7) will cause the least-significant eight bits of the content of core location 5325 plus the normal start/stop bits, to be echoed; character 7 forces out of memory the first real piece of useful data. To ensure accurate transmission of data FROM the Controller, it is advisable to read data in memory twice and compare the results. Generally, this is accomplished in blocks of data, for example 64-word blocks. This allows errors to be immediately recognized and corrected before an entire memory is read with unreliable communications.

Controller Response

When data is requested in either the TO or FROM mode by the Computer Interface, the operation of the Controller is interrupted for approximately 15 microseconds to perform the requested function. This interruption is satisfied only after the Controller completes its current memory instruction; it does *not* delay until a line solution is complete or an I/O slot is serviced. Wherever it is in the scan, the Controller will stop prior to the next instruction and either load a core word or read a core word. For the worst case, an active Computer Interface will delay the scan by only 0.7% (9600 baud, continuous transmissions).

If it is desired that the Controller be shut down (stop processing data) while a large transmission takes place (such as loading a new logic program or executive) core location 7775 should be loaded with zero. Within 15 μs the Controller will be "Trapped," not scanning logic lines nor servicing I/O modules; but the Controller will be able to respond to the Computer Interface. After the reload has been accomplished and verified, the Controller can be untrapped by cycling power. To ensure proper system operation, anytime changes are made to the executive or the user logic (data line), the Controller must be trapped. If the Controller is processing data, it is possible, unless special procedures are established, to change the operation or instruction currently being executed prior to its completion, resulting in undetermined operation.

Also available from the Service Center are the exact core locations for line data, I/O Allocation Table, register values, enable tables, etc.; each of these functions vary from executive to executive and must be defined for each MOPS/TEF. In core location 3 (of all executives) is a Program Number that represents the MOPS/TEF identification (e.g., MOPS 3, Mod 13), as well as its revision level.

The keylock switch on top of the Processor will protect certain areas of memory from change even with the Computer Interface (see 3.1.4). With memory protect ON (the normal operating mode of the Controller), the Computer Interface can read the entire memory but can only change the register and I/O status area; however, trapping a Controller is possible with memory protect ON.

Options

Two options are provided with all 1646 Computer Interfaces that can be selected by connecting jumpers on the interface connector. The pin assignments for this connector are shown in Figure 125; either or both options can be selected by installing the proper jumpers. If neither option is required, the appropriate pin is simply not connected. The memory protect option is similar to the keylock switch on the Processor, except that when it is selected, it prevents the monitoring computer from writing *any* data into the Controller's core memory. The Controller basically becomes a read-only system.

The second option allows the Controller to generate a flag character to the computer. When selected, the flag option allows the next to last line in the user's program to control the generation of the flag. If the executive provides 640 lines of logic (Watchdog Timer line is line 640), line 639's coil will initiate the flag character. When the WDT-1 line is transitioned from OFF to ON, a single flag character is sent; if additional characters are required, the WDT-1 line should be turned OFF, then ON again. A timer should be used to send flags at a convenient rate (2 per second) until response is obtained from the computer. If flag characters are sent at a sufficiently high rate, ensure that the interface has the capacity to respond to this requirement without locking out the computer. The flag character format is four zeros followed by four ones (00001111) and is transmitted in a very short time (1.1 ms at 9600 baud). If the monitoring computer is not available to respond immediately to the flag character, continuous transmissions are recommended.

If the Computer Interface is active in either a TO or FROM mode, while the WDT-1 is transitioned from OFF to ON, the flag character will be delayed until termination of the transfer. If a computer initiates a transfer while the flag character is being sent, the echo of the transfer control characters will be proceeded by the flag character.

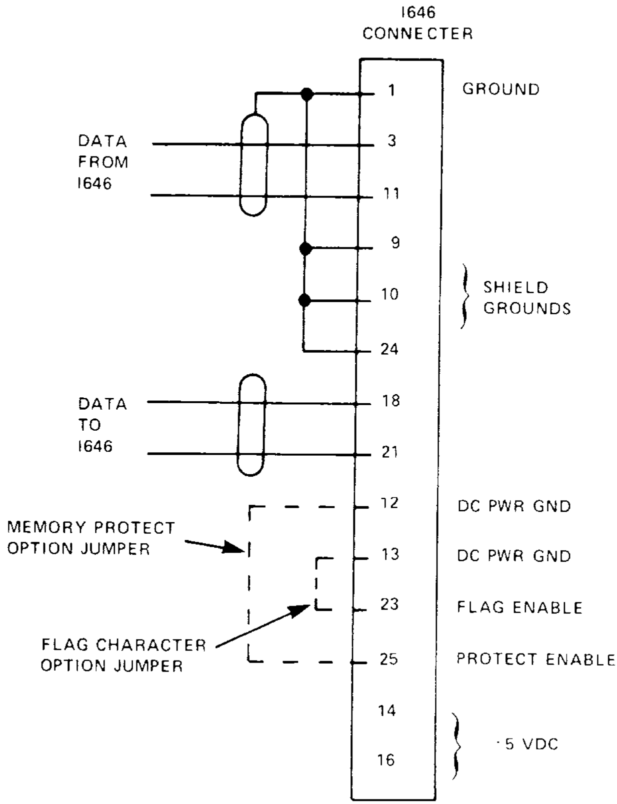


Figure 125. Pin Assignments on 1646 Connector.

System Design Recommendations

In most applications, a monitoring computer system can be designed so that all transfers (except reload of executives and/or logic data) occur via the register table. This procedure allows the Controller to operate with memory protect (keylock type) ON and still provides the computer with control capability. Logic within the Controller can be designed to count parts produced, measure equipment operating times (up time), detect system errors, etc. This data is stored in registers and thus is available to the computer for copying and can be cleared to zero if a new count level is desired. In addition, recipe data and number of batches to be produced can be loaded by the computer into registers (including input registers) for use by the Controller's logic.

If several conditions, such as error detection, end of batch, etc., can generate an interrupt (via flag character) a register should be dedicated to describing the type of interrupt. A one in this register can represent an error of type A; a two, error type B; a ten, end of batch, etc. As soon as a flag is received, the computer examines this register to determine the type of interrupt. If control of logic is required, a group of sense or calculate lines can be used to provide coil references, only when a register contains a certain bit pattern or a specific value. Of course, the contents of this register can be altered by the computer to effect control of the logic.

SECTION V
INSTALLATION

SPECIFICATIONS

Power Requirements:	115 Vac ± 15%, 50/60 Hz, 300 Volt amps (Max)
Environment Requirements	
Ambient temperature	0°C to 60°C
Humidity	0% to 95% (non-condensing)
Dimensions:	
184 Processor	22 in. x 12 in. x 13 in.
384 Processor	22 in. x 15-1/2 in. x 13 in.
Power Supply (115V)	7-5/8 in. x 25 in. x 13 in.
Power Supply (230V)	7 in. x 29-1/2 in. x 13 in.
Single I/O Housing	5 in. x 41 in. x 13-1/2 in.
Four Housings (One Channel)	20 in. x 41 in. x 13-1/2 in.
Weight:	
Processor	40 lb. (184); 45 lb. (384)
Power Supply	40 lb. (115); 45 lb. (230v)
I/O Module	5 lb.
Single I/O Housing	13 lb.
Four Housings (One Channel)	52 lb.

INSTALLATION PROCEDURE

The various parts of the MODICON 184/384 Controller system are packaged in separate containers.

Container	Contents
C184/384	Processor unit with W600 cable for I/O channel No. 1 (up to four housings)
P420	Main Power Supply
B240	Input/Output housings (up to three housings per box)
P421	Auxiliary Power Supply (with I430 as option)
Bxxx	Input/Output Modules (up to six per box)
I425	Driver Assembly

The MODICON system is easily installed on any vertical surface capable of sustaining the specified weights. Each unit is provided with holes for mounting. Figure 126 shows a typical mounting plan for marking the wall for bolt-hole drilling.

NOTE

Be sure to check cable lengths provided before marking mounting surface.

MODICON provides a standard template. Dwg. No. SK-C184-200, full-size, which is available upon request.

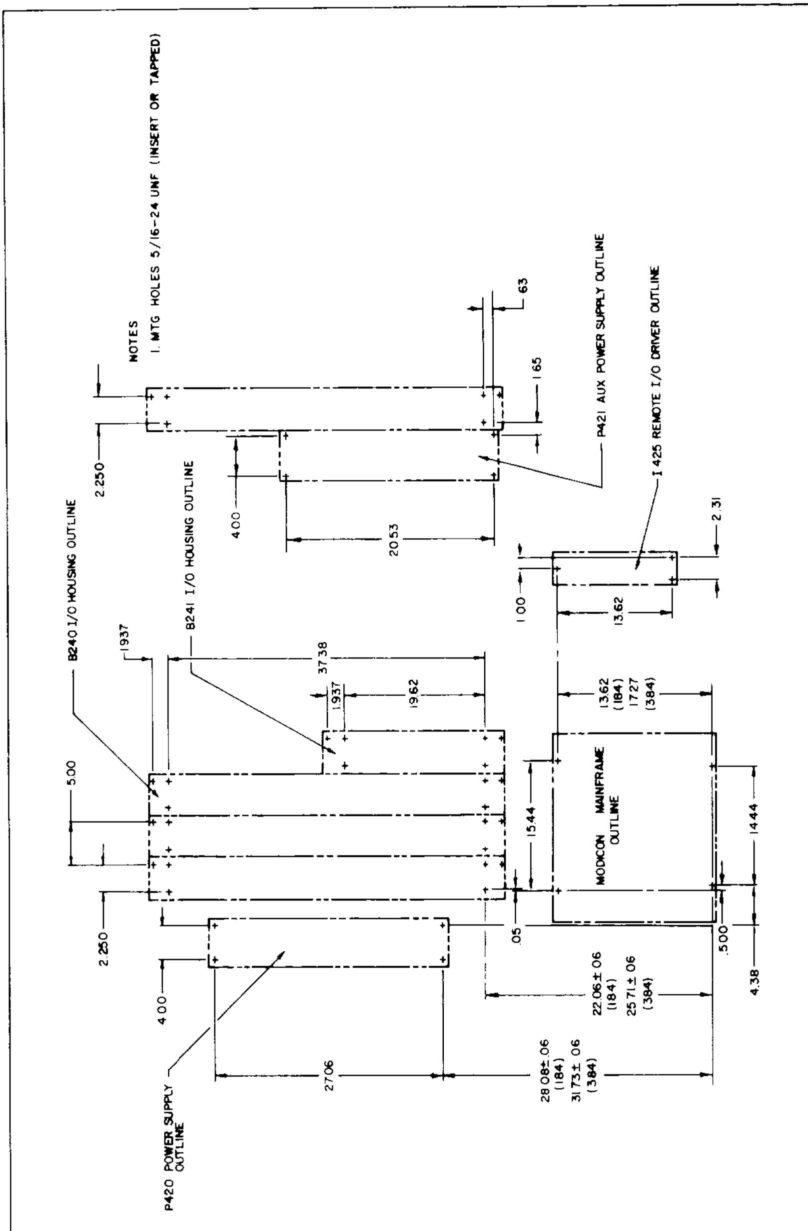


Figure 126. Typical Mounting Plan

Mounting and Check-Out Procedures

It is recommended that the Controller configuration be initially checked out (powered-up) before actual mounting. In any event, cabling procedures are the same. The following preliminary steps should be taken.

1. *Checking Serial Numbers.* The processor serial number is located on a tag positioned on the upper right-hand corner of the unit. The main Power Supply serial number is located on the underside of the supply.

NOTE

When corresponding with MODICON, concerning these units, please specify the unit type and serial number.

The capabilities of the MODICON 184 Controller's processor are expressed in terms of its memory capacity. This ranges over four options, indicated on the top of the Processor unit, which has a blue label specifying the memory size.

184-1	1K Memory Size
184-2	2K Memory Size
184-3	3K Memory Size
184-4	4K Memory Size

The MODICON 384 Controller is always supplied with 4K Memory Size.

2. Check all connectors for mechanical flaws or damage.
3. Remove protective tapes from I/O housings (both right and left sides). Leave tape intact on right side of the last housing.

First Power-Up

The following is a recommended step-by-step procedure for correctly cabling and checking out the system's power connection prior to mounting.

1. Position Processor, the Main Power Supply and a B240 Housing on a table or floor in the same relative position they will have when mounted.
2. Connect a three-wire ac cord to terminals 1, 2, and 3 of the main Power Supply, (see Figure 127.)
3. Connect jumpers from terminal 1 to terminal 5, 2 to 6, and 3 to 7 of the Main Power Supply. This connects both the Main Power input (terminals 1 - 3) and the remote 'power control' signal (terminals 5 - 7).
4. Plug in cord to a 115 Vac 60 Hz (50 Hz or 230V 50 Hz if supply is so designated). The Main Power and the Control neon lights should be illuminated.
5. Disconnect the AC source from the supply.
6. Connect the Power Supply cable to the Processor, (Figure 128).
7. Reconnect the Power Supply to the AC power source.
8. Close the Port on the left of the Processor and turn the black controller interlock knob to the "ON" position. At this time both neon lights at the top of Power Supply and both indicators at the bottom should be illuminated. The lower indicators indicate a satisfactory output of the Supply, (see Figure 129).

CAUTION

Care must be taken whenever connecting cables from the processor to the I/O housings.

9. Turn controller power off and on, using the black interlock knob, and observe indicator lights for proper function.
10. Disconnect the AC source.
11. Slide I/O channel cable/W600 connector onto I/O channel B240 housing/receptacle (Figure 130.) so that it does not quite touch the metal stop above the housing receptor pins.

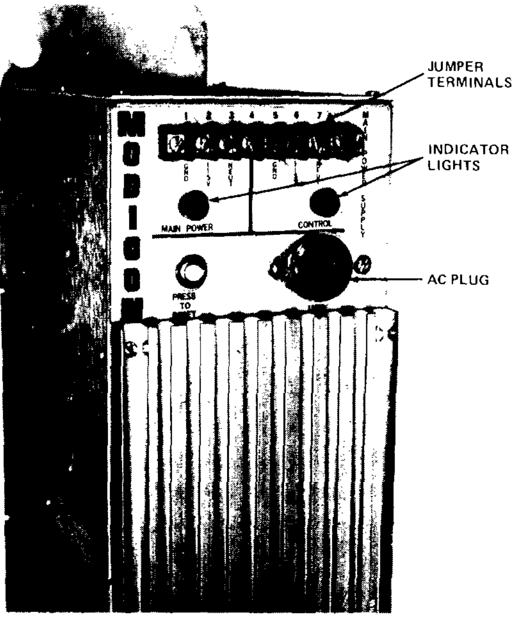


Figure 127. Main Power Supply AC Connections

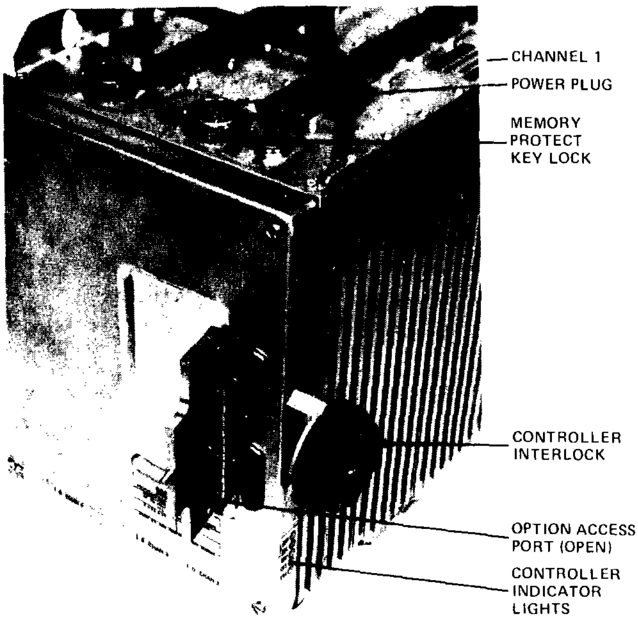


Figure 128. Cable Connection, Power Supply to P'ocessor

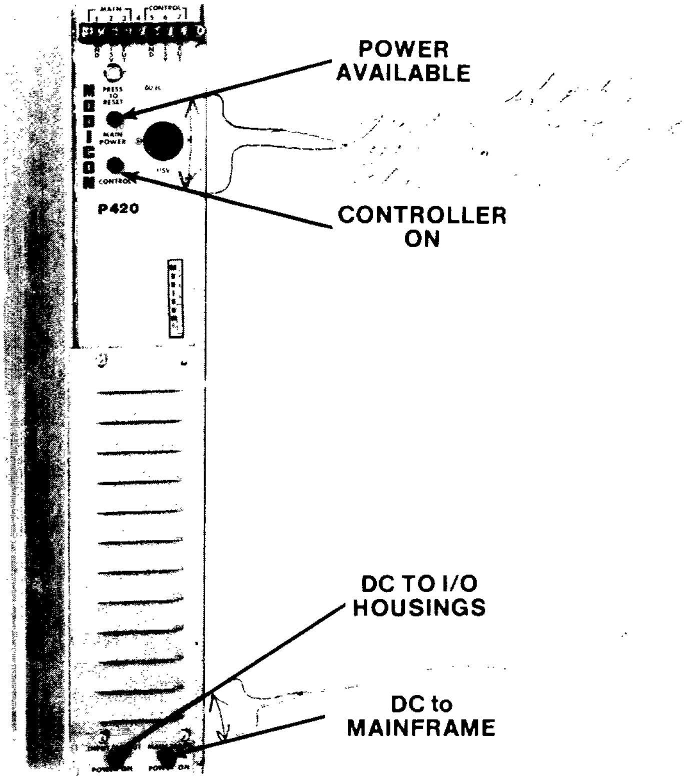


Figure 129. Power Supply Indicators

12. When properly inserted, the connector should be able to be locked into place by the locking cam provided (Figure 131.) without excessive force. If receptor pins do not easily mate with receptacle in W600 cable, realign W600 connector slightly.
13. Connect AC power and turn unit on. Repeat step 9.
14. Disconnect AC power line.

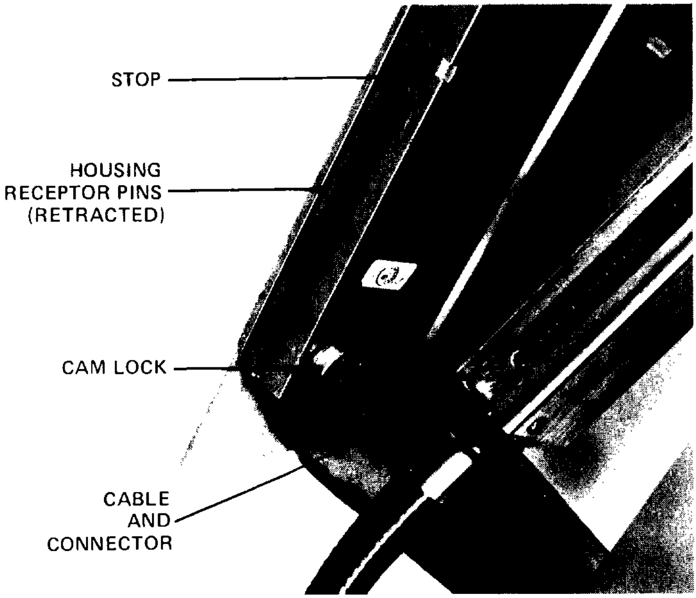


Figure 130. Typical I/O Channel Cable Connector and Housing Receptacle

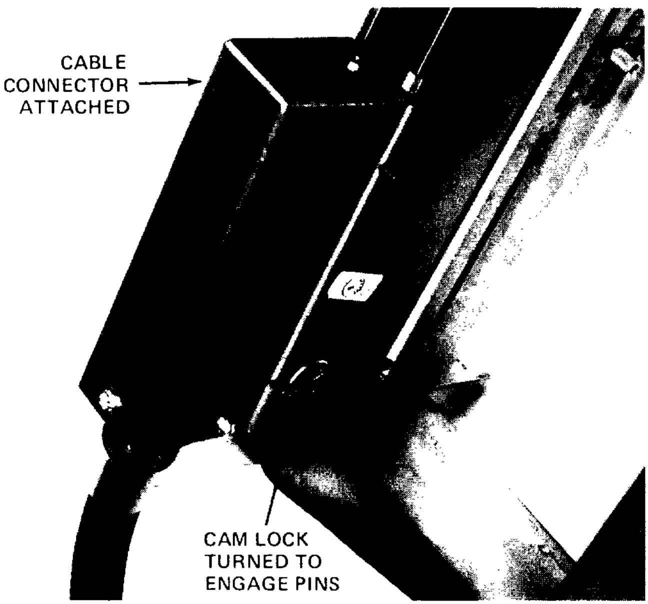


Figure 131. Cable Connector, Showing Locking Cam

Mounting Procedure

Figure 132 shows a typical system mounted, with one full channel (4 housings, each with up to four I/O modules); expansion to four such channels (total 16 housings or 64 I/O modules) is possible without modifications to the processor.

Step **Procedure**

1. Select one B240 Housing and remove the protective tape from the lower left side of the Housing. (Figure 133.)

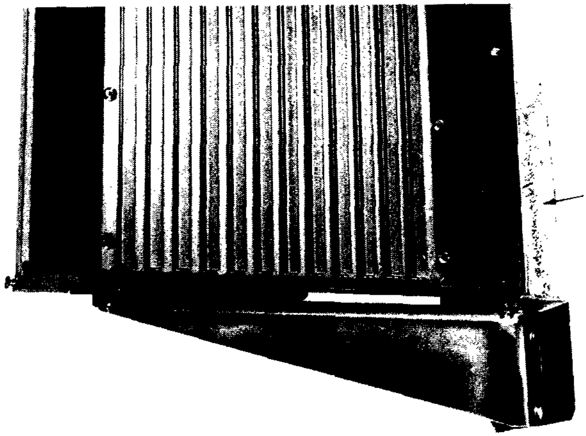


Figure 133. Mounted Housing, Showing Protective Tape

2. Loosely bolt this Housing into place for the right-most location for channel I.
3. Select the next B240 Housing and remove the protective tape from both the left and right side of the Housing.
4. Place to the left of the previously installed Housing and loosely bolt into place.
5. Rotate the connector cam located at the lower left-hand side of the previously installed Housing 180° clockwise to engage mating connectors. Use extreme caution when rotating cam so as not to damage mating connectors.
6. Repeat steps 3, 4, and 5 until the required number of I/O Housings are in place.
7. Securely tighten all mounting bolts in place.
8. If more than one channel of B240 Housings are required, assemble per steps 1 through 7 above.

Proceed next with the Processor unit mounting as follows:

9. Make sure that brackets are mounted properly (upper bracket is marked with a silver label). Securely mount the two Processor brackets to the panel.
10. Install the Processor in place and tighten.

Next mount the Main Power Supply in place as follows:

11. Start the top two bolts in place.
12. Hang the Power Supply in place by the top two bolts.
13. Insert bottom bolts in place and tighten.

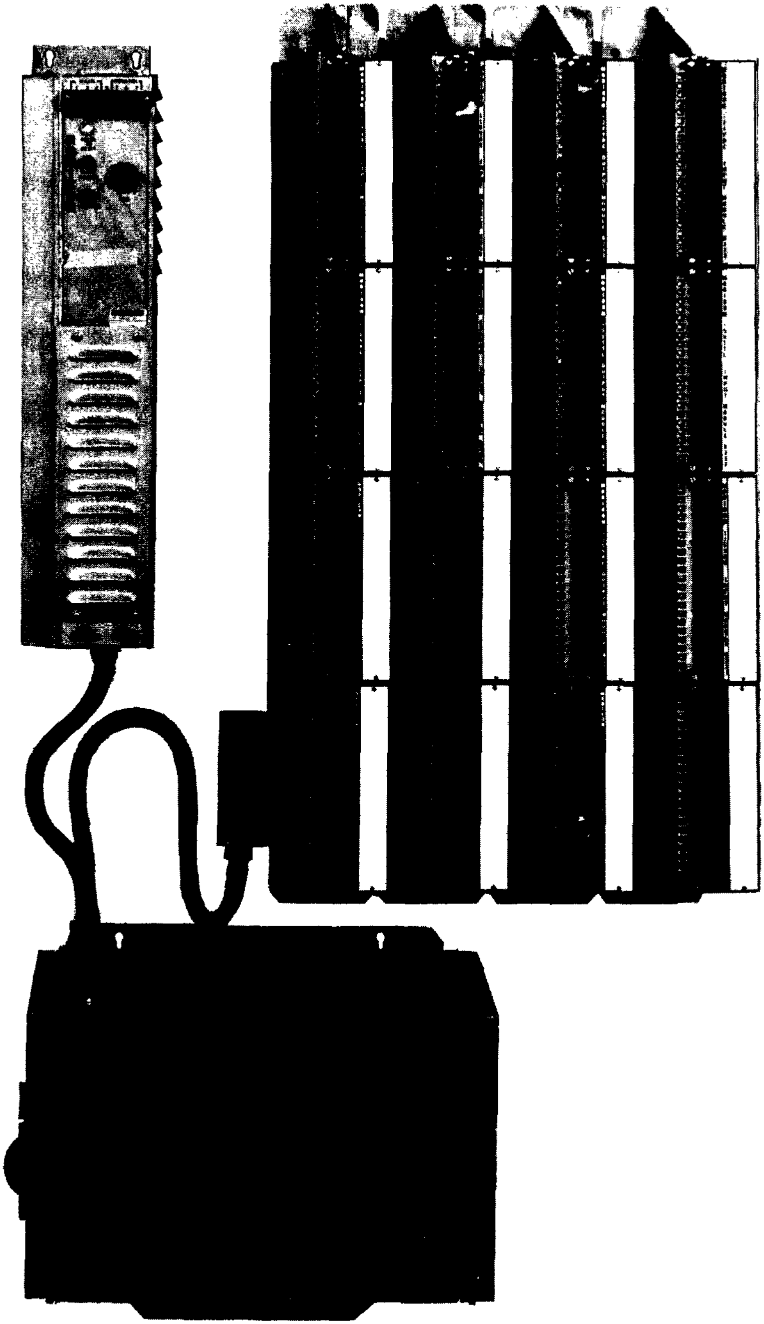


Figure 132. Typical Mounted Basic System

If more than one channel is to be used, next mount the Auxiliary Power Supply in place as follows:

14. Install the top two bolts loosely in place.
15. Hang the Power Supply in place.
16. Install lower bolts in place. Do not tighten. Rotate the connector cam for the adjacent B240 Housing 180° clockwise to engage connectors, being careful not to damage mating connectors by forcing cam.
17. Tighten mounting bolts.

Assemble connecting cables as follows:

1. Connect the W600 cable to the left-most I/O Housing for channel I by sliding it up the fitted extrusion carefully until the connectors can be engaged by turning the connector cam 180° clockwise.
2. Tighten the hex head lock screws to secure cable in place.
3. Connect the other end of the W600 cable to the smaller connector on the top rear of the Processor.
4. Connect the P420 Main Power Supply cable to the larger connector on the top front of the Processor.
5. Connect Auxiliary Power Supply cable(s) to its respective connector on the Processor. The Processor connectors are located on the bottom left side of the unit. From front to rear they are for channels II, III, and IV, respectively.

If a remote I/O I425 is to be installed, proceed as follows:

1. Bolt I425 in place.
2. Connect 6 ft. cable to the desired Processor Channel to be remoted (see Figure A-13). Attach interconnecting cable (2 required) from the I/O driver to the Auxiliary Power Supply I/O Interface. Match the 'S' location on the I425 with the 'S' location of the Auxiliary Supply*. Also match the 'C' location on the I425 with the 'C' location on the Auxiliary Supply*. Ground the outer cable shields to the posts provided to insure adequate unit grounding.

NOTE

The cable required is not provided by MODICON. Use Beldon cable part no. 8227-500, 20 AWG, 100 Ω, shielded, plastic jacketed twisted pair transmission line or equivalent.

INPUT/OUTPUT CONNECTIONS

Channel Cabling

If the user's system contains more than four I/O module housings, it is important to understand the channel concept. Standard MODICON cables connecting the housings to the Processor's unit normally handle up to four housings with their input-output signals. For this reason, the cable connecting the first four housings to the Processor is designated channel I. The internal circuitry of the Processor is designed to recognize this channel as such. Up to three additional channels (four housings each) may be used in a MODICON 184/384 Controller configuration (with Auxiliary Power Supply option). (See Figure 134.)

Specific receptacles are provided for channel cabling. The first channel in any system (channel I) is always connnected to the cable receptacle at the top of the processor (Figure 135). Additional channel cabling is discussed later.

*Where 'S' is silver-clad wire and 'C' is copper-clad wire.

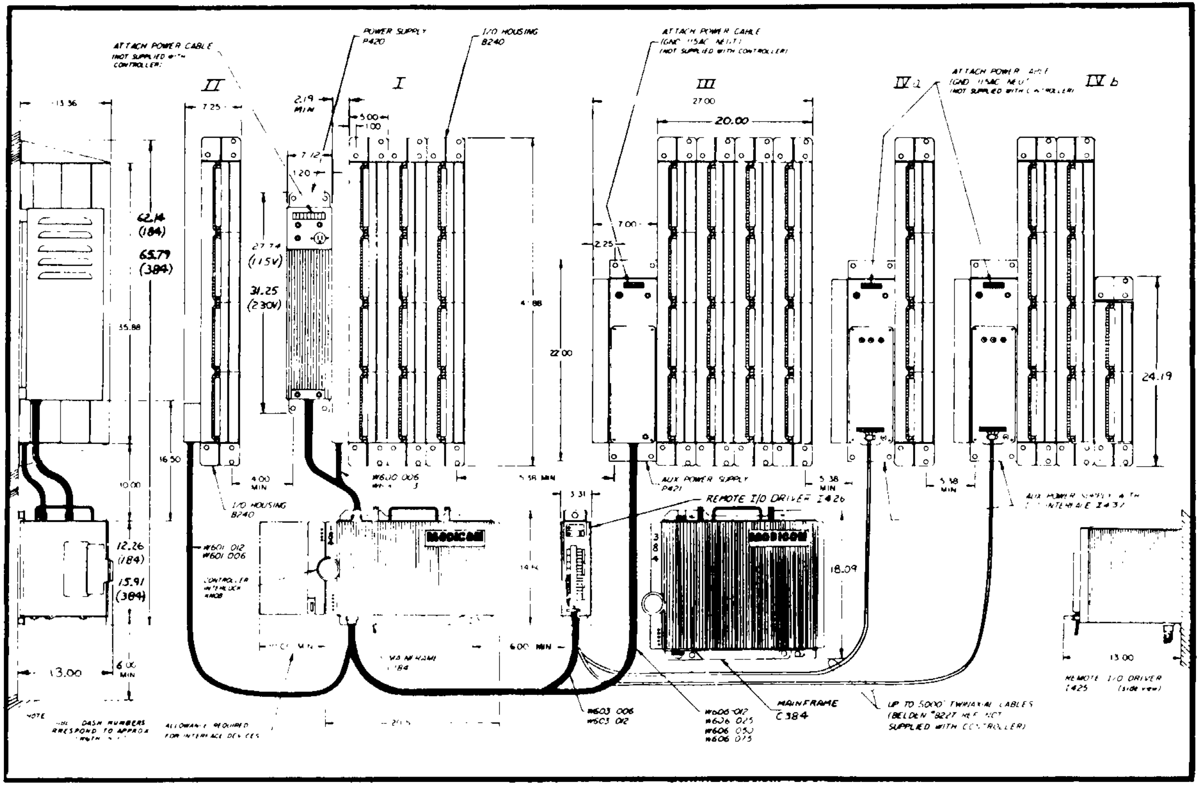


Figure 134. Expanded System Configuration, Mounted

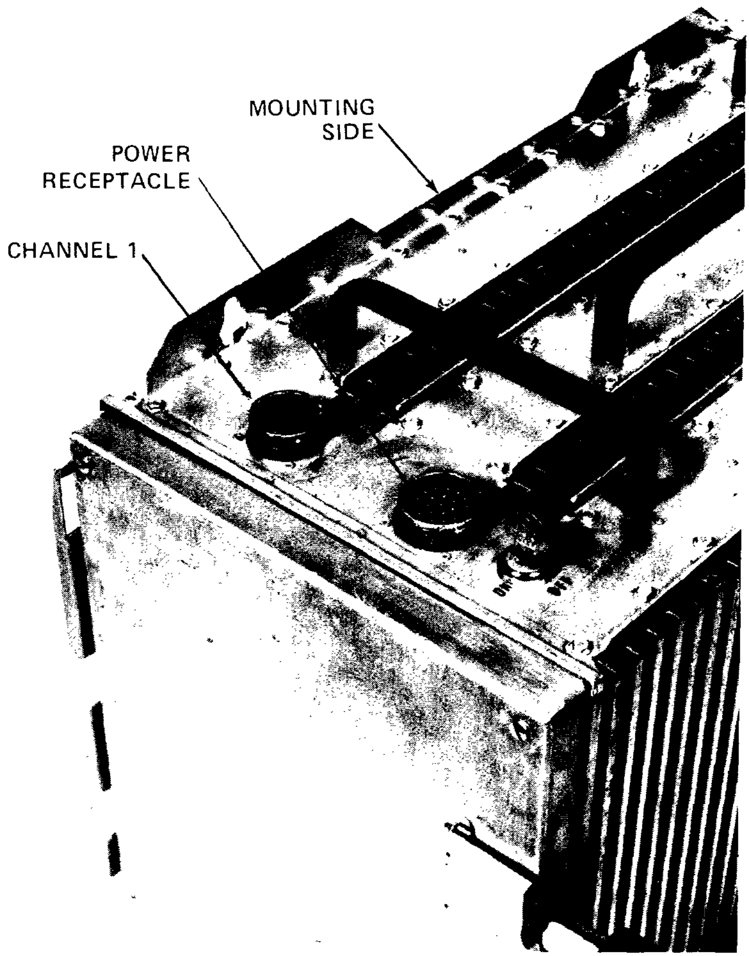


Figure 135. Processor, Top View

Module Addressing

Four housings may contain up to sixteen plug-in modules, either input circuitry or output. However, only eight of each type may be contained on one channel (with 128 points each).

Because of the Processor's internal organization, it is necessary to make a mechanical adjustment identifying (addressing) each module on a particular channel.

For this purpose, easily-adjustable address selectors are provided in slots in the housing, adjacent to the appropriate module (see Figure 136).

Care should be taken to make certain that each individual input module is separately addressed (up to eight), and likewise for the output modules. The system automatically recognizes whether the module is an input or output. Addressing should be accomplished prior to the installation of the I/O module.

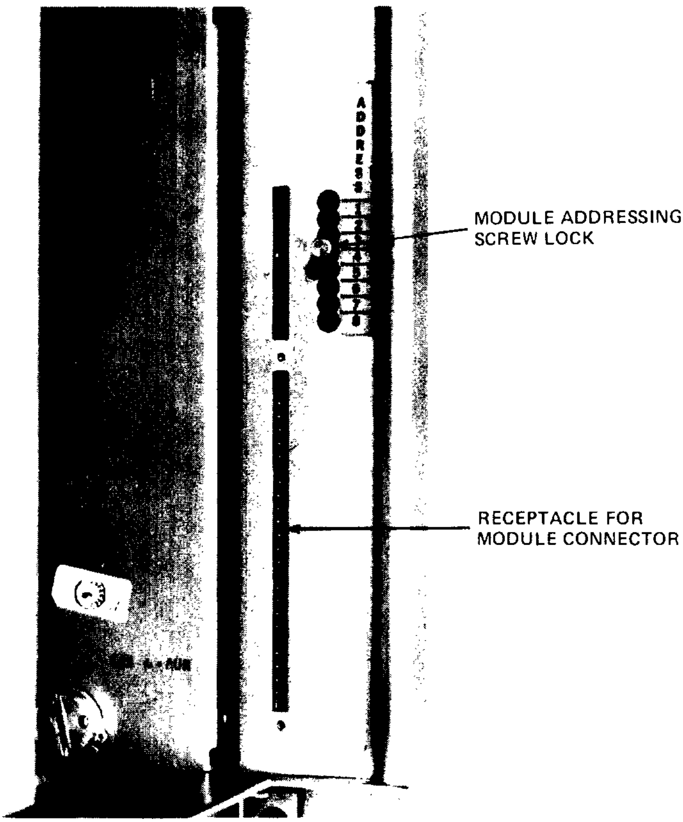


Figure 136. I/O Housing, Showing Module Address Selector

Additional Channel Cabling

Specific receptacles in the Processor are provided for channel expansion (up to three). These receptacles are located on the bottom of the Processor unit. Figure 137 shows the location of the additional channel receptacles. Figure 138 shows an expanded configuration.

I/O Housing and Module Wiring

NOTE

The protective metal tape must be removed before installing a module.

The plug-in I/O modules require no wiring since electrical contacts are automatically made via plated copper spring connectors once the module is seated in place.

NOTE

The modules are designed for heavy duty and resistance to extreme environments, and force may be required to insert and remove them from a housing after they are properly aligned. They are not easily susceptible to damage.

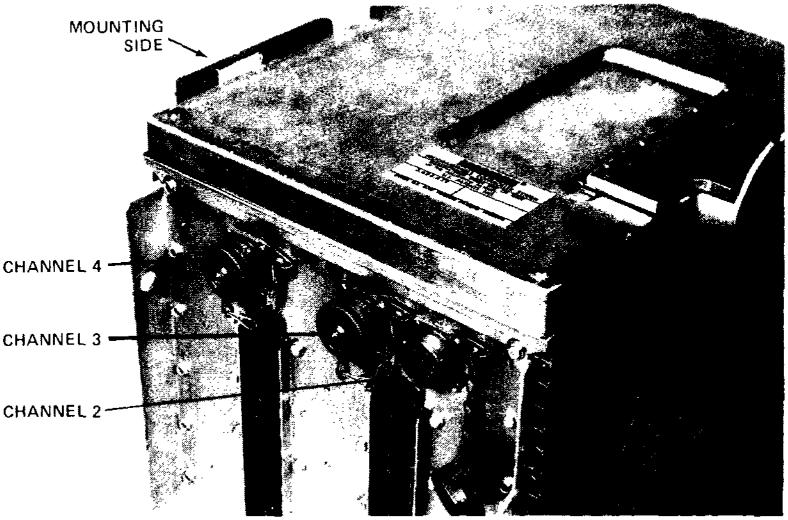


Figure 137. Processor, Bottom View

All in-plant wiring for inputs and outputs is done on the housing itself, within a wire duct on the left side. Bare-wire terminals are provided and are positioned adjacent to the appropriate module (slot). (See Figure 139.)

It will be noted that 21 terminals are provided per module. Sixteen are for input or output lines; the remainder are for power lines or not used. Each terminal is numerically designated (Figure 140) and a record should be made and kept of which signal is associated with a terminal number, on a module-to-module basis. Appendix B shows which terminals are available for either output or input lines and which are used for power or grounding, according to the type of input or output module chosen by the user.

In wiring the Programmable Controller into the system, attention to some fundamental guidelines will increase the life of the input and output circuits. Figure 141 (2 sheets) illustrates a typical wiring for the 184/384 Controller. It also shows a single CRM contact to the Main Power Supply. This must be in the hot line of a grounded system. A CRM in both lines to Remote Control is recommended.

Inductive Loads

When both sides of the line are opened by the master control relay (CRM), the wiring illustrated in Figure 142 would allow inductive energy from the motor starters 2M and 3M to be dissipated into the Controller's input circuits. This can result in damage to the input circuits. As shown in Figure 141, Model 184/384 Controller Recommended Wiring, six separate pairs of CRM contacts will eliminate this possibility. One set of CRM contacts provides power for the master relay and motor starters. A second set provides control power to the Controller. Two sets of contacts are used to provide power to the outputs from the Controller. The last two sets of contacts are used for all the input circuits (Figure 141b).

Inductive spikes would also be present when an inductive load, such as relay or motor starter, is connected in parallel with an input as shown in Figure 143. You will note on Figure 141b that only non-inductive loads, such as an indicator lamp, are connected in this manner. Figure 144 illustrates a means for protecting the input when a parallel inductive load is unavoidable.

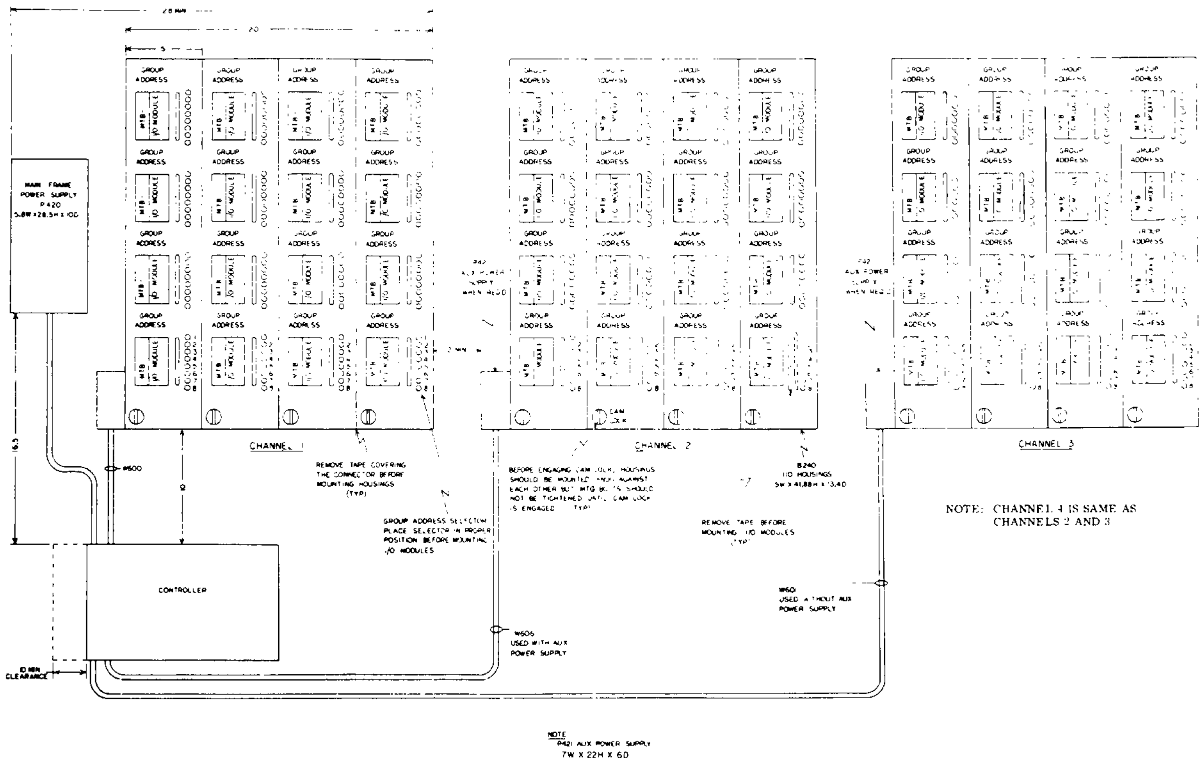


Figure 138. I/O Housing Overview, Showing Module Selection Switches

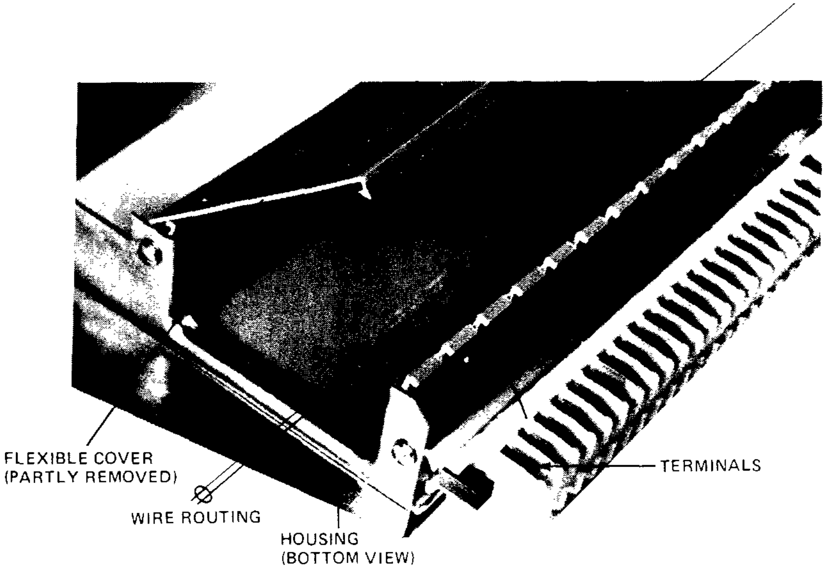


Figure 139. Housing, Showing Channel and Terminals for Wiring

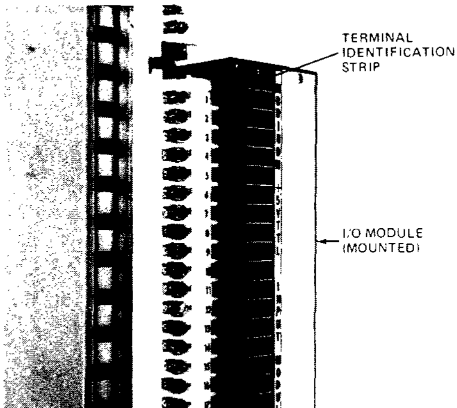


Figure 140. Housing, Showing Relationship Between Terminals and I/O Module Signal Identification Strip

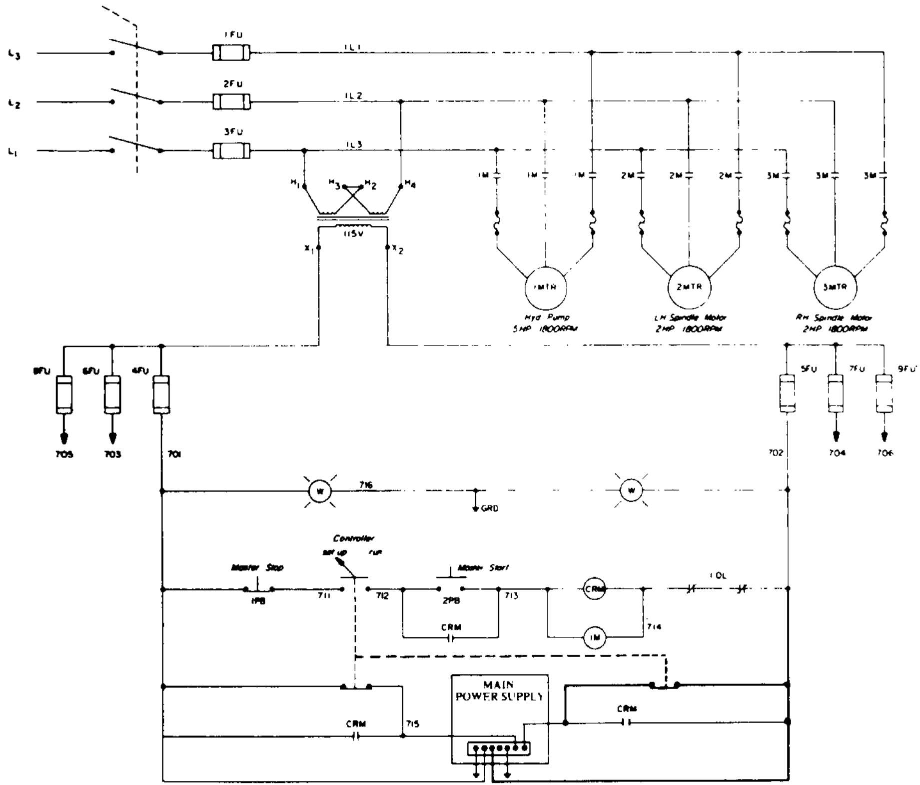


Figure 141a. Model 184/384 Controller Typical Wiring

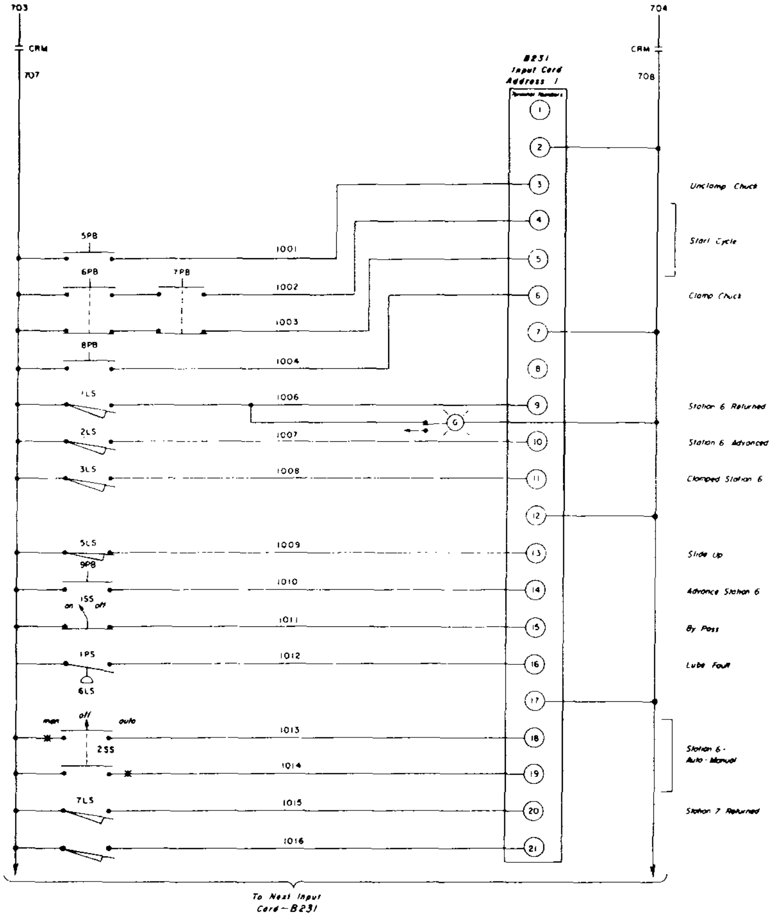


Figure 141b. Model 184/384 Controller Typical Input Wiring

There are also occasions when inductive loads must be operated by both contacts and an output from the controller. Figure 145 illustrates how this may be done with contacts both in series and in parallel with the output of the Controller. When output is in series with the contact, the contact must always be wired between the controller output and the load. The RC or thyrector is not required if the inductive load is greater than one Henry, since thyrectors are incorporated at the Output module.

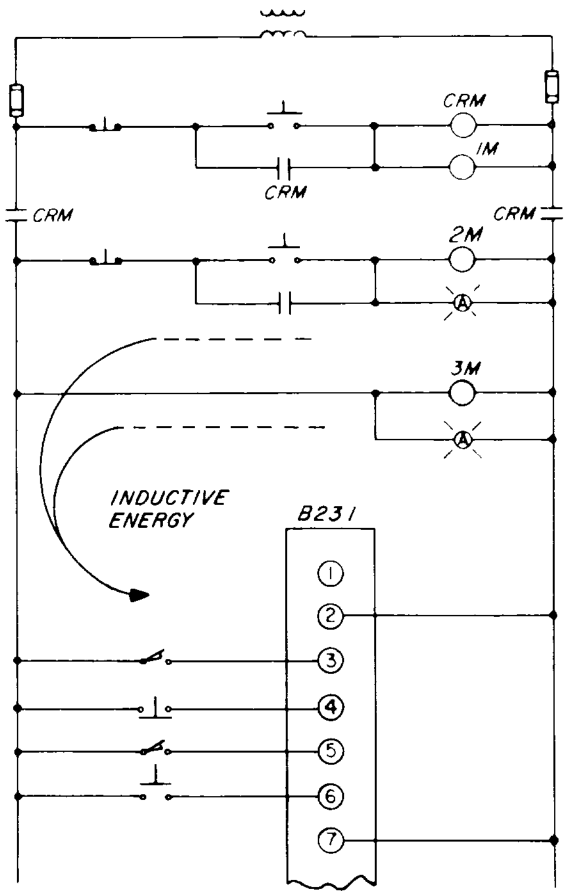


Figure 142. Example of Poor Input Circuit Wiring

Setup and Run Switch

The Setup and Run Switch, shown in Figure 141a permits the Controller to be programmed without providing power to the master control relay. This prevents any accidental operation of solenoids, motor starters, etc., while the Controller is being programmed. After programming the Controller, the switch is placed in the 'Run' position and the machine or process may be checked out in the normal manner.

Connecting Output to Input Circuits

Output circuits may be connected to input circuits in a wired 'or' configuration as shown in Figure 146. The outputs may be from the same Controller or from other Controllers. This is often used when more than one Controller is used on a single system. No more than four B230 outputs may be wired in parallel.

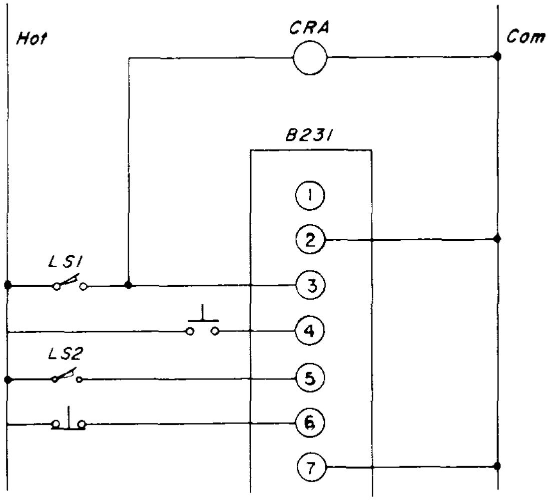


Figure 143. Inductive Load in Parallel with B231 Input Point

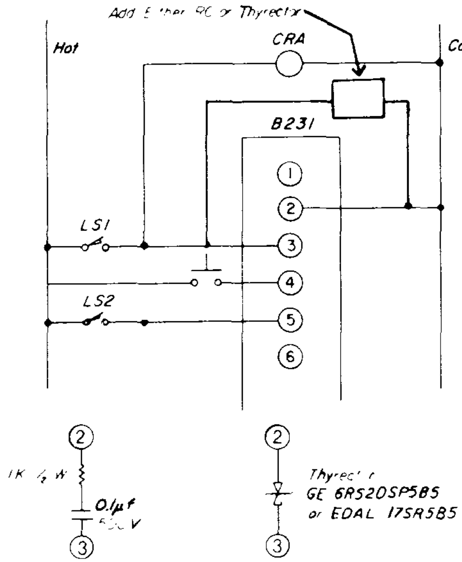


Figure 144. Protecting a B231 Input Point from a Parallel Inductive Load

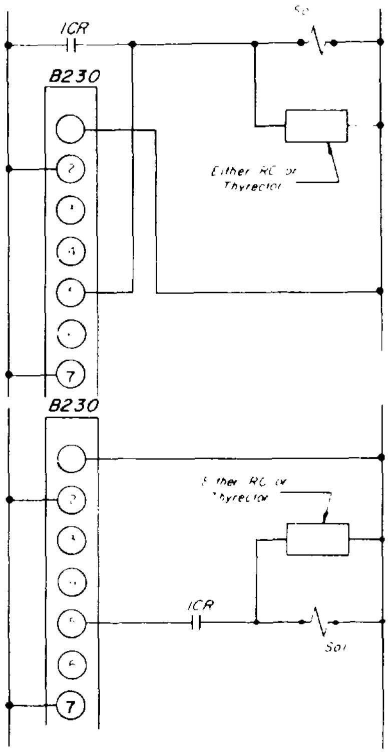


Figure 145. Inductive Load Operated by Both a B230 Outputs and a Set of Contacts

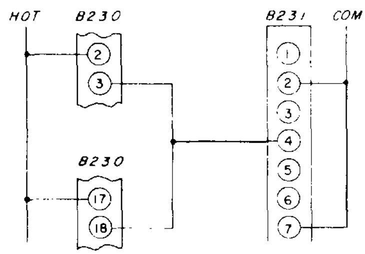


Figure 146. Connection of B230 Output to B231 Input Point

SECTION VI
TROUBLESHOOTING

INTRODUCTION

The MODICON 184/384 Controllers are rugged, heavily protected, modular systems designed specifically for industrial environments. As such, it requires no regular maintenance and, in the event of failure, any module can be quickly replaced. Indicator lights are provided to indicate proper operation of all major subassemblies.

If a suspected failure is encountered, there are several procedures which can be followed by the customer to ascertain that there is indeed a failure in the MODICON system, and to isolate that failure to a particular module. These proecedures are outlined in this section. They require no special test equipment, only a basic understanding of the functions of the modules and their indicator lights.

The major troubleshooting method available to the user is checkout of the processor, using the Programming Panel. This Panel allows any logic line, input, or output to be examined and changed in any manner desired.

Through the combination of line examination and visual examination or electrical test of I/O module terminals, failures may be isolated to the processor, I/O module, power supply, or customer's hardware. The MODICON maintenance philosophy is based on the assumption that, when a major subsystem is proved faulty, it should be immediately removed and replaced in its entirety. This procedure will greatly decrease down-time.

SYSTEM ASSEMBLY AND CABLING

As with any system in control of a large number of machines or line stations, there are many electrical connections that must be made, involving spring fasteners, screw terminals, or cable connectors. All of these connections are potential causes of system failure and should be the first area of inspection in the event of system malfunction.

All connections should be checked to make certain they are secure and that no damage or misalignment has occurred to the connectors.

I/O modules must be firmly seated in their sockets. The modules are ruggedly constructed and will withstand considerable force either during insertion or removal. On the other hand, force must not be used when connecting the cammed cable connectors to the I/O housings (see Installation). Any resistance encountered in making these connections is a warning sign. The connector should be examined and any fault, mechanical distortion or misalignment, corrected so that connection can be made freely.

INDICATOR LIGHTS

The 184/384 Controllers are modularized systems containing subassemblies, each of which has its own indicators. All of these indicators (when operating properly) show that the system is fully functional.

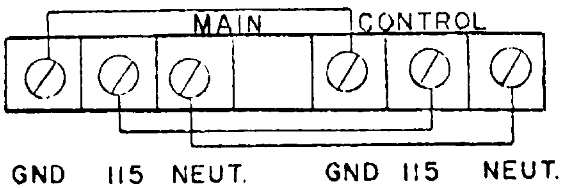
NOTE

The Controller interlock switch must be turned "ON" before the Processor and I/O power lights can function. (The interlock is the large black knob on the left front of the Processor. It also serves as the cam to hold in place, over the service port, either the peripheral device which is connected or, when none is in place, the protective cover. Either the cover or a device must be in place before power can be turned "ON".)

POWER SUPPLY

The Power Supply has four indicator lights. The Main Power light (upper left) shows that the module is receiving AC power. This indicator light only shows that power is being supplied; it does not mean that the Processor is in the running state. If this indicator does not light, check your source of AC power.

The Control Power light (upper right) indicates that power is being supplied to put the Processor in the Run (or cycling) condition. This requires that AC power be connected to the Control Power Terminals. This three-wire AC power connection will normally be made through the user's machine stop controls. For checkout of the Power Supply, jumpers can be applied on the Power Supply terminal strip:



When power has been properly supplied, the Control light of the Power Supply should light.

The Input/Output indicator lamp (lower left) shows, when lit, that dc voltage is available to the I/O housings. The Power OK or Main Frame lamp (lower right) indicates that full running power is operative in the Processor. Both of these lights will be lit only when the Processor is turned on.

For purposes of troubleshooting, the Processor may be put into an idle state by removing the voltage from the Control Power Input. The lower lamps of the Power Supply (and Run lamp of the Processor) will go off. DC voltage is still being supplied to the Processor, but no monitoring or processing of user signals will occur.

To test the power supply, it should be connected to another mainframe that is known to be operational.

PROCESSOR

The main function of the Processor is to monitor the status of all inputs continuously and direct the status of all outputs. The Processor has five indicator lights at the lower left, beneath the interlock knob.

RUN
CHANNEL I
CHANNEL II
CHANNEL III
CHANNEL IV

The Run light, when lit, shows that the Processor is cycling or running (i.e, scanning inputs and controlling outputs). It is controlled by monitoring logic within the system and will be on steady when the Processor is running. The Channel Lamps will be on when a channel is connected at the Main Frame and is being serviced by the system; they will normally be blinking at a rapid (watchdog timer) rate.

Check that the cable from the Power Supply is properly connected to its receptacle on top of the Processor. To ascertain the status of the Processor, switch the interlock knob on front of the Processor to ON. This should cause the Input/Output and Power OK lights on the Power Supply to light, and the Run light on the Processor to light.

NOTE

DO NOT remove power supply cable from mainframe while system is operating. Turn AC power OFF prior to removing this cable.

Operation of the Processor is made possible by a control module installed at the factory. The Run light shows that this is operating properly. If the Run light (and System operation) fails, call the MODICON Service Center. Using your telephone interface, they will interrogate the Processor and advise what action is necessary.

IMPORTANT

During normal operation, the Processor's key-operated Memory Protect switch should always be "ON." Only when troubleshooting by one of the means available (Programming Panel, Telephone Interface, Computer Interface, or Program Loader) should the Memory Protect be switched OFF to permit necessary interrogation or replacement of user's Executive.

MODICON maintains a complete record of the user's Executive and of his ladder-diagram logic when this has been requested by the user. They are therefore available either as paper tapes, magnetic tapes, printouts, or data transmitted via telephone for rapid replacement or modification in event of their loss from the Processor's memory. Use of the magnetic-tape Program Loader, Telephone Interface, and Computer Interface options is discussed under Auxiliary Units.

INPUT/OUTPUT HOUSINGS & MODULES

The I/O system operates on DC signals from the MODICON Power Supply. The user supplies power for all inputs from the controlled machine as well as power for the output circuits to be switched to the machine devices.

The Active light, when ON, indicates that an I/O module is being serviced properly from the Processor; individual status (Input or Output) lights indicate whether ON voltage level exists at the terminal of the output or input points. When the channel active lamps on the Processor have shown that a channel is connected and is being properly serviced, the individual modules may be checked out.

In addition to the Active light, 16 indicators (one for each point) show the status of the inputs/outputs. When lit, the status light shows the associated terminal has voltage present.

IMPORTANT

Specifications on input impedances, sinking current, must be met for correct operation of the I/O circuits and their status lamps.

AC output modules contain a fuse and neon blown fuse indicator light for each circuit in addition to the status lights. Fuses used on modules where field replacement is possible are listed in Table 23. To replace a fuse, remove the module from its housing. There is an opening (approximately 1 in. x 8 in.) on the terminal side of the module through which access to the fuses can be obtained. All fuses are oriented in accordance with the output terminals such that the top fuse is for the No. 1 output on the module and the bottom fuse is for the No. 16 output; except for the B238, whose top fuse is for the common indicator supply, and the B244 and B246 whose orientation is per Figure 147.

Table 23.

Module	Standard Size Pico Fuse	Littlefuse Pt. No. or Equiv.	MODICON Part No.
B230	5 Amps	275-005	57-0003
B232	7 Amps	275-007	57-0005
B234	5 Amps	275-005	57-0003
B236	2 Amps	275-002	57-0002
B238	3 Amps	275-003	57-0007
B239	1-1/2 Amps	276-015	57-0022
B243	1/4 Amps	275-250	57-0032
B244	7 Amps	275-007	57-0005
B246	7 Amps	275-007	57-0005
B248	3 Amps	275-003	57-0007
B256/B258	1/2 Amp	276-500	57-0024
B260	1/8 Amps	276-125	57-0023
B262	1/8 Amps	276-125	57-0023
B266	3 Amps	212-003	57-0038
B270	5 Amps	275-005	57-0003
B680	1/4 Amps	313-015	57-0036

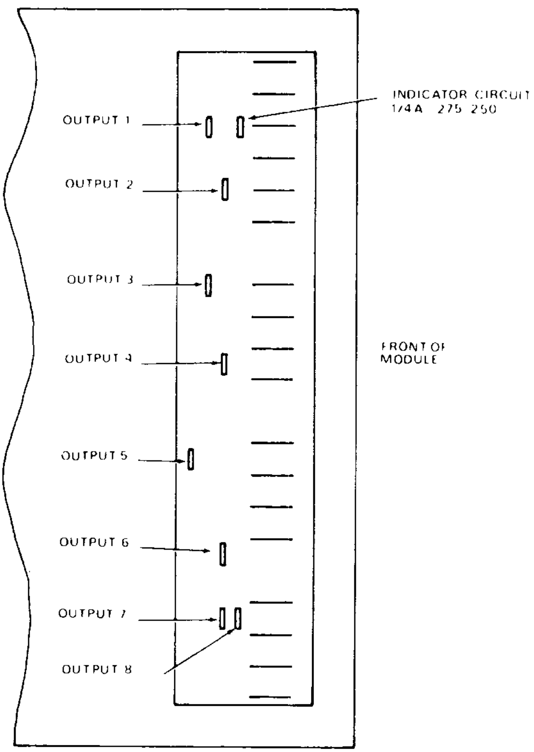


Figure 147. Location of Fuses on B244 & B246 Isolated Output Modules

User troubleshooting of his own ladder-line logic is readily accomplished using the Programming Panel described previously. The methods of simulating inputs and examining outputs have been described; the Programming Panel can also be used to diagnose user hardware problems.

CAUTION

When simulating inputs or forcing outputs, insure that these operations will NOT damage or be unsafe to the machine or process under control.

When an input from the limit switch on a transfer line is wired to the Controller's first input circuit (1001), its status is seen at the input card *and* its reception into the Controller's memory can be verified.

Circuit 1001 is selected on the Line Number thumbwheels of the Programming Panel. If the Processor is receiving the input signal, the OUTPUT button will light. In the event the Limit switch is closed and the I/O input card status lamp is OFF, check for the proper voltage at the input terminal. If the voltage is present and the input can be monitored at the Programming Panel yet the circuit lamp is not on, the lamp circuit is defective. If the status lamp is ON and the input is not seen by the Programming Panel, the input signal-conditioning card should be replaced.

When testing input circuits prior to connection to the machine, each circuit can be tested by applying the reference lead or your power source to the appropriate common terminal (2, 7, 12, 17) and the hot lead to the input terminal corresponding to the circuit under test. Input from the limit switch may be overridden or simulated through use of the Programming Panel's Disable button. Depress the Disable button to remove control of this input from the external device; the input can be switched ON or OFF by the output button.

Similarly, individual outputs may be examined via the Programming Panel while verifying the presence of the signal at the terminal with a buzzer or indicator lamp.

CAUTION

DC input/output modules are polarity-sensitive, and the proper equipment must be used when detecting signals.

COMMON FAULTS

1. *No Run Light*—This indicates that the Processor is not running through its normal cycle. All power supply indicator lights and cable connections should be checked. If a Programming Panel or other interfaces are connected, they should be disconnected, and the door securely closed. The Controller interlock knob should be turned OFF and then ON. If there is still no Run light, the MODICON Service Center should be notified. The operator on duty will advise you of subsequent action to be taken.

   Before calling Service Center, be sure to have symptoms thoroughly documented (i.e. AC power supply status, circumstances governing failure, and mainframe serial number).

2. *No Input or Output* —In the event that an individual input or output does not appear to be functioning correctly, the customer should check his program using the Programming Panel to be sure that all associated lines are correctly programmed. If the lines are correctly programmed, the suspect output should be disabled ON and OFF manually. If, in the case of an output problem, the field device cannot be turned ON and OFF by the Programming Panel, the output voltage should be measured. If the output module appears to be switching correctly, the field device or its wiring should be suspected. If the Controller does not appear to be turning the output ON and OFF, replace the suspected output module.

In testing an input, the suspected input should be manually disable(ON and OFF. If this correctly activates the associated lines of the ladder program, the on and off voltages from the field device should be checked. If these voltages appear to be correct, replace the suspected input module.

3. *No Channel Light*—Beginning with the last (right-most) I/O housing, uncam each housing including the first housing from the I/O cable or Auxiliary Power Supply, until the Channel light comes ON. Remove all I/O modules from the last housing uncammed prior to restoring the Channel light, and then recam it into the I/O channel. If the Channel light goes out, the housing is defective and its backplane should be replaced. If the Channel light remains ON after the housing is recammed, replace each I/O module until the Channel light goes Out; the last I/O module inserted is defective and should be replaced. If uncamming all I/O housings does not restore the Channel light, the Processor is defective and should be replaced. If an entire housing or group of housings have all their I/O module active lights turned OFF, the left-most housing should be suspected and tested as discussed above, by uncamming and removing all I/O modules and then replacing them one at a time.

4. *No I/O or MF Power Lights on Main Power Supply*—The main power and control power lights must be ON and all auxiliary interfaces should be disconnected. The Controller interlock knobs should be turned ON with the service port door completely closed against the side of the Processor. If there are still no I/O of MF lights, the I/O cables should be disconnected from the CPU, one at a time, cycling the main frame interlock OFF and ON each time. If the I/O power lights and MF power lights come on, the last I/O cable disconnected should be checked for possible shorts or grounds. If, however, the lights still do not come on, the power supply cable should be disconnected at the Processor, connected to either another mainframe known to function properly, or a MODICON Load Box. If the lights still do not come ON, the power supply should be replaced.

   If the Power Supply lights come ON with a different mainframe or the load box, yet does not function with the main frame (all I/O and peripherals disconnected), replace the main frame and reload the ladder program using your Program Loader or Telephone Interface and the MODICON Service Center.

AUXILIARY UNITS

All auxiliary units have indicator lamps associated with major functions to indicate proper operation. Specific troubleshooting aids are available for the Programming Panel, the Printer, and the Remote Driver.

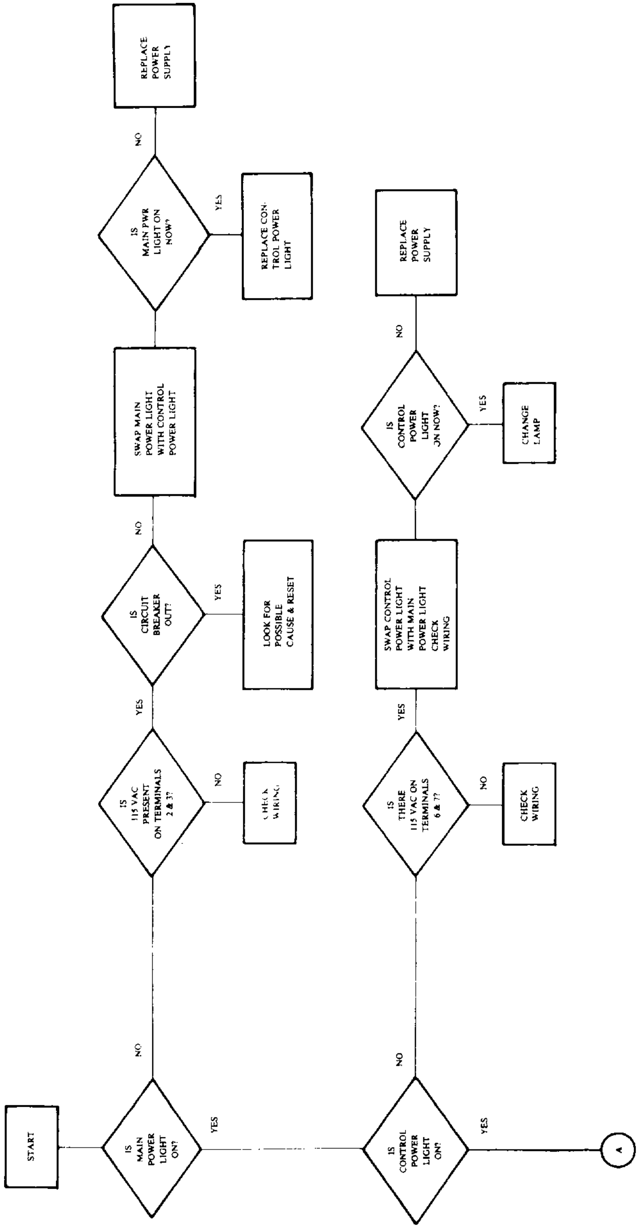
Entering the code 9999 into the line number location on the Programming Panel will allow testing of all indicator lamps and displays without effecting the processor; disconnecting the Programming Panel from the processor is NOT required. With 9999 entered as the line number, all pushbuttons can be depressed to verify the operation of their lamps. The reference display will display whatever number is dialed on the reference thumbwheels. When depressing the selected elements (A through D) pushbuttons, note that the decimal points on the reference display will also light, one at a time left to right, as elements A through D are selected. Failure of any indicator lamp will not prevent the programming panel from entering data into the processor; it only prevents the operator from visually observing his data. The programming panel will enter correct data even if it is not supplied with AC power; however, detailed record keeping is suggested if a panel is used without AC power, since monitoring of the program (other than the reference numbers) will not be possible.

The P500 Printer operates based upon data it receives from the controller via the output register. This output register can be forced to any value by the programming panel and thus instructions can be simulated under a more controlled environment. Before any attempt is made to force the output register, insure that there is sufficient paper in the printer (no paper out light on the printer) and that the two input signals (busy and form busy) are properly connected. A busy signal can be generated by depressing the paper feed pushbutton on the top of the printer and then observe it at the input module and the WDT-4 line. Both the I/O power and Motor ON indicators should be lit; the I/O power is controlled by a fuse on the top near the indicators and the Motor ON is controlled by a fuse on the back near the AC power cord. If both the busy and form busy lamps are lit for an extended period of time without change, cycle power on the printer to generate a rest signal. An automatic form feed is normal upon restoring power. If both signals cannot be cleared, abort the print operation by activating WDT-2 coil and recycle power on the printer. To assist in defining the problem, first attempt to print just numerical data (DX code 40PL) and then stored messages. If a 40PL print operation is performed and a 41XX or 4200 command results in both the busy and form busy lines ON but no printing, the problem is with the PROM card in the printer; either it is not properly seated or all PROM's are not fully installed in their sockets. After all the above checks have been made, the printer can be exercised by the commands provided in table 24. The printer reacts to changes of status not just presentation of data; thus data must be re-applied for the printer to react properly if repetitive operations are desired.

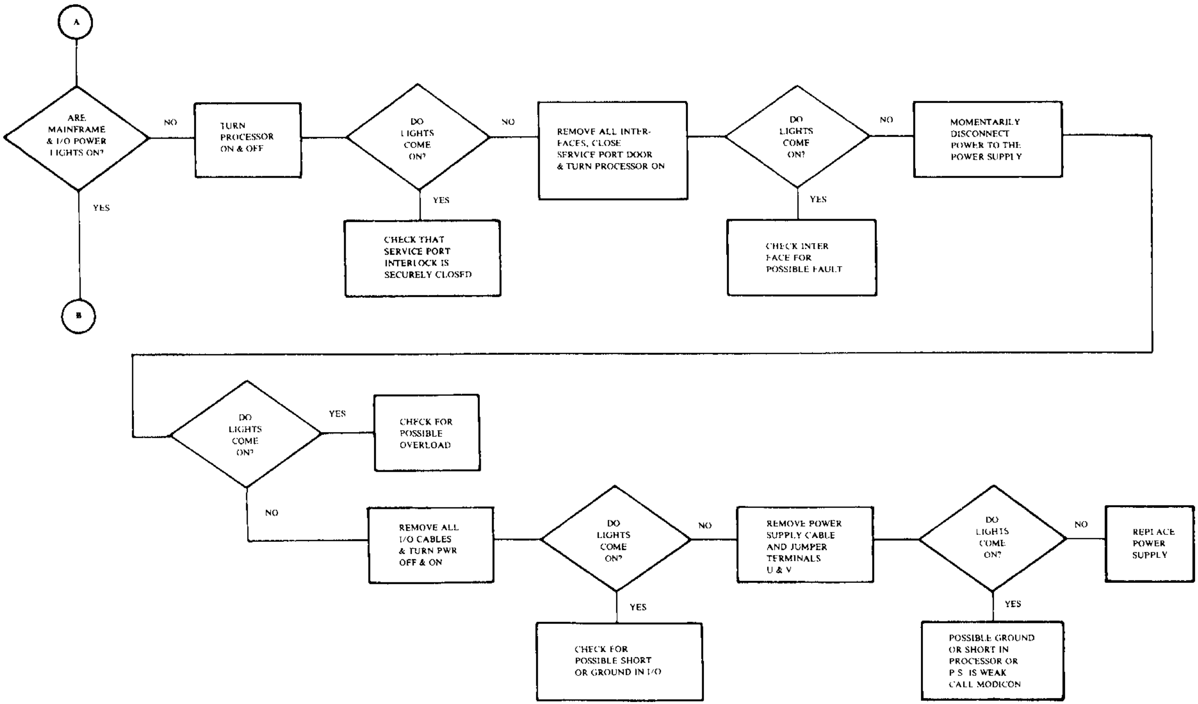
Remote installations (1425 and 1430) have a number of indications associated with them to insure data transmissions over paths up to 2000 feet (4000 feet round-trip). Data is obtained by the 1425 driver from the processor in serial format, and then it is modulated into a single carrier for transmission at 312,000 Hertz. The DATA OUT indicator on the top of the 1425 (see figure A-12) indicates data is available at all four pairs of out terminals. The LINE TO indicator on the 1430 indicates data is being received by the 1430 and the active lights on the individual modules verify that they are receiving their individual status from the processor. The LINE FROM indicator on the 1430 indicates data is being supplied for transmission to the driver. The individual DATA IN indicators indicate data is being received by the driver on the respective sub-channels. Finally, the controller indicator light (see figure 128) corresponding to the channel being remoted, will light if responses are being received by the processor. However, this indicator will be dimmer than when the channel is connected directly to its I/O housings; it may be necessary to remove other I/O cables to insure this indicator is lit. If remote data transmissions fail between any two points as previously discussed, the indicator at the receiving end will be then extinguished; the channel communications light on the processor is the last indicator to be serviced. For example, if a LINE FROM indicator on an 1430 is lit, but its respective DATA IN indicator on the 1425 is not lit, the problem is between these two units and the connections and continuity of cable 1 should be examined (see figure A-13). If a DATA IN indicator on an 1425 is lit and the channel communication light is not lit, the driver should be examined, especially the position of the Test Mode switch.

Table 24.

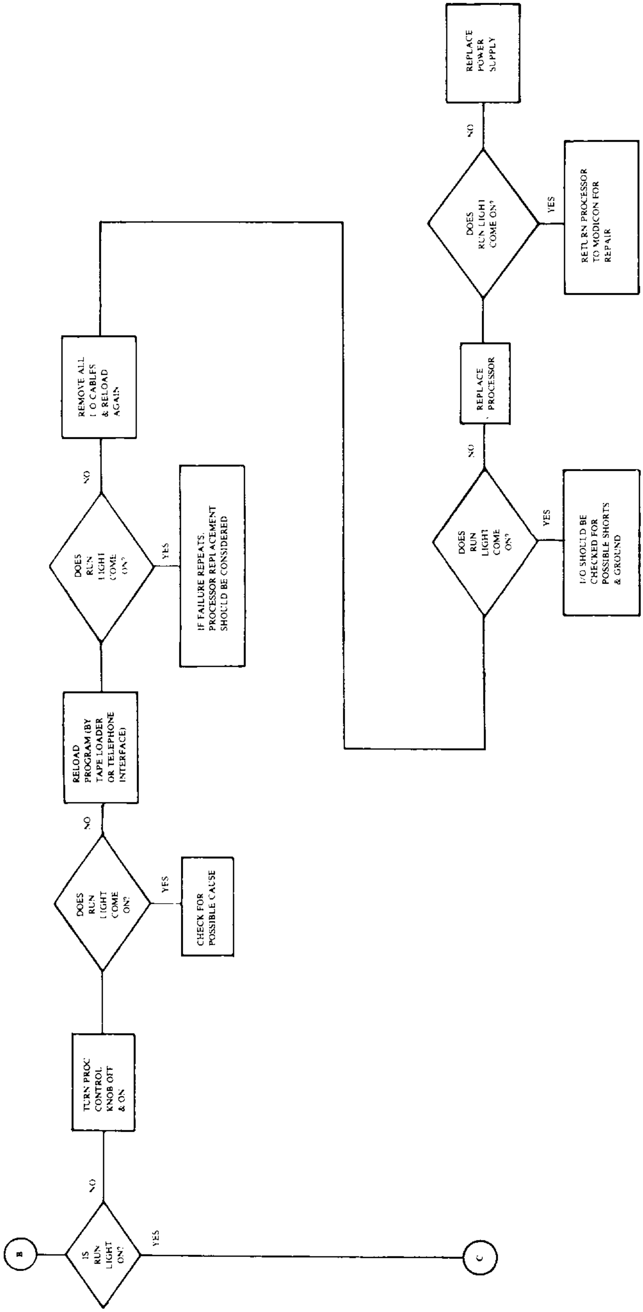
Output Register Contents	**Function**
XXX1	PRINT—causes the contents of the printer's variable data buffer to be printed.
XXX2	SPACE—loads buffer with a space.
XXX4	FORM FEED—forces printer to execute a form feed.
AAX8	START FORM—starts printing at address (message number) AA
DX1X	LOAD BUFFER—loads one buffer position with BCD value D.
XX2X	MOTOR ON—turns motor ON.
XX8X	CLEAR—clears buffer to zero.

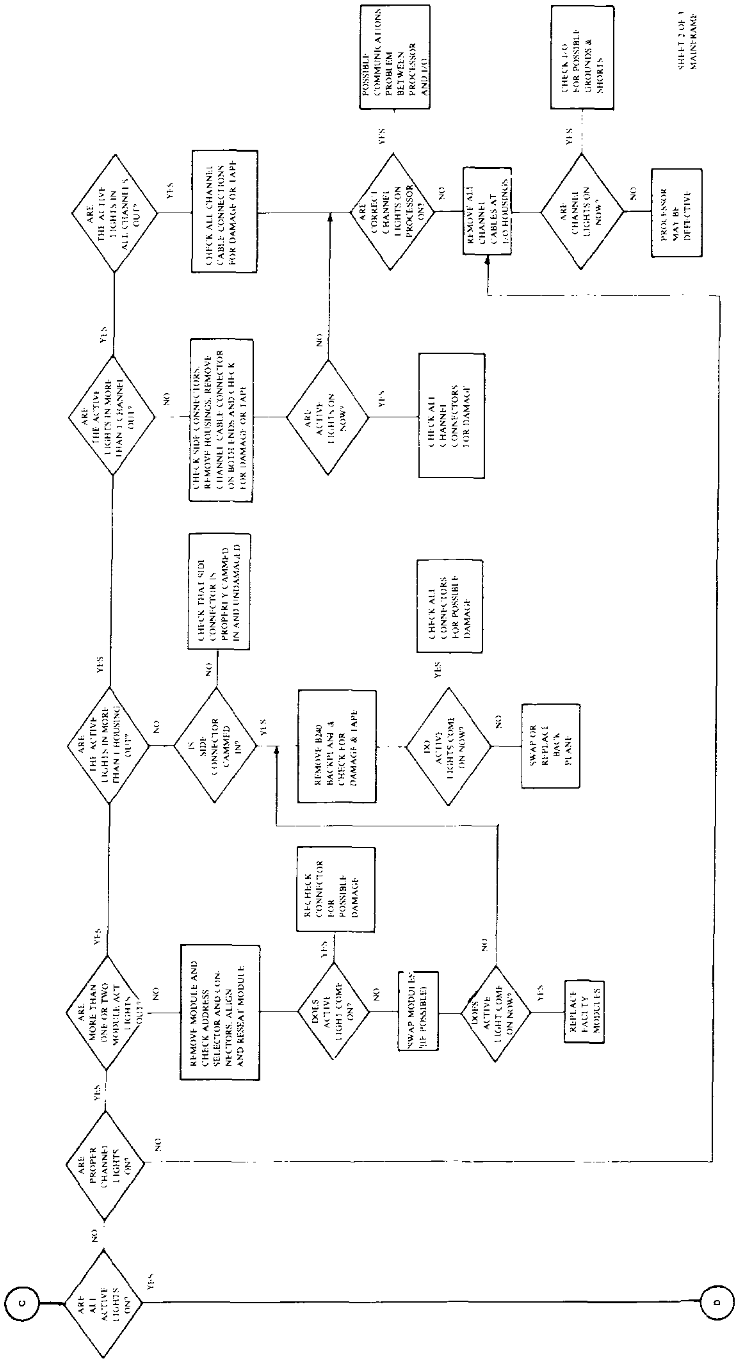


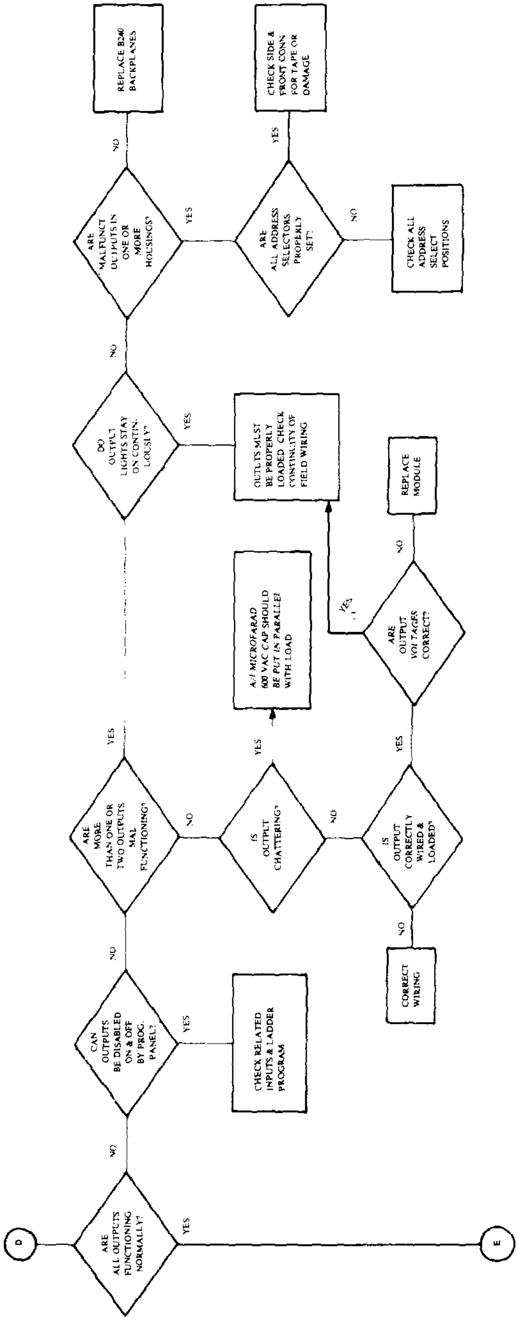
START
IS MAIN POWER LIGHT ON?
YES
NO
IS 115 VAC PRESENT ON TERMINALS 2 & 3?
NO
CHECK WIRING
YES
IS CIRCUIT BREAKER OUT?
YES
LOOK FOR POSSIBLE CAUSE & RESET
NO
SWAP MAIN POWER LIGHT WITH CONTROL POWER LIGHT
IS MAIN PWR LIGHT ON NOW?
YES
REPLACE CONTROL POWER LIGHT
NO
REPLACE POWER SUPPLY
IS CONTROL POWER LIGHT ON?
YES
A
NO
IS THERE 115 VAC ON TERMINALS 6 & 7?
NO
CHECK WIRING
YES
SWAP CONTROL POWER LIGHT WITH MAIN POWER LIGHT CHECK WIRING
IS CONTROL POWER LIGHT ON NOW?
YES
CHANGE LAMP
NO
REPLACE POWER SUPPLY



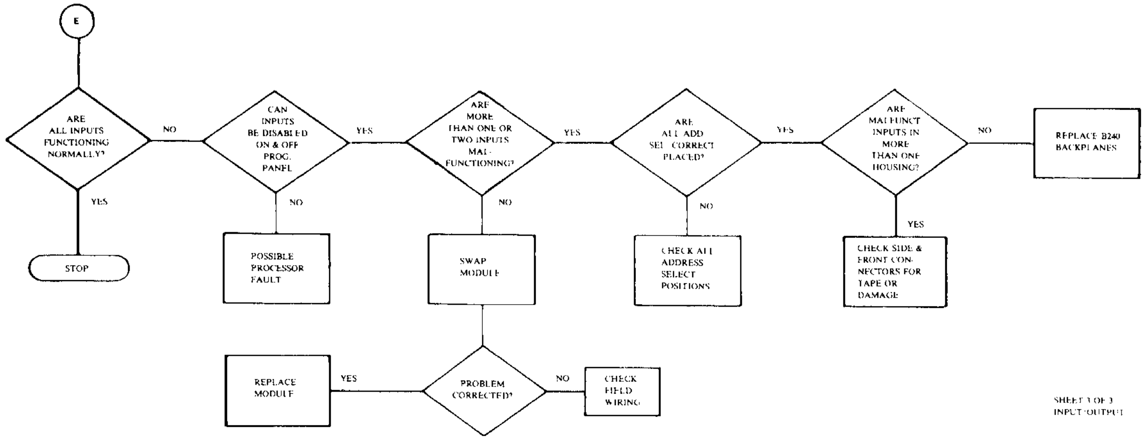
SHEET 1 OF 3
MAIN POWER SUPPLY


B
IS RUN LIGHT ON?
YES
C
NO
TURN PROC CONTROL KNOB OFF & ON
DOES RUN LIGHT COME ON?
YES
CHECK FOR POSSIBLE CAUSE
NO
RELOAD PROGRAM (BY TAPE LOADER OR TELEPHONE INTERFACE)
DOES RUN LIGHT COME ON?
YES
IF FAILURE REPEATS: PROCESSOR REPLACEMENT SHOULD BE CONSIDERED
NO
REMOVE ALL I/O CABLES & RELOAD AGAIN
DOES RUN LIGHT COME ON?
YES
I/O SHOULD BE CHECKED FOR POSSIBLE SHORTS & GROUND
NO
REPLACE PROCESSOR
DOES RUN LIGHT COME ON?
YES
RETURN PROCESSOR TO MODICON FOR REPAIR
NO
REPLACE POWER SUPPLY


C
ARE ALL ACTIVE LIGHTS ON?
YES
D
NO
ARE PROPER CHANNEL LIGHTS ON?
ARE MORE THAN ONE OR TWO MODULE ACT LIGHTS OUT?
REMOVE MODULE AND CHECK ADDRESS SELECTOR AND CONNECTORS. ALIGN AND RESEAT MODULE
DOES ACTIVE LIGHT COME ON?
RECHECK CONNECTOR FOR POSSIBLE DAMAGE
SWAP MODULES (IF POSSIBLE)
DOES ACTIVE LIGHT COME ON NOW?
REPLACE FAULTY MODULES
ARE THE ACTIVE LIGHTS IN MORE THAN 1 HOUSING OUT?
IS SIDE CONNECTOR CAMMED IN?
CHECK THAT SIDE CONNECTOR IS PROPERLY CAMMED IN AND UNDAMAGED
REMOVE B240 BACKPLANE & CHECK FOR DAMAGE & TAPE
DO ACTIVE LIGHTS COME ON NOW?
CHECK ALL CONNECTORS FOR POSSIBLE DAMAGE
SWAP OR REPLACE BACK PLANE
ARE THE ACTIVE LIGHTS IN MORE THAN 1 CHANNEL OUT?
CHECK SIDE CONNECTORS. REMOVE HOUSINGS. REMOVE CHANNEL CABLE CONNECTOR ON BOTH ENDS AND CHECK FOR DAMAGE OR TAPE
ARE ACTIVE LIGHTS ON NOW?
CHECK ALL CHANNEL CONNECTORS FOR DAMAGE
ARE THE ACTIVE LIGHTS IN ALL CHANNELS OUT?
CHECK ALL CHANNEL CABLE CONNECTIONS FOR DAMAGE OR TAPE
ARE CORRECT CHANNEL LIGHTS ON PROCESSOR ON?
POSSIBLE COMMUNICATIONS PROBLEM BETWEEN PROCESSOR AND I/O
REMOVE ALL CHANNEL CABLES AT I/O HOUSINGS
ARE CHANNEL LIGHTS ON NOW?
CHECK I/O FOR POSSIBLE GROUNDS & SHORTS
PROCESSOR MAY BE DEFECTIVE
SHEET 2 OF 3
MAINFRAME



D
ARE ALL OUTPUTS FUNCTIONING NORMALLY?
YES
E
NO
CAN OUTPUTS BE DISABLED ON & OFF BY PROG. PANEL?
YES
CHECK RELATED INPUTS & LADDER PROGRAM
NO
ARE MORE THAN ONE OR TWO OUTPUTS MAL FUNCTIONING?
NO
IS OUTPUT CHATTERING?
YES
A.1 MICROFARAD 600 VAC CAP SHOULD BE PUT IN PARALLEL WITH LOAD
NO
IS OUTPUT CORRECTLY WIRED & LOADED?
NO
CORRECT WIRING
YES
ARE OUTPUT VOLTAGES CORRECT?
NO
REPLACE MODULE
YES
OUTPUTS MUST BE PROPERLY LOADED CHECK CONTINUITY OF FIELD WIRING
YES
DO OUTPUT LIGHTS STAY ON CONTINUOUSLY?
YES
NO
ARE MALFUNCT OUTPUTS IN ONE OR MORE HOUSINGS?
NO
REPLACE B240 BACKPLANES
YES
ARE ALL ADDRESS SELECTORS PROPERLY SET?
YES
CHECK SIDE & FRONT CONN FOR TAPE OR DAMAGE
NO
CHECK ALL ADDRESS SELECT POSITIONS



SHEET 3 OF 3
INPUT/OUTPUT

APPENDIX A
AUXILIARY UNITS

ILLUSTRATIONS

PROGRAMMING PANEL, MODELS 102,112

DESCRIPTION

Models 102 and 112 differ only in that Model 102 is not designed to implement calculation and data transfers. In all other respects, the units are identical.

The Model 112 Programming Panel is used to program the 184/384 Controller to perform logic, Timing, Counting, Calculating and Data Transfers. The Panel is a portable unit that connects to the Controller thru an interface. It allows the user to:

Enter the Control Program consisting of Relay Logic, Timers, Counters, Calculate Plus and Minus, and the various Data Transfer Functions (DX).

Check out the entire Control System from limit switches and pushbuttons to solenoids and motor starters.

Debug and troubleshoot the machine or process from start-up to on-line operation.

The Control Program entered via the Programming Panel, is in the format of the conventional elementary diagram or ladder diagram (Figure A-1). Each line of the ladder diagram contains an output which is controlled by four control elements, the equivalent of relay contacts in the line. They will be normally open or closed, connected in series or in parallel combinations. Timers, Counters, Calculators and Data Transfer Lines, are also entered into the same four element line. Timers may be set for times from 0.1 seconds to 999 seconds. Counters may be set from 1 to 999. Remote set allows presets up to 9999.

Using the pushbuttons and switches on the Programming Panel, each control and pilot device shown on the elementary diagram is entered into the controller memory. Changes may be made in the manner as original entry, modifying only the specified line affected by the changes. The Panel may also be used to display the stored control program line by line.

SPECIFICATIONS

Power Requirements:	115 Vac$\pm$20% (50 Hz/60Hz), 20 Volt amps
Environmental Requirements:	
Ambient Temperature	0° to 50°C
Humidity	0% to 95% (non-condensing)
Dimensions:	14-3/4 in. x 14 in. x 10-1/2 in.
Weight:	20 lb.

INSTALLATION

To connect the Panel:

1. Turn the Controller interlock knob on the left front of the controller to the full counter-clockwise position. This removes controller power and unlocks the service connector.
2. Uncoil the Panel cables and remove the Panel interface from the panel case.

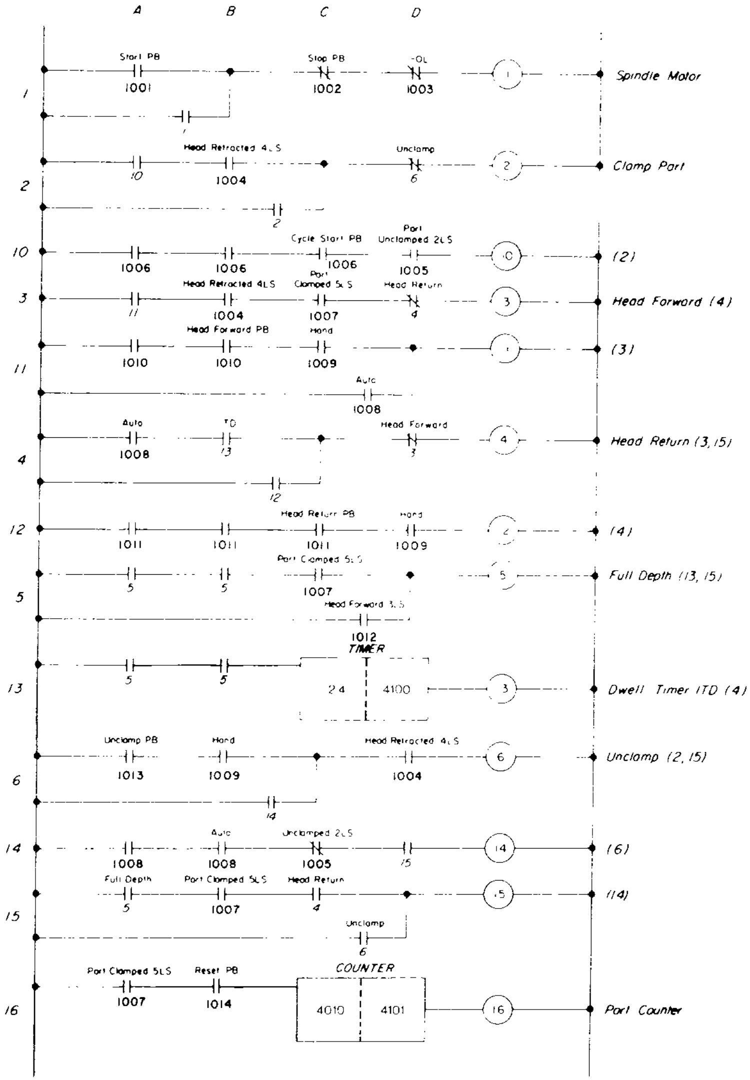


Figure A-1. Typical Ladder Diagram

3. Place the Panel interface on the hinge post to the left of the controller and swing the interface closed, engaging the interlock knob.
4. Secure the interface by rotating the interlock knob clockwise to its first detent.
5. Plug the Panel power cord into the 115 Volt convenience outlet located in the Controller's Power Supply.
6. Turn the Control knob on the Controller housing clockwise to the Power On position. This locks the interface to the Controller, preventing its removal while power is applied.

NOTE

The Panel may be disconnected from the Interface *without* removing controller power.

Controls and Indicators

Line Number Switches — The line number thumbwheel switches *select the line to be programmed* or the input or register to be displayed.

Line Type Pushbuttons — The line type pushbuttons are back-lighted pushbuttons that indicate whether the line selected is:

RELAY
TIMER SECOND
TIMER TENTHS
COUNTER
CALCULATE
DATA TRANSFER

To change a Line Type, press the desired Line type pushbutton. It will light and any light previously lit will go off. If TIMER TENTHS is selected, the line may be programmed for time settings of from .1 to 99.9 seconds in increments of .1 seconds. If a SECONDS TIMER is selected, times up to 999 seconds may be programmed.

Selected Element Pushbuttons [A-B,C,D] — The four SELECTED ELEMENT pushbuttons each contain two lights. The light in the lower half of the pushbutton indicates which of the four element positions is selected for display and entry. Pressing another of these pushbuttons will select that position and it in turn will light. The upper half of the display is labeled POWER with an arrow pointing to the right. It lights if power is being conducted through that element to the next position to the right. For example, if the A, B, and C POWER lamps are lit and the D lamp is not, then contacts in positions A, B, and C are closed while contact D is opened.

Reference Number' Display — The reference number display shows the number of the input or line that controls the contact in the element position currently selected for display or entry. A new reference number may be selected, and entered by pressing the appropriate ELEMENT TYPE. The display will also show the Constant set into the C element of a counter, timer or calculator as well as the data storage location in B, C, or D positions of non-relay lines. To view the contents of these locations, hold the SELECTED ELEMENT depressed.

NOTE

The C element of a counter or timer may also be programmed to reference a register location. In this event the actual preset is obtained from that *location* which will contain a *number*, entered via external switches or as a result of control decisions programmed into the controller. With the C position selected, the register location is displayed. Depressing the C element will display the current contents of that location.

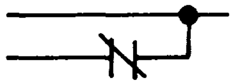
*Element Type Pushbuttons.*The four ELEMENT TYPE pushbuttons indicate the four contact types that may be programmed into the four positions of a relay line. They are:

Series Normally Open Contacts

Series Normally Closed Contacts

Parallel Normally Open Contacts

Parallel Normally Closed Contacts



When entering contacts in a relay line, the A and B element positions of a timer or counter line, or the A element of a calculate or DX line, pressing one of the ELEMENT TYPE pushbuttons will enter that contact type in that position of the line. At the same time, it will enter the input or line number associated with that contact from the REFERENCE NUMBER switches. The ELEMENT TYPE pushbuttons are also used for entering a preset constant in the C element position of a counter, timer line, or calculate line. In this case all of the ELEMENT TYPE lights are illuminated indicating that any one of them can be used to enter the number from the REFERENCE NUMBER switches in the controller memory. The element type switches are likewise used to enter register locations in the B, C, and D element positions of calculate and data transfer (DX) lines, as well as the function call code into the C position of a DX line.

Disable Pushbutton/Output Pushbutton — With the Controller memory protect off, pressing the DISABLE pushbutton will light the pushbutton and transfer control of the designated line from the elements as programmed to manual control from the OUTPUT pushbutton. Once a line has been disabled it may be controlled by the OUTPUT pushbutton. Pressing OUTPUT will power the designated line from on to off or from off to on. The line is on when the OUTPUT light is illuminated.

If an input number is selected and the DISABLE pushbutton is pressed the contacts in the control program are no longer controlled by the state of the input, instead they are controlled by the OUTPUT pushbutton just as for outputs. With the OUTPUT illuminated, the input is assumed energized.

The use of the DISABLE and the OUTPUT pushbuttons greatly facilitates both initial program checkout and system diagnosis. However, care must be exercised to return inputs and lines to the desired state of control prior to removing the program panel. Once DISABLE mode has been selected for an input or line it remains in DISABLE until taken out by the programmer.

CAUTION

Use of the DISABLE feature could cause an output or input to be energized without safety interlocks resulting in damage to the machine or process.

PROGRAM LOADER, MODEL 202

DESCRIPTION

The Model 202 Program Loader is a magnetic tape cartridge unit designed for field recording and reloading of user programs into MODICON 184 Programmable Controllers. The Program Loader features ease of operation and fully automatic error detection and protection. The Model 202 Program Loader permits the user to:

Record his control programs on magnetic tape cartridges.

Load a control program from a magnetic cartridge into the Controller.

The Model 202 is housed in a rugged case which also houses the plug-in module (Figure A-2). The case also provides space, in a dust-proof compartment, for storage of up to 14 magnetic tape cartridges. Each cartridge can store up to two MODICON "184" Programs, each consisting of an entire Programmable Controller Memory. (See Figure A-3 for cartridge insertion.)

The case is provided with a convenient hanger (Figure A-4.) which allows the Model 202 to hang from the Controller enclosure door and open like a book. This provides the optimum protection against contaminants entering the tape record/play area.

SPECIFICATIONS

Physical

Dimensions:	15 in. x 18 in. x 7-1/2 in.
Weight:	28 lb.
Cartridge Size:	3-11/16 in. x 3-1/8 in. x 3/4 in.
Cartridge Capacity:	190 feet of 0.5 mil mylar tape
Speed: Search	21 in./sec.
Rewind	21 in./sec.
Read/Write	7 in./sec.
Write Protect:	Removing the button from the cartridge inhibits further recording on that cartridge

CONTROLS AND INDICATORS (Figure A-5.)

Controls

START:	Pushbutton (black) — Depressing the START control initiates the action selected by the three position mode switch.

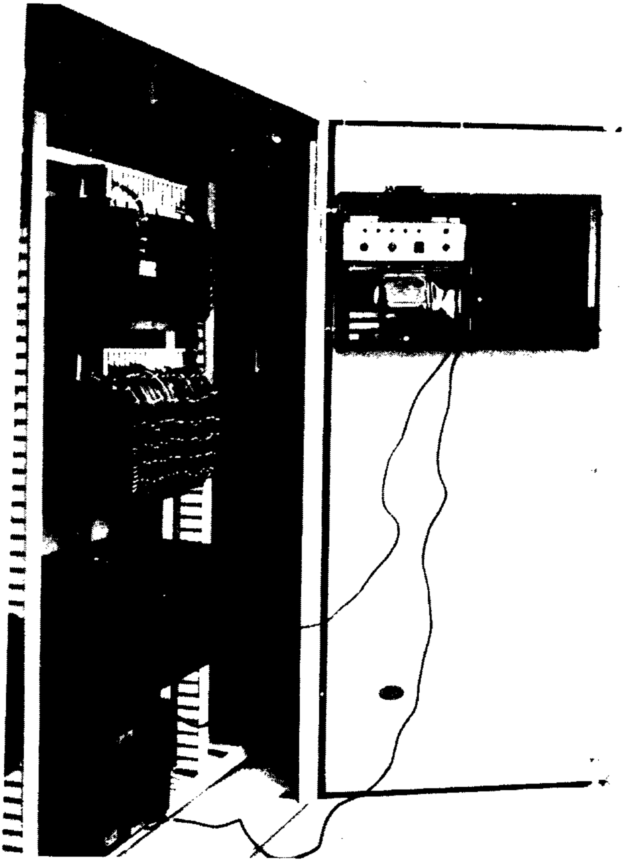


Figure A-2

MODE SELECTION:

LOAD: The counter-clockwise position of the mode selector switch. When LOAD is selected and the START pushbutton pressed, the tape advances to the selected program number (0-1) and copies the data from tape into the Controller memory.

RECORD: The clockwise position of the mode selector switch. When RECORD is selected and the START pushbutton pressed, the contents of the CONTROLLER memory is written at the position on tape designated by the program number switch.

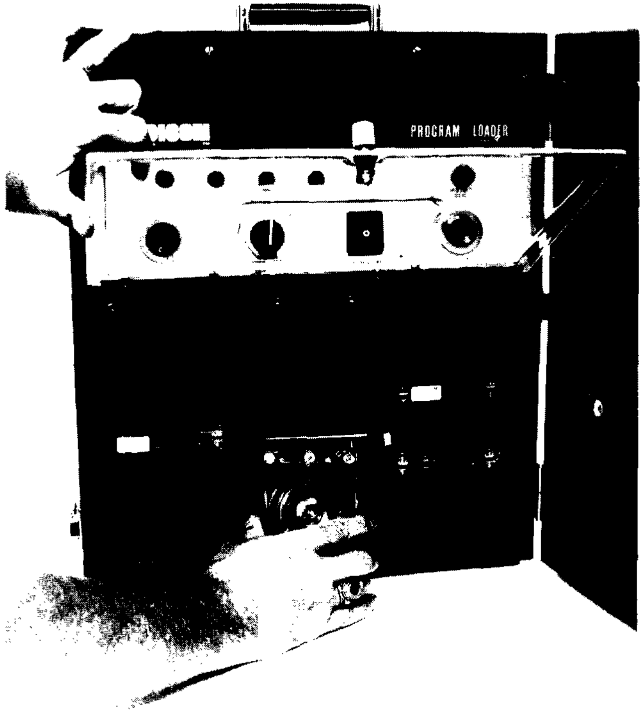


Figure A-3

RUN:	The center position of the mode selector switch. When RUN is selected and the START pushbutton pressed, the normal control cycle of the Controller is restarted.
RESET:	The RESET pushbutton is a red pushbutton for emergency use only. If it is pressed while the tape is rewinding, the tape motion is stopped. At any other time pressing RESET will cause the operation progress to stop and the tape to be rewound.

Program Number [0-1]

This switch selects the starting position on the tape at which data will be recorded or from which data will be loaded into the controller.

Indicators

POWER:	This lamp indicates that power has been applied to the program loader.

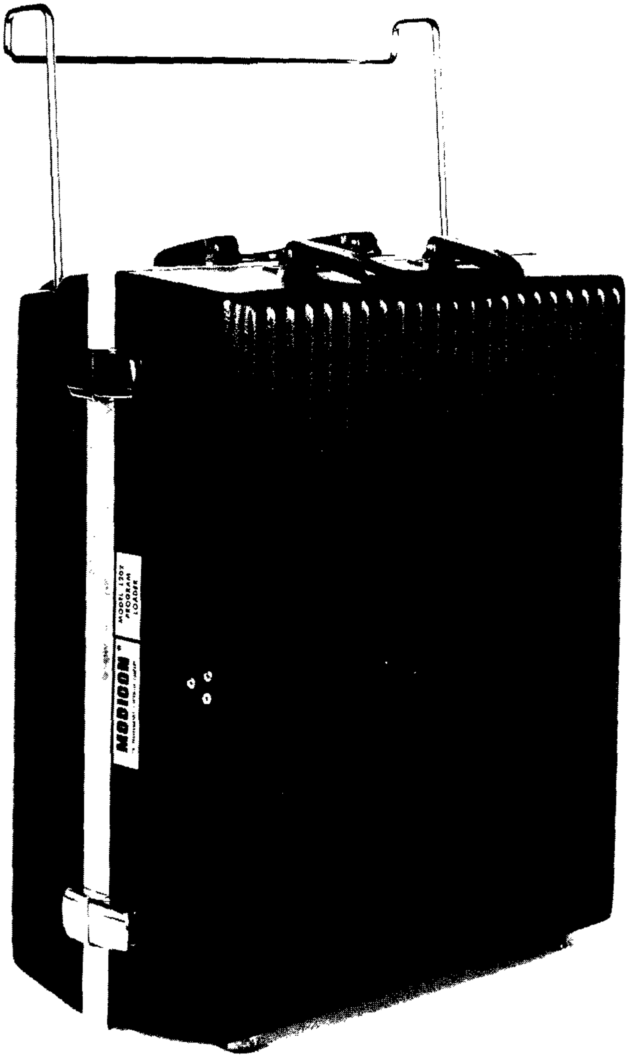


Figure A-4

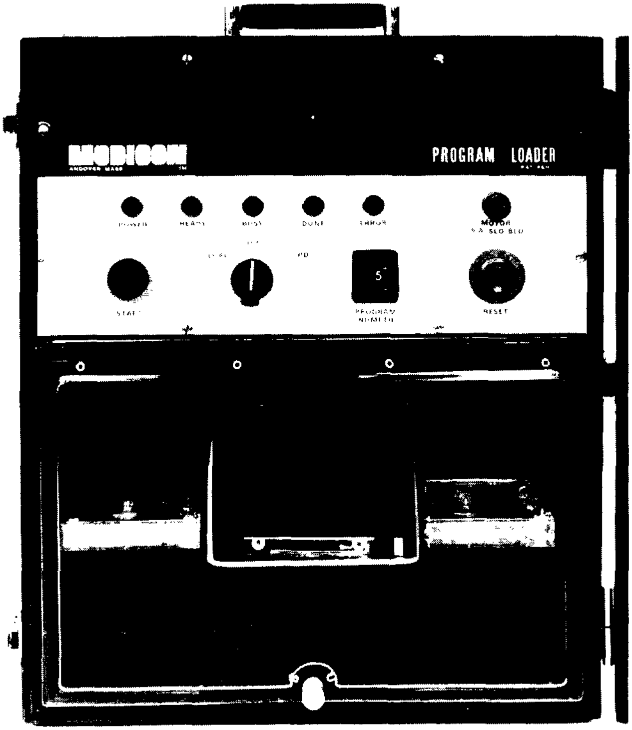


Figure A-5

READY: Indicates that the cartridge is in place, the dust-tight door is closed, no operation is currently in progress, and a load or record operation has been selected.

NOTE

Both "Power" and "Ready" must be illuminated prior to commencing an operation.

DONE: The DONE lamp indicates the selected operation has been completed. It remains on until the next operation has started.

ERROR: If this lamp is illuminated, a fault in the operation has been detected. Types of faults detected include:

a. Attempting to record on protected tape.

b. Attempting to load a non-existent program.

c. Data errors in recording.

d. Power failure.

e. Opening the dust-tight door during an operation.

f. Pressing reset while an operation is in progress.

BUSY: This lamp indicates an operation is in progress.

In addition to the five status displays and four switches, a fuse holder is mounted on the control panel. This fuse is for the 120 Vac supplied to the power supply for the tape drive motor. It contains a 1/2 amp Slo-blo fuse.

Operating Procedures

CONNECTION: Hang the program loader on the enclosure door (Figure A-2). Open the case and remove the plug-in from its compartment on the right. Open the Controller Service Port and connect the interface module to the Controller. Ensure that the interface cable is connected to the interface module. Connect the program loader ac cord to the Controller convenience outlet and turn on Controller power. The program loader POWER lamp will now be lit.

RECORD: Connect the program loader as above and select a cartridge on which you want to RECORD. (THE INTERLOCK BUTTON MUST BE IN PLACE ON THE CARTRIDGE IN ORDER TO RECORD.) Select the program number you are assigning to this tape entry. (The position on the cartridge at which the program will be entered.)

NOTE

On a new tape, recording must be at location zero. On an already recorded tape, recording at location zero will destroy the recording at location one, thus zero must only be used if the program at location one is no longer required or has not yet been recorded.

Insert the cartridge and close the dust-tight door. Place the mode selector switch in the RECORD position. At this time the READY light will be lit.

Press START: This will stop the Controller, advance the tape to the selected position and copy the Controller memory onto tape. When the operation is completed, the DONE light will come on. Return the mode selector to the RUN position and press START. This will restart the Controller causing its "RUN" light to come on. The average time for a RECORD is 6-1/2 minutes, while the maximum time is 8 minutes.

LOAD: Select the cartridge having the desired program. On the program loader control panel, dial the desired program number (0 or 1). Insert the cartridge into the tape drive mechanism (Figure A-3). Close the dust-tight cover. Move the mode selector switch to the load position. WHEN THE ABOVE STEPS ARE COMPLETED, THE "READY" LAMP WILL LIGHT. Press START. This stops the Controller's normal cycle and begins the LOAD operation. The BUSY lamp will light during this time. At the completion of the LOAD, the tape will automatically rewind and the DONE lamp will light.

(BUSY will go off.) Return the mode selector to ithe RUN position and press START to place the Controller in normal operation. The average time for a LOAD is 4 minutes.

ENVIRONMENTAL

Operates in ambient of 10°C to 50°C up to 90% humidity, and incorporates shielding and filtering for protection against both conducted and radiated, electromagnetic and electro-static noise and magnetic fields.

ELECTRICAL REQUIREMENTS

10 watts of 120 Vac single-phase at 50 to 60 H.

5 watts of +5 Vdc from Controller Power Supply.

1 watt of -5 Vdc from Controller Power Supply.

POWER-UP CONSIDERATIONS

The mode selector switch will normally be left in the "RUN" position at the completion of an operation. When power is applied to the Controller with the program loader connected and thè mode selector in RUN, the Controller will operate normally. If the mode selector is in either the LOAD or RECORD position when the power is applied, the Controller will remain idle (RUN lite out). To start, place mode selector to RUN and press START.

NOTE

Model 202 Program Loader is designed for use with only the model 184 controller. Model 206 Program Loader is designed for use with both the model 184 and 384 controllers (see page A-25).

TELEPHONE INTERFACE, MODELS 151, 152

DESCRIPTION

The MODICON Telephone Interface is a device which allows the Programmable Controller to be linked to the MODICON Service Center over standard voice grade telephone lines. It consists of an acoustical data coupler which mates with the standard telephone hand-set and an electronics package which interfaces with the Controller. Both of these are housed in a rugged case for portability and safe storage.

No special knowledge or training is required to use the Telephone Interface.

The MODICON Telephone Interface in its carrying case weighs 30 lb. and has outside dimensions of 14-3/4 in. x 14 in. x 10-1/2 in. The plug-in portion is designed for 0°C - 60°C ambient air operation, while the acoustic coupler section can operate in 0°C - 50°C ambient air. Both sections will operate in 10% - 95% relative humidity, non-condensing.

INSTALLATION

The Telephone Interface is connected to the Controller in the same manner as the Program Panel and other peripheral devices. This requires that:

1. The controller interlock be released,
2. The interface to be plugged into the Service Port, and the Control Knob turned ON,
3. The Telephone Interface is connected to 115 Vac and its power switch turned "ON",
4. The Telephone Coupler selector switch be placed in the "Full" position, and
5. The Controller Run/Set-up switch should be in the set-up position to prevent the machine or process from accidental functions.

OPERATING PROCEDURE

At this time the interface will have the "Idle" lamp on the plug-in illuminated as well as the red "Power" lamp on the acoustic coupler. It is now ready to place your call to the MODICON Service Center, (617) 475-1181. Your phone call will be answered by the Service Center Operator who will want to know:

1. Your name and company,
2. The serial number of the Controller to which you are connected, and
3. What service you desire.

He will probably ask other questions when the call is for diagnostic service.

After this discussion he will request that you switch over to "Data". At his end this entails switching from phone to data. If you are still listening, you will hear an audible tone. At your end, to make the "Data" connection, you must place the handset firmly into the rubber cups of the acoustical coupler. One of the cups is lettered CORD, which identifies the cup receiving the CORD end of the handset. The rubber cups fit snugly about the handset receiver and transmitter, reducing the possibility of room noise affecting the communication.

When you have placed the handset correctly, and the Service Center Operator has switched from voice to data, the green "Carrier" lamp on your acoustic coupler will light. The Service Center Operator is now in control. When he causes the Service Center computer to communicate with the Controller, you may observe the plug-in status lamps flashing. You must watch, however, the green "Carrier" lamp. When this lamp goes off, the Operator has switched to voice and is waiting for you to pick up the handset again.

There are four status lamps on the plug-in. The "Idle" indicates power is present but no communication is in progress. The top lamp, "Run" lights when communication is in progress. The second and third lamps, "TO" and "FROM", respectively, indicate the direction of the data being transferred. "TO" means data to the Controller.

Since communication cannot normally be accomplished while the Controller is controlling a process, you will note that shortly after switching to data a short communication will occur which will turn off the Controller "Run" lamp. Prior to terminating the call, the Operator may request that you cycle power on the Controller to restore the "Run" lamp.

It is good practice, when placing your call through your company switchboard, to explain to the operator that you are making a data call. Operators have been known to break the connection when they hear a tone rather than voices.

The Model 151 TI and the Model 152 TI transmit at 300 baud.

The Model 151 is designed to interface directly with Modicon Model 084 Programmable Controllers, and requires a Model X-435 adapter connector to interface with Model 184/384 Controllers. Telephone Interface Model 152 is designed for Model 184/384 Controllers (no adapter connector necessary), but will not interface with Model 084 Controllers.

COMPUTER INTERFACE

DESCRIPTION

The Computer Communication Equipment provides the means to interface MODICON 184/384 Controllers with a digital computer for monitoring and control purposes. Through the communications equipment the digital computer can monitor any portion of the controller memory or alter any portion of the memory (with memory protect turned off). The computer may thus accomplish virtually any type of monitoring or controlling function.

Examples of the use of the Computer Communications Equipment with a digital computer and Controller include:

1. Management reporting of: production, down-time, reject count, parts failure, etc.
2. Computer monitoring and switch-over of redundant controllers for extreme reliability.
3. Computer Service Center for program loading, dianostics, and ladder listings.
4. Connection of the Controller to a computer hierarchy controlling and/or monitoring a production line, process, plant or company.

DESCRIPTION OF THE COMPUTER COMMUNICATIONS EQUIPMENT

The Computer Communications Equipment line consists of seven standard modules. Each module has a specific purpose and may be configured with other Computer Communication modules to fit a particular application. The next paragraphs describe, in turn, each of these equipments.

List of Computer Communication Equipment

Type Number	Name	Purpose
1646-1	Computer Interface	300b/sec
1646-2	Computer Interface	2400 b/sec
1646-3	Computer Interface	4800 b/sec
1646-4	Computer Interface	9600 b/sec
1642	EIA Adapter	for 300 b/sec, used for distances between 50 and 2000 feet.
1643	EIA Adapter	for 600 to 9600 b/sec, used for distances between 50 and 1000 feet.
1644	Housing	for the 1642 and 1643 (accomodates up to eight Adapters).

1646 Computer Interfaces

The 1646 series of computer interfaces contains the logic required to obtain data from, and insert data into the controller memory. This means, for example: 1) that the state of inputs, outputs and registers may be examined by a computer, 2) that the ladder diagram and/or executive program may be examined by a computer, 3) that the state of registers may be modified by a computer, and 4) that the ladder diagram and/or executive program may be modified by a computer.

Any one member of the 1646 series is a portable plug-in unit that inserts into the service port of the Controller, and receives its power from the Controller (Figure A-6). It may interface directly with a computer up to 50 feet away through a serial data interface conforming to EIA specification RS-232-C (Type E). Longer distances may be accommodated through the use of the 1642 or 1643 Adapter modules (see below).

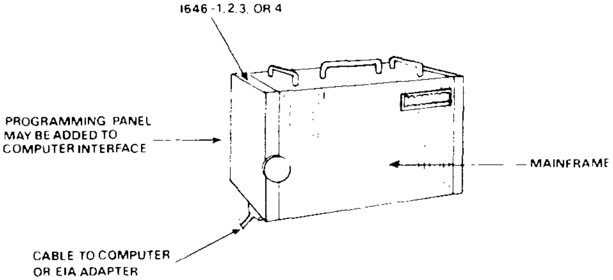


Figure A-6. 1646-1, 2, 3, or 4 Connected to 184/384 Service Port

Note that the programming panel may be attached to the Controller, without disturbing the computer interface, via a connector on the computer interface.

The four models of the 1646 line (-1, -2, -3, -4) provide standard asynchronous data rates of 300, 2400, 4800, and 9600 b/sec respectively. On special order, rates of 150, 200, 600, 900, 1200, 1800, 3600, 7200 and others may be provided.

In addition to direct connection to a computer, the 1646 series is capable of interfacing to data sets, such as the Bell 103A, or acoustic couplers, such as the Anderson Jacobson Series 240, that meet the requirements of EIA-RS-232-C (Type E). These data sets are used when communicating at a distance longer than 2000 feet.

1642 and 1643 Adapter Modules

The 1642 and 1643 Adapter Modules are used for interfacing a digital computer with cables longer than 50 feet (See Figure A-7.) In conjunction with 1646-1, Computer Interface, the 1642 may drive and terminate cables, at 300 b/sec, up to 2000 feet in length. In conjunction with the 1646-2, -3, or -4, Computer Interface, the 1643 may drive and terminate cables, at data rates greater than 300 b/sec, up to 1000 feet in length.

The interface between the 1642 or the 1643 Adapter Module and the computer is asynchronous, full duplex, and conforms to EIA Specification RS-232-C (Type E). The 1642 or 1643 is a plug-in module containing a cable driver and receiver, EIA driver and receiver, noise filters and activity indicators. They plug into and receive power from an 1644 Adapter Module housing described below.

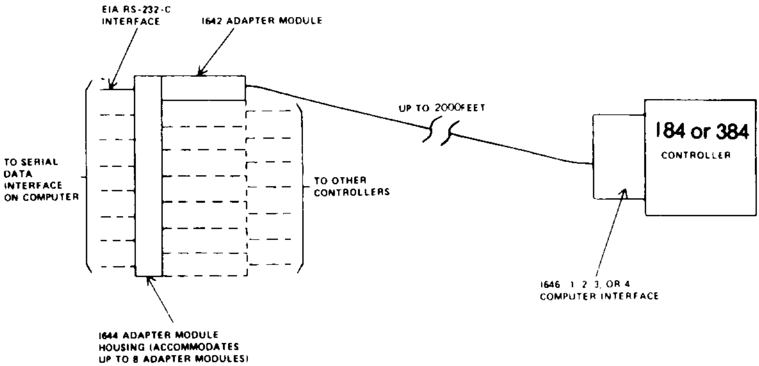


Figure A-7. Remote Computer Communication through an 1642 or 1643

1644 Multiple Adapter Housing

The 1644 Multiple Adapter Housing is a unit for housing up to eight of the 1643 and/or 1642 Adapter Modules in proximity to the digital computer. It supplies the power required by the Adapter Modules.

The front of the 1644 has displays for the "POWER ON" state and for the activity status of each Adapter Module data channel to and from the Controller. The activity indicator will be ON when the channel is idle and flashing when the channel is active. When the indicator is OFF, the channel is disconnected.

CONFIGURATION

The quantity and interconnection of each of the units comprising the Computer Communication Equipment to be used on an installation will depend upon the particular requirements. If the Controller is less than 50 feet from the computer, only the 1646-1, -2, -3, or -4 Computer Interface is required. Any Controller at a distance greater than 50 feet from the computer will require, in addition to an 1646-1, -2, -3, or -4 Computer Interface, an 1642 (for 300 bps) or an 1643 Adapter Module (for > 300 bps). If an 1642 or an 1643 are required, at least one 1644 will be required. The following allows determination of the number of each unit required for an installation.

a. 1646-1: One for each Controller communicating at 300 bps.

b. 1646-2: One for each Controller communicating at 2400 bps.

c. 1646-3: One for each Controller communicating at 4800 bps.

d. 1646-4: One for each Controller communicating at 9600 bps.

e. 1642: One for each Controller at a distance of more than 50 but not more than 2000 feet from the computer, communicating at 300 bps or less.

f. 1643: One for each Controller at a distance of more than 50 but not more than 1000 feet from the computer, communicating at greater than 300 bps.

WIRING INSTALLATION

The Computer Interface Equipment can be applied in three ways:

a. Distant (greater than 50 ft.) computer communication through an 1642 or 1643.

b. Direct computer communication (less than 50 ft.)

c. Telephone data set communication.

Each of these arrangements require somewhat different wiring. In the distant computer communication system, two cables are required:

a. The cable between the 1646-1, -2, -3, or -4 Computer Interface and the EIA Adapter (1642 or 1643) (Cable A).

b. The cable from the computer to the EIA Adapter (1642 or 1643) (Cable B).

The connectors for Cable A are provided with the 1646-1, -2, -3, or -4 Computer Interface. The cable itself is not. The cable should have two twisted pairs each individually shielded, and 22 guage (7 x 30), such as Belden 8777 or Alpha 6010. Figure A-8 shows the interconnection for Cable A. If either the Memory Protect Option or the Flag Character option is required, the jumpers must be added to the connector that plugs into the 1646-1, -2, -3, or -4. Cable B is wired in accordance with EIA specification and is not supplied with Adapters.

Table A-1. 1646-1, -2, -3, and -4 Connector Pin Assignments

Pin	Signal
1.	Protective Ground
2	Transmitted Data
3	Received Data from 1646-1, -2, -3, or -4 Computer Interface
4	(Not Used)
5	Clear to Send
6	Data Set Ready
7	Signal Ground
8	Received Line 5
9	Shield Ground
10	Shield Ground
11	From 1646-1, -2, -3, or -4 Computer Interface
12	DC Power Ground
13	DC Power Ground
14	+5 Vdc
15	(Not Used)
16	+5 Vdc
17	(Not Used)
18	To 1646-1, -2, -3, or -4 Computer Iterface
19	(Not Used)
20	Data Terminal Ready 1646-1, -2, -3, or -4 Computer Interface
21	To (TP 2)
22	(Not Used)
23	Flag Character Enable
24	Shield Ground
25	Memory Protect Enable

In the telephone data set system, the connections between 1646-1, -2, -3, or -4 CI and the data set are shown in Figure A-9. Again, the cable length is limited to fifty feet and the jumpers must be added to the connector if the Memory Protect or Flag Character Options are required. The cable shield is wired to pin 1 of both Connectors. A 10,000 ohm, 1/4 watt resistor is required between pins 9 and 20 of the connector at the data set end of the cable.

g. 1644: One for each group of eight 1642 or 1643. Any mix of 1642 or 1643 is allowed in one 1644.

h. Data set (not supplied): Two for each Controller at a distance greater than 2000 feet from the computer.

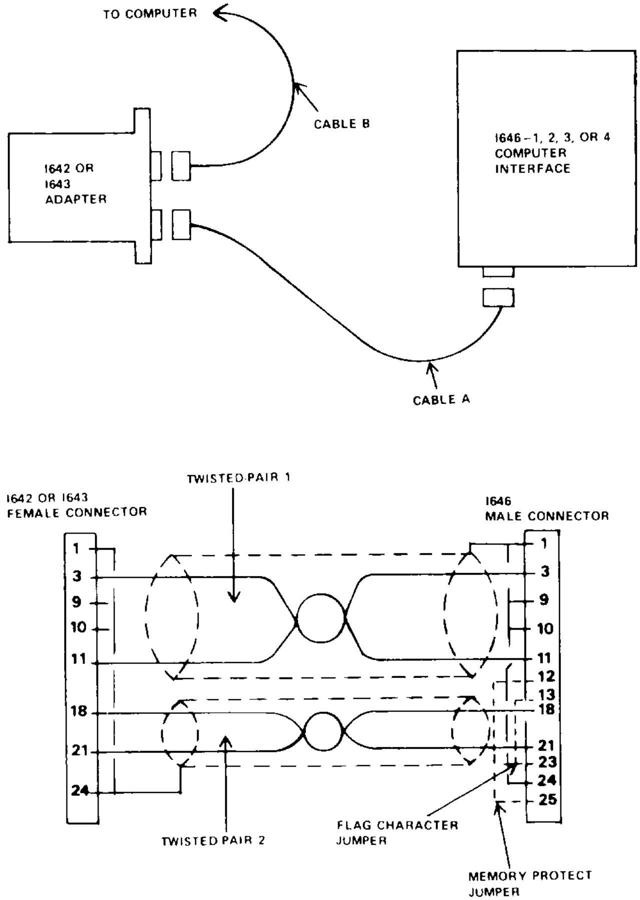


Figure A-8. Cable A

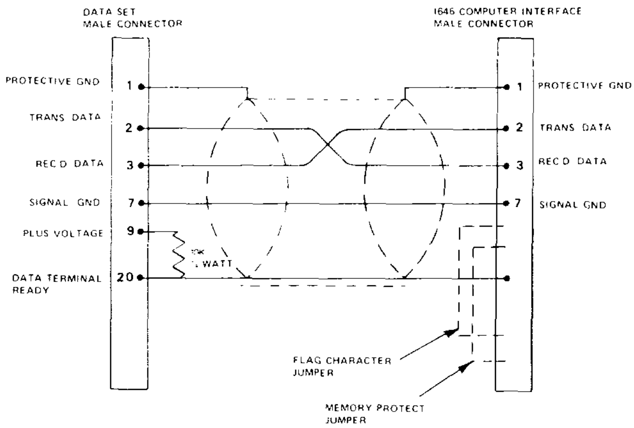


Figure A-9. Connectors Between 1646-1, 2, 3, and 4 and Data Set

PROGRAMMABLE PRINTER

DESCRIPTION

The P500 Programmable Printer is designed to provide hard-copy printouts of data such as machine conditions, running time, tool life, down-time, alarm monitoring, fault diagnostics, and management information. It is a single modular unit with heavy-duty housing, designed to withstand severe industrial environments.

The Printer is not only capable of providing printouts from a user's computer or other controller, but is specifically engineered to connect easily into 084, 184, or 384 MODICON Controller I/O housings.

Three operation formats are provided:

1. Printout of a number contained in any storage location within the processor;
2. Printout of any one of 108 pre-determined message lines stored in the Printer's own (read-only) memory;
3. Printout of a combined message.

SPECIFICATIONS

Power:	115 Vac; 50 Hz or 60 Hz
Control:In/Out:	115 Vac; 24 Vdc;
Size:	19 in. x 11 in. x 17-1/2 in.
Weight:	60 lb. (approx.)
Temperature:	0°C to 60°C ambient
Humidity:	10% to 70% relative

Read Only Memory:	108 lines of stored messages
Character Set:	Full alphanumeric plus symbols
Paper:	3-1/2 in- wide, pressure sensitive fan-fold; various colors (pre-printed - optional)
Optional Interfaces:	Parallel BCD or ASCII Serial EIA RS-232C-compatible

CONTROLS AND INDICATORS

The following controls and indicators are located on the face of the Printer:

MOTOR ON

DC POWER

I/O POWER

PAPER FEED

PAPER OUT

BELL

FORM BUSY

BUSY

AUXILIARY POWER SUPPLY, MODEL P421

DESCRIPTION

The 184/384 Controller Auxiliary Power Supply (Figure A-10) is required to provide +5 Vdc power for additional I/O channels of the system. One supply is required for each additional four I/O housings (one channel). Figure A-11 shows the method of connecting the expanded configuration together with modem option.

The Auxiliary Power Suply provides data interconnection paths and also serves as a housing for data transmission circuitry. As shown in the illustration, it is mounted (via hanger with bolt-holes) next to the first housing of any channel (up to four housings). Connection is the same as that between I/O housings.

SPECIFICATIONS

Power:	115 Vac or 230 Vac;50 Hz or 60 Hz; 150 Volt amps (Max)
Size:	18 in. x 5-1/2 in. x 7-3/4 in.
Weight:	10 lb. (approx.)
Temperature:	0°C to 70°C ambient
Humidity:	10% to 90% relative (non-condensing)

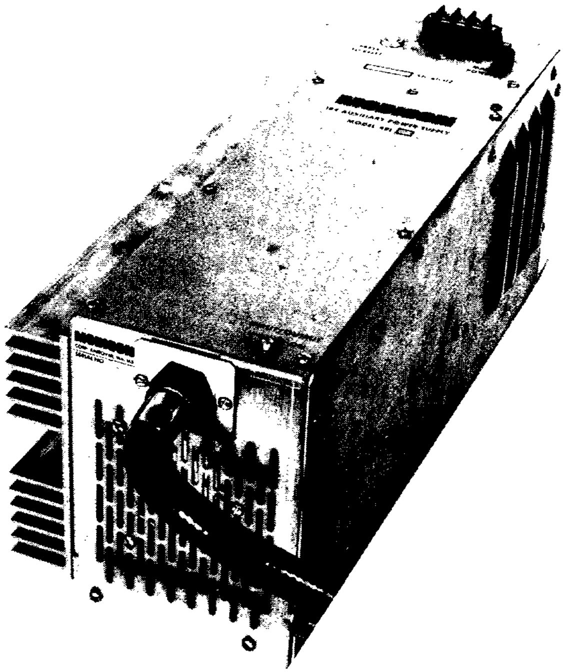


Figure A-10. Auxiliary Power Supply

CONTROLS AND INDICATORS

Two indicators are standard:

DC power	LED indicator showing the presence of dc power
Line power	Neon indicator showing the presence of power on the input line terminals

A third indicator (provided with the modem option) shows the presence of activity on both Send and Receive channels of the modem when the remote option is used.

A circuit breaker is provided to protect primary circuits.

REMOTE I/O DRIVER

DESCRIPTION

The Remote Input/Output Driver provides the capability to physically locate a channel of the 184/384 Controller's Input/Output interface (128 inputs and 128 outputs) up to 5000 feet from the mainframe. Any or all of

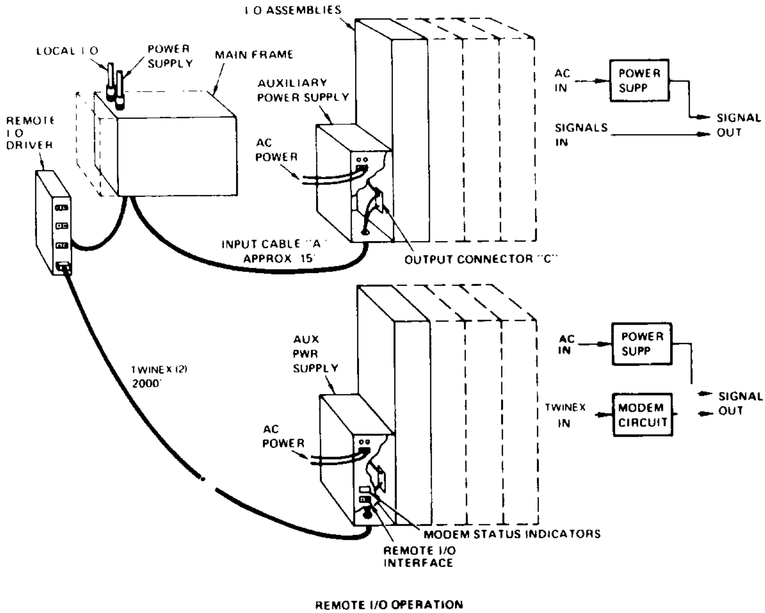


Figure A-11. Auxiliary Power Supply System Options

the 184/384 Controller's four I/O channels can be located at remote locations; each channel so located will require one I426 Remote I/O Driver. Any remote channel connected to a I426 Driver can be divided into four units of varying size, each 5000 feet from the driver, provided the total number of input or output modules used does not exceed eight (128 inputs or 128 outputs). However, each of these locations individually connected to the I426 Driver will require a P421 Auxiliary Power Supply and an I431 Remote I/O Interface.

This unit is normally supplied with a six-foot cable for connecting to the mainframe; cable type W604-006 is used when remoting channel I and W603-006 is used for remoting channels II, III, or IV. Remote Drivers can be supplied with a twelve-foot cable by specifying cable W604-012 (for channel I) or W603-012 (for channels II, III, or IV).

The I426 Driver obtains its electrical power from the mainframe and does not require any additional source of electrical power. To ensure proper heat dissipation, the I426 Driver should be mounted in the vertical position as shown. At least one-inch clearance should be provided between the Driver and the mainframe. Each I426 Driver is capable of supplying Input/Output communications for the channel to which it is connected to four separate locations. If less than four locations are utilized, no special terminations are required of the un-used connections.

Communications is provided to the remote I/O Interface mounted in the Auxiliary Power Supplies via cables containing two pairs of shielded wires and are not supplied by MODICON; Belden type 8227 or equal should be utilized and provided by the customer. Up to 5000 feet of cable can be driven by each output of the I426 Driver.

The I431 Remote I/O Interface is installed in the Auxiliary Power Supply and does not alter the size or mounting dimensions of this unit. Since dc power is not transferred via the twin axial cables, each location where Remote I/O units are to be installed will require a P421 Auxiliary Power Supply equipped with an 1431 Interface

INSTALLATION

The 1426 Driver should be mounted in the vertical position per the mounting dimensions provided in Figure 9. Connect each cable from up to four remote locations to the terminal provided on the 1426 Driver (see Figure A-13). Connect the interface cable to the main-frame connector for the channel to be remoted.

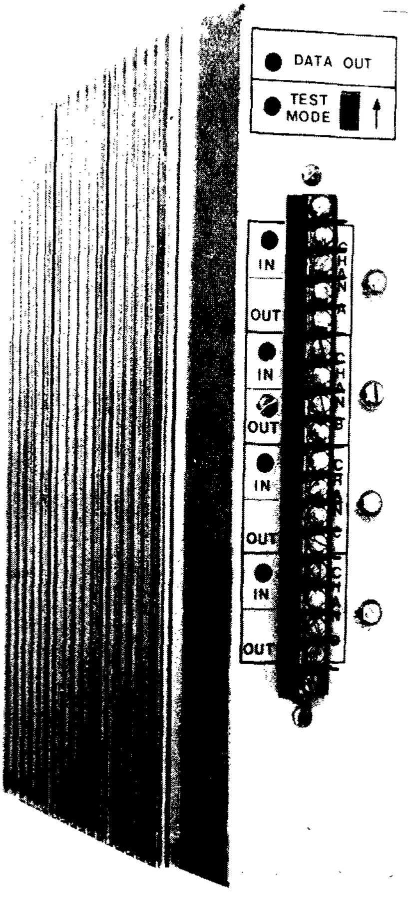


Figure A-12. 1426 Remote Driver

The 1431 interface will normally be factory-installed on the Auxiliary Power Supply. If this interface is to be added to an existing Auxiliary Power Supply, or if the Power Supply requires replacement with a unit not equipped with the interface, the following procedure should be utilized:

1. Remove 5 in. x 13 in. front cover secured by six screws from Auxiliary Power Supply.
2. Remove interface cable type W602 (for channel I) or type W606 (for channels II, III, or IV), including internal connector and bottom mounting plate secured by two screws.
3. Place 1431 Interface on front of Auxiliary Power Supply inserting connector onto printed circuit board in location vacated by interface cable connector. Secure in place with six screws on front and two screws on bottom.

NOTE

When replacing a failed Auxiliary Power Supply, reinstall interface cable and front cover removed from new unit onto failed unit prior to return to MODICON for repair.

The Auxiliary Power Supply with 1431 Interface is installed adjacent to the I/O housings of the remote location. The cables are connected to the terminal board on the 1431 Interface per Figure A-13.

NOTE

Test Mode to be used ONLY by trained service personnel.

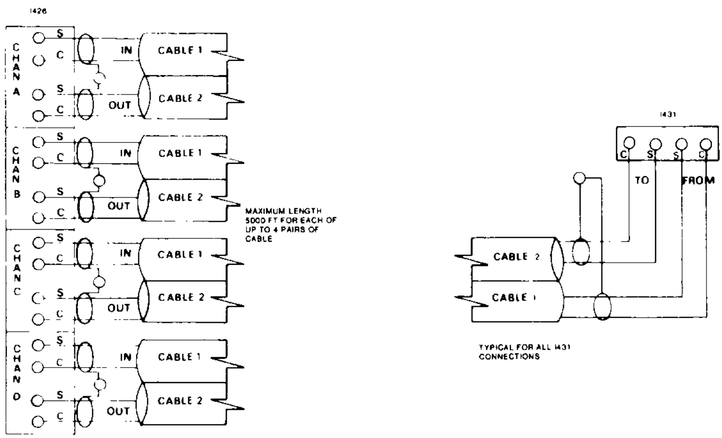


Figure A-13. Wiring Details (1426 and 1431 Interface)

OPERATION

Prior to commencing operation, ensure that the screwdriver test switch on the front of the Remote I/O Driver is in the down position and that the test indicator is not lit. This test switch is utilized to perform maintenance diagnostics available only from the MODICON Service Center. No other controls or adjustments are necessary for proper operation of the Remote Driver and transfer of I/O status from the mainframe to the remote locations.

The DATA OUT Indicator on the Remote Driver indicates data is being supplied to the output cables; the indicator opposite each of the four subchannel connections indicates data is being received from each of these subchannels. The LINE TO and LINE FROM indicators on the Remote Interface indicates data is being transferred via the To and From lines respectively. As previously noted, the Test Mode indicator on the Remote Interface is used only with special maintenance diagnostics available from MODICON.

PROGRAM LOADER, MODEL 206

DESCRIPTION

The Model 206 Program Loader is a magnetic tape cartridge unit designed for field recording and reloading of user programs with both 184 and 384 Programmable Controllers. This loader is also compatible with models 084, 284, and 1084 controllers with different interface unit. The Program Loader features ease of operation and fully automatic error detection and protection. The Model 206 Program Loader permits the user to:

- Record his control programs on magnetic tape cartridges.
- Load a control program from a magnetic tape cartridge.
- Verify a tape, either against controller's memory or internal parity check.

The Model 206 is housed in a rugged case and requires a Model I646 Computer Interface set for any standard baud rate. The case also provides space for storage of up to five magnetic tape cartridges. Each cartridge can store only one MODICON program regardless of controller type. The program from a 184 or 384 controller consists of the entire Programmable Controller core memory.

Figure A-14

SPECIFICATIONS

Dimensions:	15" x 21" x 8"
Weight	35 pounds
Cartridge Size:	300 feet
Cartridge Capacity:	512 blocks, each block 128 sixteen bit words

Speed:	Read/Write -- 18" per sec. Rewind -- 100" per sec.
Write Protect:	Rotating or removing the coded flap on the bottom of the tape cartridge inhibits recording on that cartridge.
Baud Rates:	110, 150, 200, 300, 600, 1200, 1800, 2400, 3600, 4800, 7200, 9600, and 19,200 baud.
Power Requirements:	115 V ± 10%, 50-60 Hz or 230 V ± 10%, 50-60 Hz, 60 VA
Environment:	Ambient Temperature 10-50°C Humidity up to 95% Non-Condensing

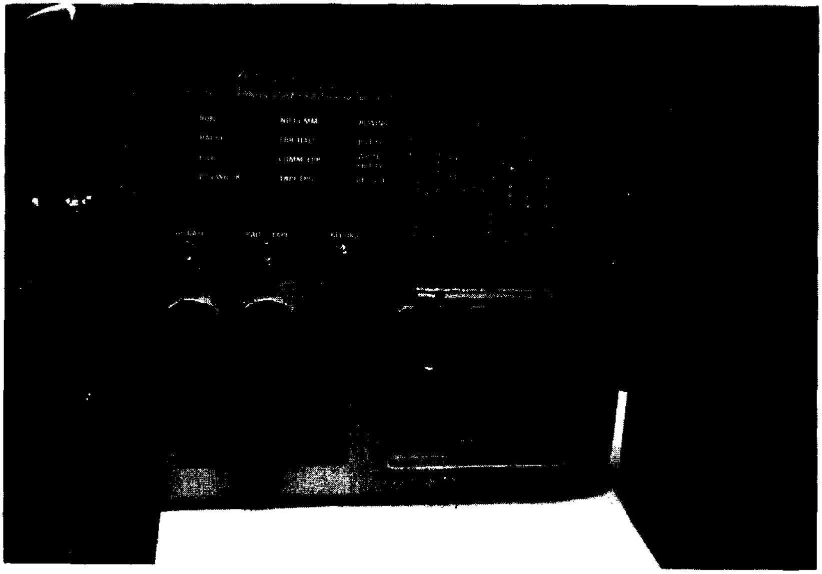


Figure A-15. Controls and Indicators

CONTROLS AND INDICATORS

ON/OFF:	Controls application of AC power.
Main Power:	Indicates when AC power has been applied.
Operate/Verify:	Selects mode of operation, either operating with tape (record tape or load controller) or verify data on tape.
Record/Load:	Selects type of operation, either recording on tape or load from tape to controller. Spring loaded toward Record position.
Pause Tape:	Interrupts tape operation; tape operation continued from where stopped by depressing GO or returned to beginning of tape by depressing RESET.
GO:	Pushbutton that initiates selected mode of operation.
RESET:	Pushbutton that terminates operation and returns tape to beginning.

Controller Type:	Twelve position thumbwheel used to select type of controller that is connected to program loader. Set to one for 184 controller and three for 384 controller.
Run:	Indicates when loader is in operating condition.
Pause:	Blinks when loader is in pause condition
Idle:	Indicates when loader is not operating but available.
DC Pwr OK:	Indicates DC power from internal power supply is within regulation.
No Comm.:	Indicates when operating was started but terminated due to inability to communicate with controller.
Error Halt:	Indicates when operation was halted by detection of sufficient error to result in unreliable operation.
Comm. Error:	Indicates whenever error is detected in communications between controller and loader.
Tape Error:	Indicates whenever error is detected in tape operation.
Rewind:	ON when rewind in progress or tape has been completely rewound.
BOT/EOT:	ON when tape is at beginning of tape (BOT) or end of tape (EOT).
Write Protect:	ON when tape inserted is protected from being written ON.
Record:	ON when tape is being recorded from controller.
Baud Rate:	Four indicators that indicate baud rate and an active communication channel to controller.

OPERATING PROCEDURES

SET-UP	Connect communications cable to controller. Cable adapter used only with 284 controller. Insert tape cartridge with side A up.
	Turn AC power ON.
	Select Controller Type
RECORD:	Insure Write Protect indicator is not lit. Select Operate mode and Record operation.
	Depress GO pushbutton. Loader will automatically select proper baud rate, starting with 19,200 baud, that matches Computer Interface to which it is connected.
	Once communications at the proper baud rate is established, the loader automatically "traps" the controller, ceasing its scanning. To untrap, the controller must be cycled ON/OFF/ON.

At end of record, tape is automatically rewound to beginning.

LOAD:

Select Operate mode. Depress and hold spring return Load operation; simultaneously depress GO pushbutton. Release both switches.

Loader will automatically select proper baud rate, starting with 19,200 baud, that matches Computer Interface to which it is connected.

Once communications at the proper baud rate is established, the loader automatically "traps" the controller, ceasing its scanning. To untrap, the controller must be cycled ON/OFF/ON.

At end of load, tape is automatically rewound to beginning.

Verify:

Select Verify mode. Two types of verify are possible, selected as follows:

1) Verify tape format (parity check). Select Record Operation.
2) Verify tape against controller memory. Select and hold Load Operation.

After type of verify is determined, depress GO pushbutton to start COMPARE. If verify against controller memory is selected, the controller will be trapped.

Failure of the verify will result in terminating of the operation with Error Halt indicator ON.

Operating Notes:

1) Once an operation has begun, all controls have no effect on the operation except Reset and Pause. The Reset pushbutton, when depressed, terminates any operation in progress and rewinds the tape to the beginning. The Pause switch causes any operation in progress to be suspended and the tape stopped. All other controls can be repositioned without affecting any operation once begun.
2) The following indicators will be on for the various modes of operation:

Mode	Run	Record	Baud Rate
Record	x	x	x
Load	x		x
Verify Tape	x		
Verify Against Memory	x		x

3) The dust cover can be opened without affecting an operation in progress.
4) If a tape is not rewound to the beginning at the start of the operation, it will be automatically rewound prior to commencing the operation.
5) Whenever an error is detected, a single tone is provided by the loader. If the error is recoverable, the operation continues

and a valid result is obtained; if the error is not recoverable, the operation is halted with Error Halt indicator lit. Poor communications or gradual degration of tape after many uses can be detected by the number of tones issued during a successful load.

6) Communications is compatible with RS-232 type D. In the service center position, the communications cable can be connected to a computer (via Telephone Interface, if necessary) to load/record from the computer.

Functional Description:

All data is recorded at least twice in 128 word blocks with parity on each block. If the first block has good parity, the second is not used; if the first has incorrect parity, data is obtained from the second block. During a record operation, parity is verified on each block. If incorrect parity is detected, successive blocks are written until at least two blocks have valid parity. The Record is terminated if more than seven blocks are required to record any block due to successive parity failures.

During a load operation, invalid parity when reading from the tape, causes successive blocks to be used until good parity is obtained. If invalid parity is obtained for all records of the same block, the operation is terminated with Tape Error indicated. Once good parity is obtained, all successive records of that block will be ignored until the next block is located.

Time required to record load depends upon baud rate and core size. The following are some typical times to record a 4K 184 or 384:

Baud Rate	Time
9600	25 seconds
4800	45 seconds
1200	3 minutes
600	5 minutes
300	10 minutes

Loading or Verifying typically takes 1/2 the time required to record a program.

CRT PROGRAMMER MODELS 140, 145

DESCRIPTION

The CRT Programmers are designed to operate not only with MODICON's 184 and 384 controllers, but also with other controllers MODICON has built. Thus they can also be referred to as Universal Programming Panels (UPP). For details in interfacing them with other controllers, refer to the manual that describes that controller and its peripheral equipment. This appendix will describe how the UPP's are connected to the 184/384 controllers and the capabilities provided with these controllers.

The model differences between 140 and 145 are mainly their size. The model 140 (see figure A-16) incorporates a 9" screen and is designed to be easily carried to various installations. The model 145 (see figure A-17) incorporates a 12" screen and is designed mainly for a fixed operation. In addition, the model 145 has a complete ASCII keyboard; however, since this keyboard is used only with the model 1084 Programmable Controller, this difference does not affect its capabilities with the 184/384 controllers. All features described below, such as dual modes of operation (multi-node and four node), on site ladder diagrams, multiple controller connections, real time programming, etc., are applicable to both model 140 and 145 unless otherwise indicated.

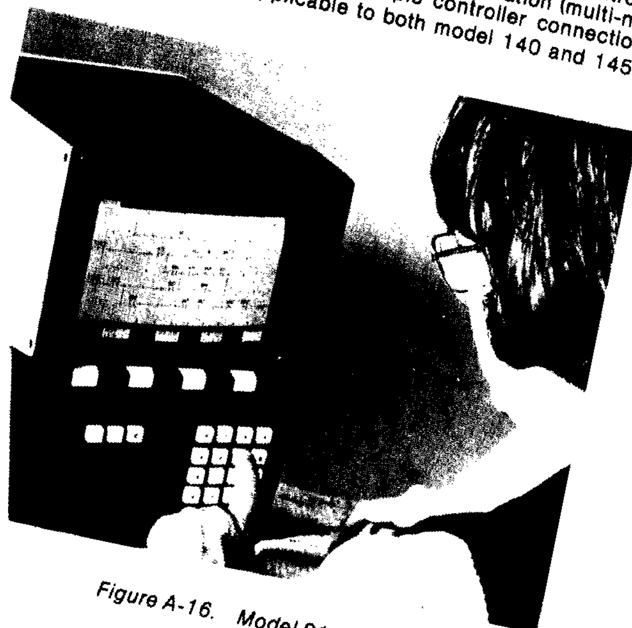


Figure A-16. Model P140

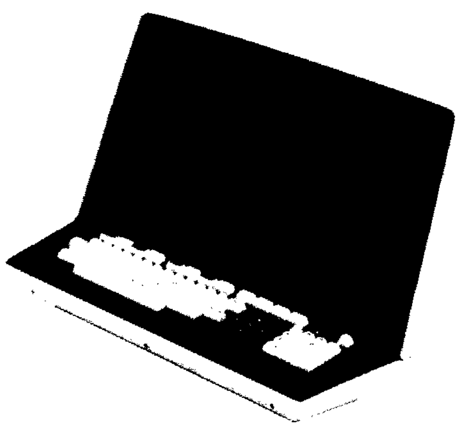


Figure A-17. Model P145

The CRT Programmer is a highly intelligent CRT terminal designed specifically to operate with MODICON controllers. When connected to a 184/384 controller, the CRT can display logic in either a multiple node or our standard four node format. Both modes are provided with all model 140 and 145 CRT Programmers; which is used, is at the operator's discretion. All programming changes are made from the CRT in real time. A multi-node format (see figure A-18) allows the operator to build his logic in a ten by seven node pattern, including up to seven coils on the screen at one time. As a maximum, seven rungs of a ladder diagram can be programmed, each with ten contacts and a coil. Vertical connections can be made between adjacent rungs after any or all nodes. In addition, timers, counters, calculate, and data transfer functions can be incorporated into any of these logic runs where screen space is available (see figure A-19).

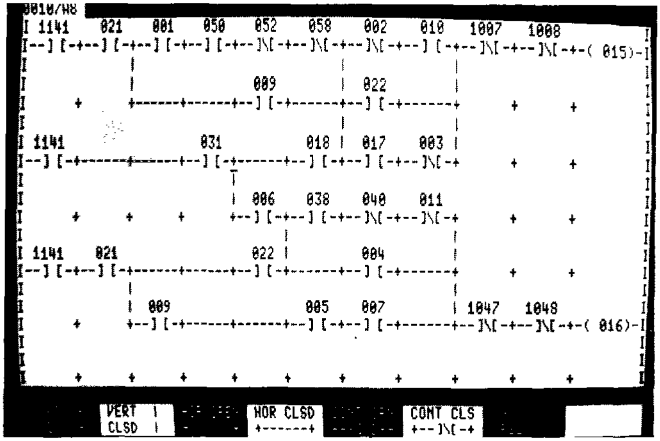


Figure A-18. Multi-Node Format

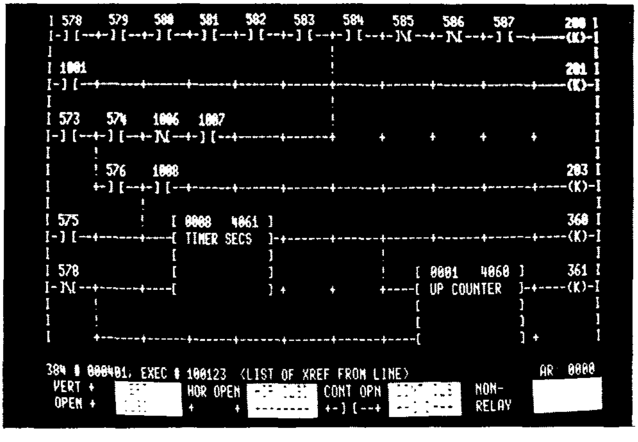


Figure A-19. Multi-Node with Non-Relay

The four node format (see figure A-20) allows programs to be built in the standard MODICON four element logic line. The screen will be split to allow logic to be shown on both the left and right half. Any logic can be shown on either side. Since the logic is displayed under operator control, data does *not* have to be in numerical order when displayed. Up to fourteen logic lines, 40 registers, 40 inputs, 40 latches, or combinations thereof in any order that can be seen on the screen, can be displayed. The real time power flow and coil status of any one logic line on the screen can be obtained. Register contents can be shown in decimal, hexadecimal, or binary; one register content is updated every scan of the controller.

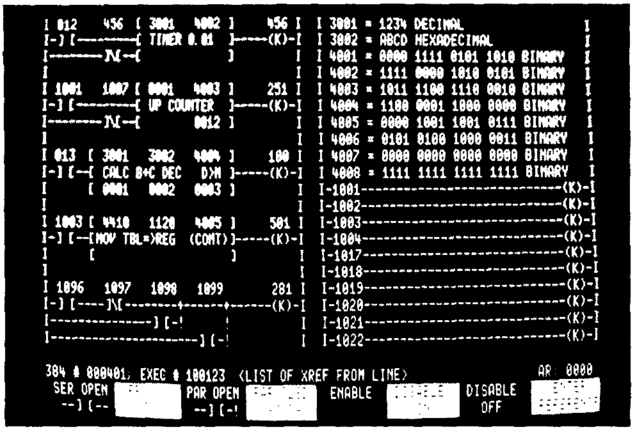


Figure A-20. Four Node Format

The CRT Programmer can be simultaneously connected to sixteen controllers at one time. These connections are in a "daisy-chain," such that the distance from the CRT to the first controller, or the distance between controllers can be up to 1000 feet. If all 16 controllers are 1000 feet apart, the overall distance from the CRT to the last (16tht controller is 16,000 feet (approximately 3 miles). The cabling between the CRT and the controllers is one Belden type 8777 or Alpha type 6010 cable or their equivalent. Which controller is being programmed (only one can be actively connected to the CRT at one time) is under the operator's control and does not require action at any controller.

Each CRT Programmer is capable of interfacing to a standard RS-232C device. This capability allows on-site ladder diagrams to be provided in either multi-node or the standard four node format. This interface can be driven with various baud rates set by the operator up to 9600 baud. Data that is in the keyboard register (under operator control) will be printed at the top of each page, to allow the operator to date or otherwise identify the ladder diagram.

SPECIFICATIONS

	P140	**P145**
Power Requirements:	115VAC ± 10% (50 or 60 Hz) 150 Volt Amps	115 VAC ± 10% (50 or 60 Hz) 200 Volt Amps

Environmental Requirements:

	P140	P145
Ambient Temperature:	10 to 40°C	10 to 38°C
Humidity:	20 to 80% (non-condensing)	20 to 80% (non-condensing)
Dimensions:	15 in. x 10 in. x 24 in.	25 in. x 22 in. x 16 in.
Weight:	35 lbs.	68 lbs.

DETAIL CAPABILITIES

MULTI-NODE

When in the multi-node format, the operator builds his logic in a convenient 10 x 7 matrix of relay contacts/logic entries. Once he has entered his logic, the CRT will, upon command, break the multi-node logic into four node elements and place them into the controller's standard four element logic lines. If any of the user's logic is incomplete due to branches that do not connect or reference numbers that are not entered, an error statement will appear. The operator must correct the error before the compiling can be accomplished and the controller's memory altered.

When entering the multi-node format, the operator designates those logic lines (e.g., lines 1-144) that he wants to reserve as output lines. The CRT Programmer will assign all other lines (e.g. lines 145-831) for internal storage, to be used by the compiler for multiple node logic storage. When assigning logic coils on the CRT screen, output coils only must be used. Once programmed, all logic lines whether used as output lines or internal lines, are still compatible with the other programming tools, such as the P112 or P102. The CRT programmer (e.g., model 145) can be used to install and check out a program and the other programmers (e.g., models P102, P112, or P140) can be used to troubleshoot and maintain the system. Power flow is shown by reversing (white symbols on black background) all relay contacts that are closed, i.e., can pass power if it is available from the left.

Once programmed in multi-node, a system can be reconnected at a later date to a CRT programmer and the identical multi-node logic will be displayed "packed" to the top left; however, the logic itself including element order, will not have been changed. A program that has been entered by a multi-node programmer, but modified (not just monitored) by a four element device, will most likely result in a logic system that is *not* compatible with the multi-node CRT programmer. The only method of restoring compatibility is to reload the original logic.

FOUR-NODE

When displaying the standard four element logic line, the CRT can make use of the maximum capability of the 184/384 controller. Logic lines or inputs or registers are entered onto the screen at the bottom of either the left or right side, and all existing data being displayed is shifted towards the top. Exactly what reference is displayed and on which side, is under operator control and can be varied at will. Registers and/or inputs can be intermixed with logic lines. Power flow is shown again by reversing the relay contacts (i.e., white symbols on black background) that are closed, i.e., can pass power if it is available from the left. Power flow is shown on one logic line or coil as selected by the operator.

SPECIAL FEATURES

1. Search All—Coils can be searched for a disable condition and those that match the condition are either listed or displayed as the operator desires. The search can be conducted through line coils only, input

coils only, or both line coils and inputs. The disable conditions can be just disabled, or disabled OFF, or disabled ON, or enabled.

2. Trace—A reference on one selected relay contact can be displayed on the screen as a separate logic line, to verify either its disable status or power flow condition. The logic line from which the trace was performed is stored and can be used to return immediately by retracing. Up to sixteen logic lines can be stored sequencially for retrace before the oldest entry is lost.
3. Cross-Reference—A reference can be selcted and all logic lines where that reference is used are listed on the screen. This reference can be an input, logic line coil, register, or even a latch.
4. Variable Labeled Pushbuttons—Eight pushbuttons, through which the user performs the majority of his programming, have labels that are assigned by the CRT depending upon where the user is in his programming. This reduces both the quantity of pushbutton on the CRT and the opportunity to depress the wrong pushbutton, since only those that are legal are available to the operator.

D285 CRT DISPLAY UNIT

This unit provides the ability to display error messages, status reports, management information, and other data via a CRT display. This unit is very simply programmed and interfaced to the 184 or 384 controller; its internal design is very similar to the P500 Printer. In fact, it is connected to the controller exactly as the P500 Printer is, requiring one output module (register - 115Vac or 24Vdc) and two discrete inputs (busy and form busy) per D285. Multiple D285's and/or P500's can be connected and controlled by a single 184 or 384 controller. A W280 cable is available to connect the D285 to the 184/384 Input/Output Section.

The D285 utilizes the same hand-shaking communications as does the P500 Printer. Controllers shipped three years ago, that currently have the P500 DX Print capabilities, can drive the D285 Display Unit. The D285 utilizes an industrial 12" CRT that is capable of displaying up to sixteen lines of alpha-numerical information; each line can contain up to 64 characters. Within the D285 is a PROM memory for storage of message format. This memory contains lines of messages, each line 64 characters wide. The basic unit with 8K of memory provides 112 message lines; the maximum memory (32K) provides 496 message lines. Any unit can have up to 496 unique message addresses; messages are addressed 1 to 496. The following are the major characteristics of the D285:

Screen Size:	12 inch (diagonal measurement)
Screen Format:	16 lines, each 64 characters
Message Entry:	Either bottom entry schrolling up, or top entry schrolling down
Blinking Rates:	Any portion of a line at 2, 4, or 8 cycles per second
Memory Size:	8K with optional 2K increments up to 32K
Character Set:	Any ASCII character
Input/Output Voltage:	115Vac or 24Vdc ±20%
AC Power:	115Vac ±10%, 50 or 60 Hz ±5%, 130VA
Size (WxHxD):	20x11x25 inches
Weight:	95 pounds
Environment:	Temperature - 0 to 55°C Humidity - 10 to 80% (non-condensing) Max. altitude - 10,000 feet

Options: Additional Memory, 2K increments, maximum 12 increments

Input/Output Devices (wired separately to controller I/O)

ASCII output port for hard copy

Memory is coded at the factory and can be altered by replacing PROM's. Any legal ASCII characters can be used; forms are available from any sales office for coding the PROM memory. Blanks can be left in any message for digits to be entered from controller's registers. Messages can be coded to be entered either at the bottom of the screen or at the top; to save error conditions, the most recent four messages entered at the top are retained when messages are entered at the bottom and schrolled up. Any portion of a message up to one line long can be blinked to obtain operator attention; three rates are available, with only one provided with any D285. As an option, an ASCII port can be provided to output messages as they are placed on the CRT screen. The controller can select messages for CRT only or both CRT and ASCII port.

D285 CRT Display Unit

J540 ADAPTER

This adapter allows the 500 series of I/O modules to be interfaced with any 184/384 controller. One adapter is required per I/O channel providing 128 input points and 128 output points. The 500 series of I/O modules provide I/O points in groups of four in lieu of the 200 series which provides I/O points in groups of sixteen. The modules are totally input or output (four points per module) and are similar in industrial performance as the B230 to B237 modules discussed in Appendix B. For exact specifications, wiring details, and cost, contact your nearest MODICON Sales Office.

The J540 Adapter can be interfaced to the 184/384 controller in a number of methods as listed below:

1. W600 or W601 Cable
2. Auxiliary Power Supply (P421) with W602/W606 Cable or at end of Remote Driver.
3. B240 I/O Housing containing standard 200 Series I/O Modules.

The total quantity of I/O points per channel is the same as listed in this manual (Section II). Within the 500 Series of I/O, modules are placed in housings, 8 modules per housing, for a total of 32 I/O points per housing. There is no limitation of module placement within a housing (i.e., input vs. output, or 5 VTTL vs. 115 Vac, etc.). Since a channel can be 128 input and 128 output points (total 256 I/O points), eight housings are required for an entire 184/384 I/O channel. Each housing can be separately addressed as number 1 to 4. Two housings can be addressed as the same number to allow a total of eight housings. When two housings have the same address, one must be the exact opposite of the other (inputs versus outputs).

On the front of the J540 Adapter, there are four indicators and two sets of switches. Indicators are as follows:

POWER — ON if DC power has been applied.

RUN — ON if adapter being serviced by 184/384 Scan at least once every 200 msec.

ERROR — ON if I/O communication has been detected and cannot be corrected by error checking capabilities.

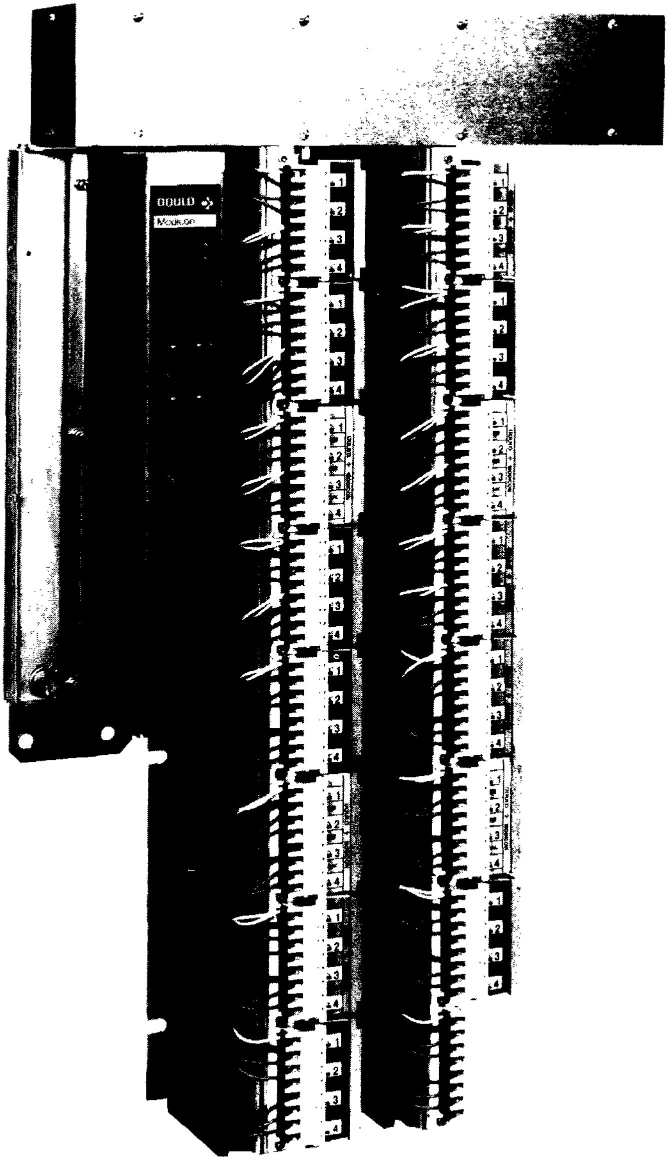
TEST — ON if in test mode to be utilized by MODICON Service technicians only.

The switches enable the 500 series I/O to provide information normally obtained from the address index pin in that channel. Two sets of switches are provided, one controlling inputs and the other outputs. Normally, these switches will all be ON. However, if a channel has a mix of 200 series I/O and 500 series I/O, they can be used to "lock-out" the 500 series from those index pins whose information is being used by the 200 series I/O. Correlation between index pin location and 500 series I/O is as follows:

184/384	**500 Series I/O Module Location**	
Index Pin	**Housing**	**Top/Bottom Four Modules**
1	1	Top
2	1	Bottom
3	2	Top
4	2	Bottom
5	3	Top
6	3	Bottom
7	4	Top
8	4	Bottom

J340/J342 I/O COMMUNICATOR

This communicator connects the output from one channel of a controller to the inputs of another controller. Up to 128 discrete outputs, or 8 output registers, or some mix of both can be transferred simultaneous in each direction every scan. The communicator can be used to link the logic and I/O of two 184/384 Controllers or to use one controller as numerical storage for a second. No modification of either controller is required to use the communicator; nor are special executive programs required. The information transferred is under the control of the I/O Allocation Table (Traffic Cop) of each controller. When connected by the communicator, each controller operates independently upon its stored logic in a scan mode.

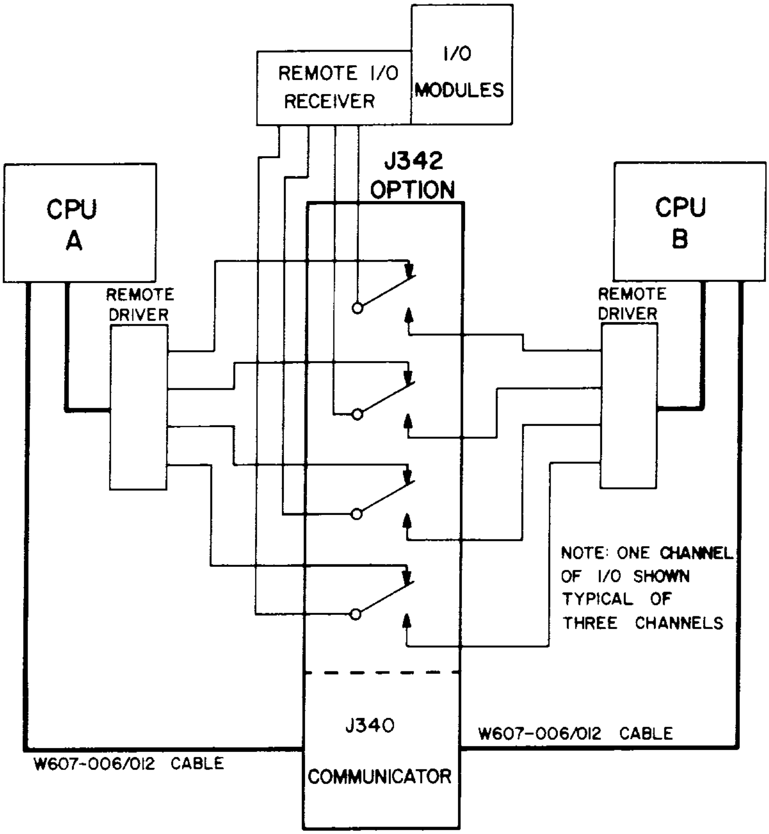


J540 Interface with 500 Series I/O

The communicator can be connected to channel II, III, or IV of a 184 or 384 mainframe; the CPU type or channel number does not have to be identical at both ends. To illustrate a typical installation, the following example is provided for illustrative purposes only. It is assumed a Traffic Cop modification has been made; further modifications are possible to tailor the communication's path to the application.

Slot Number	184/384 CPU A Output		184/384 CPU B Input	
1	0257 - 0272		1127 - 1144	
2	0273 - 0288		1145 - 1160	
3	0289 - 0304		1161 - 1176	
4	0305 - 0320		1177 - 1192	
5	4021	Binary	3021	Binary
6	4022	BCD	3022	BCD
7	4023	BCD	3023	BCD
8	4024	Binary	3024	Binary
	Input		**Output**	
1	3013	BCD	4023	BCD
2	3014	BCD	4024	BCD
3	3015	BCD	4025	BCD
4	3016	Binary	4026	Binary
5	3017	CD	4011	BCD
6	3018	BCD	4012	BCD
7	1225 - 1240		0209 - 0224	
8	1241 - 1256		0225 - 0240	

As an option, the I/O Communicator can be equipped with transfer relays. These relays are designed to transfer a shared remote I/O system from one CPU to another. This transfer will be automatically accomplished within 2 mSec of a failure in the "Master" unit. Failures within either the Main Power Supply (including loss of AC power) or the Mainframe that will cause the scan to stop, will activate the transfer. Model J340 is not equipped with these relays; model J342 can both communicate information and transfer remote I/O control of up to three I/O channels. Provisions are also made on model J342 to manually transfer control from one CPU to another. After a transfer occurs, the back-up or slave CPU becomes the "Master." Within each CPU, the status of this transfer is available. Bit 2 (high order data) will be a one in slot 8 of the input if that CPU is the "Master" and in control of the remote I/O. Bit 1 of this input will be a one if the other CPU is not operating.



Connections of I/O Communicator

APPENDIX B
I/O MODULES

APPENDIX B
I/O MODULES

GENERAL INFORMATION

The MODICON input/output modules convert and condition signals from user equipment into logic voltage levels used by the Controller's processor and vice-versa. Each standard (non-isolated) module is capable of conditioning up to sixteen input/output signals. Voltages other than 5 Vdc used by the processor internally are supplied to the module housings by the user. The following signal-conditioning module options are available.

Model	Type
B230	Conditions 115 Vac outputs
B231	Conditions 115 Vac inputs
B232	Conditions 24 Vdc outputs
B233	Conditions 24 Vdc inputs
B234	Conditions 230 Vac outputs
B235	Conditions 230 Vac inputs
B236	Conditions 5 Vdc outputs for TTL logic
B237	Conditions 5 Vdc inputs for TTL logic
B238	Conditions 24 Vdc High Current outputs
B239	Counts High Speed Pulse Signals
B243	Conditions Analog (0-10 Vdc, 1-5 Vdc, or 4-20 mA) inputs
B244	Conditions 230 Vac Isolated outputs
B245	Conditions 230 Vac Isolated inputs
B246	Conditions 115 Vac Isolated outputs
B247	Conditions 115 Vac Isolated inputs
B248	Conditions 10-60 Vdc Outputs
B256/258	Controls Sixteen Analog Inputs
B260	Conditions Analog Voltage (0-10 Vdc or 0-5 Vdc) outputs
B262	Conditions Analog Current (4-20mA only) outputs
B266/268 274/276	Conditions Reed isolated outputs
B270	Conditions 48 Vac outputs
B271	Conditions 48 Vac inputs
B275	Conditions 10-60 Vdc Inputs
B680	Conditions ASCII I/O

All modules are 3 in. x 8-7/8 in. by 12-5/8 in. and weigh approximately 5 lb. Each input or output is electrically isolated from the 184/384 Controller through optical couplers or isolation transformers and will withstand severe voltage transients without damage or adverse affect on the Controller. (The modules are designed to withstand 25,000V spark noise from a Tesla Coil type device.)

User connections are made to standard barrier strips on the B240 Input/Output Housing. A module is plugged into the housing and secured by two screws, one at the top and one at the bottom of each module. This configuration permits a replacement of modules without disturbing the field wiring.

Terminals are numbered from one at the top of the barrier strip. Table B-1 is a matrix showing terminal assignments for commonly used I/O modules. The following descriptions show input/output terminal numbering and connections. Note that, for ac-conditioning modules, terminals 2, 7, 12, and 17 are not connected together internally; while, for dc-conditioning modules, these terminals are connected internally.

When a module is secured in the housing, each output or input wire has, adjacent to it, the appropriate status indicator (input or output) and a marking strip for labels.

In addition, each module is provided with a status lamp (Active Indicator) which remains lit when the module is being monitored by the processor during normal operation. This light only indicates processor scanning, it does not show whether input signals are being communicated to the processor. On the other hand, if output signals are not being sent to the module by the processor, both signal lights and the status lights will be off.

ENVIRONMENTAL CONDITIONS

The following applies to all input/output modules.

Temperature:	0° to 60°C ambient
Humidity:	0% to 95% relative (non-condensing)

Terminal	B230 115 Vac Outputs	B231 115 Vac Inputs	B232 24 Vdc Outputs	B233 24 Vdc Inputs	B234 230 Vac Outputs	B235 230 Vac Inputs	B236 5V TTL Outputs	B237 5V TTL Inputs	B238 24 Vdc High-Current Outputs	B243 Analog Inputs
1	Lamp Common	Not Used	Bias Input	Bias Input	Lamp Common	Not Used	Bias Input	Bias Input	Bias Input	Not Used
2	Group 1 Line	Group 1 Common	*Common	*Common	Group 1 Line	Group 1 Common	*Common	*Common	*Common	+ Input 1
3	Output 1	Input 1	Output 1	Input 1	Output 1	Input 1	Output 1	Input 1	Output 1	– Input 1
4	Output 2	Input 2	Output 2	Input 2	Output 2	Input 2	Output 2	Input 2	Output 2	Shield 1
5	Output 3	Input 3	Output 3	Input 3	Output 3	Input 3	Output 3	Input 3	Output 3	Not Used
6	Output 4	Input 4	Output 4	Input 4	Output 4	Input 4	Output 4	Input 4	Output 4	Not Used
7	Group 2 Line	Group 2 Common	*Common	*Common	Group 2 Line	Group 2 Common	*Common	*Common	*Common	+ Input 2
8	Output 5	Input 5	Output 5	Input 5	Output 5	Input 5	Output 5	Input 5	Output 5	– Input 2
9	Output 6	Input 6	Output 6	Input 6	Output 6	Input 6	Output 6	Input 6	Output 6	Shield 2
10	Output 7	Input 7	Output 7	Input 7	Output 7	Input 7	Output 7	Input 7	Output 7	Not Used
11	Output 8	Input 8	Output 8	Input 8	Output 8	Input 8	Output 8	Input 8	Output 8	Not Used
12	Group 3 Line	Group 3 Common	*Common	*Common	Group 3 Line	Group 3 Common	*Common	*Common	*Common	Not Used
13	Output 9	Input 9	Output 9	Input 9	Output 9	Input 9	Output 9	Input 9	Output 9	+ Input 3
14	Output 10	Input 10	Output 10	Input 10	Output 10	Input 10	Output 10	Input 10	Output 10	– Input 3
15	Output 11	Input 11	Output 11	Input 11	Output 11	Input 11	Output 11	Input 11	Output 11	Shield 3
16	Output 12	Input 12	Output 12	Input 12	Output 12	Input 12	Output 12	Input 12	Output 12	Not Used
17	Group 4 Line	Group 4 Common	*Common	*Common	Group 4 Line	Group 4 Common	*Common	*Common	*Common	Not Used
18	Output 13	Input 13	Output 13	Input 13	Output 13	Input 13	Output 13	Input 13	Output 13	+ Input 4
19	Output 14	Input 14	Output 14	Input 14	Output 14	Input 14	Output 14	Input 14	Output 14	Input 4
20	Output 15	Input 15	Output 15	Input 15	Output 15	Input 15	Output 15	Input 15	Output 15	Shield 4
21	Output 16	Input 16	Output 16	Input 16	Output 16	Input 16	Output 16	Input 16	Output 16	Not Used

*NOTE: DC commons are internally jumpered on the DC modules and require only one connection per module

Table B-1. I/O Module Terminal Assignments

ALTERNATING CURRENT MODULES

115V MODULES

INPUTS-B231 MODEL

Each input draws sufficient 'wetting' current to inhibit the buildup of contaminants on the surface of silver contacts used in pushbuttons, limit switches, pressure switches, etc.

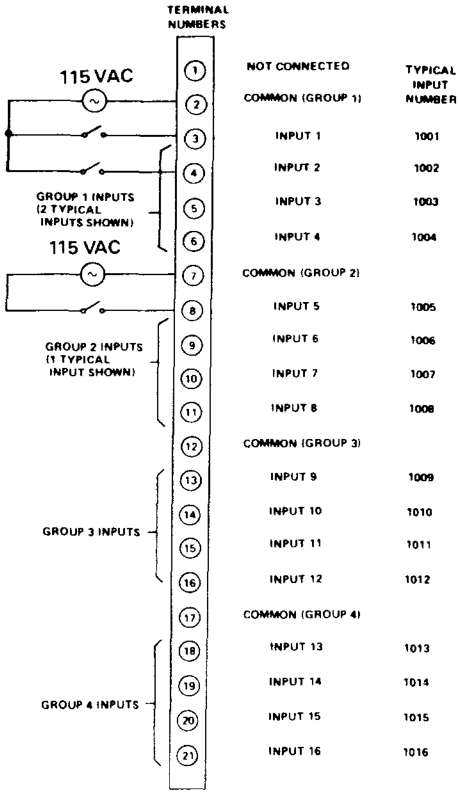
Following are the input signal requirements for each of the 16 inputs.

ON

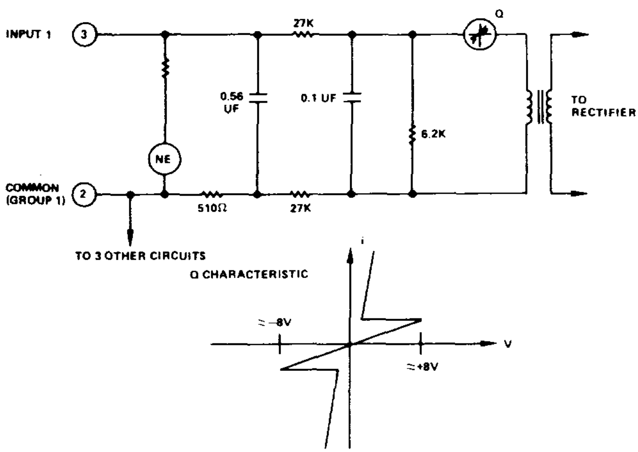
Condition:	Input at high level Input indicator ON Controller input ON
Level:	115 ±15 Vac, Source in series with 0 to 1000 ohms 48 to 62 Hz

OFF

Condition:	Input at low level Input indicator OFF Controller input OFF
Level:	0 to 30 Vac, or 0 to 130 Vac Source in series with greater than 25,000 ohms; 48 to 62 Hz.
Switch Level:	Approximately 65 Vac
Input Impedance:	510 ohms in series, with 0.56 μf (approximately 4,700 ohms, −90° at 60 Hz)
Input Current:	25 mA at 115V (contact wetting current at 60 Hz)
Common Mode Voltage:	200 Vac steady state (60 Hz) 1500V for 10 ms
Maximum Input Voltage:	Not to exceed 400 volts peak on any input
Output Response Time:	OFF to ON - 10 ms at 60 Hz maximum 12 ms at 50 Hz ON to OFF - 30 ms maximum



B231 115 Vac Input Module
Terminal Numbering and Input Connection



B231 115 Vac Input Module Simplified Schematic

OUTPUTS - B230 MODEL

The MODICON B230 Output Module conditions the signals used internally in the Controller to sixteen independent 115 Vac output capable of driving solenoids, motor starters, and other loads up to two amperes. Each module uses sixteen triac devices to switch the loads of the user-supplied Vac line.

Self-contained damping networks and voltage-limiting thyrectors or varistors surpress line voltage spikes and prevent false triggering. The module is also fused to protect its circuitry from overload currents and voltages.

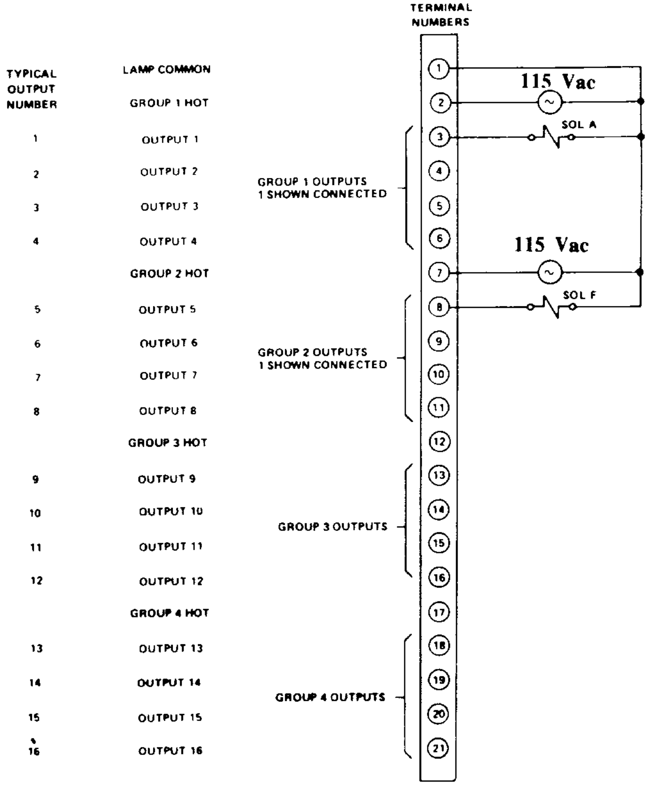
The following are the electrical characteristics of the B230 Output Module.

Load Current	
OFF Current:	5 mA maximum 115 Vac, at 60 Hz
ON Current:	2 amperes maximum per output; 5 amperes maximum per group of four outputs
ON Holding Current:	60 mA maximum for B230, 0.5 mA max. for B230-1.
Inrush Load Current:	5 amperes maximum for 100 ms 15 amperes maximum for 10 ms
Fuse Rating:	5 amperes (one fuse per output)
Load Voltage	
Working Voltage:	115 ± 35 Vac 48 to 62 Hz
Transient:	200V maximum; thyrector limited
ON Voltage Drop:	2 Vac at 2 amperes current
Common Mode Voltage	Working 200 Vac, 1500 Vac maximum for 10 ms
Response Time	B230: OFF to ON - 0.3 - 2 ms ON to OFF - 0.3 - 8 ms B230-1: OFF to ON - 0.3 - 10 ms ON to OFF - 0.3 - 8 ms
Output Status Indicator	A neon lamp is provided for each output. The lamp will be ON when the output is ON.

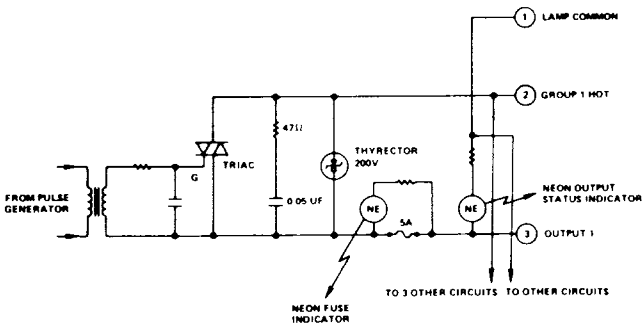
NOTE

B230 only, the lamp will be ON when no output load is present.

Fuse Indicator	A neon lamp is provided for each output. The lamp will be ON when the fuse is blown.



B230 115 Vac Output Module
Terminal Numbering and Output Connection



B230 115 Vac Output Module Simplified Schematic

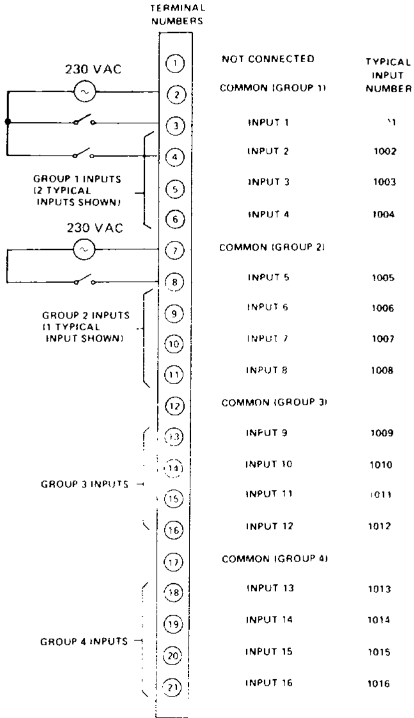
230V MODULES

INPUTS - B235 MODEL

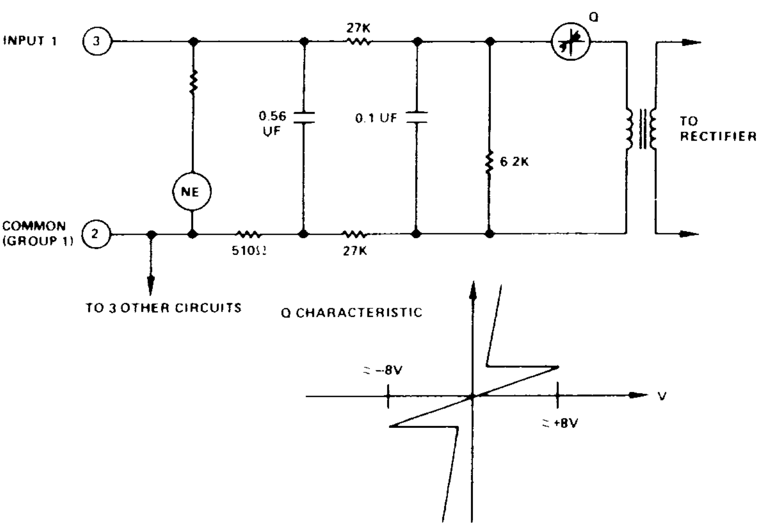
Each input draws sufficient 'wetting' current to inhibit the buildup of contaminants on the surface of silver contacts used in pushbuttons, limit switches, pressure switches, etc.

Following are the input signal requirements for each of the 16 inputs.

ON	
Condition:	Input at high level Input indicator ON Controller input ON
Level:	230 ±30 Vac Source in series with 0 to 1000 ohms 48 to 62 Hz
OFF	
Condition:	Input at low level Input indicator OFF Controller input OFF
Level:	0 to 60 Vac, or 0 to 260 Vac Source in series with greater than 50,000 ohms; 48 to 62 Hz.
Switch Level:	Approximately 130 Vac
Input Impedance:	1K ohms in series, with 0.33 mF (approximately 8,000 ohms, −90° at 60 Hz)
Input Current:	28 mA at 220V (contact wetting current at 60 Hz)
Common Mode Voltage:	400 Vac steady state (60 Hz); 1500V for 10 ms
Output Response Time:	a. OFF to ON - 10 ms at 60 Hz maximum 12 ms at 50 Hz b. ON to OFF - 30 ms maximum



B235 230 Vac Input Module
Terminal Numbering and Input Connection



B235 230 Vac Input Module Simplified Schematic

OUTPUTS - B234 MODEL

The MODICON B234 (230 Vac) Output Module conditions the signals used internally in the Controller to 16 independent 230 Vac outputs capable of driving solenoids, motor starters, and other loads up to two amperes. Each module uses 16 triac devices to switch the loads of the user-supplied Vac line.

Self-contained damping networks and voltage-limiting thyrectors suppress line voltage spikes and prevent false triggering. The module is also fused to protect its circuitry from overload currents and voltages.

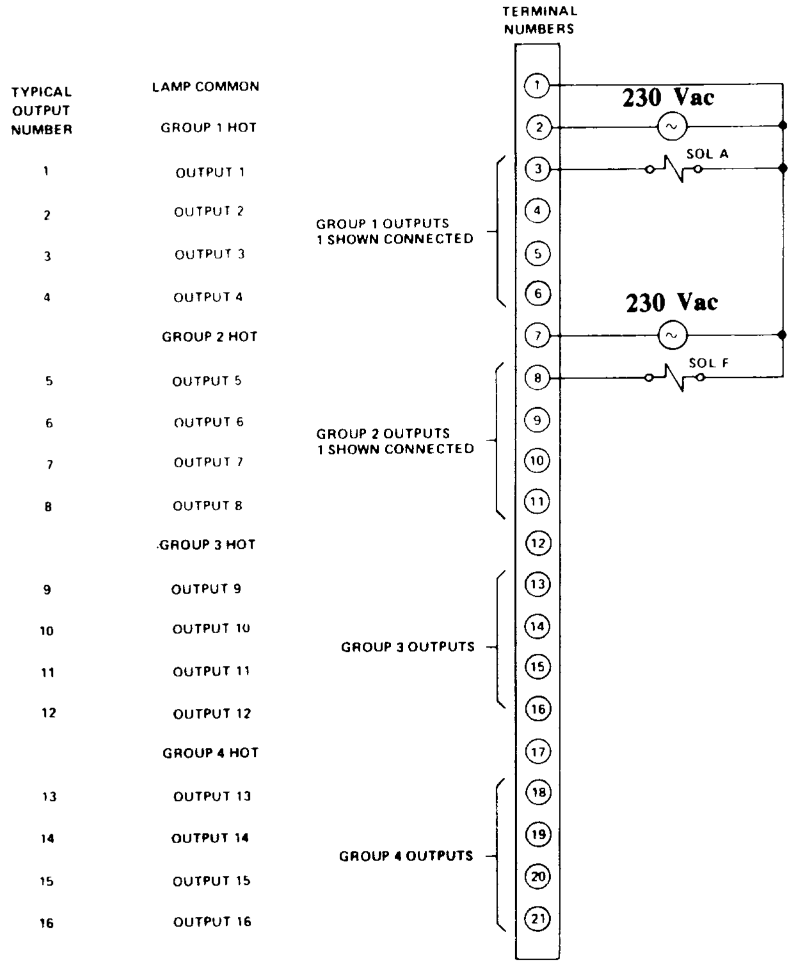
Following the electrical characteristics of the B234 Output Module.

Load Current	
OFF Current:	5 mA maximum
ON Current:	2 ampres maximum per output; 5 amperes maximum per group of four outputs
ON Holding Current:	60 mA maximum for B234, 0.5 mA max. for B234-1.
Inrush Load Current:	5 amperes maximum for 100 ms 15 amperes maximum for 10 ms
Fuse Rating:	5 amperes (one fuse per output)
Load Voltage	
Working Voltage:	230 $\pm$ 50 Vac; 48 to 62 Hz
Transient:	400V maximum; thyrector limited
ON Voltage Drop:	2 Vac at 2 amperes current
Common Mode Voltage	Working 400 Vac, 1500 Vac maximum for 10 ms
Response Time	B234: OFF to ON 0.3 - 2.0 ms ON to OFF - 0.3 - 8.0 ms B-234-1: OFF to ON - 0.3 - 10 ms ON to OFF - 0.3 - 8 ms
Output Status Indicator	A neon lamp is provided for each output. The lamp will be ON when the output is ON.

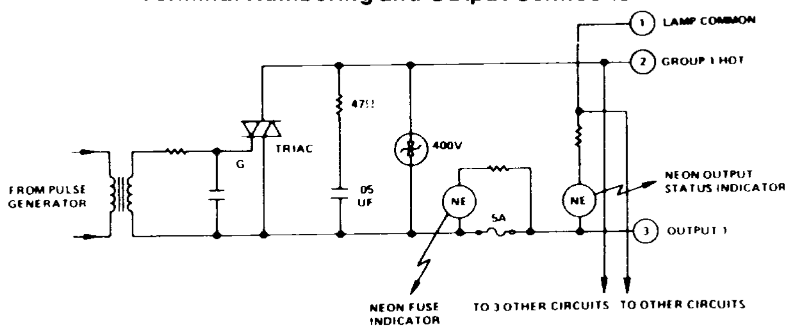
NOTE

B234 only, the lamp will be ON when no output load is present.

Fuse Indicator	A neon lamp is provided for each output. The lamp will be ON when the fuse is blown.



B234 230 Vac Output Module
Terminal Numbering and Output Connection



B234 230 Vac Output Module Simplified Schematic

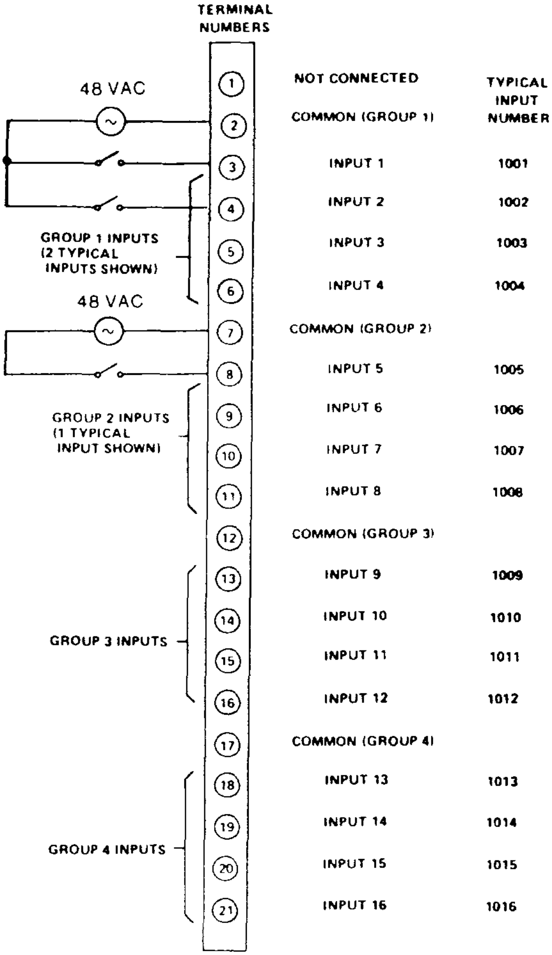
48V MODULES

INPUTS-271 MODEL

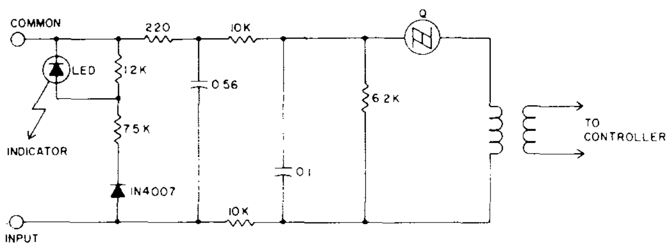
Each input draws sufficient 'wetting' current to inhibit the buildup of contaminants on the surface of silver contacts used in pushbuttons, limit switches, pressure switches, etc.

Following are the input signal requirements for each of the 16 inputs.

ON	
Condition:	Input at high level Input indicator ON Controller input ON
Level:	48 ± 12 Vac, Source in series with 0 to 500 ohms 48 to 62 Hz
OFF	
Condition:	Input at low level Input indicator OFF Controller input OFF
Level:	0 to 15 Vac, or 0 to 60 Vac source in series with greater than 20,000 ohms; 48 to 62 Hz.
Switch Level:	Approximately 24 Vac
Input Impedance:	220 ohms in series, with 0.56 mF (approximately 4,700 ohms, −90° at 60 Hz)
Input Current:	10 mA at 48V (contact wetting current at 60 Hz)
Common Mode	
Voltage:	200 Vac steady state (60 Hz) 1500V for 10 ms
Maximum Input	
Voltage:	Not to exceed 400 volts peak on any input
Output Response	
Time:	OFF to ON - 10 ms at 60 Hz maximum 12 ms at 50 Hz ON to OFF - 30 ms maximum



B271 48 Vac Input Module
Terminal Numbering and Input Connection



B271 48 Vac Input Module Simplified Schematic

OUTPUT-B270 MODEL

The MODICON B270 Output Module conditions the signals used internally in the Controller to sixteen independent 48 Vac outputs capable of driving solenoids, motor starters, and other loads up to two amperes. Each module uses sixteen triac devices to switch the loads of the user-supplied Vac line.

Self-contained damping networks and voltage-limiting thyrectors suppress line voltage spikes and prevent false triggering. The module is also fused to protect its circuitry from overload currents and voltages.

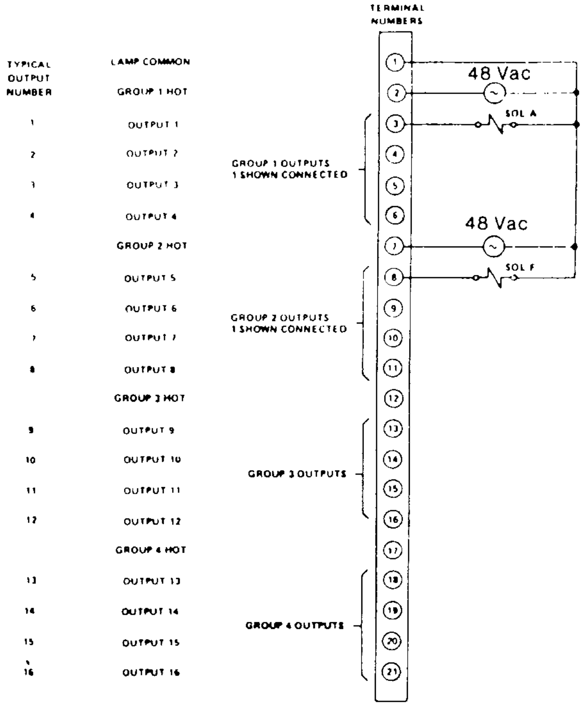
Following are the electrical characteristics of the B270 Output Module.

Load Current	
OFF Current:	5 mA maximum 48 Vac, at 60 Hz
ON Current:	2 amperes maximum per output; 5 amperes maximum per group of four outputs
ON Holding Current:	0.5 mA maximum
Inrush Load Current:	5 amperes maximum for 100 ms 15 amperes maximum for 10 ms
Fuse Rating:	5 amperes (one fuse per output)
Load Voltage	
Working Voltage:	48 ±12 Vac 48 to 62 Hz
Transient:	200V maximum; thyrector limited
ON Voltage Drop:	2 Vac at 2 amperes current
Common Mode	
Voltage:	200 Vac maximum working 1500 Vac maximum for 10 ms
Response Time:	OFF to ON - 0.3 - 10 ms ON to OFF - 0.3 - 8 ms

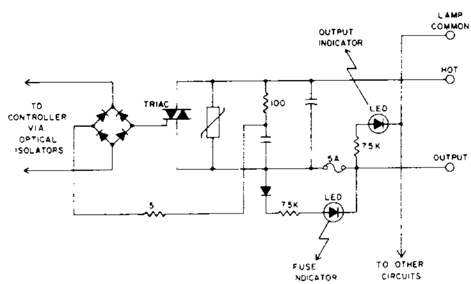
Output Status

Indicator:
A LED (light emitting diode) is provided for each output. The light will be ON when the output is ON.

Fuse Indicator:	A LED is provided for each output. The light will be ON when the fuse is blown.



B270 48 Vac Output Module Terminal Numbering and Output Connection



B270 48 Vac Output Module Simplified Schematic

DIRECT CURRENT MODULES

24V MODULES

INPUT-MODEL B233

The Modicon B233 Input Module conditions 16 independent 24 Vdc signals to the signals used internally in the Controller.

ELECTRICAL CHARACTERISTICS

Input Signal Requirements—for each of the 16 inputs:

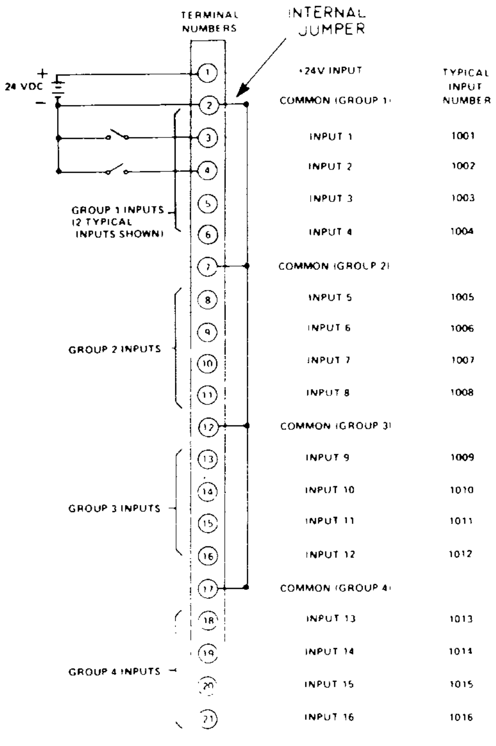
ON	
Condition:	Input "Low" or short circuit to common Input Indicator ON Control Input Line ON
Level:	Less than +1 Vdc referenced to common or less than 200 ohms to common Maximum current: −15 mA
OFF	
Condition:	Input "High" or open circuit Input Indicator OFF Controller Input OFF
Level:	+24 ±6V or open circuit (greater than 10,000 ohms)
Switching Level	Approximately 7 volts
Common Mode Voltage	200 Vac 1500V for 10 ms
+24 Bias Supply	Voltage: 15-30 Vdc Current: 200 mA maximum
Maximum Input Voltage	Not to exceed 500V for 3 ms
Output Response Time	High to Low: 13 ms maximum Low to High: 4 ms maximum
Input Status Indicator	A LED (light-emitting diode) is provided for each input. The light will be ON when that input is ON.

Compatibility with Output Module

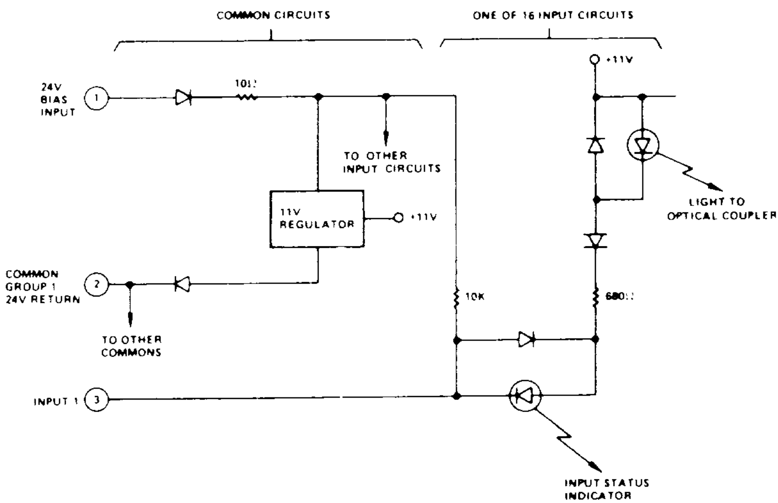
The B233, 24 Vdc Input Module is capable of interconnection with the B232 or B238 24 Vdc Output Module without the use of additional components.

Protection

Polarity reversal of bias supply or operation with parallel unclamped inductive loads shall not cause circuit failure.



B233 24 Vdc Input Module Terminal Numbering and Input Connections



B233 24 Vdc Input Module Simplified Schematic

OUTPUT-MODEL B232 (24 Vdc, 1/4 Amp)

The Modicon B232 Output Module converts the signals used internally in the Controller to 16 independent 24 Vdc outputs capable of driving relays, pilot lamps, or other loads up to 250 mA. The module uses 16 transistor switches to control loads connected to the user-supplied 24 Vdc source.

Self-contained clamp diodes suppress transient voltages when inductive loads are driven. The B232 module is also fused to protect its circuitry against overload currents and accidental polarity reversal.

ELECTRICAL CHARACTERISTICS

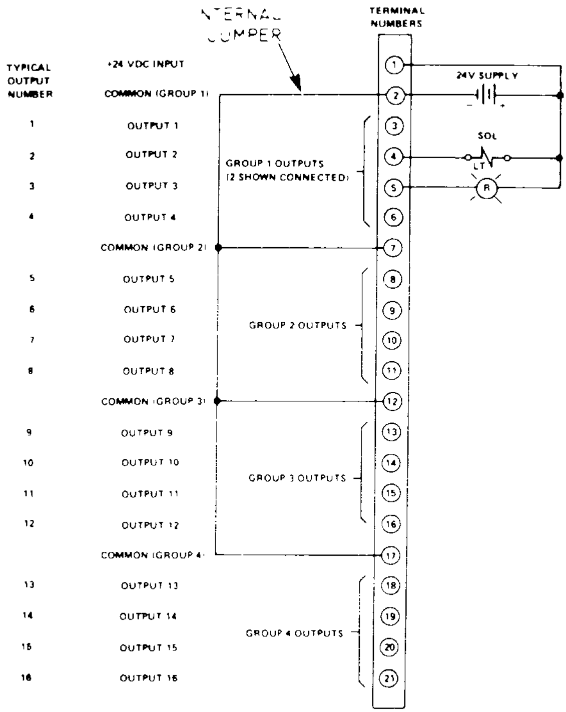
Load Current	
OFF Current:	0.5 mA maximum at maximum voltage
Steady State ON Current:	250 mA maximum per output
Inrush Current:	1.0 ampere maximum per output for 10 ms
Fuse Rating:	7A (one fuse per module)
Load Voltage	
Working Voltage:	15-30 Vdc
Peak Voltage:	40 Vdc
ON Voltage:	0.5 Vdc at 250 mA
24 VDC Supply (supplied by user):	Voltage: 15-30 Vdc Current: 0.5 amp maximum
Common Mode Voltage	200 Vac steady state maximum (at 60 Hz) 1500Vdc for 10 ms
Response Time	OFF to ON - 14 ms maximum ON to OFF - 13 ms maximum
Output Status Indicator	A LED (light-emitting diode) is provided for each output. The light is ON when the output is ON.

Compatibility with Input Module

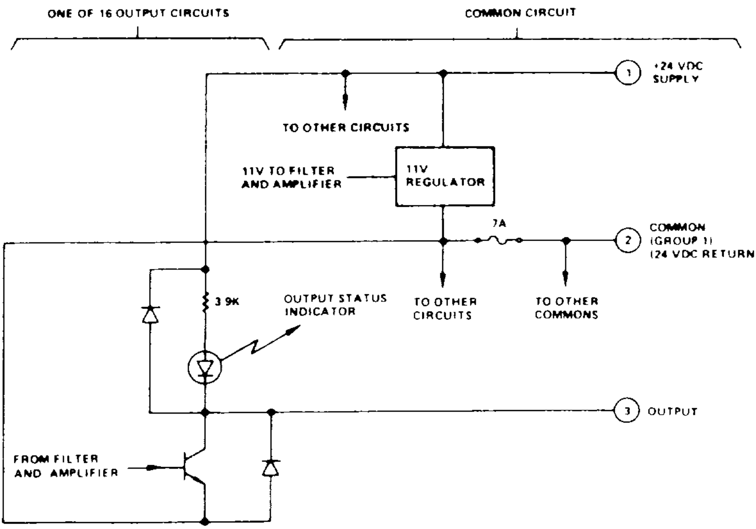
The B233, 24 Vdc Input Module is capable of interconnection with the B232 24 Vdc Output Module without the use of additional components.

Protection

Polarity reversal of 24 Vdc supply or input voltage will not cause circuit failure (the protective fuse may be blown, however). Operation with parallel unclamped inductive loads will not cause circuit failure.



B232 24 Vdc Output Module Terminal Numbering and Output Connections



B232 24 Vdc Output Module Simplified Schematic

OUTPUT-MODEL 238 (24 Vdc, 2-1/2 Amp)

The MODICON B238 Output Module is a high-current version of the B232 module; each of 16 independent 24 Vdc outputs is capable of driving relays, pilot lamps, or other loads up to 2.5A. The module uses 16 transistor switches to control loads connected to the user-supplied 24 Vdc source.

Self-contained clamp diodes suppress transient voltages when inductive loads are driven. Each circuit on the B238 module is fused to protect its circuitry against overload currents and accidental polarity reversals.

ELECTRICAL CHARACTERISTICS

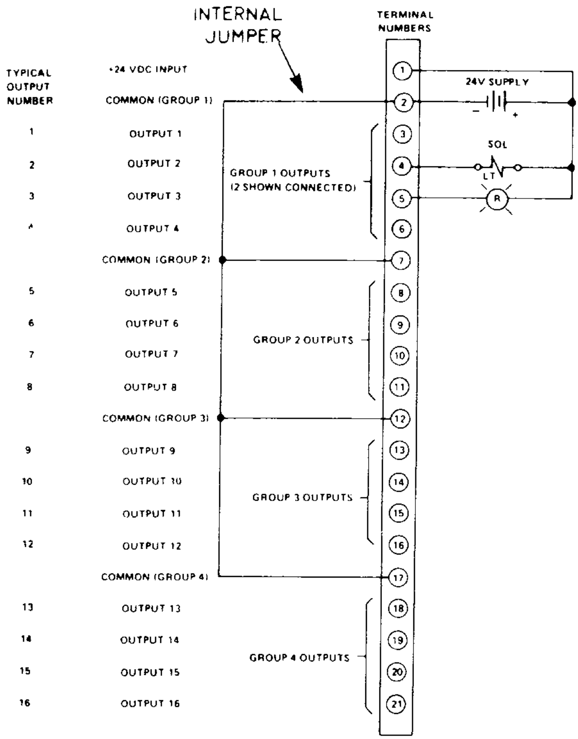
Load Current	
OFF Current:	20 mA maximum at maximum voltage
Steady State ON Current:	2.5A maximum per output
Inrush Current:	10.0 ampere maximum per output for 10 ms
Fuse Rating:	3A (one fuse per circuit) plus one for bias supply
Load Voltage	
Working Voltage:	15-30 Vdc
Peak Voltage:	35 Vdc
ON Voltage:	0.7 Vdc at 2.5A
24 VDC Supply (supplied by user):	Voltage: 15-30 Vdc Current: 1.5 amp max
Common Mode Voltage	200 Vac steady state maximum (at 60 Hz) 1500 Vdc for 10 ms
Response Time	OFF to ON - 14 ms maximum ON to OFF - 13 ms maximum
Output Status Indicator	A LED (light-emitting diode) is provided for each output. The light is ON when the output is ON.

Compatibility with Input Module

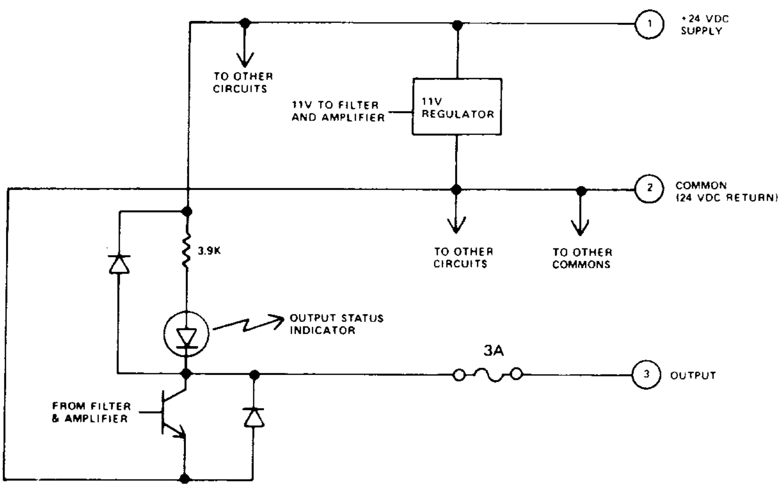
The B238, 24 Vdc High-Current Output Module is capable of interconnection with the B233, 24 Vdc Input Module without the use of additional components.

Protection

Polarity reversal of 24 Vdc supply or input voltage will not cause circuit failure (the protective fuse may be blown, however). Operation with parallel unclamped inductive loads will not cause circuit failure.



B238 24 Vdc Output Module Terminal Numbering and Output Connections



B238 24 Vdc Output Module Simplified Schematic

5V MODULES

INPUT-MODEL B237

The Modicon B237 Input Modules conditions up to 16 independent +5 Vdc input signals to the signals used internally by the Controller.

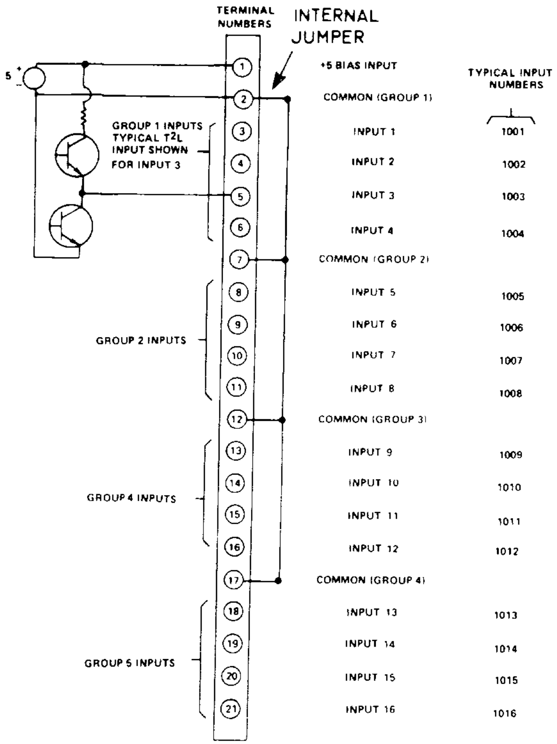
ELECTRICAL CHARACTERISTICS

Input Signal Requirements—for each of the 16 inputs:

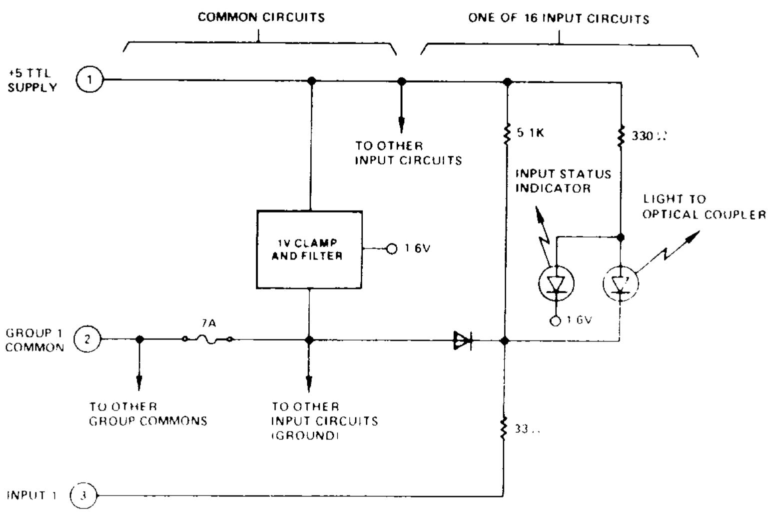
Logic One State	
Conditions:	Input "High" or open circuit Input Indicator ON Controller Input Line ON
Level:	VIH = 2.0V minimum II = 0.1 mA maximum at VIH = 5.5V; Vcc = 5.0V Maximum Input Voltage: +8.0 Volts Maximum Positive Clamp Current: 50 mA
Logic Zero State	
Conditions:	Input "Low" Input Indicator OFF Controller Input OFF
Level:	VIL = 0.8V maximum IIL = 14.0 mA maximum at Vcc = 5.25V (9 TTL load equivalent) VIL +0V Maximum Negative Voltage: −2 Volts Maximum Negative Clamp: 50 mA
Common Mode Voltage	200 Vac steady state maximum (at 60 Hz) 1500V for 10 ms
+5V Supply (supplied by user)	Voltage: 5.0 ± 0.25 Vdc Current: 0.3 amp maximum
Response Time	OFF to ON - 4 ms maximum ON to OFF - 13 ms maximum
Input Status Indicator	A light (light-emitting diode) is provided for each input. The light is ON when the input is in the Logic One state.

Compatibility with Output Module

The B237, 5 Vdc TTL Input Module is capable of interconnection with the B236, 5 Vdc TTL Output Module without the use of additional components.



B237 5 Vdc TTL Input Module Terminal Numbering and Input Connection



B237 5 Vdc TTL Input Module Simplified Schematic

OUTPUT MODULE B236 (5 Vdc)

The MODICON B236 Output Module conditions the signals used internally in the Controller to 16 independent outputs capable of driving up to 50 mA of TTL or DTL loads. The module uses 16 transistor drivers to control logic loads associated with an externally applied 5 Vdc source. The B236 Output Module is fused to protect its circuitry against overload currents and accidental polarity reversal.

ELECTRICAL CHARACTERISTICS

Logic One State	Line Output ON Output transistor OFF Output indicatorON Output Voltage: 4.V minimum at 0.5 mA current, and +5V supply at 4.75 Vdc
Logic Zero State	Line Output OFF Output transistor ON Output indicator OFF Output Voltage: +0.4V maximum at 50 mA Rated Current: 50 mA continuous, 100 mA peak (10 ms, 20% duty cycle)
+5V Suppy (supplied by user):	+5 Vdc ±0.25 Vdc 200 mA maximum current
Common Mode Voltage	200 Vac steady state maximum (at 60 Hz), 1500 Vdc for 10 ms
Response Time	a. OFF to ON - 4 ms maximum b. ON to OFF - 13 ms maximum
Output Status Indicator	A LED (light-emitting diode) is provided for each output. The light is on when the output is in the Logic One state.

NOTE

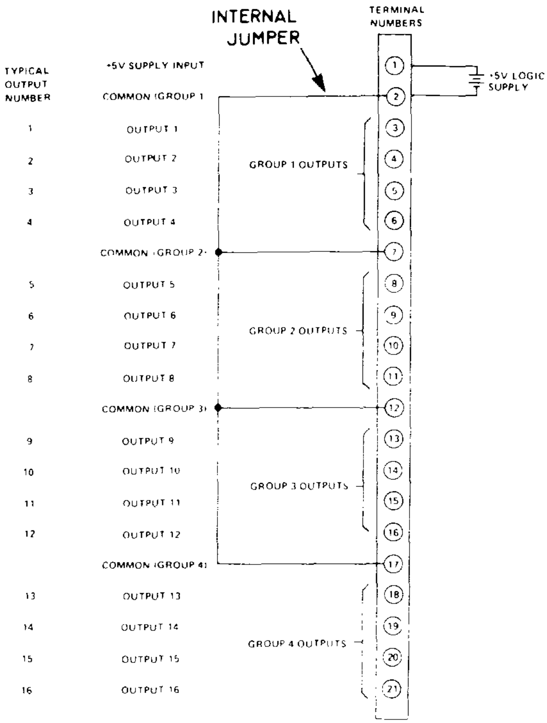
When controller or B236 Output Module is not operating all outputs will assume the ON state.

Compatibility with Input Module

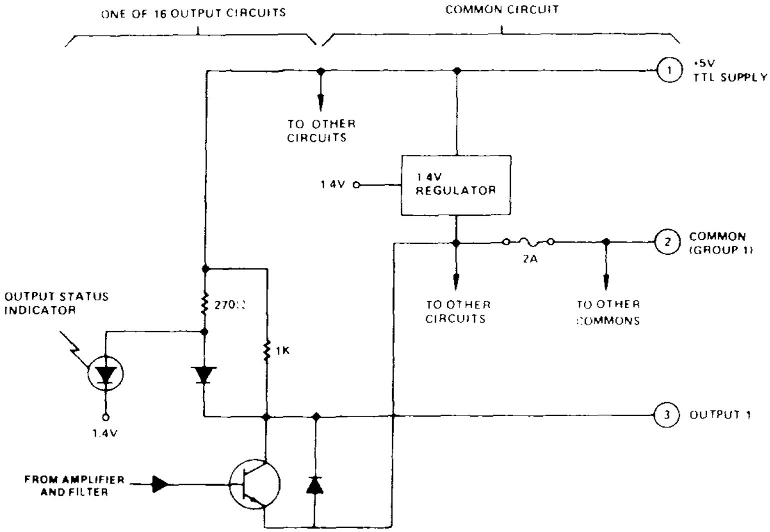
The B236, 5 Vdc TTL Output Module is capable of interconnection with the B237, 5 Vdc TTL Input Module without the use of additional components.

Protection

Polarity reversal of the +5 Vdc supply will not cause circuit failure. (The protective fuse may be blown, however.)



B236 5 Vdc TTL Output Module Terminal Numbering and Output Connections



B236 5 Vdc TTL Output Module Simplified Schematic

10-60V MODULES

INPUT — MODEL B275

The Modicon B275 Input Module conditions 16 independent signals each between 10 and 60 Vdc, to the signals used internally in the Controller.

ELECTRICAL CHARACTERISTICS

Input Signal Requirements - for each of the 16 inputs:

ON

Condition:	Input "Low" or short circuit to common Input Indicator ON Control Input Line ON
Level:	Less than 25% of voltage connected to terminal 1. Maximum current: -22 mA (+60 Vdc) -8 mA (+10 Vdc) (B275 supplies current)

OFF

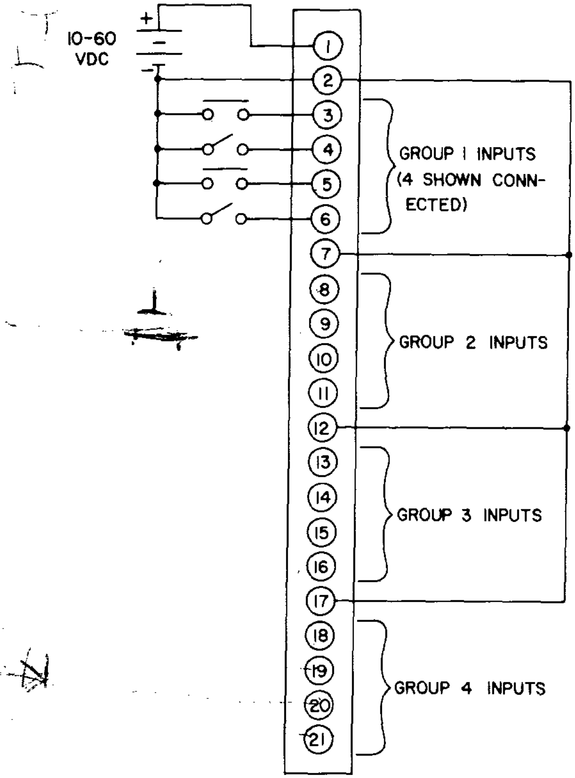
Condition:	Input "High" or open circuit Input Indicator OFF Controller Input OFF
Level:	75% of voltage connected to terminal 1 or open circuit (greater than 10,000 ohms)
Switching Level	40 - 60% of voltage connected to terminal 1
Common Mode Voltage	300 Vac maximum (at 60 Hz) 1500 Vdc for 100 ms
Bias Supply	400 mA at +60 Vdc, 150 mA at +10 Vdc
Maximum Input Voltage	Not to exceed 500 V for 3 ms
Output Response Time	High to Low: 12 ms maximum Low to High: 12 ms maximum
Input Status Indicator	A LED (light-emitting diode) is provided for each input. The light will be ON when that input is ON.

Compatibility with Output Module

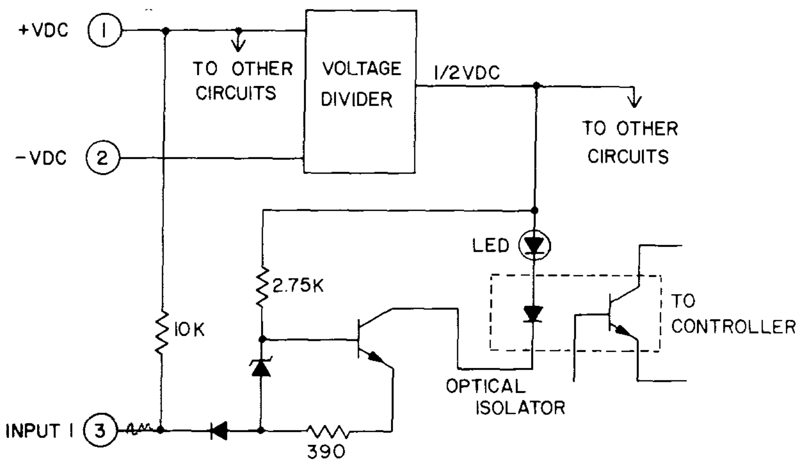
The B275, 10 - 60 Vdc Input Module is capable of interconnection with the B248 10 - 60 Vdc Output Module without the use of additional components.

Protection

Polarity reversal of bias supply or operation with parallel unclamped inductive loads shall not cause circuit failure.



B275 10-60 Vdc Input Module Terminal Numbering and Input Connections



B275 10-60 Vdc Input Module Simplified Schematic

OUTPUT - MODEL B248 (10 - 60 Vdc)

The Modicon B248 Output Module converts the signals used internally in the Controller to 16 independent 10 - 60 Vdc outputs capable of driving relays, pilot lamps, or other loads up to 2.5 amps. The module uses 16 transistor switches to control loads connected to the user supplied DC voltage source.

Self-contained clamp diodes are available on each circuit for use with inductive loads. Since multiple DC power sources can be used with this output module, connect the highest voltage source to terminal one(+) to utilize clamping diodes.

ELECTRICAL CHARACTERISTICS

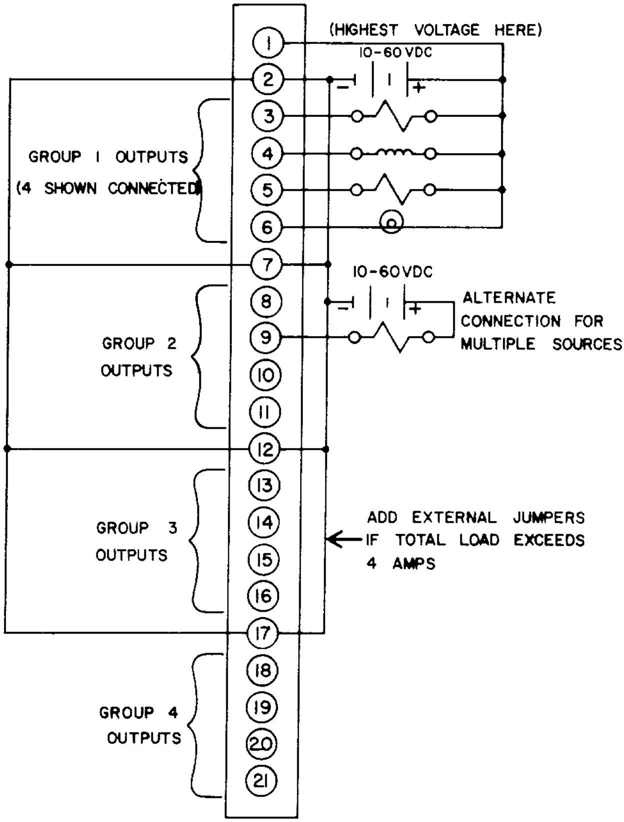
Load Current	
OFF Current:	5 mA maximum at maximum voltage
ON Current	
Steady State:	2.5 A maximum per output
Inrush Current:	10.0 A maximum per output for 10 ms
Fuse Rating:	3 A (one fuse per circuit)
Load Voltage	
Working Voltage:	10 - 60 Vdc
Peak Voltage:	80 Vdc
ON Voltage	1.5 Vdc at 2.5A
Common Mode Voltage	300 Vac steady state maximum (at 60 Hz) 1500 Vdc for 10 ms
Response Time	OFF to ON - 1 ms maximum ON to OFF - 1 ms maximum
Output Status Indicator	A LED (light-emitting diode) is provided for each output. The light is ON when the output is ON.

Compatibility with Input Module

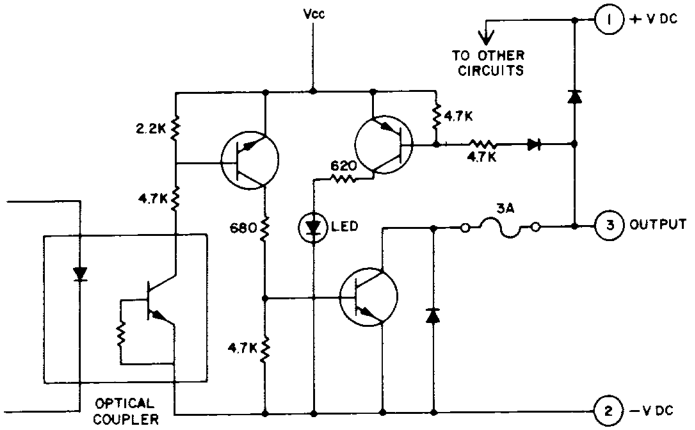
The B248 10 - 60 Vdc Output Module is capable of interconnection with the B275 10 - 60 Vdc Input Module without use of additional components.

Protection

Polarity reversal of supply voltage will not cause circuit failure; however, the protective fuse may be blown. Operation with parallel unclamped inductive loads will not cause circuit failure when properly connected to clamping diodes.



B248 10-60 Vdc Output Module Terminal Numbering and Output Connections



B248 10-60 Vdc Output Module Simplified Schematic

ANALOG MODULES

INPUTS - B243 MODEL

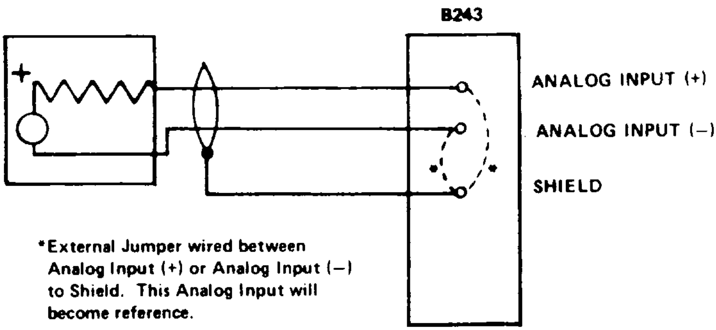
The B243 Analog Input Module accepts four DC voltages between 1V and 5V or 0V and 10V, and converts them to four register inputs. Any mix of 1-5V or 0-10V inputs are allowed on the B243 module, if specified at time of ordering. All input conversions are made once per controller sweep and the resulting numbers are presented in four consecutive input registers.

The B243-105 and B243-110 are revised and improved versions of the B243. The B243-105 accepts four 1-5V or 4-20 ma inputs and the B243-110 accepts four 0-10V or −10 to +10V inputs. Intermixing different voltage levels on one B243-105 or B243-110 is NOT possible.

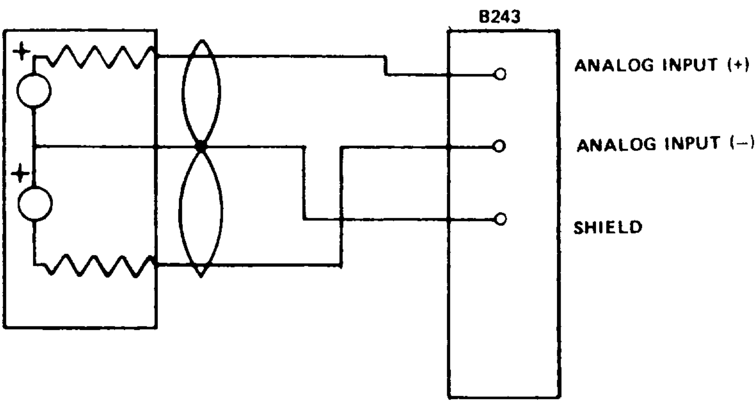
CONNECTION

User connections are made to standard barrier strips on the B240 Input/Output Housing. The B243 Analog Input Module is plugged into the B240 Input/Output Housing and secured by two screws. This configuration allows for quick replacement of the modules without disturbing the field wiring. The input module may be mounted in any slot of the B240 Input/Output Housing.

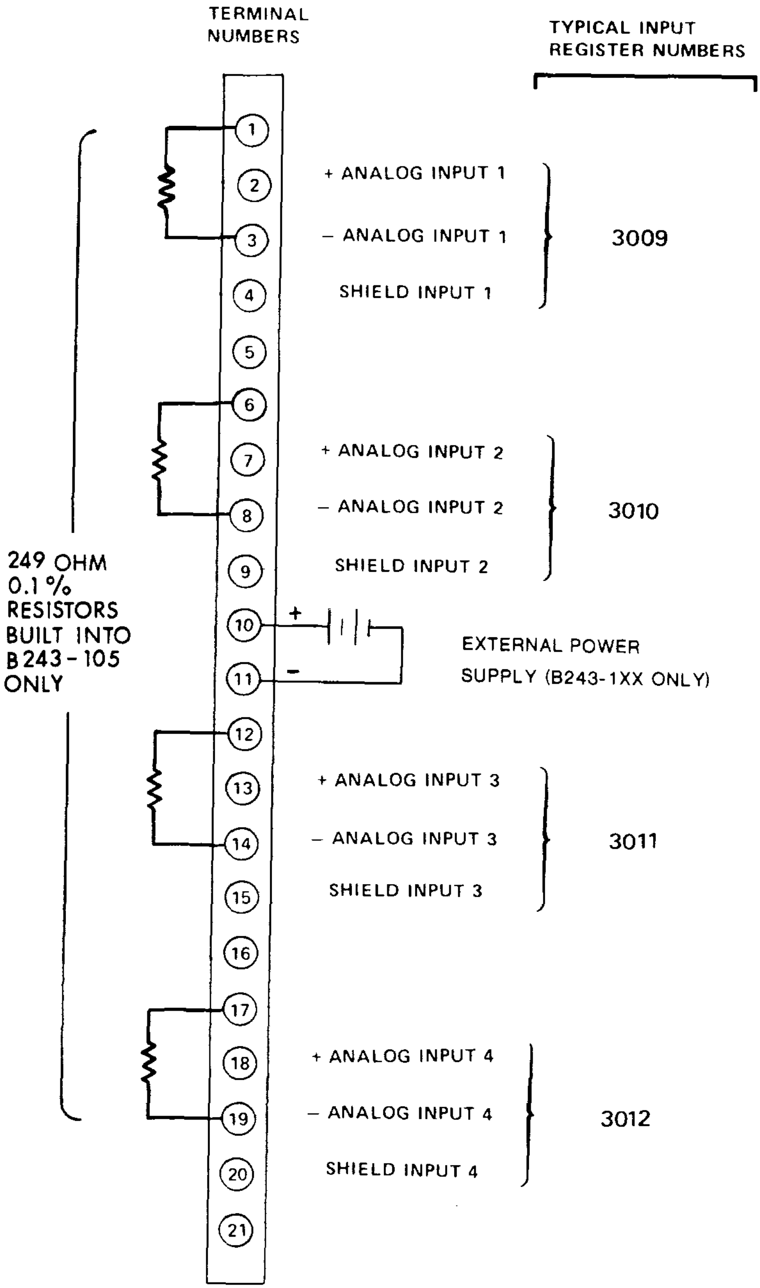
However, it must be referenced by the module address as number one or five and the next three input sequence numbers may not be used by other



Single-Ended Connection



Differential Connection



B243 Analog Input Module Terminal Numbering and Input Connections

input modules. Any I/O Module can be installed in the other three slots of the B240 Housing.

Terminals are numbered from one at the top of the barrier strip and assigned as shown. Note that terminals 4, 9, 15, and 20 are connected internally in the module.

ELECTRICAL CHARACTERISTICS

Input Range:	B243-000: 0-10V or 1-5V. B243-105: 1-5V or 4-20 ma. B243-110: 0-10V or −10 to +10V.
Output:	A number between 0 and 2^{12}-l linearly related to the input, deposited in four input registers numbered sequentially from the sequence number selected on the B240 Input/Output Housing.
Sample Timing:	All four inputs are updated on each controller scan.
Resolution (12 bit word):	Two bits in 4096 binary counts (B243). One bit for model B243-1xx.
Absolute Accuracy:	One-half percent.
Linearity Error:	Less than 0.1% of full scale referenced to a straight line through maximum and minimum points. (0.05% for 243-1xx)
Common Mode Rejection:	Greater than 1000 (60 dB)
Maximum Common Mode Signal:	±5V peak referenced to shield, ±12 Vdc on 0-10V range and ±6 Vdc on 1-5V range.
Maximum Input Signal: (for linear operation)	Voltage Input: ±15V (including common mode) no foldover inside of this range.
(Voltage):	±10 Vdc for B243-1xx
(Current):	±6 Vdc for B243-105
Input Impedance:	Voltage Input: more than 10^6 ohms.
Temperature Coefficient:	Gain: less than 0.1%/ °C. (0.007%/°C for B243-1xx) Offset: less than 0.1%/°C. (0.007%/°C for B243-1xx)
Crosstalk:	One input shall not couple more than 0.01% of its signal into any other input
Frequency Response:	60 Hz notch filter, 135 dB at 60 Hz
Noise:	Less than 0.3% of full scale (rms). (All unused inputs should be externally shorted to the Shield/Module Circuit Ground.)
Power Requirements:	B243: None B243-1xx: 28 Vdc ±4 Vdc 250 ma.
Isolation:	a. Input to Input — None b. Input to Controller — 230 Vac continuous and 1500 Vdc for 10 ms maximum.

FUNCTIONAL OPERATION

Each of the four analog inputs is connected to a multiplex switch which will automatically address each input during the controller scan. As each input is addressed, the analog-to-digital converter places a 12-bit binary number proportional to the input signal in the transmitter buffer. When the input register is addressed by the controller input/output processor, the latest sample is placed in the controller.

APPLICATION NOTES

Since the B243 Analog Input module provides the binary equivalent of analog input voltages, for proper operation the input registers (four per module) must be coded as binary in the I/O Allocation Table. When directly monitoring the input register with the Programming Panel, convert the display to its binary equivalent to obtain the correct magnitude (see Table 13).

The shield terminal on each operating input circuit must be connected to either the positive (+) or negative (−) input terminal to prevent a charge from accumulating on the input filter circuits. Any unused analog circuits should have their input terminal (including shield) jumpered together and connect to ground.

To monitor a 4-20 mA signal, a 250-ohm resistor should be placed on the I/O housing between the positive (+) and negative(−) input terminals. This resistor will convert the 4-20 mA signal into a 1 to 5V signal for monitoring by the analog module. A 100-ohm resistor will provide similar conversion for a 10-50 mA signal.

Each circuit on the module can be set for either 0-10V or 1-5V operation, by adjusting internal jumpers (not field changeable). Depending on the range selected, the magnitude of the number in the input register (0-4095) will reflect different voltages as follows:

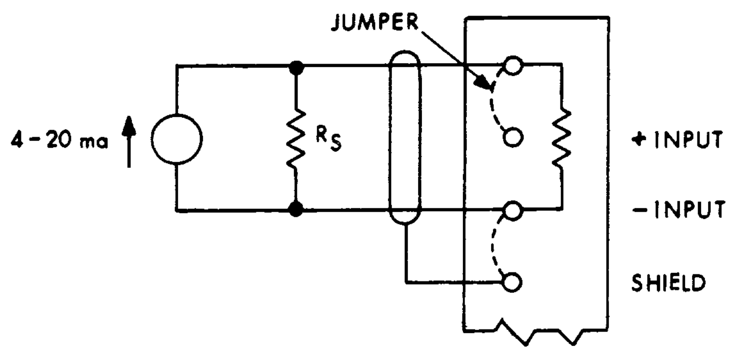
	Input Range			
Value	0-10V	1-5V	4-20 mA	10-50 mA
0 (Minimum Input)	0V	1V	4 mA	10 mA
2047 (Mid-Range)	5V	3V	12 mA	30 mA
4095 (Maximum Input)	10V	5V	20 mA	50 mA

NOTE

The analog input module always outputs values 0 to 4095; for values between these limits, use linear interpolation.

4-20 ma CONNECTIONS TO B-243-105

For user convenience, model B243-105 analog input module incorporates four 249 ohm precision (±0.1%) resistors to convert 4-20 ma into a 1-5V signal. To utilize these resistors, make connections shown below for each circuit, including external jumpers:



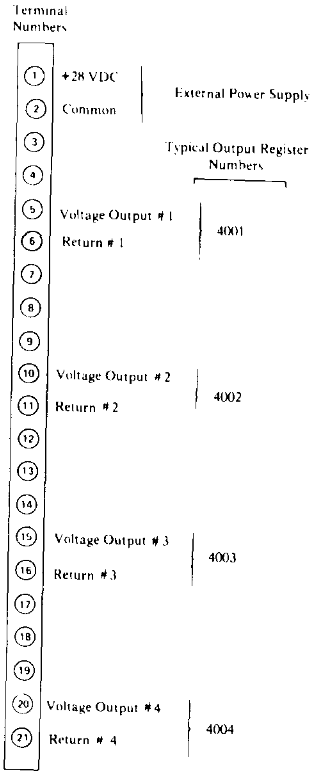
ANALOG OUTPUTS - GENERAL

The analog output modules convert values in four output registers into analog output signals. Separate modules are provided for voltage signals (0 to 10V or 0 to 5 Volts) and current signals (4 to 20 ma); each module provides four separate voltage or current circuits. All output conversions are made once per controller sweep and the resulting signals are available on four output terminals.

CONNECTION

User connections are made to standard barrier strips on the B240 Input/Output Housing. The analog output module is plugged into the B240 Input/Output Housing and secured by two screws. This configuration allows for quick replacement of the modules without disturbing the field wiring. The output module may be mounted in any slot of the B240 Input/Output Housing.

However, it must be referenced by the module address as number one or five and the next three output sequence numbers may not be used by other output modules. Any I/O module can be installed in the other three slots of the B240 Housing.



B260 Analog Voltage Output Module Terminal Connections and Output Numbering

* Current returns are referenced to +28 Vdc (Terminal 1).

CURRENT OUTPUT - B262 MODEL

The B262 Analog Output Module provides four separate 4-20 ma circuits per module. Also provided with each current circuit is a 1 to 5 Vdc signal that can be used to monitor the operation of the analog output. The input resistance of the voltmeter must be greater than 500K ohms for proper operation of this monitoring circuit.

Maximum Load Impedance:	1000 ohms with 28 Vdc available from external power supply. 800 ohms with 24 Vdc available from external power supply.

For any unused outputs, connect 250 ohm, ½ watt, ±5% resistor between current output terminal and +28 Vdc (terminal 1). This resistor also provides 1-5 Vdc signal.

ANALOG MULTIPLEXERS

These modules are designed to operate with the B243 Analog Input module to time share or multiplex one circuit on this input module. Up to sixteen separate independent analog signals can be connected to one analog multiplexer (MUX). Based upon the user's logic program, one of these 16 signals will be connected to the B243 input circuit at a time. Since there are four circuits on each B243 input module, up to four MUX's can be connected to one input module, allowing up to four analog signals out of 64 to be sampled each scan.

The B256 or B258 MUX can be placed anywhere in the controller's I/O structure and index to any slot position. However, it must be provided with the BCD content of an output register (40XX). The value in this register (0000 - 0015) will control which input signal is connected to the B243 input module.

NOTE

Signals are numbered starting at zero not one.

If more than one MUX is used and independent control of each is NOT required, they all can be controlled by the same output register (i.e. same index pin position). The only difference between the MUX models is the type of relay used in the switching circuit. The B256 used standard dry contacts and the B258 uses mercury wetted contacts for improved reliability.

ELECTRICAL CHARACTERISTICS

Number of Isolated Inputs:	16
Maximum Input Voltage:	10 Vdc for linear operation 100 Vdc on switch 200 Vdc between any two inputs
Maximum Input Current:	10 ma
Input Impedance:	1 Megohm
Maximum Transfer Time:	10 m Sec
Maximum Souruce Impedance:	1,000 ohms
Offset Voltage:	10 mv maximum at 25° 0.5 mv per °C drift
Transfer Accuracy:	0.05% at 25°C 0.01% per °C drift (B256) 0.005% per °C drift (B258)
Transfer Type:	Break before Make
Output Impedance:	100 ohms
Maximum Output Current:	5 ma
Input Isolation to Controller:	300 Vac 1500 Vdc for 100 m Sec
Input Isolation to Output:	300 Vac
External Power Required:	15 - 30 Vdc, 500 ma

Life Rating On Reed Relay:

B256 (Dry) 50,000,000 operations
B258 (Wet) 50,000,000,000 operations

USER CONNECTIONS

All analog input signals are connected via a 37 pin Delta connector (Modicon part number 52-2119, Cannon number DC37S or equal) supplied with the MUX module. The following table relates the input signal controlled by the value in the holding register versus the pin numbers for wiring.

Input	Pins + −	Input	Pins + −	Input	Pins + −
0000	14,32	0005	28,10	0011	17,16
0001	21,23	0006	29,30	0012	34,15
0002	24,6	0007	31,33	0013	2,20
0003	25,26	0008	22,3	0014	1,4
0004	8,27	0009	7,5	0015	13,12
		0010	18,36		

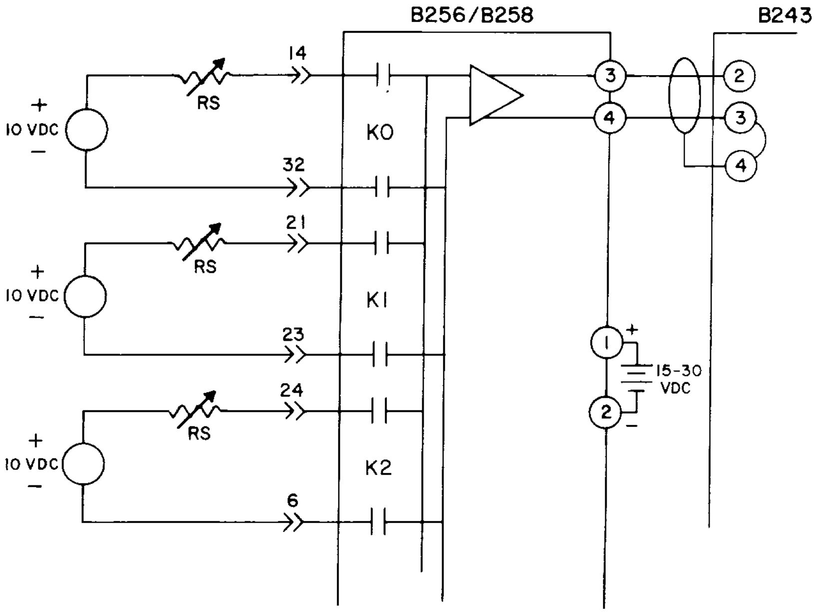
When activitated, the input signal on the first pin listed above will be connected to I/O terminal 3 (positive) and the second pin will be connected to terminal 4 (negative).

PROTECTION

If the MUX is unable to communicate with the controller or if the BCD value received is greater than 15, all relays will be deenergized disconnecting all inputs from the output terminals. The 15 - 30 Vdc power input is protected against polarity reversal or over voltage, such that it can not damage the module; however, a one ampere fuse may blow. Loss of DC power will render the module non-operational with all inputs disconnected.

INDICATORS

In addition to the active light LED, which indicates valid communications with the controller, the B256/B258 module incorporates an over range indicator. This LED will be energized whenever the BCD value received exceeds 0015. There is also a two-digit numerical display that indicates which input (00 - 15) is currently connected to the output terminals. This display will be blank for all values about 15.



Typical B256/B258 Connections

ISOLATED AC MODULES

Since isolated AC modules require approximately twice as many I/O terminals than standard modules, only eight circuits are provided on each module. Using the eight index pin positions in each channel, this would normally reduce the I/O capacity to 64 points per channel in lieu of 128.

To provide the full channel capacity with isolated modules, each module is equipped with a 'first half' or 'last half' switch. Thus, two modules can be installed with the same index pin position, one module set for 'first half' and the other for 'last half', and all 16 usable references are provided. However, this does require more than the normal number of I/O modules and possibly more than four I/O housings per channel.

The only limitation on the number of isolated modules to be installed in any channel, is the I/O load applied to the power supply. The load cannot exceed 27 units per channel unless remote I/O is utilized to subdivide the channel, or special cables used.

INPUTS-B247 MODEL (115 Vac),
B245 MODEL (230 Vac)

Each input draws sufficient 'wetting' current to inhibit the buildup of contaminants on the surface of silver contacts used in pushbuttons, limit switches, pressure switches, etc.

Following are the input signal requirements for each of the 8 inputs:

ON

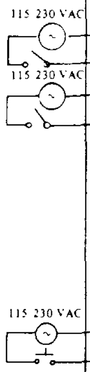
Condition:	Input at high level Input indicator ON Controller input ON
Level:	115 ± 15 Vac, or 230 ± 30 Vac Source in series with 0 to 1000 ohms 48 to 62 Hz

OFF

Condition:	Input at low level Input indicator OFF Controller input OFF
Level: (115 Vac)	0 to 30 Vac, or 0 to 130 Vac Source in series with greater than 25,000 ohms; 48 to 62 Hz
(230 Vac)	0 to 60 Vac, or 0 to 260 Vac Source in series with greater than 50,000 ohms; 48 to 62 Hz

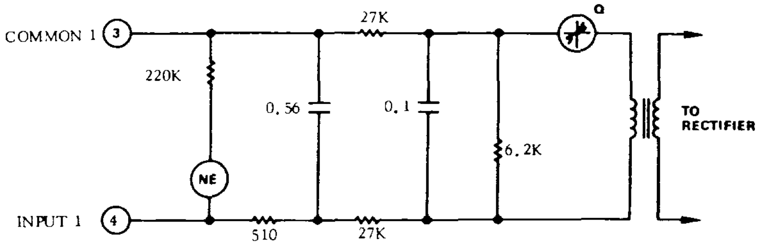
115 Vac (B247 Module)

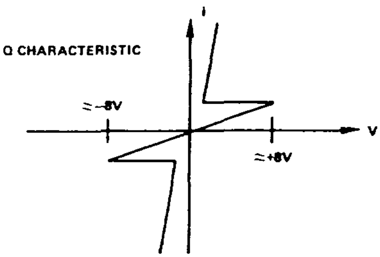
Switch Level:	Approximately 65 Vac
Input Impedance:	510 ohms in series, with 0.56 mF (approximately 4,700 ohms, -90° at 60 Hz)
Input Current:	25mA at 115V (contact wetting current at 60 Hz)
Common Mode Voltage:	400 Vac steady state (60 Hz) 1500V for 10 ms
Maximum Input Voltage:	Not to exceed 800 volts peak on any input
Output Response Time:	a. OFF to ON - 10 ms maximum b. ON to OFF - 15 ms maximum



Terminal Number		TYPICAL INPUT NUMBER First 8 Selected	Last 8 Selected
1	NOT CONNECTED		
2	NOT CONNECTED		
3	COMMON 1		
4	INPUT 1	1001	1009
5	COMMON 2		
6	INPUT 2	1002	1010
7	NOT CONNECTED		
8	COMMON 3		
9	INPUT 3	1003	1011
10	COMMON 4		
11	INPUT 4	1004	1012
12	NOT CONNECTED		
13	COMMON 5		
14	INPUT 5	1005	1013
15	COMMON 6		
16	INPUT 6	1006	1014
17	NOT CONNECTED		
18	COMMON 7		
19	INPUT 7	1007	1015
20	COMMON 8		
21	INPUT 8	1008	1016

B247 115 Vac and B245 230 Vac Isolated Input Module Terminal Numbering and Input Connections

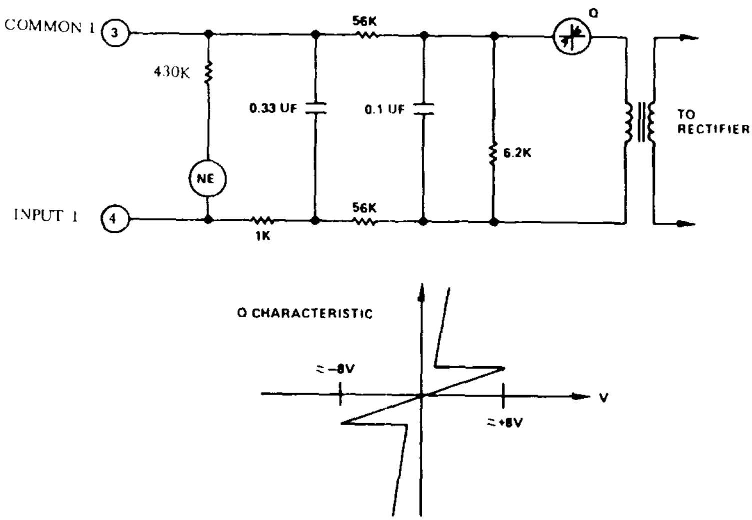




B247 115 Vac Isolated Input Module Simplified Schematic

230 Vac (B245 Module)

Switch Level:	Approximately 130 Vac
Input Impedance:	1K ohms in series, with 0.33 mF (approximately 8,000 ohms, -90° at 60 Hz)
Input Current:	28mA at 230V (contact wetting current at 60 Hz)
Common Mode Voltage:	400 Vac steady state (60 Hz) 1500V for 10 ms
Maximum Input Voltage:	Not to exceed 800 volts peak on any input for 1.0 ms
Output Response Time:	a. OFF to ON - 10 ms maximum b. ON to OFF - 15 ms maximum



B245 230 Vac Isolated Input Module Simplified Schematic

Each input circuit is provided with its own common terminal, thus isolating each input from any other connected to the module. A two-position rotary switch is provided on each module to select either the first eight or last eight input references from the 16 assigned to the module by the address index pin. Two active lights are provided on the front of the module to indicate which of the two groups of inputs are being provided to the processor.

OUTPUTS -B246 MODEL (115 Vac), B244 MODEL (230 Vac)

The MODICON B246 (115 Vac) and B244 (230 Vac) Output Modules condition the signals used internally in the Controller to eight isolated outputs capable of driving solenoids, motor starters, and other loads up to four amperes. Each module uses eight triac devices to switch the loads to the user-supplied Vac line; maximum continuous loads controlled by any one isolated output module is 20 amperes.

Self-contained damping networks and voltage-limiting varistors suppress line voltage spikes and prevent false triggering. The module is also fused to protect its circuitry from overload currents and voltages.

Following are the electrical characteristics of the B246/B244 Isolated Output Modules:

Load Current	
OFF Current:	5 mA maximum
ON Current:	4 amperes maximum per output; 20 amperes maximum per module, continuous
ON Holding Current:	B244 and B246: 60 mA maximum B244-1 and B246-1: 0.5 mA maximum
Inrush Load Current:	5 amperes maximum for 100 ms 15 amperes maximum for 10 ms
Fuse Rating:	7 amperes (one fuse per output)
Load Voltage	
Working Voltage:	115 ± 35 Vac or 240 ± 50 Vac; 48 to 62 Hz
Transient:	200V or 400V maximum; varistor limited
ON Voltage Drop:	2 Vac at 2 amperes current
Common Mode Voltage	200 or 400 Vac maximum working; 1500 Vac maximum for 10 ms
Response Time	B244 and B246: OFF to ON - 0.3 - 2 ms ON to OFF - 0.3 - 8 ms B244-1 and B246-1: OFF to ON - 0.3 - 10 ms ON to OFF - 0.3 - 8 ms
Fuse Indicator	A neon lamp is provided for each output circuit. The lamp will be ON when the fuse is blown.
Output Status Indicator	A neon lamp is provided for each output operated from a common lamp supply. The lamp will be ON when the output is ON.

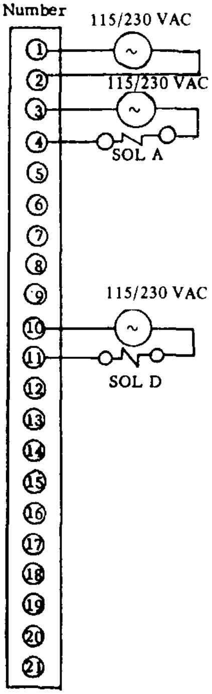
NOTE

On B244 and B246 only, the lamp will be ON when no output load is present.

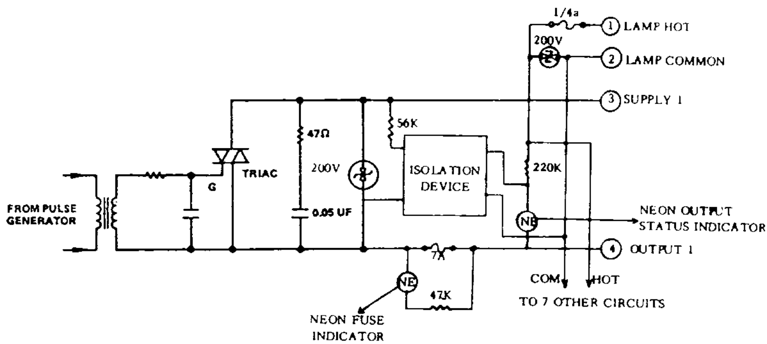
Indicator Lamp Supply	10 ma at 230 Vac, 60 Hz (B244) or 115 Vac, 60 Hz (B246). Fused at 1/4 amperes.

A two-position rotary switch is provided on each module to select either the first eight or last eight outputs from the 16 outputs provided to the module from the processor. Two active lights are provided on the front of the module to indicate which of the two groups of outputs are being driven by the output circuits.

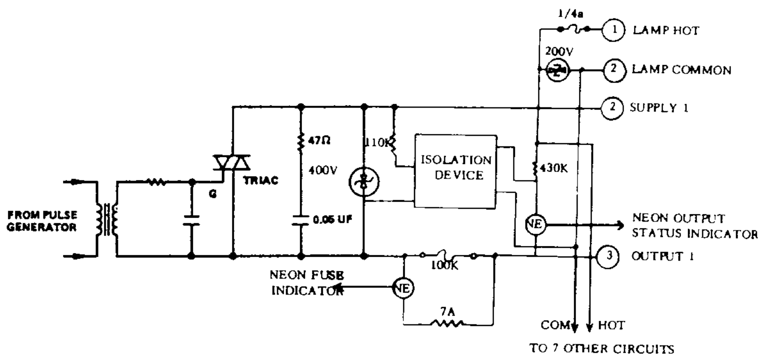
TYPICAL INPUT NUMBER First 8 Selected	Last 8 Selected	Function	Terminal Number
		Indicator Lamp Supply	1
		Indicator Lamp Common	2
		Supply 1	3
1	9	OUTPUT 1	4
		Supply 2	5
2	10	OUTPUT 2	6
		NOT Connected	7
		Supply 3	8
3	11	OUTPUT 3	9
		Supply 4	10
4	12	OUTPUT 4	11
		NOT Connected	12
		Supply 5	13
5	13	OUTPUT 5	14
		Supply 6	15
6	14	OUTPUT 6	16
		NOT Connected	17
		Supply 7	18
7	15	OUTPUT 7	19
		Supply 8	20
8	16	OUTPUT 8	21



B246 115 Vac and B244 230 Vac Isolated Output Module Terminal Numbering and Output Connections



B246 115 Vac Isolated Output Module
Simplified Schematic



B244 230 Vac Isolated Outut Module
Simplified Schematic

SPECIAL PURPOSE MODULES

B239—Dual High Speed Counter

This module provides the capability to count DC pulses up to 30,000 pulses per second. The counting is done on logic within the I/O module and does not depend upon the scanning of the controller. Start, stop, and reset signals are provided to the module and outputs are received from the module directly. The controller provides to the counter the preset value as an output register (40xx) and receives its current count as an input register (30xx). These registers must be BCD coded and are four digits long (maximum value 9999). There are two separate circuits on each module which utilize consecutive registers in the I/O structure. The module is placed in a single slot in an I/O housing, type B240 or B241, and must be indexed as module number 1, 3, 5, or 7.

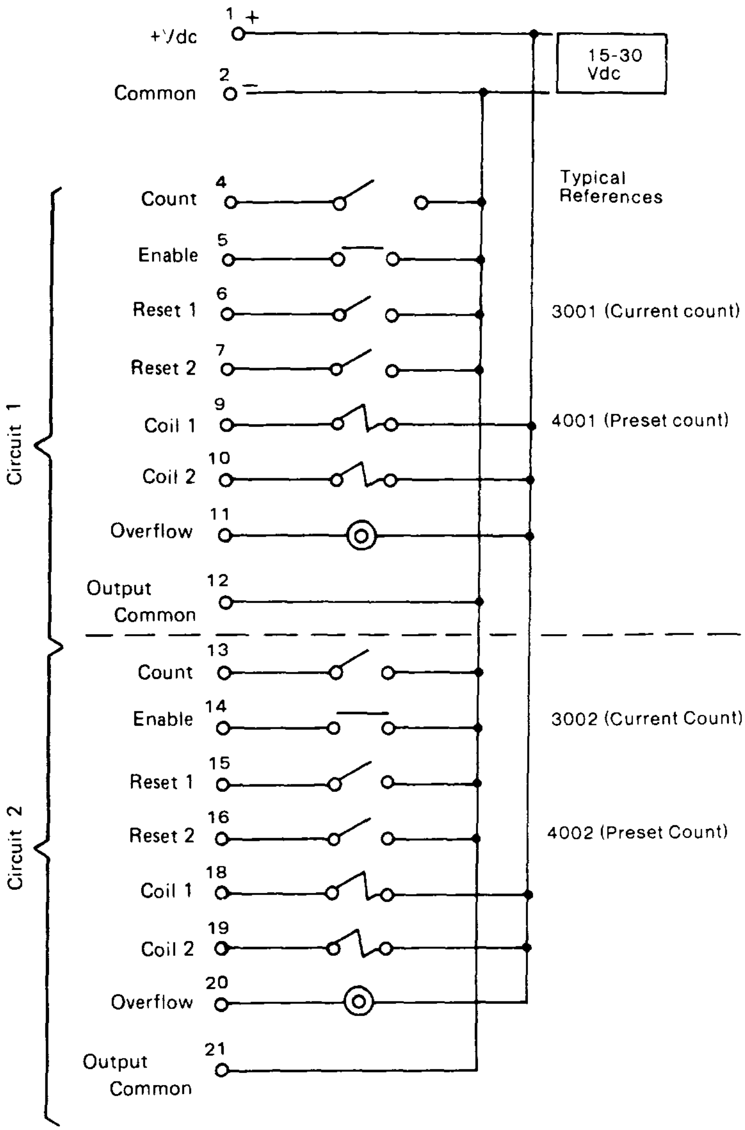
Indicators are provided to indicate the ON/OFF status of all inputs and outputs. The count input signal can be a pulse train up to either 200 pulses per second or 30,000 pulses per second. The slower speed is designed for dry contact closures such as reed switches where contact bounce must be rejected. This signal must be ON for at least 4 mSec and OFF for at least 1 mSec for the B239 to increment its count on the OFF to ON transition. The higher speed is for Solid state generated signals where only noise must be rejected. This signal must be ON for at least 25 μSec and OFF for at least 8 μSec. The selection of low or high speed is made separately for each circuit by a customer settable switch. Each count input signal can be between 5 and 30 VDC and must be capable of sinking between 3 and 6 ma of current.

The enable input allows the counter to count; without this signal, the counter will not count, but will hold its current value. The counter will respond to this input within 10 μSec of receipt at its terminals. The enable signal can be either a maintained level or a short pulse (at least 10 μSec wide). If it is a pulse, it will be held internally until the circuit is reset. The selection of type of enable signal is made separately for each circuit by a customer settable switch. Each input can be between 5 and 30 VDC and must be capable of sinking between 3 and 6 ma.

Basically, there are two outputs from each circuit, coil 1 and coil 2. Each will be between 5 and 30 VDC and be capable of sinking up to 500 ma. They will respond within 10 μSec of the count reaching its preset; their ON voltage is less than 0.4 VDC and OFF current is less than 1 ma. Coil 1 comes ON whenever the counter reaches or exceeds its preset count; the counter will continue to count after its preset is reached. If the preset is changed such that it is greater than the current count, coil 1 will be OFF; if the counter is reset to zero, coil 1 will go OFF. Coil 2 comes ON whenever the counter reaches its preset and remains ON until reset by reset 2, regardless of changes to the count or preset. Both of these coils are energized by the counter and do*not* depend upon the controller's scan.

Another output with the same characteristics (voltage, current and speed) as the coils, is the overflow bit. This output is energized whenever counter exceeds 9999. If the counter has a current count of 9999 exactly, this bit is not ON; it will come ON with the next pulse following 9999. The counter will count up to 9999 and reset itself to zero with the next pulse (10,000th) regardless of the preset, unless it is reset externally prior to reaching 9999. The overflow bit is reset by either reset signal.

Two resets are available to each circuit; both have the same characteristics (voltage, current, speed) as the enable/count signals. Reset 1 clears the count to zero, clears the overflow bit, and clears the enable if it is a pulse type enable. Reset 2 on the other hand, clears only coil 2 and the overflow bit. Unless the preset is zero, Reset 1 will also clear coil 1 since the current count is no longer equal to the preset.



B239 Typical I/O Connections

When installed, the B239 module requires an external power supply of 15-30 VDC (250 ma, 10% regulation, and PARD less than 250 mv). All inputs and outputs are isolated from the controller's internal circuits by optical isolators; these inputs and outputs are compatible with MODICON's 24 VDC and 5 VTTL modules and can be interfaced between each other. Outputs have protection diodes for switching inductive loads and polarity reversal.

All outputs on each circuit are protected by a single 1½ a fuse, such that, if one output is overloaded, all outputs on that circuit will be de-energized. If the controller stops communicating with the module, its active light goes out. As long as external power and inputs are maintained, the counter will continue to count using its last preset and drive outputs as discussed above (coils 1 & 2 as well as overflow). If the external power fails, the module will provide its last count to the controller and its outputs will go OFF.

SPECIFICATIONS

Maximum Count Speed 30,000 pulses per second (optionally 200 pulses per second)

Minimum Level	**ON** (0 VDC)	**OFF** (5-30 VDC)
30,000 pps	25 μSec	8 μSec
200 pps	4 mSec	1 mSec

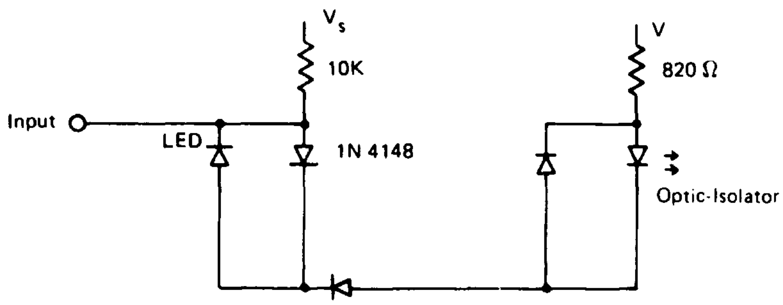
INPUTS

5-30 VDC, sinking 3-6 ma, > 10 μSec duration

Enable — Allows counter to start, either level or pulse input. Pulse input cleared by Reset 1.

Reset 1 — Clears counter to zero.
Clears Overflow bit.
Clears pulse enable circuit.

Reset 2 — Clears Overflow bit.
Clears Coil 2.



Typical Input Circuit

Count, Enable, and Reset Signals

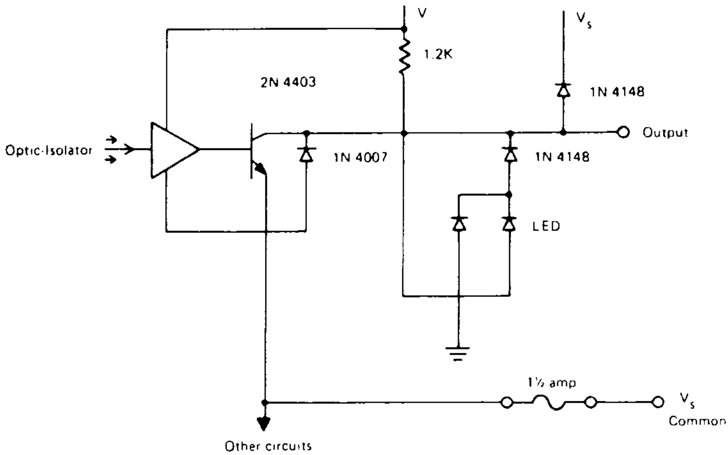
OUTPUTS

5-30 VDC, capable of sinking 500 ma (continuously), 10 μSec response time, ON voltage < 400 mv, OFF current < ma.

Coil 1 — ON if count is equal to or greater than preset (counter will continue to increment with coil 1 ON).

Coil 2 — ON once count equals preset and cleared *only* by Reset 2.

Overflow — ON if count exceeds 9999 and remains ON until cleared by either Reset 1 or 2. Counter reset to zero at 10,000 and can continue to count.



Typical Output Circuit

POWER REQUIREMENTS

External Power Supply

15-30 VDC, 250 ma maximum, 10% regulation, and PARD < 250 mv.

Two circuits per module, each protected by a 1½ amp fuse.

The external power supply is protected by a ½ amp fuse.

B266/B268/B274/B276 - Reed Relay Output Modules

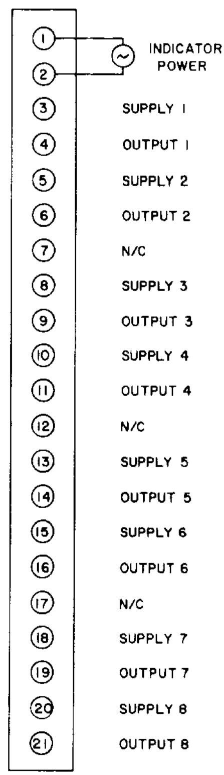
These modules provide eight isolated dry contact output circuits. Each B266/B268 circuit is a normally open contact, whose coil is controlled by eight consecutive discrete outputs. The B266 utilizes 115 Vac power for the Reed relay coils and the B268 utilizes 220 Vac power; otherwise the two modules are identical. The following are the specifications for these modules:

Switching Capability	
Voltage:	400 V maximum
Current:	2.0 A maximum
Power:	100 VA maximum
Current Carrying	
(after closure);	5.0 A maximum
Fuse (each circuit):	3A

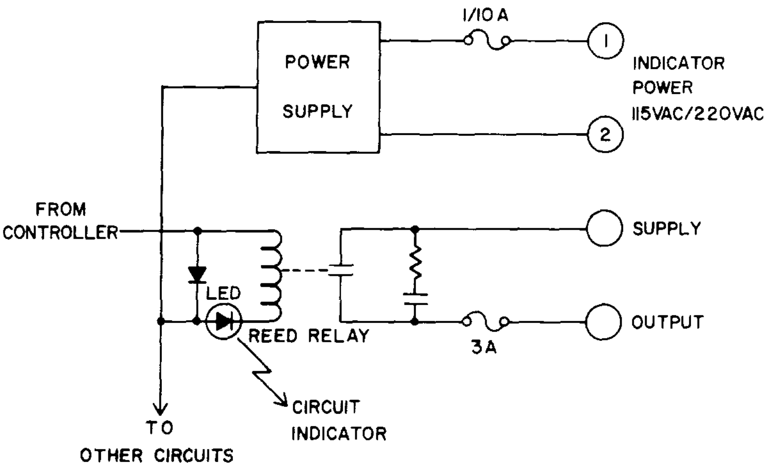
Operating Times:	2mSec (typical)
External Power	
B266:	115 Vac, 10 VA, 48-63 Hz
B268:	220 Vac, 10 VA, 48-63 Hz
Contact Material:	Mercury-wetted Reed relay contacts
Contact Life:	100 million operations at rated load
Circuit Resistance:	0.1 ohms (typical)
Open-Circuit Impedance:	25K capacitive reactive at 60 Hz
Circuit Isolation:	2000 Vdc

Each module has a selection switch that can be set in the field to establish which group of eight outputs control the Reed coils. Since each output slot number is provided with sixteen coils, the module can be set to respond to either the first eight or last eight coils. Two modules can be addressed to the same slot number and thus provide all sixteen outputs (one module set for first eight, the other for last eight). Two active lights are provided to indicate which group the module is responding to, when installed in the I/O housings.

For proper operation, the module must be placed in an upright position. This module is useful to provide unique voltage outputs, to multiplex analog values, or to interface to circuits requiring a dry contact. A pair of modules



B266 Terminal Numbering



B266 Typical Output Circuit

with normally closed reed relay contacts are also available. These modules have the same characteristics as discussed above; module B274 is 115 Vac type, equivalent to B266, and module B276 is 220 Vac version with normally closed contacts.

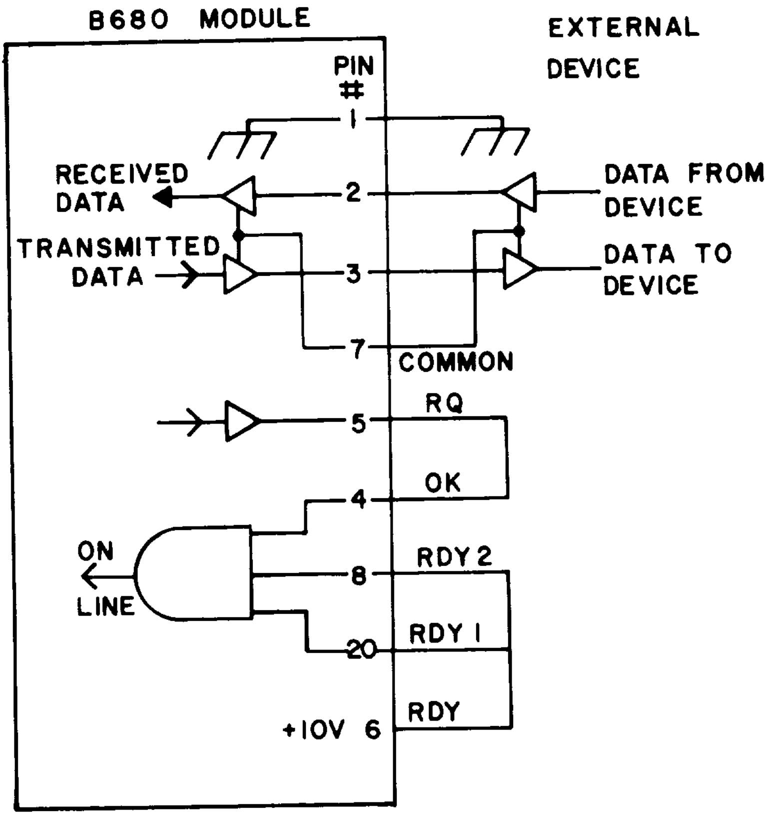
B680/B684 - ASYNCHRONOUS (ASCII) I/O

The ASCII I/O module provides an interface to any standard ASCII device, such as card readers, CRT's, badge readers, teletypes, etc. The module requires only one B240 or B241 I/O housing slot and can be addressed to any index pin; however, it must be placed in the I/O structure where registers are utilized. The ASCII module electrically represents both one input register and one output register, as selected by its index pin. Data can be transmitted asynchronously; that is, it can be sending data to the ASCII device as well as receiving data simultaneously.

The ASCII module requires an external AC power source, regardless of type of connections used (EIA or TTY). This voltage can be either 115V or 230V; the only difference between module types is that the B680 requires 115 Vac and the B684 230 Vac. The AC voltage is applied to terminals 1-3 of the I/O housing, and the selection voltage level is made by factory installed internal jumpers. All input and output signals are completely isolated from the controller's internal logic by optical couplers.

Both EIA voltage connections as well as TTY current signals are available from the ASCII module. The EIA connections are made from a 25 pin female connector on the front of the module, wired per RS-232C specification as follows:

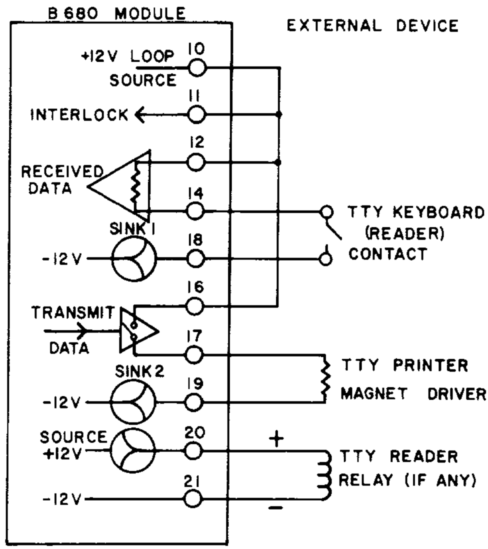
Pin	Circuit	Function (Relative to Module)
1	AA	Protective Ground
2	BA	Transmitted Data (to module)
3	BB	Received Data (from module)
7	AB	Signal Ground
4	CA	Request to Send (to module)
5	CB	Clear to Send (from module)
6	CC	Data Set Ready (from module)
20	CD	Data Terminal Ready (to module)
8	CF	Carrier Detect (to module)



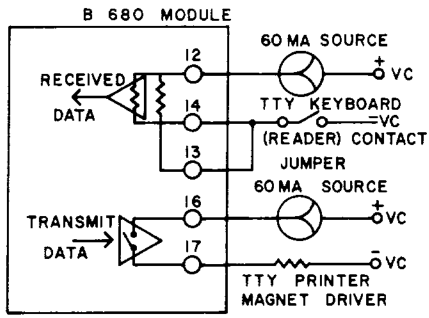
Typial EIA Connections

The teletype (TTY) connections are made to the standard field terminals available on the I/O housing. These signals are provided for standard ASR and KSR teletypes with either 20 or 60 ma loops. 20 ma is provided by the ASCII module; 60 ma current must be provided by external device. connections are made as follows:

Terminal	Function
1	AC power neutral
2	AC power hot
3	AC power ground (connected to chassis as well as pin 1 of EIA connector)
10	Current loop source (driven from +12VDC)
11	TTY Interlock
12	TTY Input
13	TTY 60 ma Input Return
14	TTY Input Return
16	TTY Output
17	TTY Output Return
18	20 ma Sink No. 1
19	20 ma Sink No. 2
20	Reader Relay (+)
21	Reader Relay (−)



Typical 20ma Loop Connections



Typical 60ma Loop Connections

LED indicators are provided on the front of the module to indicate the operation of this module. These indicators monitor the following five functions:

RUN	—	Illuminated whenever the module is serviced by the controller.
TRANSMIT	—	Flashes each time a character is transmitted by module.
RECEIVE	—	Flashes each time a character is received by module
ON LINE	—	Illuminated whenever the module is capable of operating
POWER	—	Illuminated whenever AC power is applied to module.

Each module has a number of options which the user can select. This selection is made by adjusting a rotary 16 position switch and eight ON/OFF switches located on the left side of the module. Normally, the module must be removed from the I/O Housing to adjust the options; however, access to these switches is provided from the outside of the module. The rotary switch sets the baud rate for the asynchronous communication as follows:

Position	Baud Rate	Position	Baud Rate
0	9600	8	600
1	7200	9	300
2	4800	10	150
3	3600	11	134.5
4	2400	12	110
5	1800	13	75
6	1200	14	50
7	900	15	None

The ON/OFF switches establish other options as follows (left to right, O = open, X = closed).

S1-S3 Eighth bit option

OOX = Even Parity
OOO = Odd parity
XOO = Mark
XXO = Space
XXX = Transparent

S4 Controls echo mode

ON causing incoming serial data to be placed on outgoing serial data signal
OFF for full duplex (transmitter and receiver are independent)

S5 Controls number of stop bits

ON for one stop bit
OFF for two stop bits

S6 Controls interlock

ON for bypass
OFF for normal

S7 and S8 are not used at present time.

APPENDIX C
NUMBER THEORY

Unit **Page**

GENERAL

For those unfamiliar with the representation of numerical values with solid-state electronic circuitry, the following descriptions are provided. Normally complete comprehension of these descriptions will not be required for most applications; only the more sophisticated logic (DX Matrix) and computer interfacing design will require understanding these various numbering systems.

BINARY

The binary numbering system, consisting only of ones and zeros, is the simplest way of designating the functioning of the electronic switches that comprise an electronic data system, since these switch or gate signals are either 'ON' or 'OFF'.

Input/Output	State	Binary Number
Signal A	On	1
Signal B	Off	0
Signal C	Off	0
•		
•		
•		
(etc.)		

Since, in electronic representation of a number of functions (including arithmetic), a large number of input/output signals are handled by groups of switches in flip-flop 'registers', the entire contents of a register may be dealt with at the same time and designated by a single binary number. For example, assuming an eight-bit register and assigning arbitrary numbers to the switches, such a correspondence may be shown as follows:

BIT:	B0	B1	B2	B3	B4	B5	B6	B7
SWITCH STATE:	ON	OFF	OFF	ON	ON	OFF	OFF	ON
BINARY NUMBER:	1	0	0	1	1	0	0	1

Bit BO is the most-significant or highest bit in the register, since it will represent the largest magnitude. The state of the register can be instantly stated as: 10011001.

As in common decimal notation, when the highest number (9 in decimal) is surpassed, it is replaced by a zero and the next digit to the left becomes a one (or has one added to it). Thus when one is added to nine (the highest digit in decimal), the result is ten (10). The same is true for binary notation, e.g.:

Decimal	Binary Equivalent
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001

Looking at this above example, it is clear that both numbering methods have advantages and disadvantages. The decimal system is short, yet makes it difficult to tell immediately the state of any one flip-flop or bit in a register once the number becomes larger than eight or so. On the other hand, the binary method shows at once which switches are in what state, yet it is cumbersome because of the amount of numbers needed.

OCTAL SYSTEM

The octal notation system is commonly used as a compromise between binary and decimal. In effect, it divides up binary numbers into groups of three - in actuality counting up to seven - commencing a new group when binary digits are exceeded.

Decimal	Binary	Octal
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	10
9	1001	11
10	1010	12

Using the octal system makes it easy to translate large numbers of identical switches into their actual states. Very little practice is needed to become accustomed to seeing binary numbers in groups of three, then translating them into octal numbers, and vice-versa.

BINARY: $\underbrace{1\ 0}\quad \underbrace{0\ 1\ 1}\quad \underbrace{0\ 0\ 1}$

OCTAL: 2 3 1

Therefore, the state of the register example given at the beginning of this appendix may be simply given in octal notation as:

$$\text{REGISTER} \quad B = 231_8$$

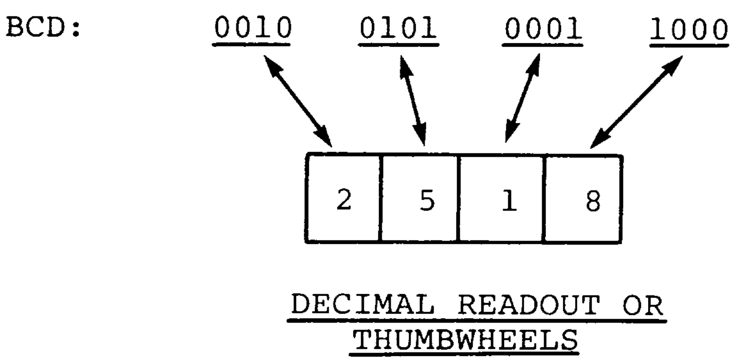
Thus, if a register is loaded with a value such 172 (octal), it is apparent that the output from the register should look like this:

REGISTER OUTPUT

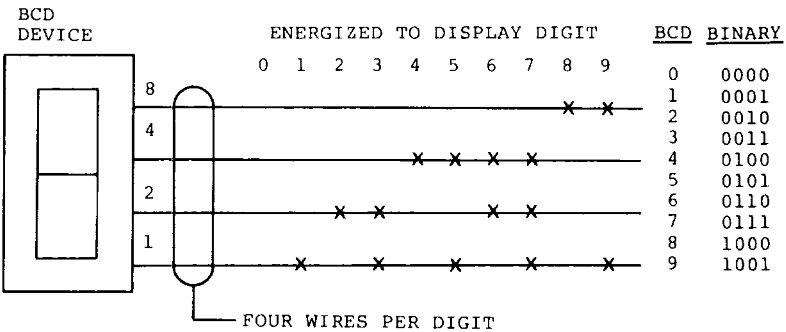
OCTAL:	1		7			2		
BIT:	B0	B1	B2	B3	B4	B5	B6	B7
STATE:	0	1	1	1	1	0	1	0
	OFF	ON	ON	ON	ON	OFF	ON	OFF

BINARY-CODED DECIMAL (BCD)

Although formidable sounding, BCD simply refers to the system by which decimal digits (0-9) are represented by bits allocated in groups of four. The octal system previously discussed used bits in groups of three, but could only represent the digits 0-7; thus a fourth bit must be added if digits 8 and 9 are to be represented. Bit combinations are obviously wasted, but the convenience and usefulness of a system that allows operators to enter or receive decimal data without mentally converting to octal or binary, more than compensates for the loss of combinations.



Standard hardware for encoding and decoding BCD numbers is commonly available. To increase the available range of BCD I/O, additional standard hardware in 'units' of one digit are added and separately wired-in (four lines per digit). Since the value in each digit only depends on its four wires and not wires sent to other digits, BCD I/O can be increased or decreased in single-digit increments. As described previously under 'Basic Principles', several operations of the MODICON 184/384 Controller involve automatic encoding or decoding of BCD numbers.



HEXADECIMAL NOTATION

Since the MODICON 184/384 Controller, like many modern electronic data devices, uses a 16-bit word, it is useful to utilize a numbering system in which each of the 16 bits has a single identifying symbol. For ease in decoding, the 16 bits are separated into groups of four similar to the BCD format. However, all bit combinations are utilized with unique displays representing digits beyond 9. The P112 Programming Panel display and some commercially available BCD displays, use the following notation:

P112 Display	Decimal Value	Binary Value	Standard Hexadecimal
0	0	0000	0
1	1	0001	1
2	2	0010	2
3	3	0011	3
4	4	0100	4
5	5	0101	5
6	6	0110	6
7	7	0111	7
8	8	1000	8
9	9	1001	9
⊏	10	1010	A
⊐	11	1011	B
⊔	12	1100	C
⊒	13	1101	D
Ŀ	14	1110	E
(blank)	15	1111	F

While converting numbers from decimal to 'hex' and back again is clumsy, conversion from octal to hexadecimal notation and vice-versa is quite easy. It is done mentally by expanding the octal notation field by one digit, and recalling that 8 plus 7 equals 15.

```
                 1   1 1 1
OCTAL EQUIV:     1     7      (17₈)  OR 15 IN
                                     DECIMAL
                 1  1  1  1
HEX EQUIV:        (blank)
```

OR:

```
                 1   0 1 1
OCTAL EQUIV:     1     3      (13₈)  OR 11 IN
                                     DECIMAL
                 1  0  1  1
HEX EQUIV:         ( ɔ )
```

The advantages of this form of numbering system is obvious: It permits the entire numerical value in a 16-bit register to be displayed on a four-unit readout.

P112 DISPLAY:

⊏	⊔	8	⊑
1010	1011	1000	1101

Binary Equivalent (Bits Stored in a Register)

NOTE

The P112 Programming Panel display is *always the* BCD equivalent of the data in the register. As long as the magnitude of the number does not exceed 9999, no hexadecimal display will occur. These displays will occur only if the binary input register is being integrated or if matrix (binary) data is being utilized. The Controller always converts the contents of a register from binary to BCD prior to displaying its value on the Programming Panel, except if it is an input register coded binary in the I/O Allocation Table, which is displayed as 16 bits without any conversions.

MAGNITUDE CONVERSIONS

The decimal numbering system uses ten digits (0-9) to represent numerical quantities. The digit to the right is the least-significant, i.e., lowest value or weight, and that to the left is the most-significant. For example, we all know how many dollars the number 2805 represents; but why does the digit 2 represent more than the digit 5? Because of position; the digit 2 represents the number in thousands of dollars, and the digit 5 the number of single dollars. Another method of decoding the magnitude of 2805 is as follows:

2 8 0 5

	Value of Each Digit Position			How That Value is Computed
5	5 x 1	=	5	(1 = 10^0)
0	0 x 10	=	00	(10 = 10^1)
8	8 x 100	=	800	(100 = 10^2)
2	2 x 1000	=	2000	(1000 = 10^3)
			2805 - TOTAL	

The above technique to evaluate the magnitude of a number is basic to number theory and can be similarly applied to other systems (e.g., binary, octal, hexadecimal, etc.). Note that each digit represents a magnitude ten times greater than the digit to the right, and the magnitude ten is the same as the number of digits in the system.

The binary number system uses just two digits (0 & 1) to represent numerical quantities. The conversion to the decimal number system for comparison in a system we are most familiar with, requires only that each position be assigned a value in decimal. The least significant (rightmost) digit is assigned the value one (2^0); the next is given the value two (2^1; continuing in power or multiples of two as follows: four, eight, sixteen, thirty-two, sixty-four, etc. For example, the following 16 bits can be converted to a decimal magnitude as illustrated:

0 0 0 0 1 0 1 0 1 1 1 1 0 1 0 1

Value of Each Binary Position			
1 x 1	=	1	(1 = 2^0)
0 x 2	=	0	(2 = 2^1)
1 x 4	=	4	(4 = 2^2)
0 x 8	=	0	(8 = 2^3)
1 x 16	=	16	(16 = 2^4)
1 x 32	=	32	(32 = 2^5)
1 x 64	=	64	(64 = 2^6)
1 x 128	=	128	(128 = 2^7)
0 x 256	=	0	(256 = 2^8)
1 x 512	=	512	(512 = 2^9)
0 x 1024	=	0	(1024 = 2^{10})
1 x 2048	=	2048	(2048 = 2^{11})
0 x 4096	=	0	(4096 = 2^{12})
0 x 8192	=	0	(8192 = 2^{13})
0 x 16384	=	0	(16384 = 2^{14})
0 x 32768	=	0	(32768 = 2^{15})
		2805 - TOTAL	

A similar, but less complex, conversion can be made for both octal and hexadecimal systems, since these systems are a shorthand notation to represent binary information with fewer characters. The previous binary value can be easily converted to the now familiar octal and hexadecimal systems as follows:

$$(0\ 000\ 101\ 011\ 110\ 101)_2 = (005365)_8$$

$$(000\ 1010\ 1111\ 0101)_2 = (0AF5)_{16}$$

Conversion from either octal or hexadecimal again only requires assignment of values to each character position as illustrated below:

0 0 5 3 6 5

Value of Each Octal Position				
5 x 1	=	5	(1	$= 8^0$)
6 x 8	=	48	(8	$= 8^1$)
3 x 64	=	192	(64	$= 8^2$)
5 x 512	=	2560	(512	$= 8^3$)
0 x 4096	=	0	(4096	$= 8^4$)
0 x 32768	=	0	(32768	$= 8^5$)
		2805- TOTAL		

0 A F 5

Value of Each Hex Position				
5 x 1	=	5	(1	$= (16^0$)
15 x 16	=	240	(16	$= (16^1$)
10 x 256	=	2560	(256	$= (16^2$)
0 x 4096	=	0	(4096	$= (16^3$)
		2805 - TOTAL		

The above examples have shown that the same number of dollars is represented by $(2805)_{10} = (0000101011110101)_2 = (005365)_8 = (0AF5)_{16}$. The significance of each characters depends on its position in the number and the numbering system used.

APPENDIX D
GLOSSARY OF TERMS

TERM	DEFINITION	For Additional Details, See PAGE NO.
ABORT	A signal used to terminate a message currently being printed on the P500 Printer.	123
ACTIVE LIGHT	A LED indicator on each I/O module, used as a maintenance aid, and indicating the module is receiving valid communications from the Processor.	28, 195
ADDITIONAL REFERENCES	Capability provided with some MOPS 3 level executives that allows selected discrete references to be utilized both as discretes and as if they were controlling the contents of input registers.	99, 133
ADDRESS INDEX PIN	A screw-lock slide pin used to establish proper identification of I/O modules. Separate pins are provided for each I/O module location in the I/O housing.	24, 31, 33, 63, 134, 183
AND (Logical)	A mathematical operation between two bits that requires both bits to be a One for the result to be a One. This operation can be performed between groups of bits with each pair of bits (one from each group) examined by their relative location within each group.	90
BCD (Binary-Coded Decimal)	A system of numbers representing decimal digits (0-9) with four binary (ON/OFF) lines. BCD is a recognized industrial standard; BCD input (e.g., thumbwheels) and output (e.g., numerical displays) are readily available. (Also refer to Appendix C.)	61,139, 141, 150, 158
BINARY	A numerical system wherein values are represented only by numbers 1 and 0 (ON/OFF). This system is commonly employed in modern electronic hardware since circuits can be economically designed for ON/OFF status. (Also refer to Appendix C.)	61, 88, 150, 158
BIT	A single number whose value can be either a ONE or a Zero. Commonly represented in hardware by a small magnetic toroid device that can be either magntized or not magnetized.	89, 90, 147, 148
BORROWING POWER	The capability to operate a channel of I/O (other than channel I) from the main power supply I/O power section.	15
BUSY	A signal from the P500 Printer indicating it is busy and not available to respond to new commands.	120

CALCULATE	A type of logic line used to add, subtract, or compare two numerical values.	68, 150, 154
CHANNEL	A portion of the total I/O capability of the Controller. Each channel represents 25% of the total available I/O.	11, 14, 24, 26, 28, 134, 179
CHANNEL LIGHT	LED indicators on the Processor to indicate, when blinking, that the respective channel is communicating to the Processor.	18, 198
CORE MEMORY	An electronic component used to store data for future utilization that is retentive upon power failure.	11, 18, 36, 38, 63, 146, 147, 159, 161
COUNTER LINE	A type of logic line that is used to simulate the operation of external counters.	56, 150, 152
CPU (Central Processor Unit)	See PROCESSOR.	
DATA TRANSFER (DX)	A technique of moving and manipulating data within the Controller under control of the DX logic lines.	75, 125, 150
DELAYED OUTPUT	See LATCH.	
DELIMITOR	A special ASCII character that terminates or ends an ASCII COMMUNICATION. Normally this is a Carrage Return.	137, 139, 141, 142
DISABLE	The capability to disconnect a logic line coil or a discrete input from its normal control, and force it ON or OFF.	37
DISCRETE	References that can be either ON or OFF; can be input, output, or internal references.	31, 100, 128, 146, 157
DOUBLE PRECISION	The technique of storing a single numerical value in two consecutive registers. Since each register can store up to four digits (maximum value 9,999), double-precision allows magnitudes of up to 99,999,999 to be stored.	70, 103
DUMP	Recording the entire core memory of a Controller onto paper tape by the Service Center. Generally accomplished by use of a Telephone Interface at the Controller.	44, 161
DX LINE	A type of logic line used to control internal transfer of data. Four types of DX lines are available, each with unique groups of functions: MOVE, MATRIX, EXTENDED ARITHMETIC, and PRINT.	76, 107, 116, 155
EXCLUSIVE OR	A mathematical operation between two bits that requires either to be a One for the result to be a One, but not (excluding) the case where the both are Ones. This operation can be performed between groups of bits with each pair of bits (one from each group) examined by their relative location within each group.	97

EXECUTIVES	See MOPS and TEF.	
EXTENDED ARITHMETIC	A type of data transfer with function codes of the form 3YXX; current capabilities include multiply, divide, and PID control, and sort.	103
FIFO STACK	Special table controlled by DX lines that maintains the order of data entered into the table, First In, First Out, (FIFO).	85
FLAG CHARACTER	A special eight bit character that is transmitted to a monitoring computer. This is an option selected at the computer interface and controlled by user logic.	170
FORM BUSY	Signal from P500 Printer that indicates when the printer is printing a message from its internal PROM.	120
FUNCTIONAL CODE	A four-digit number placed in the C element of a DX line to indicate specifically what type of function is to be performed.	76
GUARDED LINES	A group of lines that are protected from being altered even with memory protect ON. If any of these lines are altered, all their coils will be forced OFF and the controller must be reloaded.	132
HEXADECIMAL	The numbering system that represents all possible statuses of four bits with sixteen unique digits. (Also refer to Appendix C.)	90
INCLUSIVE OR	A mathematical operation between two bits that requires either to be a One for the result to be a One, including the case where they are both Ones. This operation can be performed between groups of bits with each pair of bits (one from each group) examined by their relative location within each group.	92
INPUT	A signal that provides information to the Controller; can be either discrete input (pushbutton, relay contacts, limit-switches, etc.) or numerical input (thumbwheel, external solid-state device, etc.).	31, 38, 61, 64, 148
I/O	Input/Output, the Controller connection to the 'real world'; includes both discrete and register signals.	6, 11,18, 24, 26, 62, 133, 134, 145, 181, 184, 195, 197
I/O ALLOCATION TABLE	A portion of the MOPS that controls how input and output data is interpreted relative to its channel number and address index position. Due to its function, I/O allocation is also called the Traffic Cop.	117, 135, 149
ISOLATED I/O	Special AC I/O modules where each circuit on the module has its own common or supply connection, in lieu of sharing commons or supplies in groups of four as is done on the standard I/O modules. Eight circuits are provided on each Isolated I/O module.	145

LATCH	A discrete reference that can be utilized to remember the status of a logic line coil during a power failure, such that when power is restored, the line can be returned to the condition (ON or OFF) it held prior to the power failure if properly programmed. Also referred to as 'delayed outputs' due to their unique timing.	41, 42, 45, 64, 148
LOGIC LINE	A 'building' block used to construct the customer's unique logic. Each logic line contains exactly four elements labeled A-D, and one coil. The coil is referred to by the line number. Logic lines can be of the following type: Relay, Timer, Counter, Calculate, or DX.	33, 38, 40, 146, 150
MAINFRAME	See PROCESSOR.	
MASK	A matrix technique used to force individual bits or groups of bits to either a Zero or a One.	90
MATRIX	A group of consecutive registers referred to by a logic line, such that individual bits can be utilized in lieu of numerical values. Bit operations that can be performed include: AND, OR (inclusive), COMPARE, CLEAR, SET, SENSE, COMPLEMENT, OR (exclusive), ROTATE LEFT, and ROTATE RIGHT. Maximum matrix size is 1584 bits (99 registers).	88
MEMORY PROTECT	The hardware capability to prevent a portion of the core memory from being altered by an external device. This hardware feature is under keylock control.	18, 36, 64, 65, 170, 195
MODULE	Hardware sub-assembly that can be easily replaced for maintenance purposes. If a failure occurs, the module is rapidly replaced to restore the control system with minimum down-time. The failed module (Processor, Power Supply, or I/O module) is then repaired at a later time.	11, 13, 18, 24, 27, 31, 62, 193
MOPS (Modicon Operating System)	A software capability designed by MODICON for installation into the 184 Controller's core memory. The MOPS defines the type of I/O, number of logic lines, registers, and latches, as well as providing the specific intelligence the Processor can have (line types). Also called Executive in a general sense.	18, 33, 38, 50, 59, 61, 62, 64, 65, 69, 75, 77, 162, 170
MOVE	A DX capability which allows data to be transferred without modification within the Controller. Data can be transferred from a register to a table, from a table to a register, from a table to a table, into an FIFO stack, or out of an FIFO stack.	76, 81
NULL DATA	The initial condition of the user's area of core memory when a new MOPS is installed. All logic lines are coded as	44

	relay lines such that their coils cannot be energized and all registers contain Zeros.	
ONE-SHOT	A discrete reference, typically a logic line's coil, that is energized (valid) for exactly one scan of the Controller's logic.	45
OR(Logical)	See EXCLUSIVE OR or INCLUSIVE OR.	
OUTPUT	A signal provided from the Controller to the 'real world'; can be either discrete output (solenoid valve, relay, motor starter, indicator lamp, etc.), or numerical output (e.g., display of values stored within the Controller).	31
P.I.D. (Proportional, Integral, Derivative Control)	A mathematical function that simulates an analog controller. The control tecnique responds to an error with an output signal that is proportional to the error, the error's integral, and the error's rate of change (derivative). The exact response depends on constraints entered by the customer or the operator.	105, 130
POINTER	The value contained in a register which is utilized to indicate specifically which register of a table or bit in a matrix is being referred to by the logic line.	81, 85, 93, 136
PRESET	The limit established for a counter or timer line; the preset is entered into the C element of each line. The current count or time available from the register referred to in the D element cannot exceed this limit. At the preset value, the logic line's coil is energized.	50, 51, 56
PRINT	A DX line type used to specify and control the printing of messages via the P500 Printer.	111, 116, 119, 135
PRIVILEGED REGISTERS	A series of holding registers with the reference 5XXX that cannot be altered with memory protect on. Used to store system constants that are not to change once the controller is placed in operation.	132
PROCESSOR	The 'brain' of the Controller system, wherein the customer's logic and executive is stored; all logic solving and decision making is performed by the Processor. Also called the CPU or mainframe.	5, 12, 16, 179, 186
PROM (Programmable Read-Only Memory)	A retentive memory used within the P500 Printer to store customer messages. This memory is erased with ultraviolet light and reprogrammed with special electronics; thus, it is not readily alterable in the field, but programmed at the factory.	110, 111
RAM (Random-Access Memory)	A memory where individual bits are stored and accessed, in lieu of groups of bits as used for numerical storage.	147

	Random Access Memory is used to store the state (ON or OFF) of discrete references.	
REFERENCES	Four-digit numbers used in the construction of the customer's logic. Every element of each logic line uses a single reference number. References can be either discrete (logic line's coils, inputs, or latches) or register (input or holding).	31, 34, 61, 146
REGISTER	A location within the Controller allocated to the storage of numerical values (up to 9999) or bit status (16 bits per register). All registers are retentive on power failure. There are three types of registers: input whose contents are controlled by the 'real world' outside the Controller; holding registers whose contents are controlled from within the Controller; and output registers, which are special holding registers since their contents can also be provided to the 'real world'.	31, 51, 56, 60, 62, 63, 66, 76, 87, 128, 146, 148, 157
RELAY LINE	A logic line used to simulate the effect of relays. The relay line's coil will be energized when 'power' can flow from the left leg of the ladder diagram to the right leg.	38, 150, 151
REMOTE I/O	The capability to physically place a portion of the Controller's I/O (typically one channel) up to 2000 feet from the Processor. Communications from the I/O to the Processor is provided via only two twin axial cables.	14, 181, 199
REMOTE PRESET	The capability for placing the preset for a timer or counter line into a register and referring to that register in the C element of the logic line. The preset is no longer fixed since the contents of the register (and thus the preset) can be altered at any time.	65
RS-232C	Electronic Institute of America (EIA) standard for data communications, RC-232 type C. Data is provided at various rates, eight data bits per character.	165
RUN LIGHT	A LED indicator on the Processor that indicates, when lit, that the logic is being processed.	18, 28, 44, 195, 197
SCAN	The technique of examining or solving logic lines one at a time in their numerical order. After the last logic line is solved, the next scan begins at line one; lines are always solved in this fixed cyclic process.	36, 135, 136, 143, 156
SOLID-STATE	Circuitry designed using only integrated circuits, transistors, diodes, etc.; no electro-mechanical devices such as relays are utilized. High reliability is obtained with solid-state	3

	logic, which would be degraded by depending upon electro-mechanical devices.	
SUB-CHANNEL	A remote I/O location driven from the remote driver. Subchannels can be located up to 2000 feet from the Processor and require an auxiliary power supply (P421) with remote interface (I430) mounted on it. Ip to four sub-channels can be driven from one driver.	12
TABLE	A group of consecutive registers used to store numerical values; maximum table size is 99 registers.	81
TEF (Three Eighty Four)	A software capability designed by MODICON for installation into the 384 Controller's core memory. The TEF defines the type of I/O, number of logic lines, registers, and latches, as well as providing the specific intelligence the Processor can have (line types). Also called Executive in a general sense.	18, 33, 38, 50, 60, 61, 62, 65, 69, 134, 162, 170
TIMER LINE	A logic line used to measure and record the time of an event or sequence of events. Timer lines can accumulate time in either seconds or tenths of seconds.	50, 150, 153
TRAFFIC COP	See I/O ALLOCATION TABLE.	
TRAPPED	The ability to stop a controller from scanning; can be exercised only from a computer. The controller can still communicate to the computer but will have all outputs OFF.	170
UNIT OF I/O LOAD	The internal (± Vdc) load a single input module places on a power supply. An output module represents twice the internal load that an input module does; two units of I/O load per output module.	14, 24
WDT (Watchdog Timer)	The last line of each MOPS is always the WDT line; the Programming Panel does not have access to this line. The WDT line constantly cycles ON/OFF/ON/OFF; it is ON for one scan, OFF for the next scan, etc. Hardware error checking monitors this line such that if it does not change states within 200 ms, the system is shut down.	43

APPENDIX E
ESTIMATING SYSTEM REQUIREMENTS

INTRODUCTION

This appendix describes several ways to determine controller size and equipment required to satisfy a control requirement. The techniques presented here result in estimates that have been proven accurate in most applications. However, there will be a few applications in which these estimating techniques are not suitable; in these few situations, the results can be either too high or too low. The estimating techniques presented in this appendix do not replace sound engineering practices and experience with controller systems.

I. ESTIMATING CONTROLLER SIZE

A. Using I/O Quantity (Relay, Timer and Counter Logic)--if the number of discrete inputs and outputs are available, the number of logic lines (and thus required memory size) can be estimated. Multiply the number of outputs by three to estimate the quantity of logic lines required. Also estimate the total number of timers and counters required. Utilizing table 9, select a MOPS configuration that provides sufficient logic lines, one register for each timer or counter, and sufficient discrete inputs. Once the MOPS is selected, the minimum memory size is also available from table 9. If register I/O is required to display numbers or allow operator control of timer/counter presets, select MOPS from table 11 as previously discussed.

   Example: A system with 128 I/64 O and 40 timer/counters would require a 2K memory size. The estimated logic lines required is 192, which can be satisfied with a MOPS 1 Mod 1 (1K) executive; however, only 32 holding registers are available with the MOPS Mod 1, thus requiring a 2K memory for this particular application.

B. Using Existing Ladder Diagram (Relay, Timer and Counter Logic) -- If a ladder diagram is available for the application (which does not have to be four elements per line), the memory size can be estimated from it. Separately sum all relay contacts and timer/counters. Divide the total number of contacts by three and add to the quotient the number of timer/counters. This is an estimate of the logic lines required. Refer to table 9 and select MOPS that provide estimated logic lines required and one register for each timer/counter. If register I/O is required to display numbers or allow operator control over timer/counter preset, select MOPS from table 11. In either case, the core memory required is also available from these tables once the MOPS is selected.

   Example: A system which previously used 872 relay contacts, 62 timer/counters, and register I/O can be accommodated with a MOPS 2

Mod 1 executive requiring 2K of memory. The relay contacts indicate 291 logic lines, plus 62 timer/counters, for a total of 353 lines. Since register I/O is required, table 11 is used and MOPS 2 Mod 1 selected, providing 400 logic lines (353 required), 100 holding registers (62 required), and register I/O.

C. System Requiring Calculate Capability -- For applications requiring calculate capability to add, subtract, or compare numbers (set point control), the relay, timer, and counter logic can be estimated by using one of the two previous methods. To the estimated quantity of logic lines and registers obtained by these methods, must be added the logic line and register requirements to support the calculate capability. To add or subtract four digit numbers (maximum value 9999) requires one logic line and one register (to store result). Count up the number of times an addition or subtraction is required in the application; if double precision arithmetic is required (maximum value 99,999,999), count each such operation as two logic lines and two registers. Set Point control generally requires one logic line per set point and one register among all set points.Thus, count each set point as one logic line.

In general, when using the calculate capability, the logic lines and not register requirements will determine memory size. Add the number of logic lines required (one per addition/subtraction, two per double precision arithmetic operation, and one per set point) to the quantity of lines required for relay timers and counters. Obtain from Table 11 the various MOPS that provide the logic lines and I/O required. Select specifically the executive that provides the B+C coil option most desired by the application--standard if double precision arithmetic is to be accomplished and B=C if exact equality compare is to be utilized. As a final check, verify that the MOPS provides sufficient registers for timer/counters as well as calculate capability required.

Example: A system is estimated to require 417 logic lines including 125 timers and counters by a previous method. This system also must perform 47 arithmetic operations for inventory control of which 15 are double precision, as well as 83 set points for weigh scale control. Total logic lines required is 562 (417+47+15+83). MOPS 2 Mod 2 is selected for this system from Table 11 for this application. The register requirement is 188 (125+47+15+1) which is more than satisfied by the 999 registers provided with MOPS 2 Mod 2. Memory size required as 4K to support this executive.

D. System Requiring DX Capability -- Whenever the DX capability is required, the memory size is automatically established at 4K, since all MOPS 3 level executives require 4K memories. The selection process now becomes one of picking which MOPS 3 executive is required. All MOPS 3 executives provide the MOVE capability; this is given--MOVE is always available with MOPS 3 systems. The next consideration is, does the application require BASIC MATRIX, IMPROVED MATRIX, MULTIPLY/DIVIDE, PID, or PRINT? Select the DX capabilities required and review table 12, identifying those executives that provide the required capabilities. For example, there are four executives that provide MOVE only, and six executives that provide MOVE and MATRIX. The final selection is based upon differences between these final candidates, such as I/O capacity, B=C coil option, latch location, etc.

The number of logic lines and registers required to support the relay, timer, counter, and calculate requirements can be estimated as previously discussed. There is no simple "cookbook" method of estimating the logic lines and registers required to support the DX functions. In general, the best method is to select a small representative portion of the application and sketch the logic required for it. Multiply the number of logic lines and registers required for this sample by the number of similar samples that exist in the application. This will result in an estimate of the logic lines and registers required for the DX logic. In general, more emphasis should be placed on DX use of registers (storage of standards, recipes, report information, etc.) than of logic line requirements. If the selected executive does not provide sufficient logic lines and/or holding registers, contact MODICON's Application Engineering Department for assistance on your application. Alternate solutions include use of 384 controller, altering the logic to satisfy your application within the 184 controller, or use of multiple controllers.

Example: A system has been estimated at 252 logic lines and 173 registers to perform its relay, timer, counter, and calculate functions. The application requires the use of DX Move (to multiplex input data) and Matrix (to monitor I/O for errors). A portion of the system is selected that represents 6% of the DX requirements; that logic required 18 logic lines and 34 registers. The total DX requirement is thus estimated at 300 (18 x 1/0.06) logic lines and 567 (34 x 1/0.06) registers resulting in a total system requirement of 552 logic lines and 740 registers. Any of the MOPS 3 executives in Table 12 with Move and Matrix would satisfy this requirement; however, since the application also required B=C coil option, MOPS 3 Mod 16 was selected.

II. ESTIMATING I/O EQUIPMENT REQUIRED

A. Basic I/O -- The majority of the controller's cost will be in the I/O sections. In general, this area is also easy to estimate and can be reduced to a step-by-step process. Provided as figure E-1 and Table E-1 are a configurator drawing and quick estimator chart to assist in the estimating process. The following are the recommended steps required:

1. The controller can be envisioned as a black box to which wires are connected. Some of these wires contain input information (pushbutton, limit switches, relay contacts, thumbwheels, analog signals, etc.) and some contain output information (solenoid valves, motor starters, indicator lights, numerical displays, analog signals, printed data, etc.). Review your application and count up the number of discrete (ON/OFF) and register (numerical) inputs and outputs separately by voltage levels (115VAC, 24VDC, 5V, TTL, etc.). The following is an example of one such system selected for illustrative purposes only:

Voltage Level	Discrete Input	Discrete Output	Register Input	Register Output
115VAC	108	75	0	o
24VDC	30	0	4	0
5V TTL	0	0	0	4

2. Divide each individual input or output discrete quantity by 16 to estimate I/O modules required. If there is a remainder, round off each quotient to the next higher value. Next, sum the number of I/O modules in each category. If the above example is continued, the result would be the following:

I/O Modules Voltage	Discrete Input	Discrete Output	Register Input	Register Output
115VAC	7	5	0	0
24VDC	2	0	4	0
5V TTL	0	0	0	4
TOTALS	9	5	4	4

3. Utilizing Table E-1, obtain number of B240 I/O housing, power supplies, and cables required to support discrete I/O. For above example, with 9 discrete inputs and 5 discrete outputs, five housings and a W601 cable is required (no auxiliary power supply).

4. Add to discrete support equipment the number of B240 I/O housings, power supplies, and cables required to support register I/O. If channel III is not used for discrete I/O and the configuration does not qualify for "borrowed" power (see page of text), a P421 power

supply is required on each register channel utilized. Enter Table E-1 with the number of input and output registers (modules) to determine only the quantity of I/O housings required. Each P421 power supply utilized requires a type W606 cable and each channel connected without a P421 requires a type W601 cable.

If channel III is used for discrete I/O, register I/O can be added to vacant slots in discrete B240 housings, or additional housings added. Total register I/O cannot exceed that provided by the MOPS (see Table 10). Requirement for P421 power supply and cable type (W601 or W606), must be re-evaluated based upon total (discrete plus register) I/O placed in channel III.

For the above example, the configuration does not qualify for borrowed power (total channel III load is 12 units of I/O power); thus a P421 is required. Four input modules and four output modules on Table E-1 require two B240 and can be totally accommodated within one channel. In addition, one W606 cable is required for channel III.

5. Complete Figure E-1 with the equipment required and determine physical location. Utilize appendix B to determine I/O module type. Recall that I/O module reference numbers are assigned by index pin locations and NOT physical location. Thus locate I/O modules for system maintenance convenience. In addition, only eight input or output modules of the standard type are allowed in any channel (maximum 16 modules).

   For the above example, the following is a summary of equipment required for that Application:

Item	Quantity
C184-2 Controller (including Main Power Supply and W600 cable)	1
B240 Housings (5 for discrete and 2 for register)	7
P421 Auxiliary Power Supply (Channel III only)	1
W601 Cable (Length six or twelve feet)	1
W606 Cable (Length 12, 25, 50, or 75 feet)	1
B230 (115VAC Outputs)	5
B231 (115VAC Inputs)	7
B233 (24VDC Inputs)	6
B236 (5V TTL Outputs)	4

B. Additional I/O System Notes

1. Remote I/O -- Each channel of I/O to be remoted requires one I425 remote driver and its associated cable (type W602 or W603). Any or all channels can be simultaneously remoted. However, each remote driver consumes 5 units of I/O power (equivalent to two output modules and one input module) from the I/O power normally available for Channel I. Thus, when utilizing table E-1 with a system containing remote I/O, add two output modules and one input module for each I425 connected to the controller prior to determining the need for an auxiliary power supply; do not alter the quantity of I/O modules to determine number of B240 housings needed.In the previous example, if the register I/O in channel III is to be remoted, enter Table E-1 with 10 input modules and 7 output modules resulting in no auxiliary power supply required. Use the original 9 inputs and 5 output modules to determine quantity of B240 housings (five) and one W601 cable requirement.

   The remote I/O can be placed up to 2000 feet from the I425 driver and can be subdivided into a maximum of four subchannels. Each subchannel (1 to 4 per remote channel) will require a P421 power supply and an I430 interface--there is no choice. The quantity of

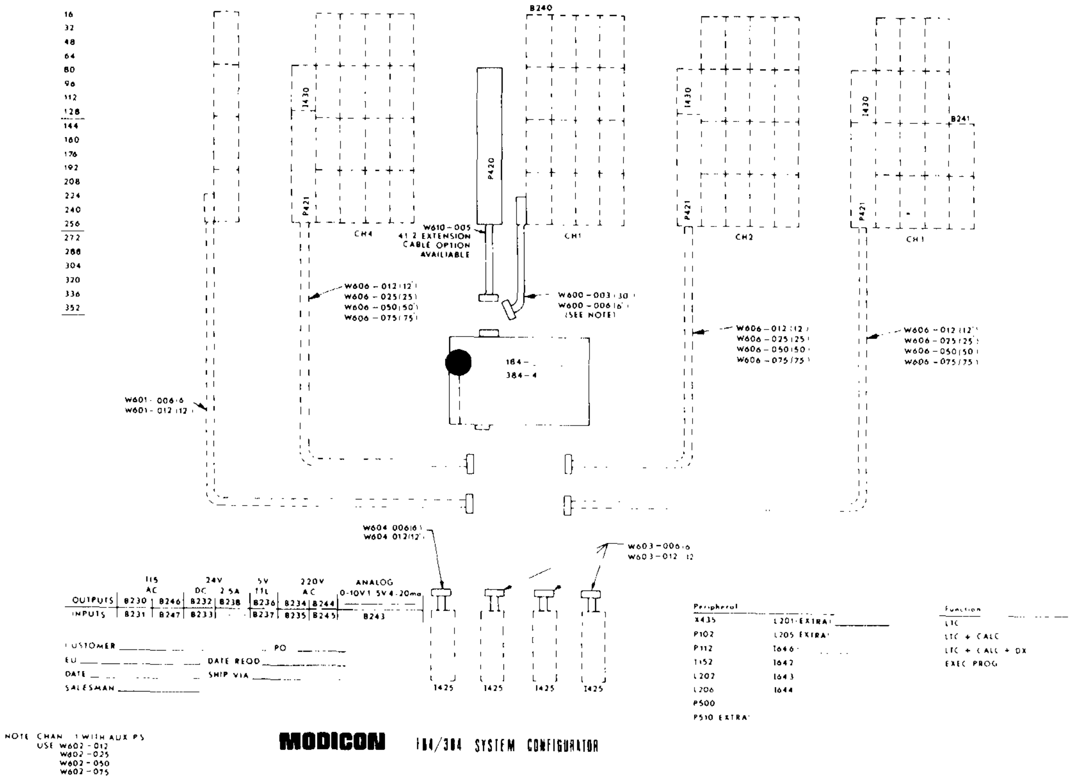


Figure E-1. MODICON 184/384 System Configuration

OUTPUT MODULES

Quantity of B240 ⟶ X/Y ⟵ Quantity of P421

INPUT MODULES		Chan I 0	1	2	3	4	5	6	7	8	Chan II 9	10	11	12	13	14	15	16	Chan III 17	18	19	20	21	22
Chan I	0	0/0	1/0	1/0	1/0	1/0	2/0	2/0	2/0	2/0	3/*	3/*	3/*	3/*	4/*	4/1	4/1	4/1	5/1*	5/1*	5/1*	5/1*	6/1*	6/2
	1	1/0	1/0	1/0	1/0	2/0	2/0	2/0	2/0	3/0	4/*	4/*	4/*	4/*	5/*	5/1	5/1	5/1	6/1*	6/1*	6/1*	6/1*	7/1*	7/2
	2	1/0	1/0	1/0	2/0	2/0	2/0	2/0	3/0	3/0	4/*	4/*	4/*	4/*	5/1	5/1	5/1	5/1	6/1*	6/1*	6/1*	6/1*	7/2	7/2
	3	1/0	1/0	2/0	2/0	2/0	2/0	3/0	3/0	3/0	4/*	4/*	4/*	4/*	5/1	5/1	5/1	5/1	6/1*	6/1*	6/1*	6/1*	7/2	7/2
	4	1/0	2/0	2/0	2/0	2/0	3/0	3/0	3/0	3/0	4/*	4/*	4/*	4/1	5/1	5/1	5/1	5/1	6/1*	6/1*	6/1*	6/2	7/2	7/2
	5	2/0	2/0	2/0	2/0	3/0	3/0	3/0	3/0	4/0	5/*	5/*	5/*	5/1	6/1	6/1	6/1	6/1	7/1*	7/1*	7/1*	7/2	8/2	8/2
	6	2/0	2/0	2/0	3/0	3/0	3/0	3/0	4/0	4/0	5/*	5/*	5/1	5/1	6/1	6/1	6/1	6/1	7/1*	7/1*	7/2	7/2	8/2	8/2
	7	2/0	2/0	3/0	3/0	3/0	3/0	4/0	4/0	4/0	5/*	5/*	5/1	5/1	6/1	6/1	6/1	6/1	7/1*	7/1*	7/2	7/2	8/2	8/2
	8	2/0	3/0	3/0	3/0	3/0	4/0	4/0	4/0	4/0	5/*	5/1	5/1	5/1	6/1	6/1	6/1	6/1	7/1*	7/2	7/2	7/2	8/2	8/2
Chan II	9	3/*	4/*	4/*	4/*	4/*	5/*	5/*	5/*	5/*	5/*	5/1	5/1	6/1	6/1	6/1	6/1	7/1	8/1*	8/2	8/2	8/2	9/2	9/2
	10	3/*	4/*	4/*	4/*	4/*	5/*	5/*	5/*	5/*	5/1	5/1	6/1	6/1	6/1	6/1	7/1	7/1	8/1*	8/2	8/2	8/2	9/2	9/2
	11	3/*	4/*	4/*	4/*	4/*	5/*	5/*	5/*	5/*	5/1	6/1	6/1	6/1	6/1	7/1	7/1	7/1	8/1*	8/2	8/2	8/2	9/2	9/2
	12	3/*	4/*	4/*	4/*	4/*	5/*	5/*	5/*	5/1	6/1	6/1	6/1	6/1	7/1	7/1	7/1	7/1	8/1*	8/2	8/2	8/2	9/2	9/2
	13	4/*	5/*	5/*	5/*	5/*	6/*	6/*	6/*	6/1	6/1	6/1	6/1	7/1	7/1	7/1	7/1	8/1	9/1*	9/2	9/2	9/2	9/2	9/2
	14	4/*	5/*	5/*	5/*	5/*	6/*	6/*	6/1	6/1	6/1	6/1	7/1	7/1	7/1	7/1	8/1	8/1	9/1*	9/2	9/2	9/2	10/2	10/2
	15	4/*	5/*	5/*	5/*	5/*	6/*	6/*	6/1	6/1	6/1	7/1	7/1	7/1	7/1	8/1	8/1	8/1	9/1*	9/2	9/2	9/2	10/2	10/2
	16	4/*	5/*	5/*	5/*	5/*	6/*	6/1	6/1	6/1	7/1	7/1	7/1	7/1	8/1	8/1	8/1	8/1	9/1*	9/2	9/2	9/2	10/2	10/2
Chan III	17	5/**	6/**	6/**	6/**	6/**	7/**	7/1*	7/1*	7/1*	8/1*	8/1*	8/1*	8/1*	9/1*	9/1*	9/1*	9/1*	9/1*	9/2	9/2	10/2	10/2	10/2
	18	5/**	6/**	6/**	6/**	6/**	7/1*	7/1*	7/1*	7/1*	8/1*	8/1*	8/1*	8/1*	9/1*	9/1*	9/1*	9/1*	9/2	9/2	10/2	10/2	10/2	10/2
	19	5/**	6/**	6/**	6/**	6/**	7/1*	7/1*	7/1*	7/1*	8/1*	8/1*	8/1*	8/1*	9/1*	9/1*	9/1*	9/1*	9/2	10/2	10/2	10/2	10/2	11/2
	20	5/**	6/**	6/**	6/**	6/1*	7/1*	7/1*	7/1*	7/2	8/2	8/2	8/2	8/2	9/2	9/2	9/2	9/2	10/2	10/2	10/2	10/2	11/2	11/2
	21	6/**	7/**	7/**	7/**	7/1*	8/1*	8/1*	8/1*	8/2	9/2	9/2	9/2	9/2	10/2	10/2	10/2	10/2	10/2	10/2	10/2	11/2	11/2	11/2
	22	6/**	7/**	7/**	7/1*	7/1*	8/1*	8/1*	8/2	8/2	9/2	9/2	9/2	9/2	10/2	10/2	10/2	10/2	10/2	10/2	11/2	11/2	11/2	11/2

NOTES:

1. Chart assumes channel I will be completed (eight input or eight output modules) prior to expansion into channel II. Similarly channel II must be completed prior to utilizing channel III.
2. *indicates no auxiliary power supply is required, however a W601 cable is required. **indicates two W601 cables are required. Each auxiliary power supply utilized will also require type W606 cable.
3. Example: A system using 12 output modules and 19 input modules would require eight B240 I/O housings, one P421 auxiliary power supply, and one W601 cable. Output modules are placed in channels I and II, and input modules in channels I, II, and III.

Table E-1. Quantity of B240 I/O Housings and P421 Auxiliary Power Supplies Required to Support Discrete I/O

B240 housings required must be separately estimated for each subchannel using Table E-1. The cables connecting each subchannel to its driver (Belden type 8227 is recommended) is NOT supplied with the remote I/O equipment; two cables per remote subchannel are required.

2. Analog Modules -- The analog I/O modules physically require only one slot each in the B240 housings; other I/O modules can be placed in the same housing with the analog modules. However, the analog modules must be placed in channels III or IV where there is register I/O, and indexed as either module number one or five. Electrically, the analog I/O modules represent four I/O registers. Thus, when one is indexed as input module 1, input modules 2, 3, and 4 cannot be utilized in that channel; if indexed as input module 5, input modules 6, 7, and 8 cannot be used. A similar requirement exists for analog output modules.

   If an analog input module is to be added to channel III of the previous example, one more B240 housing is required (total 9 I/O modules in that channel). The total load on the P421 is 18 units (4 inputs, +4x2 for outputs, +6 for B243 analog input--see table 3), which is not excessive.

3. Alternate I/O Equipment -- B241 housing can also be utilized if height limitations exist. The B241 housing is approximately half as tall as the standard B240 housing and accommodates only two modules per housing. Typically, a system using B241 housings will require twice as many housings as Table E-1 indicates.

   Isolated I/O modules provide only eight circuits in lieu of the standard 16. Thus, to support the same quantity of I/O, twice as many isolated modules will be required as standard 16 circuit modules. More isolated I/O modules can be added to any channel up to a limit of 16 input or 16 output modules (maximum 32 isolated modules), until the capacity of the available I/O power is reached. This capacity is indicated in Table E-1 by the requirement for a P421 power supply (e.g., a channel could contain as a maximum 5 isolated input modules and 11 isolated output modules). Once this capacity is reached, I/O modules must be placed in another channel or subchannel if remote I/O is used.

   In some applications, several separate machines can be connected to one controller. When this is to be accomplished, consideration should be given to dedicating I/O modules to individual machines. This may result in slightly more I/O modules being required than if the I/O is combined onto a few modules. However, the maintenance advantages of being able to replace an I/O module and affecting only one machine at a time, can more than offset the slight additional costs.

APPENDIX F
SUMMARY OF MODEL DIFFERENCES 384 CONTROLLER COMPARED TO 184 CONTROLLER

384 CONTROLLER COMPARED TO 184 CONTROLLER

The 384 controller is basically an internally redesigned 184 controller. Externally the two controllers are very similar. The 384 controller is compatible with the 184 power supplies (models P420 and P421), I/O Housings (models B240 and B241), I/O Modules (see Appendix B), I/O cables (types W600-W606), Programming Panels (models P102, P112 and K112), Computer Interface (model I646) and Telephone Interfaces (models T151 with X435 and T152). It also uses the same programming format as the 184 controller, including same four element logic lines, same reference numbers, same DX codes, etc. Once a user is familiar with the 184 Programmable Controller, he is 90% familiar with the 384 controller. The purpose of this appendix is to note the difference between the controllers and thus fill in the other 10% knowledge required to be fully qualified on the 384 controller.

Physically, the 384 controller is about 3.5 inches taller than the 184 controller and is clearly labeled 384 above the black interlocking knob (see Figure F-1). An existing 184 installation can be replaced with a 384 by merely removing the 184 mainframe and replacing it with a 384 mainframe. The only change would be to have the lower mounting screws (if utilized) moved down 3.5 inches to accommodate the larger mainframe.

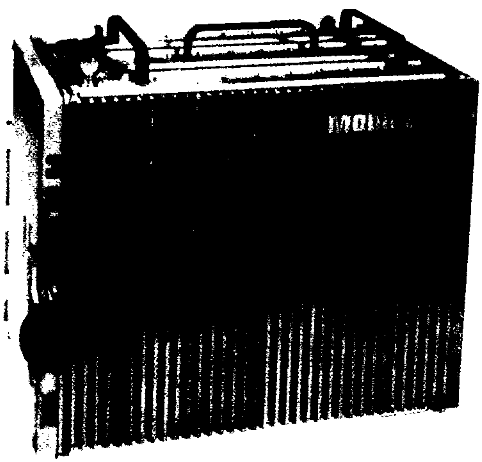


Figure F-1. 384 Controller

The model 200 and 202 Program Loaders are not compatible with the 384 controller. A new Program Loader, model 206, has been developed that is compatible with the 384 controller. This Program Loader is also compatible with the 084, 184, 284 and 1084 controllers and uses the high reliability triple redundant recording. Different interface devices may be required to interface to other model controllers (see their technical manuals).

The 384 controller is available only with 4K of core memory. Its internal redesign has resulted in significantly more logic lines than a 184-4 controller with similar capabilities. In addition, the 384 scanning or line solving times are much faster. All 384 controllers have the capability to program relay, timer, counter, calculate, and data transfer (DX) logic lines. All DX codes available in the 184 such as Move, Basic Matrix, Improved Matrix, Multiply/Divide, and P500 Print are also available in all 384 controllers.

To illustrate the improved capabilities, several example comparisons will be presented. First, compare the logic lines in a 184-4 Controller with MOPS 3 Mod 19 (288 lines, Move, Basic Matrix, Multiply/Divide and P500 Print) with a typical 384 Controller (672 lines, Move, Improved MATRIX, Multiply/Divide and P500 Print). This results in 133% more logic lines plus Improved Matrix capabilities. Another example: compare a 184-4 controller with MOPS 3 Mod 32 (464 lines, Move Improved Matrix, and P500 Print) with another typical 384 controller (768 lines, Move, Improved Matrix, Multiply/Divide, and P500 Print); this results in 66% more logic lines plus Multiply/Divide.

Finally, some comments on scan time. Individually line types require various time to solve in the 184 controller; the same is true of the 384 controller. However, each line type will be faster in the 384 than in the 184 controller. Exactly how much faster depends upon the specific line types. Relay lines will be about 20% faster; timer, counter and calculate lines, ten times faster; DX functions, up to forty times faster. The overall effect on a real system for which the 384 is intended (large system with extensive use of DX) should be a scan time of six to eight, possibly ten times faster in the 384 than the 184 controller, performing the same functions.

Internally, the 384 improvements were accomplished by altering the memory allocation. Figure F-2a illustrates a typical 184 core memory allocation. Stored in this memory is the MOPS (MODICON Operating System or executive), the logic line data, storage registers, and I/O status plus latches. As the MOPS added additional features, it required more core memory. In most applications, the more sophisticated capabilities more than offset the lesser quantity of logic lines, since this core area becomes smaller.

The 384 memory allocation is shown in Figure F-2b. Approximately 2K of ROM (Read-Only-Memory) is added and most of the executive is stored in this non-alterable memory. However, a small portion of the core memory is still required for the executive called TEF (Three Eighty Four) and defines the system (number of logic lines and registers, type of I/O, options selected, etc.). Since the TEF is in core memory, it can be altered by the MODICON Service Center via the Telephone Interface, to effect system configuration changes. The smaller executive in core allows more core memory to be allocated to logic lines, register, etc. In addition, use of the ROM for most of the routine executive capabilities, allows these lines to be solved significantly faster since the ROM speed (memory access time) is much faster than the core memory.

The fixed executive (firmware) stored in the ROM for the 384 controllers has been modified to add additional DX capabilities. These improvements have resulted in the 384A and 384B controllers. Each improvement was to add capabilities such that the controllers are backwards compatible. A 184 can be replaced by a 384, a 384 can be replaced by a 384A, and a 384A can be replaced by a 384B; however, each controller will require a different executive program. If provided with the proper notice, the Service Center can "overlay" or take the logic from one controller and match it with an executive designed for another type controller. The following chart illustrates the DX capabilities of the various model 384 controllers:

DX Group:	Quantity of Line Types Provided 384	384A	384B
Move (1YXX)	8	10	10
Matrix (2YXX)	9	10	10
Ext. Arth. (3YXX)	4	8	8
Print (4YXX)	3	3	7
TOTAL	24	31	35

See paragraphs 3.7 and 3.8 for details on DX functions with 384A and 384B controllers.

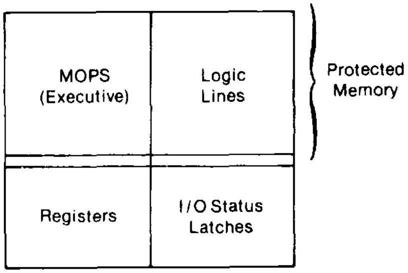


Figure F-2a 184 Controller

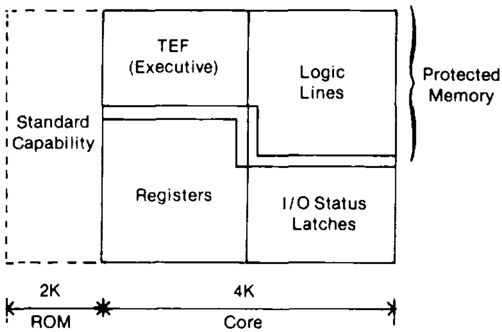


Figure F-2b. 384 Controller

The 384 executive (TEF) allows trade-offs to be conducted in the user's area of the core memory; Table F-1 illustrates the results of these trade-offs for various logic line vs. holding register quantities. In addition, one word of core memory is set aside to describe the various options that are available for any particular controller. Table F-2 defines these options and how to specify them; a complete definition of the TEF numbering system is provided in Figure F-3. If no options are specified, a "standard" system will be provided that contains: two timers in seconds and tenths of seconds, one up counter, calculate B + C with coil ON when result exceeds 9999, I/O serviced once a scan, and variable scan time. The use of several of these options may not be obvious, thus the following paragraphs will discuss each option in detail.

Table F-1. Typical Tradeoffs with Complete 30XX References

Total Logic Lines	384 Holding Registers	384A and 384B Holding Registers	384A and 384B Privileged Registers
976	43	38	37
960	91	86	36
944	139	134	35
928	187	182	34
912	235	230	33
896	283	278	32
880	331	326	31
864	379	374	30
848	427	422	29
832	475	470	28
816	523	518	27
800	571	566	28
784	619	614	30
768	667	662	32
752	715	710	34
736	763	758	36
720	811	806	38
704	859	854	40
688	907	902	42
672	928	923	27
656	929	924	75
640	930	925	123
624	931	926	171
608	932	927	219
592	933	928	267
576	934	929	315
560	935	930	363
544	936	931	411
528	937	932	459
512	938	933	507
496	939	934	555
480	940	935	603
464	941	936	651
448	942	937	699
432	943	938	747
416	944	939	795
400	945	940	843
384	946	941	891
368	947	942	939
352	948	943	987
336	949	944	999

NOTES

1. All configurations include maximum discrete inputs, up to 352.
2. Configurations shown are for maximum holding registers. Within a 384A or 384B controller, holding registers can be traded for privilege registers.
3. If another holding versus privileged register configuration is attempted for a 384A or 384B controller with line quantity at or above 688, the quantity of holding and privileged registers must be equal to or less than the quantity holding registers shown above.

Selection of Z Modifier

B = C Coil Option on Calculate Add	Timer 1/10 and 1/100 Sec	Down Counter	Constant Sweep	Hex Character
(None)				0
Yes				2
Yes	Yes			A
Yes	Yes	Yes		E
Yes	Yes	Yes	Yes	F
Yes	Yes		Yes	B
Yes		Yes		6
Yes		Yes	Yes	7
Yes			Yes	3
	Yes			8
	Yes	Yes		C
	Yes	Yes	Yes	D
	Yes		Yes	9
		Yes		4
		Yes	Yes	5
			Yes	1

Selection of Y Modifier

Binary Calculate (No Check of Resultant Magnitude)	I/O Twice a Scan	Hex Character
(None)		0
Yes		1
Yes	Yes	3
	Yes	2

Table F-2. Special Options

TEF UV Mod WX YZ

384 Executive — TEF

Executive Level: — UV

384	384A	384B
01 = Preproduction	05 = Preproduction	09 = Preproduction
02 = Basic Capability	06 = Basic Capability	10 = Current Capabilities
03 = PID in Core Memory	07 = All features except 29XX	
04 = Current Capability	08 = Full capabilities	

Configuration (See Tables F-3 or 4) — WX

Options (See Table F-2) — YZ

Figure F-3. 384 Executive Numbering

The standard 184 timers as indicated on the P112 Programming Panel, increment or count in either seconds or tenths of seconds. In the 384 controller, an option can be selected that converts these timers to increments ten times faster (tenths and hundredths of a second). When programming with this option, the pushbutton labels on the P112 should be divided by ten. This option is similar to the executive selection between some MOPS' level programs in the 184 controller. When selected, all timers in the 384 controller will be converted to ten times faster time increments.

A down counter can be provided in addition to the up counter. This down counter will replace the high order timer (either seconds or tenths of a second, depending on timer options previously discussed). When enabled, this counter will start with a current count equal to its preset and decrement its count once for every OFF/ON transition of the A element contact. At a current count of zero, its coil will be energized and remain ON until reset to the preset value via the B element contact. This option is similar to the executive selection between some MOPS 1 AND 2 level programs in the 184 controllers. When selected, all high order timers will be replaced by down counters.

Two options are available for the B + C calculate line coil status. Calculate B − C lines are always energized when the result of the subtraction is positive (including zero); there are no options with this line type. One option for the B + C calculate coil is to be energized when the B value exactly equals the C value (B = C coil option). With this option, the addition is still performed, including truncation of results if greater than 9999; however, the coil will energize only if B equals C, NOT when there is an overflow (resultant sum greater than 9999). This option is similar to the B = C coil option available with a number of MOPS 2 and 3 level programs in the 184 contoller. The second option for the B + C calculate line is a binary calculate, wherein the result of the addition is not checked for magnitude. With the binary calculation option selected, the coil will be ON if the result is greater than one register can contain in its sixteen bits (greater than 65,535 in magnitude). There is no 184 controller option equivalent to this binary calculate available in the 384 controller. Either of these B + C calculate options can be selected, but not both. When selected, all B + C calculate lines will reflect the B + C calculate coil option selected.

Normally in the 184 and 384 controllers the Inputs and Outputs (I/O) are serviced once a scan concurrent with logic line solutions. In some applications, it is desirable to service the I/O more than once a scan. The 384 controller has the option available to service the I/O twice a scan. If selected, the I/O will be serviced by pairing channels I and III together and II and IV together. Thus, when channel I slot 1 is normally serviced, channel III slot 1 will also be serviced. This pairing is on a slot by slot basis through channel II slot 8 and continues with channel III slot 1 paired with channel I slot 1. After channel IV slot 8 and channel II slot 8 have been serviced, only logic lines will be solved until the start of the next scan. Normally, unless special provisions are made by MODICON Engineering Department, the information obtained from the "extra" input servicing only will NOT be used to update the data in the controller's core memory. Thus, input status (discretes and registers) are still updated once a scan. This option is similar to the I/O servicing used on some MOPS 3 level programs in the 184 controller with extended sweep capability.

The final option is a constant scan feature. When selected, this option allows a maximum scan time to be specified which the controller monitors at the end of each scan. If that scan time is less than the limit specified, the controller delays until the scan time equals the limit, and then starts the next scan. If the scan time is greater than the limit, the next scan is immediately started and a value representing the amount of overshot is provided to the control system for monitoring. The desired constant scan time is placed into the last holding register available, and any overshot will be placed into the next to last register. Values are placed into these registers in 32 μSec increments (value 0950 = 30.4 ms). Constant sweeps greater than 200 ms (value 6250) are not allowed; if a value greater than 6250 is placed in the

WX	Lines	Input/Output Discrete	Input/Output Register	Holding Registers	Latches	No Additional 30XX References
01	896	128	16	283	0	
02	880	128	16	332	16(2865-2880)	
03	864	128	16	381	32(2833-2864)	
04	848	160	16	428	16(2001-2016)	
05	832	128	16	479	64(2769-2832)	
06	816	128	16	528	80(2001-2080)	
07	800	160	16	575	64(2737-2800)	
08	784	176	16	623	64(2721-2784)	
09	768	256	16	667	0	
10	752	256	16	716	16(2001-2016)	
11	736	256	16	765	32(2529-2560)	
12	720	256	16	814	48(2673-2720)	
13	704	256	16	863	64(2641-2704)	
14	688	256	16	912	80(2001-2080)	
15	672	256	16	934	96(2577-2672)	
16	608	384	8	930	32(2577-2608)	
17	640	256	16	936	128(2001-2128)	
18	592	400	7	930	32(2561-2592)	
19	432	256	16	992	336(2001-2336)	X
20	848	176	16	427	0	
21	752	128	16	724	144(2481-2624)	
22	752	64	16	728	208(2481-2688)	
23	720	256	16	830	48(2001-2048)	X
24	704	256	16	879	64(2001-2064)	X
25	592	256	16	992	176(2001-2176)	X
26	720	304	13	881	0	
27	768	256	16	683	0	X
28	432	160	16	992	432(2001-2432)	X
29	800	192	16	573	32(2769-2432)	
30	816	128	16	536	80(2001-2080)	X
31	672	256	16	977	96(2577-2672)	X
32	720	304	13	830	0	X
33	560	336	11	936	128(2433-2560)	
34	800	224	16	571	0	
35	640	384	8	928	0	
36	496	256	16	945	272(2001-2272)	
37	624	256	16	937	144(2481-2624)	
38	848	80	27	433	96(2001-2096)	
39	864	48	29	389	112(2001-2112)	
40	656	256	16	992	112(2545-2656)	X
41	800	208	19	572	16(2529-2544)	
42	768	240	17	668	16(2529-2544)	
43	816	192	20	524	16(2545-2560)	
44	752	256	16	732	16(2001-2016)	X

Table F-3. Available TEF04 Configuration

last holding register, the constant sweep option will use the value 6250. If the constant sweep option is NOT selected, these last two holding registers can be used for any purpose required by the application, just like any other holding registers; they have special significance only when the constant sweep option is selected. There is no 184 controller option equivalent to this constant sweep available in the 384 controller. Note that if a scan limit of zero is specified, the next to last holding register will be loaded every scan with a value that represents the actual scan time of the previous scan.

In addition to the above options, there are a few other differences in the 384 controller design not previously discussed. The internal clock that is used by all timers is crystal controller, not driven from the line frequency as in the 184 controller. This provides highly accurate timers in areas when line frequency is not closely regulated. The DX move codes 10xx and 11xx can be programmed as a register to register move (table length one) by using codes 1001 or 1101. When defined as a table of length one, there is no pointer involved and a direct register to register transfer is accomplished.

NOTE

When programming DX logic lines in the 384 controller, the C element must be programmed prior to the B or D elements, to insure that proper error checking criteria are selected.

WX	Lines	Input/Output Discrete	Input/Output Register	Registers Holding	Registers Privileged	Latches	Sequencer Inputs
01	720	256	16	809	40	48(2673-2720)	0
02	800	128	24	572	40	96(2001-2096)	0
03	784	128	24	616	40	32(2753-2784)	80
04	768	256	16	662	40	0	0
05	752	256	16	711	40	16(2001-2016)	0
06	704	256	16	854	40	0	64
07	688	256	16	907	42	80(2001-2080)	0
08	672	320	12	925	44	32(2001-2032)	0
09	656	256	16	925	75	32(2625-2656)	80
10	640	256	16	923	123	0	128
11	736	256	16	760	40	32(2529-2560)	0
12	512	512	0	923	507	0	0
13	704	256	16	855	40	16(2689-2704)	48
14	704	96	26	855	40	16(2001-2016)	208
15	576	352	10	929	315	96(2001-2096)	0
16	560	256	16	928	363	80(2481-2560)	128
17	544	256	16	925	411	32(2513-2544)	192
18	528	400	7	924	459	16(2513-2528)	80
19	512	256	16	929	507	96(2417-2512)	160
20	496	256	16	940	555	272(2001-2212)	0
21	480	352	10	927	603	64(2417-2480)	128
22	464	320	12	928	651	80(2385-2464)	160
23	448	256	16	923	699	0	320
24	432	400	7	925	747	32(2401-2432)	160
25	416	352	10	939	795	256(2001-2256)	0
26	400	320	12	932	843	144(2257-2400)	160
27	384	352	10	925	891	32(2353-2384)	256
28	368	400	7	927	939	64(2305-2368)	192
29	352	320	12	923	987	0	352
30	624	352	10	925	171	48(2001-2048)	0
31	608	256	16	925	219	32(2577-2608)	128
32	592	256	16	924	267	16(2577-2592)	160
33	752	128	24	711	40	16(2737-2752)	128
34*	720	304	13	811	38	0	0
38	688	256	16	904	42	32(2657-2688)	48
39	432	256	16	944	747	336(2001-2336)	0
40**	640	384	8	992	123	0	0
41	640	384	8	923	123	0	0
42*	560	336	11	936	363	128(2433-2560)	0

NOTES:

* Indicates configurations without system status 30XX references.
** Indicates configurations without additional 30XX references nor system status references.

Table F-4. Available TEF08 Configuration

WX	Lines	Input/Output Discrete	Input/Output Register	Registers Holding	Registers Privileged	Latches	Sequencer Inputs
01	720	256	16	809	40	48(2673-2720)	0
02	800	128	24	572	40	96(2001-2096)	0
03	784	128	24	616	40	32(2753-2784)	80
04	768	256	16	662	40	0	0
05	752	256	16	711	40	16(2001-2016)	0
06	704	256	16	854	40	0	64
07	688	256	16	907	42	80(2001-2080)	0
08	672	320	12	925	44	32(2001-2032)	0
09	656	256	16	925	75	32(2625-2656)	80
10	640	256	16	923	123	0	128
11	784	128	24	616	40	32(2753-2784)	80
12	752	160	22	717	40	0	0
13	512	336	11	934	507	176(2337-2512)	0
14	720	256	16	809	40	48(2673-2720)	0
15	576	320	12	931	315	128(2449-2576)	0
16	720	304	13	806	40	0	0
17	848	176	21	422	40	0	0
18**	672	352	10	992	27	0	0
19**	512	256	16	992	507	80(2433-2512)	64
20	704	96	26	868	40	16(2001-2016)	0
21	752	128	24	711	40	16(2001-2016)	128
22	608	256	16	925	219	32(2001-2032)	128
23	752	128	24	711	40	16(2737-2752)	128
24	608	256	16	925	219	32(2577-2608)	128
25*	720	256	16	814	38	0	0
26	704	96	26	855	40	16(2001-2016)	208

NOTES:

* Indicates configurations without system status 30XX references.
** Indicates configurations without additional 30XX references nor system status references

Table F-5. Available TEF 10 Configurations

184/384 MANUAL 9/78
CUSTOMER COMMENTS

1. Typographical Errors (P·

DO NOT SCAN REMAINING PAGES

2.

3. Fea

4. General Comments/Recommendations

Name ________________ ☐ Have Salesman Call

Company ________________ ☐ Have Applications Engineer Call

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516 Valley Forge Way
Cambell, CA 95008
(408) 379-9240

5512 Indiana Drive
Concord, CA 94521
(415) 827-0488

25 Erstwild Court
Palo Alto, CA 94303
(415) 854-6623

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Schaumburg, IL 60195
(312) 397-2707

105 Arrowhead Court
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(309) 694-4397/4398

140 Adams Street
Marengo, IL 60152
(815) 568-5300

INDIANA
7202 N. Shadeland Avenue
Suite 125
Indianapolis, IN 46250
(317) 842-4600

1311 South Main Street
Auburn, IN 46706
(219) 925-5843

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1322 Edna S.E.
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MINNESOTA
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81-3 217-4111

Yaskawa Electric America Ltd.
16722 Hale Avenue
Irvine, CA 92714
(714) 751-4103

USEFUL INFORMATION

GENERAL PROGRAMMING RULES

1. Any logic line can be converted to any valid line type
2. Logic lines are solved in numerical order with all results (coil status or register content) immediately available to next logic line
3. Any reference can be used as many times as necessary (no relay pole limitation)
4. All logic lines, regardless of type, contain exactly four elements and one coil.
5. The A element of all logic lines must be series relay contact
6. The B, C, or D elements of relay lines can be either series or parallel contacts If parallel, they always return to left.
7. Elements of logic lines can be programmed in any order
8. Holding registers are used to store numerical data. They are retentive upon power failure and contain maximum BCD value of 9999 or 16 bits of binary information
9. If in doubt, read the manual.

DX Codes

MOVE

10XX Table to Register (Incremental)
11XX Table to Register (Continuous)
12XX Register to Table (Incremental)
13XX Register to Table (Continuous)
14XX Table to Table (Incremental)
15XX First-In, First-Out Entry
16XX First-In, First-Out Exit
17XX Table to Table (Continuous)
18XX 30XX/4XXX to 5XXX Move (Block)
19XX 5XXX to 4XXX Move (Block)

MATRIX

20XX Matrix AND
21XX Matrix OR (Inclusive)
22XX Matrix Compare
23XX Bit Clear/Sense
24XX Bit Set/Sense
25XX Matrix Complement
26XX Matrix OR (Exclusive)
27XX Matrix Rotat Left
28XX Matrix Rotate Right
29XX Matrix Sequencer Move

EXTENDED ARITHMETIC

3000 General Multiply
3100 General Divide
32XX Fixed Multiply
33XX Fixed Divide
34XX PID Control (Classic)
35XX PID Control (Improved)
36XX Ascending Sort
37XX Descending Sort

PRINT (MODEL P500)

40PL Numerical Print
41XX Fixed Form Print
4200 Variable Form Print
43XX ASCII Output
44XX ASCII Input
45XX ASCII Numerical Output
46XX ASCII Numerical Input

Reference Numbers

0XXX — Logic Lines/Discrete Outputs
1XXX — Discrete Inputs
2XXX — Latches
30XX — Input Registers
4XXX — Holding Registers/Output Registers
5XXX — Privileged Registers

ERROR CODES

⊔11⊔ Memory Protect ON
⊔22⊔ Invalid Line Number
⊔33⊔ Invalid Reference
⊔44⊔ Illegal Line Type
⊔55⊔ Invalid Contact
⊔66⊔ DX-Illegal Reference
⊔77⊔ DX-Illegal Type

P112 BCD CODES

0	0000	5	0101	⊏	1010
1	0001	6	0110	⊐	1011
2	0010	7	0111	⊔	1100
3	0011	8	1000	⊑	1101
4	0100	9	1001	⊢	1110
				(Blank)	1111

BINARY VALUES

1
2
4
8
16
32
64
128
256
512
1024
2048
4096
8192
16384
32768

MULTIPLES OF SIXTEEN

(1)	1- 16	129-144	257-272	385-400	513-528	641-656	769-784	897- 912
(2)	17- 32	145-160	273-288	401-416	529-544	657-672	785-800	913- 928
(3)	33- 48	161-176	289-304	417-432	545-560	673-688	801-816	929- 944
(4)	49- 64	177-192	305-320	433-448	561-576	689-704	817-832	945- 960
(5)	65- 80	193-208	321-336	449-464	577-592	705-720	833-848	961- 976
(6)	81- 96	209-124	337-352	465-480	593-608	721-736	849-864	977- 991
(7)	97-112	225-240	353-368	481-496	609-624	737-752	865-880	993-1008
(8)	113-128	241-256	369-384	497-512	625-640	753-768	881-896	1009-1024