584 PROGRAMMABLE CONTROLLER BASICS

Programmable Controller Definition

A programmable controller (PC) is an electronic digital device designed to receive instructions for the monitoring and control of industrial processes.

Start/Stop Circuit

A ladder diagram for a conventional stop/start circuit is shown on the next page, along with a schematic for a typical motor starter. The ladder diagram depicts an normally open, momentary start button, which, when pressed, will energize the motor starter coil via the normally closed, momentary stop button. When this coil is energized it will cause the normally open contacts on the motor starter to close, powering the motor. A small auxiliary contact will also close. This contact is typically wired in parallel across the start button to create a "seal circuit", which will continue to power the motor starter coil after the operator releases the start button. Momentarily pressing the stop button will de-energize the motor starter coil causing its power and auxiliary contacts to open, which will de-energize the motor and return the stop/start circuit to its original state.

Additional overload contacts are wired in series with the motor starter coil so that when an overload condition exists the coil will de-energize.

Block Diagram

A basic block diagram of a programmable controller is also shown on the next page. Note that the motor start/stop circuit components are shown connected to the input and output modules.

A programmable controller performs three basic functions:

- *Monitors the field* via its input modules
- *Solves* programmed *logic* via the CPU
- Drives output modules to *direct field action*

Central Processor

The CPU is composed of four parts:

- Executive — A collection of programs which tell the CPU how to:
  1. Execute the control program (solve user logic)
  2. Communicate with peripheral devices (e.g. a printer)
  3. Perform system housekeeping activities (e.g. diagnostic routines)

  These programs are stored in programmable read only memory (PROM). This type of memory is termed "nonvolatile" meaning the executive program will not be lost if power is removed.
- Scratch Pad — Used by the CPU to temporarily store small amounts of data (e.g. calculations).
- State Ram — Random access memory where the system's I/O status is continuously updated.
- User Memory — Storage area for programmed instructions entered by the user. Includes ladder logic, ASCII messages, and system database information.

  This random access memory (RAM) is composed of CMOS (Complimentary Metal Oxide Semiconductor) integrated circuits that require DC power to retain their content. This type of memory is termed "Volatile", however, the amount of DC power required to maintain memory is very low, allowing relatively small batteries to maintain memory for relatively long periods of time.

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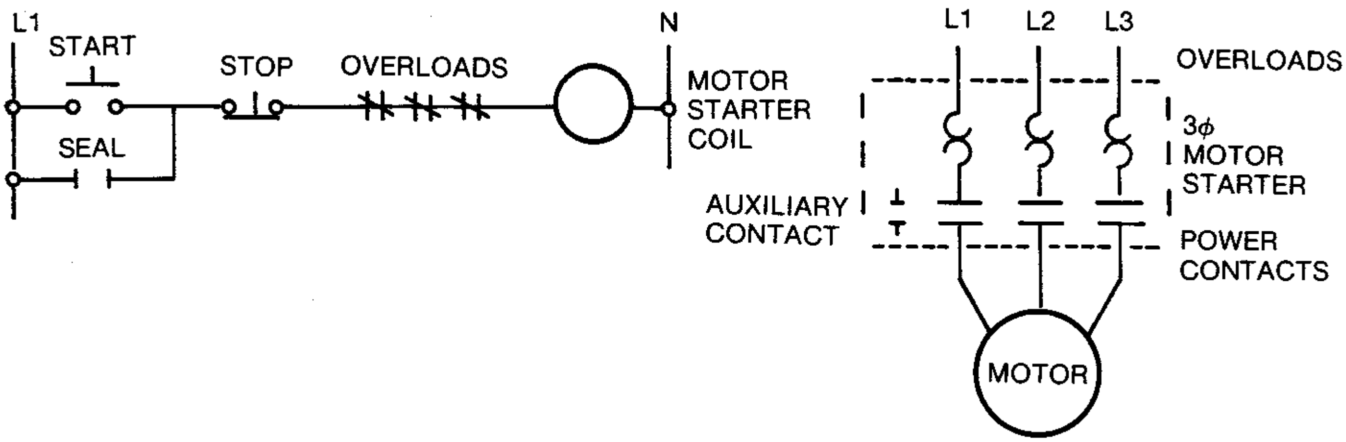
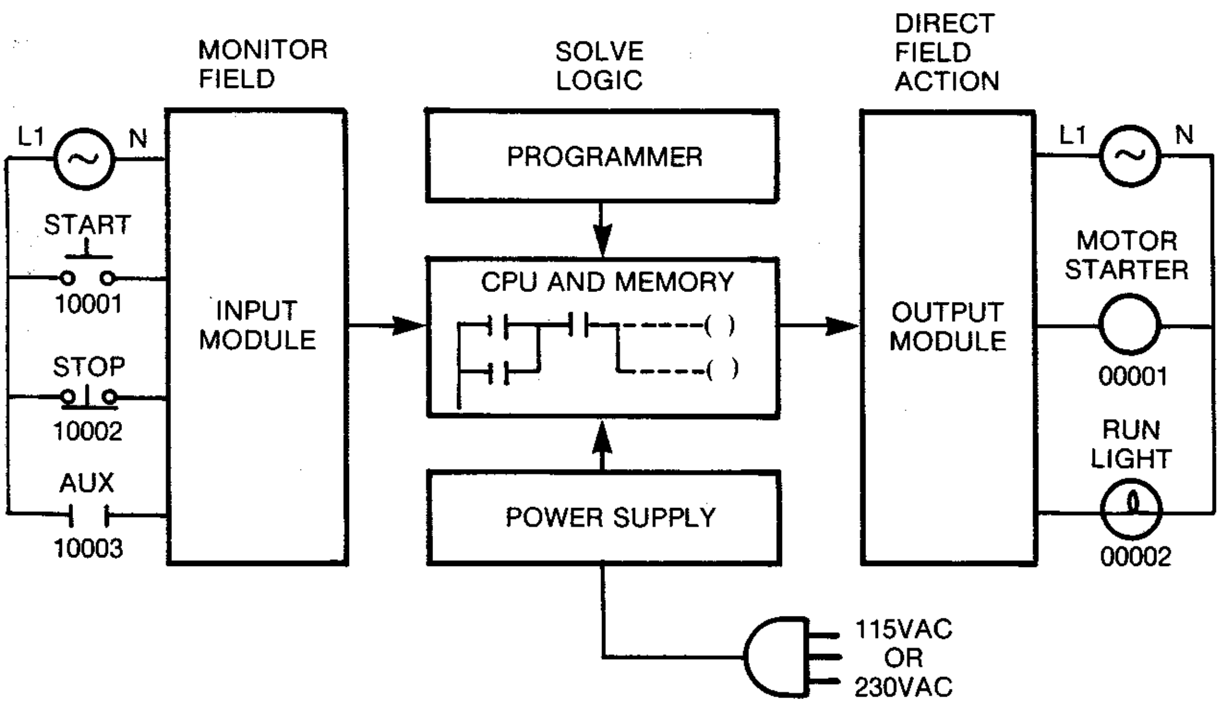
Conventional Start/Stop Circuit



Programmable Controller Basic Block Diagram



Input/Output Modules

A programmable control system requires a means to receive and send signals from the field which are processed and executed by the controller's CPU. This is accomplished by the system's input and output modules.

Input modules accept signals from the user's machine or process, such as limit switches, thumbwheel switches, or transducers. Input modules accept signals that fall within predetermined voltage and/or current ranges, and convert the electrical signals into acceptable voltage levels for processing by the computer.

Output modules return a control signal back to the machine or process to such devices as motor starters, lighted displays, or valve actuators. The output modules accept electrical signals from the controller and convert these signals into voltage and/or current levels necessary to activate the user's working or indicating devices.

The 584 is capable of communicating with 200, 500, and 800 series I/O modules.

All modules feature:

- Conduit for user wiring
- Pressure terminals for 1 #12 or 2 #14 wires
- I/O status indicators which reflect the on or off state for each discrete I/O point. These indicators are connected to the field side of the modules circuitry to provide easy system troubleshooting.
- Fused outputs and blown fuse indicators
- Individual 1500 volt opto-isolators to prevent field wiring transients from affecting internal logic.
- Surge suppressors capable of sinking 10 joules of energy in nanoseconds (approximately 80 #5 starters or 350 small relays).
- Operation from 0 to 60 degrees C.
- Operation from 0 to 95% relative humidity (non-condensing).
- Even model numbers for input modules, and odd model numbers for output modules.
- The ability to be removed or replaced without interrupting power, the controller's scan, or the field wiring, and without damage to the module.

  Output modules with triacs may, upon insertion into a powered housing, cause the output to momentarily energize. The following warning is excerpted from the "Gould Programmable Controller's Handbook":

WARNING: *Do not remove or insert any modular unit (power supply, I/O module, processor, memory board, etc.) when the primary AC power is applied to the power supply (hot swapping). Always remove power before removing or inserting the unit. Failure to do so may cause unreliable control operation and, in some circumstances, injury to personnel or damage to equipment.*

200 and 800 series modules have an "active" light which indicates that the module is communicating with the mainframe.

Each I/O module is labeled with its part number, type, and voltage range. A color coded strip is added to decrease the chance of replacing the module with one of the wrong type. 800 series modules have a mechanical keying scheme. At the user's option, pins can be installed to code specific slots within the I/O housing, completely preventing the possibility of improper module replacement.

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Power Supply

The power supply provides the various DC voltages required by the 584. It is designed to operate in severe operational environments such as temperature and humidity extremes, steady shock and vibration, high frequency electromagnetic fields, and power line transients. It is "strappable" for either single phase 115 VAC or 230 VAC operation and is also designed to accept the "dirty" power typically found in factory environments where motor starting surges and high energy inductive load switching are common.

The power supply will accept significantly "out of range" input voltages; +15% on a continuous basis. The power supply will also operate at 60 degrees C without the need for cooling fans. Because of these high performance capabilities, isolation transformers will not normally be required.

The power supply is protected from unsafe conditions. If AC voltage drops out of range for more than one power cycle, the power supply will initiate a logical shutdown of the system. The power supply is also capable of maintaining power for up to 30 msec. on loss of supply voltage, thereby allowing the 584 to control this shutdown.

Programmer

The P190 programmer is used to program the user's control logic and interface with the controller's CPU. The P190 provides the following features:

- On-line programming.
- A 9" CRT screen which displays programs, database configuration data, register contents, and other useful control information.
- Printer interface.
- Formats ASCII messages.
- Loads, records, and verifies integrity of programs via built-in tape drive.

Reference Numbers

Five digit numbers, termed "Reference Numbers", are used in user logic to identify the following:

- Inputs
- Outputs
- Relay contacts in user logic
- Coils in user logic
- Input registers
- Holding/output registers

The 584 uses five types of reference numbers. Note that the first digit determines the reference number type.

0XXXX = Coils/Discrete Outputs

- A discrete (On/off) signal controlled by user logic
- Can be used to drive a real output via an output module
- Can be used internally to drive one or more contacts in user logic

1XXXX = Discrete Inputs

- A discrete signal controlled by an input module
- Used to drive one or more contacts in user logic

3XXXX = INPUT REGISTERS

- A numerical input from an external source (e.g. thumbwheel switches, analog signals, or hi speed counter module)
- Can be sixteen consecutive discrete signals
- Can be binary or binary coded decimal (BCD)

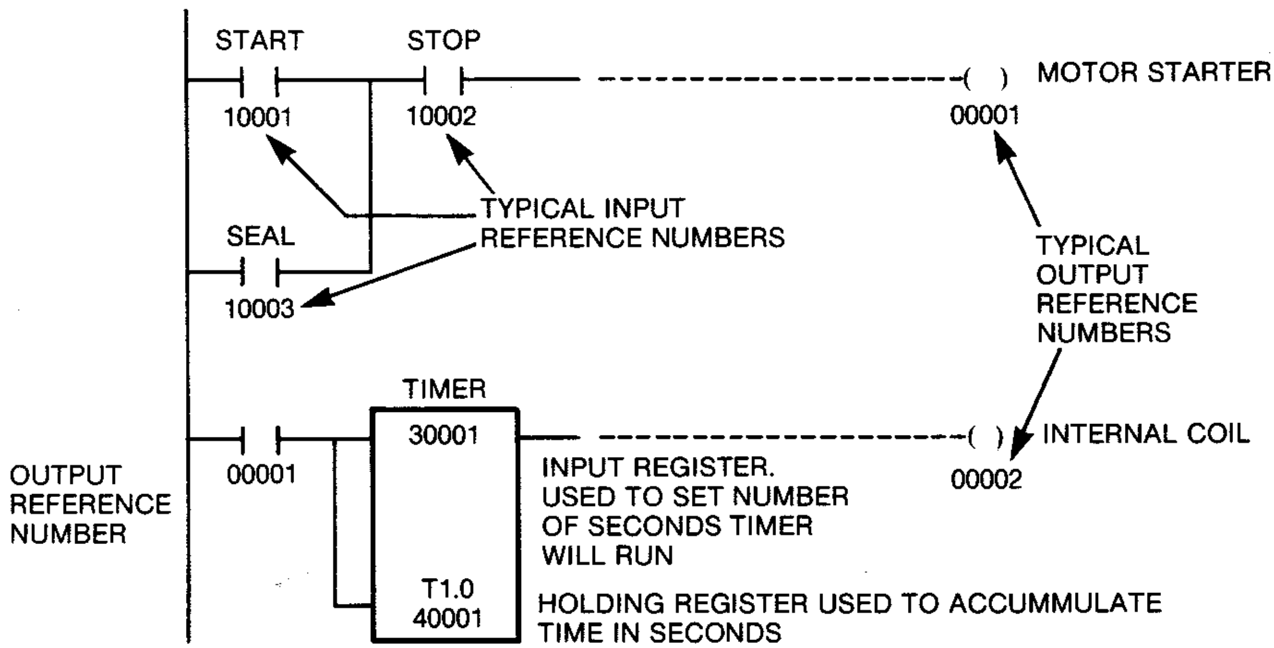
4XXXX = Holding/Ouput Registers

- Used to store numerical information, decimal or binary, in the controller
- Can output numerical information to an output module (e.g. LED display)

6XXXX = Extended Memory Registers

- Used to store binary information in the extended memory area of a *584L only*

Reference Number Examples



STATE RAM

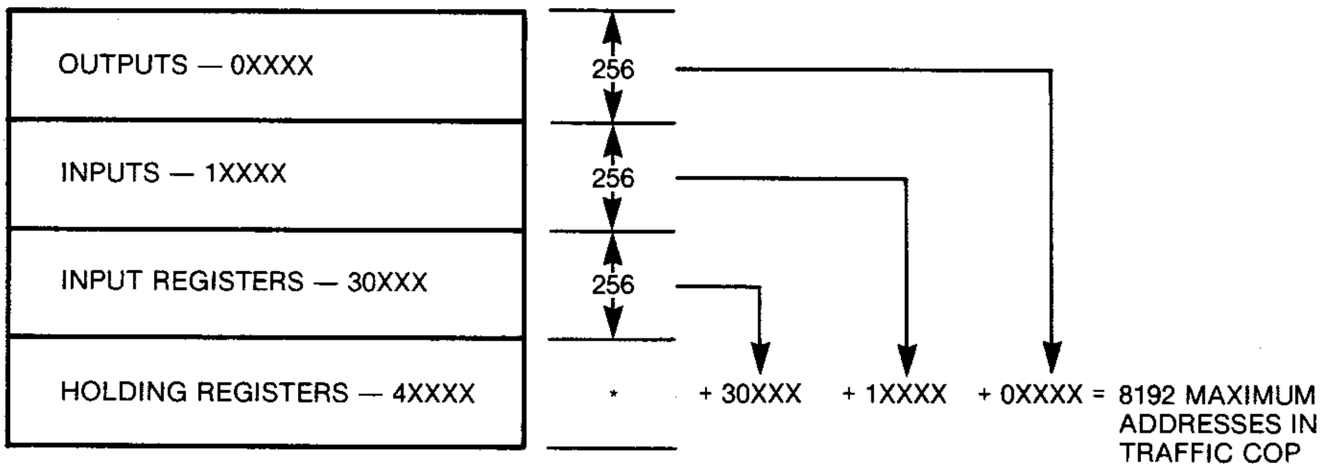
Definition

Random access memory where the system's I/O status is continuously updated.

Minimum Configuration

The minimum configuration possible is 16 outputs, 16 inputs, 1 input register, and 1 holding register.

MAP



* THE MAXIMUM NUMBER OF HOLDING REGISTERS VARIES ACCORDING TO THE CONTROLLER MODEL.

State RAM Examples

The following example assumes that the 584 has been configured for:

48 Outputs (00001 thru 00048)
48 Inputs (10001 thru 10048)
2 Input Registers (30001 & 30002)
5 Holding Registers (40001 thru 40005)

00001	00002	00003	00004	00005	00006	00007	00008	00009	00010	00011	00012	00013	00014	00015	00016
00017	00018	00019	00020	00021	00022	00023	00024	00025	00026	00027	00028	00029	00030	00031	00032
00033	00034	00035	00036	00037	00038	00039	00040	00041	00042	00043	00044	00045	00046	00047	00048
10001	10002	10003	10004	10005	10006	10007	10008	10009	10010	10011	10012	00013	00014	00015	00016
10017	10018	10019	10020	10021	10022	10023	10024	10025	10026	10027	10028	10029	10030	10031	10032
10033	10034	10035	10036	10037	10038	10039	10040	10041	10042	10043	10044	10045	10046	10047	10048
							30001								
							30002								
							40001								
MSB							40002								LSB
							40003								
							40004								
							40005								

The following state RAM example depicts the resultant bit pattern assuming:

Odd numbered outputs are on (00001 — 00048)
Even numbered inputs are on (10001 — 10048)
30001 = 1
30002 = 3
40001 = 7
40002 = 15
40003 = 31
40004 = 63
40005 = 127

00001	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	00016
00017	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	00032
00033	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	00048
10001	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	10016
10017	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	10032
10033	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	10048
30001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
30002	0	0	0	0	0	0	0	0	0	C	0	0	0	0	1	1	
40001	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	
40002	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	
40003	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	
40004	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	
40005	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	

STATE RAM

00001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	00016
00017	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	00032
10001	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10016
10017	0	0	0	1	0	0	1	0	0	1	0	0	1	0	0	0	10032
30001	0	0	0	1	0	0	1	0	0	1	0	0	1	0	0	0	30001
30002	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	30002
40001	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	40001
40002	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	40002
DISCRETE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
BINARY	32K	16K	8K	4K	2K	1K	512	256	128	64	32	16	8	4	2	1	
BCD	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1	
	THOUSANDS				HUNDREDS				TENS				UNITS