About this manual

This manual describes the installation and use of PL7-PCL V6 software installed under X-TEL or MINI X-TEL software workshops.

PL7-PCL V6 software lets the user develop applications for TSX/PMX V4 or V5 level PLCs.

Under X-TEL, before the user can run PL7-PCL software, the TSX/PMX PLC station that will run the application must be selected. PL7-PCL takes into account the type of "target" station and displays V5 level screens and menus when a V5 level station is selected or V4 level screens and menus when a V4 level station is selected.

The main development between PL7-PCL V5 and PL7-PCL V6 is the use of the TSX AEM 1212 module.

Developments since PL7-PCL V4, as well as how to convert previous V4 applications, are described in the appendix of this manual.

Important

A process control application, designed using PL7-PCL, can only run on a TSX or PMX model 40 processor, software version 4.3 or higher (refer to the label on the processor).

1.1 Features Supported by PL7-PCL

PL7-PCL software is used for the control of industrial processes designed for use with the TSX AEM family of analog input modules.

The PL7-PCL program comprises two main components:

- One that supports process control,
  - PID algorithm in an Optional Function Block (OFB),
- One that lets the user implement TSX AEM 411/412/413/811/821/1601/1602/1613 or 1212 modules,
  - Configuration, threshold selection, etc,
  - Configuration load OFBs,
  - Diagnostic OFBs.
- **Process control features,**
  - Process control processing (proportional, integral or derived action, filters, alarms, limits, etc.),
- **Analog input module features,**
  - User assistance with configuration parameter input through easy to use menus and on-line documentation,
  - User assistance with diagnostics and debug actions,
  - Configuration transfer between the PLC memory, TSX AEM module memory and disk storage,
  - Configuration and threshold documentation,
  - Configuration and threshold data storage on disk,
  - Configuration print-out.

1.2 Installing PL7-PCL

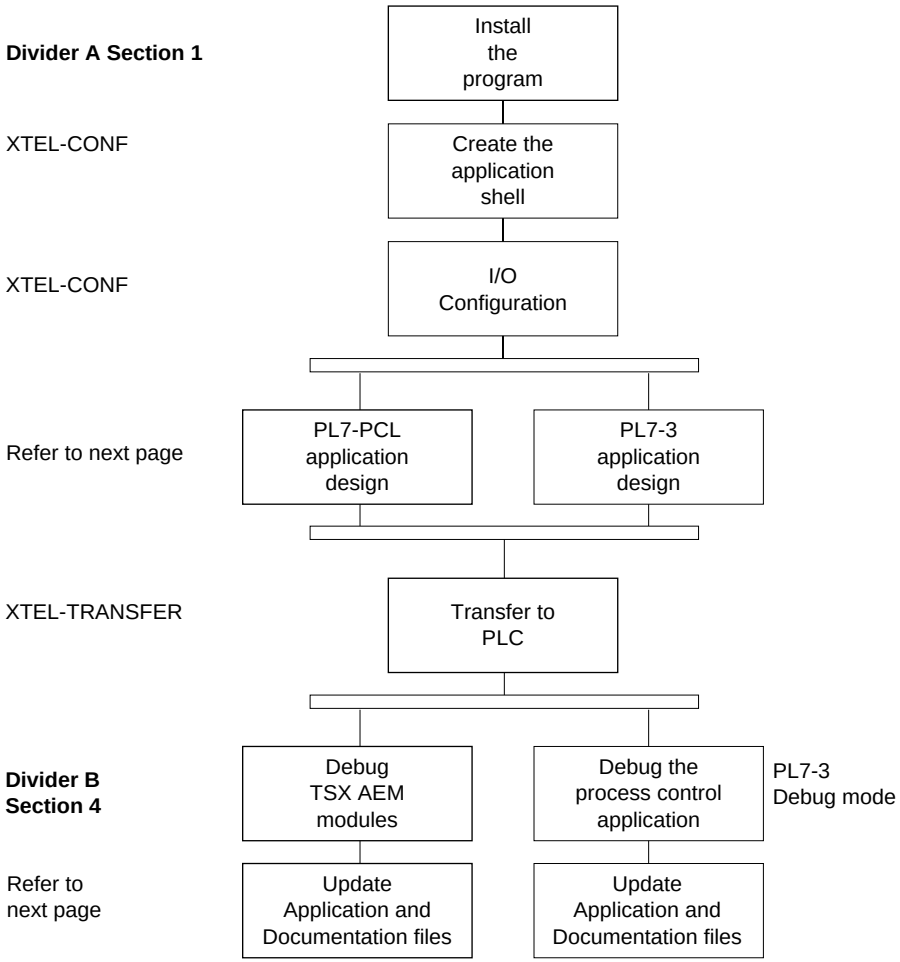
PL7-PCL runs under OS/2, in the X-TEL or MINI X-TEL software workshop. It also requires PL7-3 to be installed.
During installation of PL7-PCL, select the following software :

- PL7-PCL configuration software,
- the PL7 OFB function block library.

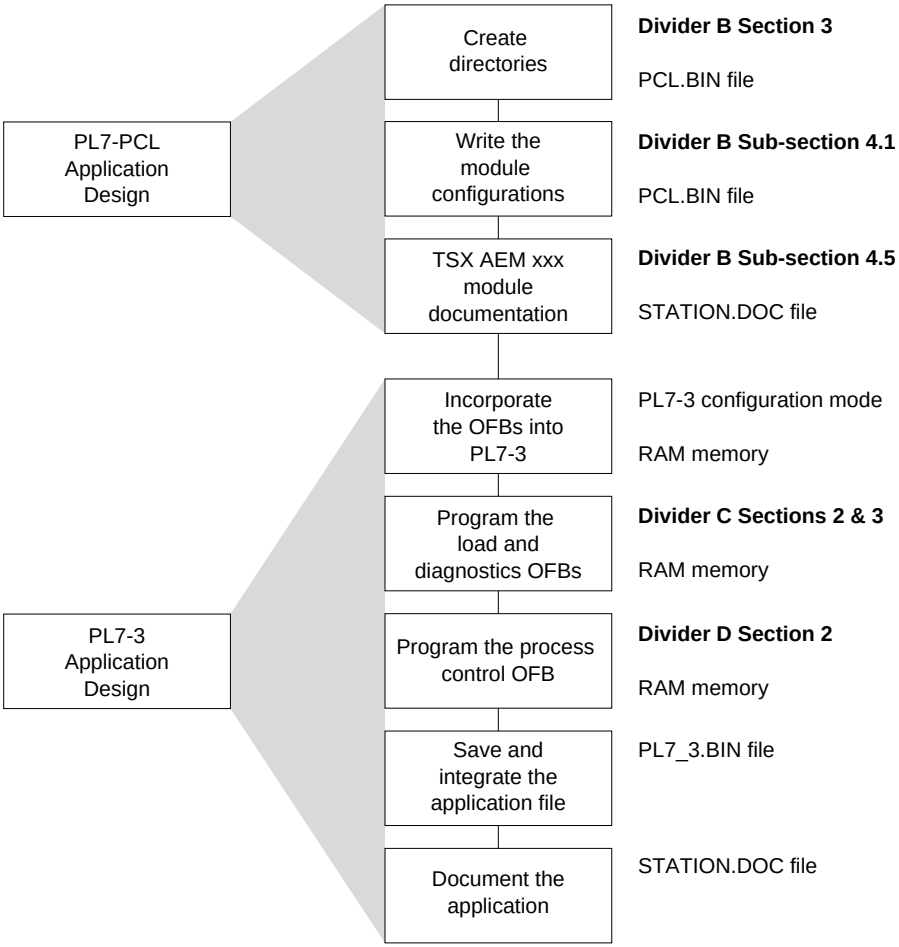
Its use is protected by PL7-PCL V4 accesss rights.

2.1 Methodology Proposal for Setting up a Process Control Application on a TSX Series 7 PLC

The methodology example described here is designed to assist the user during the generation, debug, storage and documentation phases of application development. As this is a methodology example only, the various operations are described without detailing the operating modes required.



PL7-PCL and PL7-3 application design phases



1.1 Selecting the Configuration Program

The TSX AEM module configuration program is run by opening the corresponding PCL window. To do this:

- Access the XTEL station containing the modules to be configured (access via XTEL, MINI XTEL or the XTEL Browser),
- Open the Station by double clicking on its icon,
- Open the PCL function by double clicking on its icon. If the icon is not available in the Functions secondary window even after the program has been installed, then the function has not yet been defined. To define the function:
  - Pull down the **Define** menu and select **New**,
  - Click on PCL then click on OK to validate.
- For greater visual comfort, select a full screen PCL session.

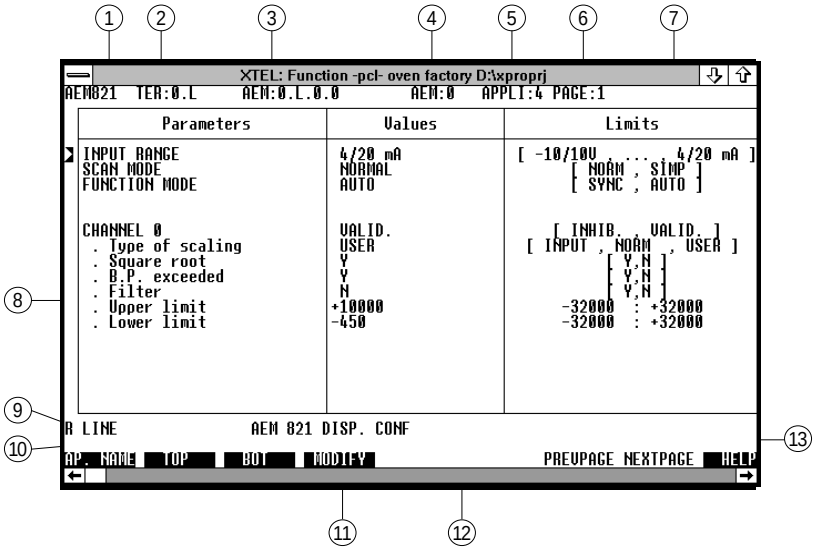
Notes

- If a PL7-PCL session is already open (the corresponding icon is already displayed on-screen outside the Functions secondary window), simply double click on the icon to open its window,
- To close a session, click on the corresponding icon, which will pull down a menu. Then click on the **Close/Exit** command.

1.2 Display Screen Presentation

The display screen is the window that displays PL7-PCL screens. All of the elements that are common to all Mini X-TEL or X-TEL Software Workshop programs (icons, window title line, window commands, etc.) are described in the appropriate Mini X-TEL or X-TEL Software Workshop documentation.

Information displayed



① Working memory,

② Network address of the terminal,

③ Working memory and its address if MEM AEM or MEM TSX is selected,

④ TSX AEM module number or the file name if DISK working memory is selected,

⑤ Application number,

⑥ Current page number,

⑦ Application name,

⑧ Configuration parameter display field,

⑨ Real-time events field: displays the PLC status,

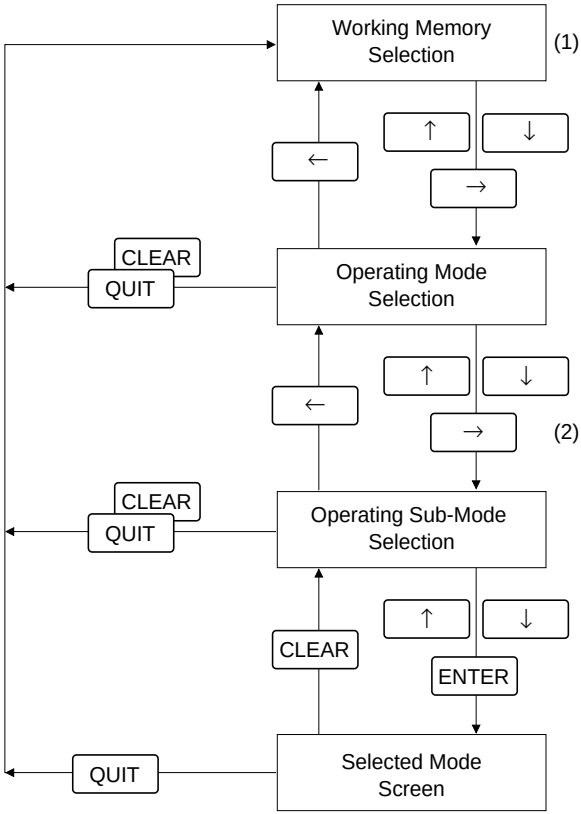
⑩ Parameter entry line,

⑪ Current task display field (DISP, MODIFY, etc.),

⑫ Display line for dynamic soft keys [F1] to [F9],

⑬ User or syntax error message display field.

Screen display sequence principles

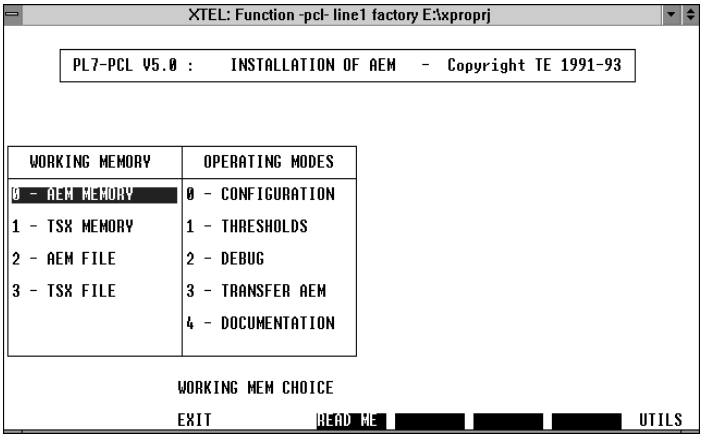


(1) Access to connected mode: AEM MEMORY or TSX MEMORY requires:
- Previous transfer of the memory configuration file to the PLC memory,
- At least one TSX AEM module is declared in the XTEL-CONF I/O configuration.

(2) Only in Debug and Transfer modes.

1.3 Mode Selection

The mode selection screen, which is the basic screen in PL7-PCL, lets the user access all of the functions supported by the program.



This screen comprises two parts:

- A menu field that lets the user select the:
  - Working memory (Module, PLC or Disk),
  - Operating modes (Configuration, Thresholds, Debug, Transfer AEM and Documentation),
  - Operating sub-mode for Debug and Transfer AEM modes.
- A data field (in connected mode operation) that displays the:
  - Working memory,
  - Processor type,
  - Current directory.

Function keys

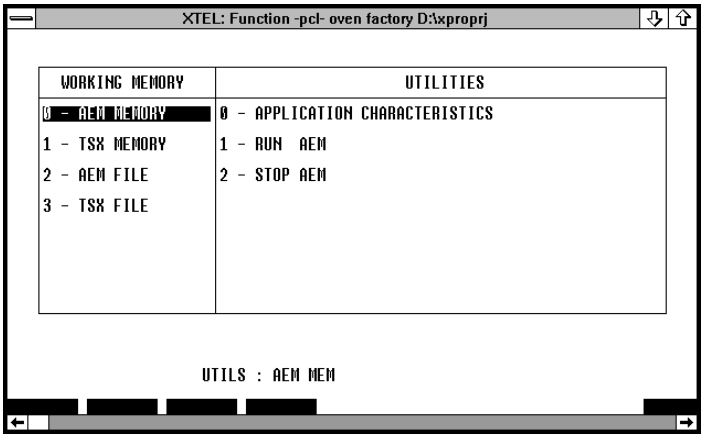
< ↑ > < ↓ >	Move the cursor within the active column: working memory, operating modes or operating sub-modes. An item in a column can also be selected by entering its number.
< → > < ← >	Let the user move between columns.
<Enter>	Validates all of the selections made.

Dynamic soft keys

[EXIT] Lets the user exit PL7-PCL with the possibility to select save or compare actions.

[READ ME] Lets the user access the on-line documentation.

[UTILS] Lets the user access the utility functions.

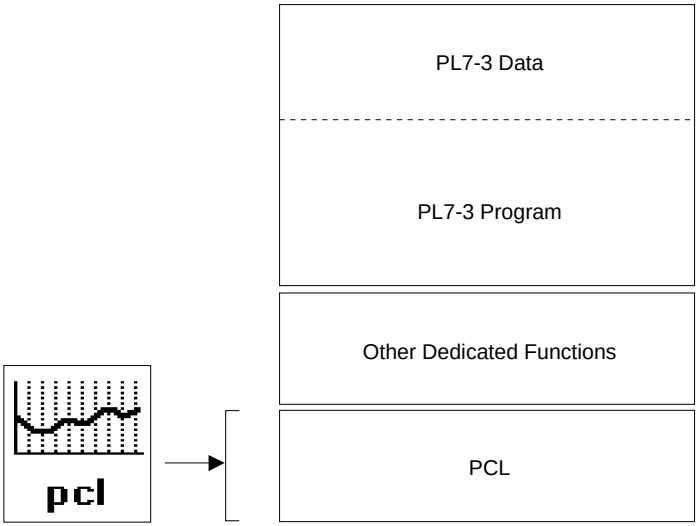


The other dynamic soft keys that are specific to the selected mode are described in Section 2, Selecting the Working Memory.

1.4 Link with the PLC Memory

1.4-1 Dedicated PCL Field in the PLC Memory

When the PCL function is declared at station level, a dedicated field is automatically created by XTEL-CONF when the STATION.APP field is generated. The size of this field, which is assigned a default setting by XTEL-CONF, can be modified by the user. The position of the field is determined by the size of the fields assigned to PL7-3 and the other dedicated functions that it follows. This field is fully controlled by the PL7-PCL program.



PCL field contents

When the image of the PLC memory is created by XTEL-CONF, this field is blank. It will be filled-in later by the PL7-PCL(1) program. It comprises:

- A directory comprising a:
  - Correspondence table between logical and physical slot numbers of the modules in the racks. The program generates a default assignment(2) that can be modified by the user,
  - Table that gives the start address and the size of the configurations stored in the dedicated field.
- The configurations stored in rising order of logical number.

(1) On condition that the PLC memory image comprises the I/O configuration with the slots taken by TSX AEM xxx modules.

(2) Numbering from 0 to 63 is the order in which modules are entered in the I/O configuration using XTEL-CONF.

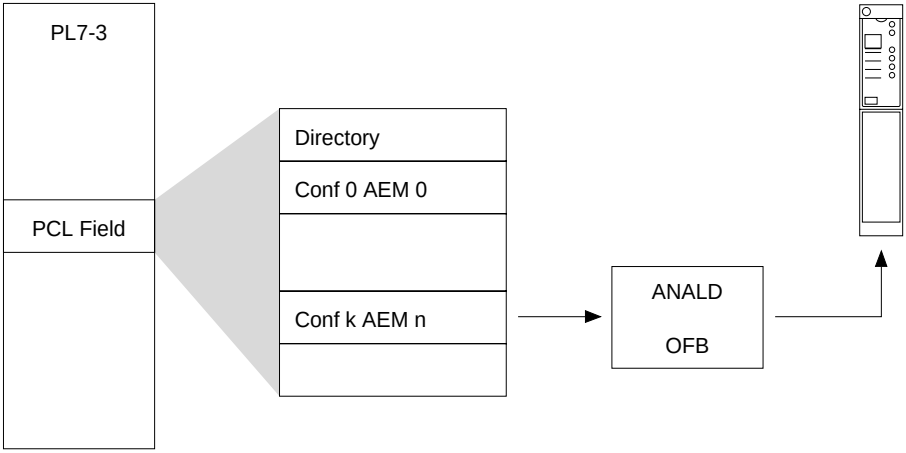
PCL dedicated field

Correspondence table between configuration number and module location
Address and size of stored configurations
Configuration 0 AEM 0
Configuration 1 AEM 0
Configuration 0 AEM 1
Configuration j AEM n

Directory

This field contains data that can only be accessed by PL7-PCL program functions that handle the PCL field organization. A compacting function lets the user optimize the contents of the field. The image of the dedicated PCL field is stored in the PCL.BIN file in the PCL\APPLI directory.

A configuration stored in this field can be transferred to a TSX AEM module by the ANALD OFB.



The ANALD OFB is described in Divider C, Section 2.

The term **configuration** used here designates all of the parameters defined:

- In Configuration mode to adapt the module to the sensors used,
- In Threshold mode to define the threshold values.

It is equivalent to the term **application** used on-screen by the implementation program. For each module, the user can define a number of **configurations** that differ only in the selected threshold values (each **configuration** is numbered from 0 to 8). In most cases, a single **configuration** (numbered 0) is all that is required (with set threshold values or without the need to use the Threshold function).

1.4-2 Reservation in Connected Mode Operation

On a single MAPWAY/ETHWAY/FIPWAY/ETHERNET network, any FTX 507/417 or compatible microcomputer can be physically connected to any TSX Series 7 PLC station. Therefore a number of terminals can request logical connection to the same PLC station.

To avoid access and procedure conflicts, each terminal will on request reserve the entire PCL dedicated field. This reservation is only performed when access, in read or write, is required to a directory or configuration.

If the PCL dedicated field is not already reserved by another logical device, the device that requests the reservation can gain access to the field.
From this moment on, any attempt to access it by another logical device will be rejected and the message TSX ALREADY RESERVED will be displayed. Once the action in progress is completed, the reservation is terminated.

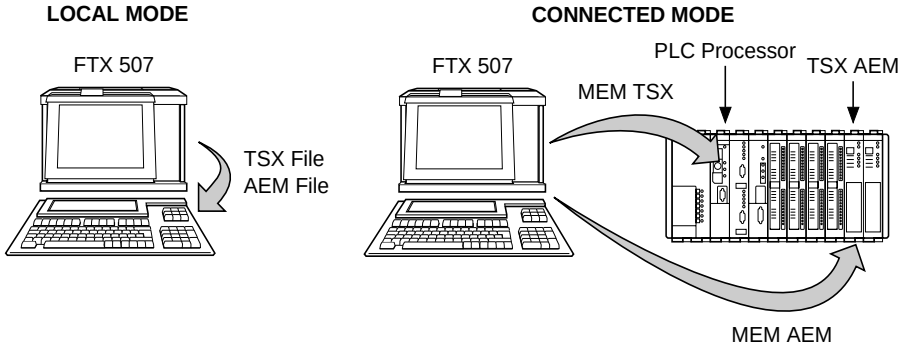
Attention

PL7-PCL cannot be used to setup a remote station via a TELWAY network.

1.5 Methodology

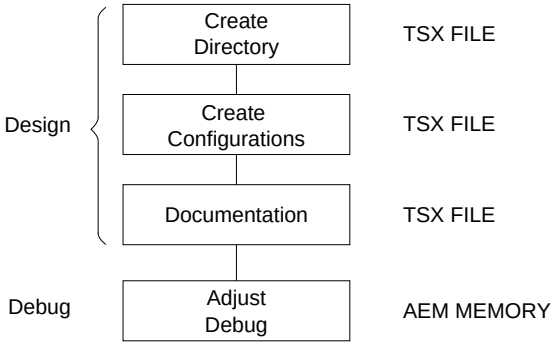
The TSX AEM module configuration program lets the user work in:

- Local mode, with the disk as working storage,
- Connected mode (on-line) with the module memory (MEM AEM) or the PLC memory (MEM TSX) as the working memory.



Using the local memory to create TSX AEM configurations and the dedicated PCL field is recommended. There is nothing to stop the user generating a complete application in connected mode but this mode should preferably be reserved for modifications, corrections and debug functions.

The set-up process comprises a design phase followed by a debug phase:



Design phase

- Create the directory
  - Open the PCL window,
  - Select TSX/PMX FILE as the storage media,
  - Select DIR PCL (the program automatically recognizes the STATION.APP file),
  - Select <Enter> to exit.
- Create the configurations
  - Select TSX/PMX FILE as the storage media,
  - Select the TSX AEM module and application numbers,
  - Create the configurations (parameters, thresholds, etc.),
  - It is possible to generate a library of configurations by performing the MEM TSX → AEM FILE transfer action. Any files stored in this way take a 411, 412, 413, 811, 821, 16I (for 1601), 16U (for 1602), 16P (for 1613), or 12T (for 1212) extension, depending on the type of TSX AEM module selected.
- Documentation
  - Select TSX/PMX FILE as the storage media,
  - Document each configuration, the output will be sent to the printer or to a disk file.

Debug phase

- Debug and adjustments
  - Select MEM AEM as the storage media,
  - Modify the configuration (parameters, thresholds, etc.),
  - Transfer the configuration to the PLC memory (MEM AEM → MEM TSX),
  - Debug all of the configurations that may be downloaded to TSX AEM modules.
- Documentation
  - Select MEM TSX as the storage media,
  - Document each configuration (the output will be sent to the printer or to a disk file).

Remark

In file mode, PL7-PCL acts directly on the PCL.BIN file. No backup copy is required.

2.1 Presentation

2.1-1 Operating modes

The working memory selection determines the operating mode of the PL7-PCL program and whether it uses local (off-line) or connected (on-line) modes.

Local mode operation

In this case, the hard disk is selected as the location of the working memory field. The local mode lets the user:

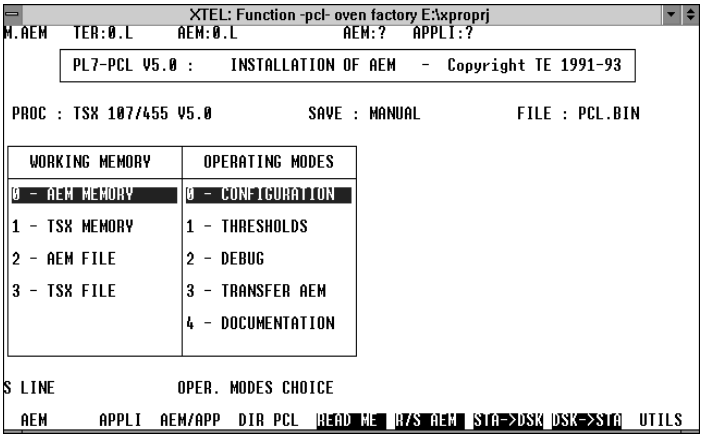
- Define configurations for all TSX AEM module channels (AEM file).
  The configurations that are generated in this way are assigned to specific types of TSX AEM module (TSX AEM 411, etc.),
- Generate the PCL.BIN file that is the image of the dedicated PCL field (TSX file).

Connected mode operation

In this example the AEM memory field (module memory) or TSX memory field (dedicated memory field in the PLC) was selected as the working memory field. The connected mode lets the user:

- Generate or modify a configuration,
- Generate the dedicated PCL field,
- Transfer the configurations from the disk to the module memory or the dedicated memory field in the PLC.

When the terminal is connected to a TSX AEM module, the PL7-PCL program also lets the user perform Debug actions.



2.1-2 Common Dynamic Soft Key Functions

The dynamic soft keys that are common to the various modes are described below:

[AEM] Selects the number of the working module. In Documentation mode, the "*" validates all configured TSX AEM modules,

[APPLI] Selects the number of the working configuration. In Documentation mode, the "*" character validates all of the configurations of the selected module. AEM = * and APPLI = * let the user document all of the configurations stored in the PLC memory,

[AEM/APP] Selects the number of the module and of the working configuration,

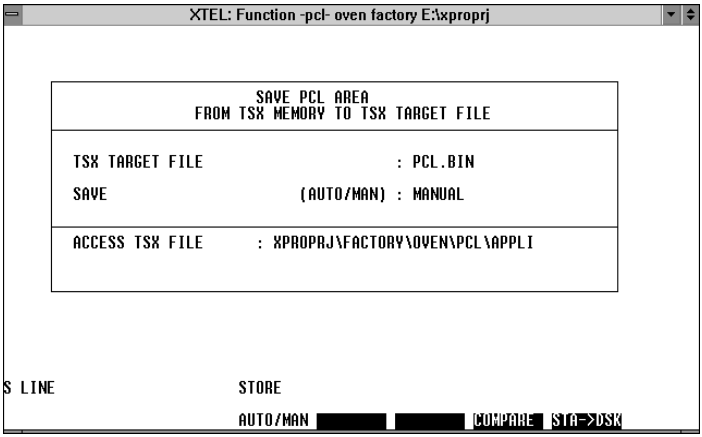
[DIR PCL] Lets the user access the AEM directory on-screen (refer to Divider B, Sub-section 3.2) or create it if it does not already exist.

[READ ME] Lets the user access the PL7-PCL program help screens,

[R/S AEM] Toggles the TSX AEM module between Run and Stop,

[R/S TSX] Toggles the PLC between Run and Stop.

[STA → DSK] Displays a screen that lets the user store the dedicated PCL field to disk as a PCL.BIN file stored in the XPROPRJ\PROJECT\STATION\PCL\APPLI directory:

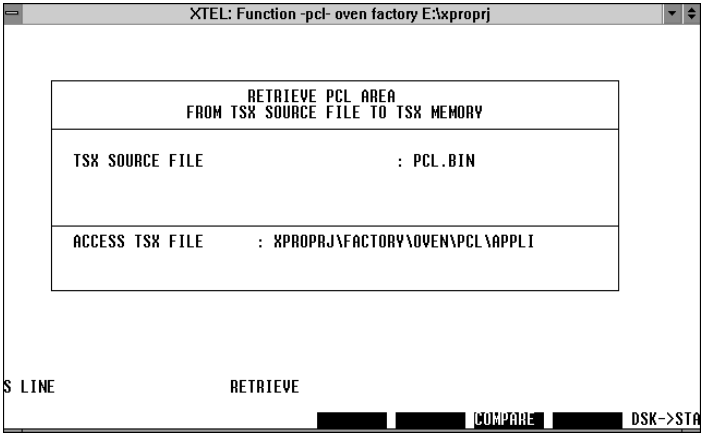


[AUTO/MAN] Lets the user select the type of save to perform. In Automatic mode, all of the modifications are systematically stored. In Manual mode, all of the modifications made will only be stored when the user presses the [STA → DSK] key.

[COMPARE] Compares the source and target (destination) files.

[STA → DSK] Stores the file and after confirmation by the user, runs XTEL-CONF to update the STATION.APP file corresponding to the configuration.

[DSK → STA] Displays a screen that lets the user transfer, to the dedicated PCL field in the PLC memory, the contents of a PCL.BIN file previously stored on disk:



[COMPARE] Compares the source file and the dedicated PLC field,

[DSK → STA] Retrieves the selected file.

2.2 Selecting the AEM Memory

```
WORKING  MEMORY
0 - AEM  MEMORY
1 - TSX  MEMORY
2 - AEM  FILE
3 - TSX  FILE
```

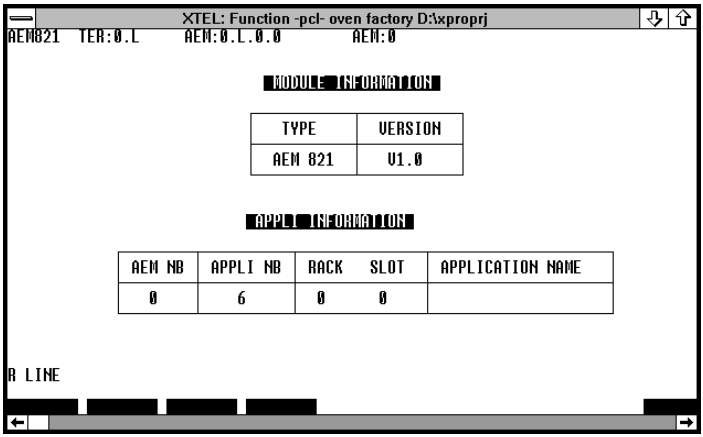
The AEM Memory field is the only one that supports module debug and operation actions.

The configuration is saved directly to the module memory each time it is validated.

The AEM memory can only be used if a STATION.APP configuration file, containing at least the I/O configuration defined using XTEL-CONF, has been previously transferred to the PLC memory. The PLC can be stopped (STOP) or running (RUN).N.

[UTILS] Lets the user access AEM memory utility functions :

0 - APPLICATION CHARACTERISTICS : displays information relating to the module and its configuration,



1 - RUN AEM : Starts the module running,

2 - STOP AEM : Stops the module.

2.3 Selecting the PLC Memory

WORKING MEMORY
0 - AEM MEMORY
1 - TSX MEMORY
2 - AEM FILE
3 - TSX FILE

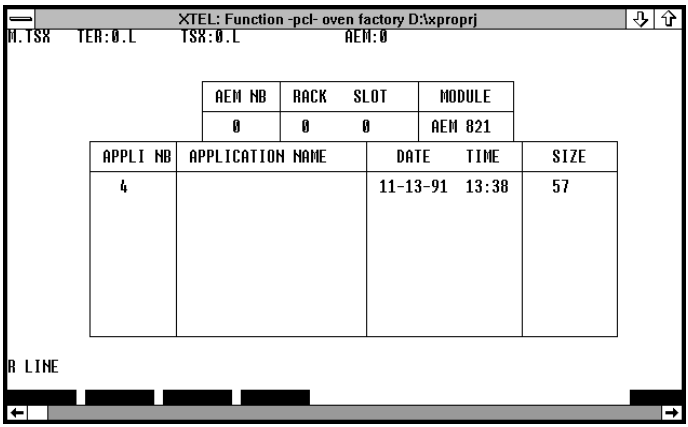
The PLC memory is primarily a storage location. It lets the user store the various configurations in the dedicated PCL field of the PLC.

Storing the configurations in the PLC memory means that the PLC program, via the ANALD Optional Function Block (OFB) can, if necessary, reload the configurations in the module. The ANALD OFB is described in Divider C, Section 2).

The TSX memory can only be used if a STATION.APP configuration file, that must at least contain the I/O configuration defined in XTEL-CONF, has first been transferred to the PLC memory. The PLC can be stopped (STOP) or running (RUN).

[UTILS] Lets the user access TSX MEMORY utility functions:

0 - LIST OF APPLICATIONS: Displays a screen with a list of configurations assigned to a module:
The upper boxes show the module number, location address and type,
The lower boxes show the number, name, date and time of creation or of the last modification and the size of each configuration stored in the PLC memory.



1 - RUN TSX: Starts the PLC running,

2 - STOP TSX: Stops the PLC,

3 - DELETE THE APPLICATION: After confirmation by the user, this action deletes the configuration of the selected channel.

4 - CHANGE THE FIELD NAME: Assigns a comment of up to 24 characters to the configuration.

2.4 Selecting the AEM File

WORKING MEMORY
0 - AEM MEMORY
1 - TSX MEMORY
2 - AEM FILE
3 - TSX FILE

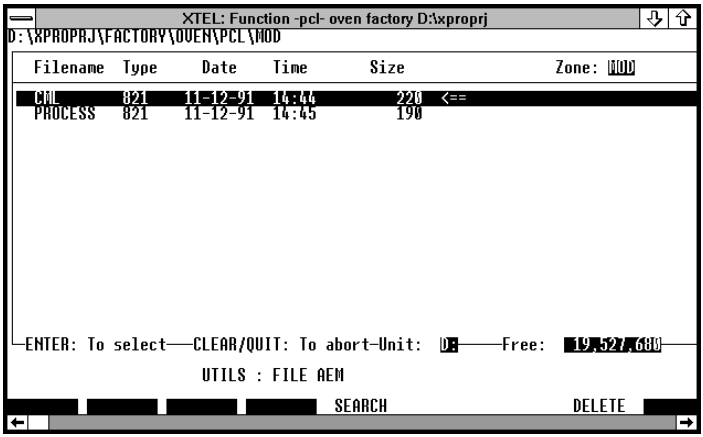
Selection of this type of storage is recommended when creating TSX AEM module configurations in the design office or when archive storage is required. This selection does not require the physical presence of a PLC, an I/O module or a configuration.

The configurations are saved to a hard disk or diskette (the storage media is defined in the X-TEL Software Workshop at Volumes level) as they are validated.
All of the configurations created in this way are generic. They are not assigned to a specific module, nor to a specific PL7-3 application (library function).

[UTILS] Lets the user access DISK memory utility functions:

0 - DIRECTORY (MOD): Displays a list of files stored in the PCL\MOD directory.

1/9 - LIST OF APPLICATIONS: Displays the list of all the configuration files associated with each type of module, stored in the PCL\MOD directory.

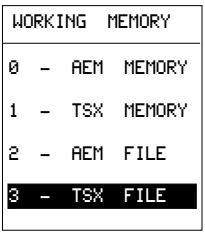


Regardless of the utility function selected:

[SEARCH] Lets the user search for a file in the list,

[DELETE] After user confirmation (YES), deletes the file selected by the cursor.

2.5 Selecting the TSX File



This mode lets the user generate, in Local mode, the image of the PLC memory.

The TSX file can only be used if the station configuration has first been created using XTEL-CONF.

[STORE] Stores the configuration to an xxx.BIN file. The default name used is PCL.BIN. This screen displays to dynamic function keys:

[FILE] To select another name for the file to store.

[STORE] To start storing the file.

[RETRIEVE] Retrieves the xxx.BIN stored using the STORE function. The file is retrieved to the XTEL field as PCL.BIN.

[UTILS] Lets the user access the TSX file utility functions:

0 - DIRECTORY\APPLI: Displays the list of files stored in the PCL\APPLI directory (.BIN, .DOC files etc.),

1 - LIST OF TSX FILES: Displays the list of configuration files (.BIN files),

2 - LIST OF APPLICATIONS: Displays a list of all of the configurations assigned to a given TSX AEM module in the current .BIN file,

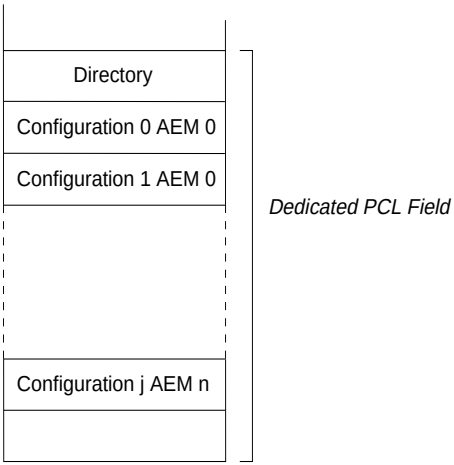
3 - DELETE THE APPLICATION: Deletes the configuration specified by an TSX AEM module number and by a configuration number from the current .BIN file,

4 - MODIFY FIELD NAME: Assigns a comment of up to 24 characters to the current .BIN file.

3.1 Dedicated PCL Field

This field in the PLC memory is used to store the various configurations that may be downloaded to the TSX AEM modules.
This field is fully managed and controlled by the PL7-PCL program:

- The directory is created by PL7-PCL,
- The configurations originate with:
  - Direct entry into the TSX Series 7 PLC memory using PL7-PCL,
  - An AEM FILE to TSX MEMORY transfer,
  - An AEM MEMORY to TSX MEMORY transfer.



An attempt to transfer a configuration to the PLC memory or any attempt to modify an existing configuration can cause the display of one of the two messages listed below:

- **Space full:** The dedicated PCL field is not large enough to store the new configuration. The user should change the size of this field using XTEL-CONF and then repeat the transfer of the STATION.APP file and its assigned binary file.
- **Space to pack:** The size of the dedicated PCL is adequate if it is first packed (compacted). Optimizing the dedicated memory field ensures that any "gaps" created by configuration transfer or deletion operations are eliminated. The packing operation is selected by the [PACK] key that is accessed from the directory screen (refer to Subsection 3.2).

3.2 PCL Directory

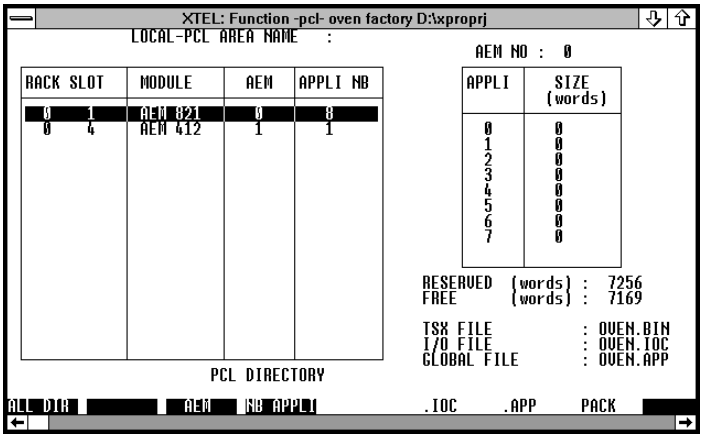
A TSX AEM configuration is defined by:

- A module number from 0 to 63,
- An application number from 0 to 8.

The directory defines the correspondence between the physical location of the module in the I/O configuration of the PLC and its logical number in the configuration.

The directory is created by PL7-PCL and stored at the start of the dedicated PCL field in the PLC memory. The TSX AEM modules that are found in the I/O configuration are assigned an AEM number in rising order, from 0 to 63.
The assignment of these numbers can be changed by the user.

If the PL7-PCL program is run in connected mode (AEM MEMORY or TSX MEMORY), selecting the [DIR PCL] dynamic soft key will display the PCL DIRECTORY screen or lets the user create this directory.



TSX-PCL Field

RESERVED The number of words reserved is set by XTEL-CONF. This number cannot be modified using PL7-PCL.

FREE The number of words free is the amount of unused memory space.

TSX FILE PCL.BIN is the file name assigned to the PCL field stored on disk with the [STA -> DSK] command.

Dynamic soft keys

[ALL DIR] Lets the user gain detailed access to the PCL directory, specifying the following information for each module:

- Hardware location: rack, module,
- Type (TSX AEM 411, 412, etc.),
- Assigned AEM number,
- The size of the configuration assigned to each application.

[TOP]	Displays the start of the directory field,
[BOT]	Displays the end of the directory field,
[PREVPAGE]	Displays the previous page,
[NEXTPAGE]	Displays the next page.

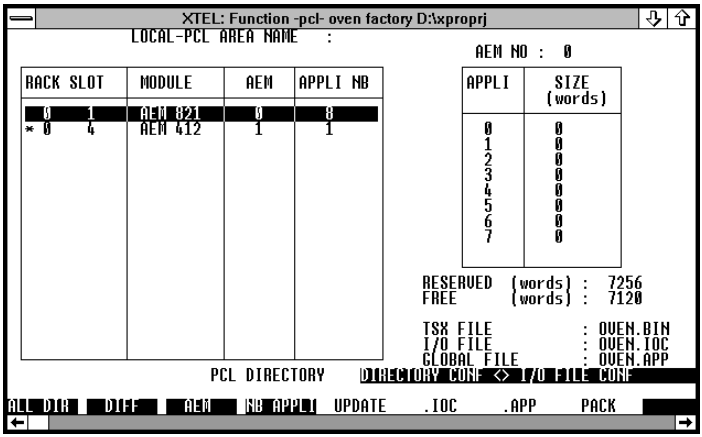
This view of the directory is the one provided for documentation purposes.

[AEM] Modifies the AEM number assignments that are proposed by default by the system. A number can only be assigned to a single slot.

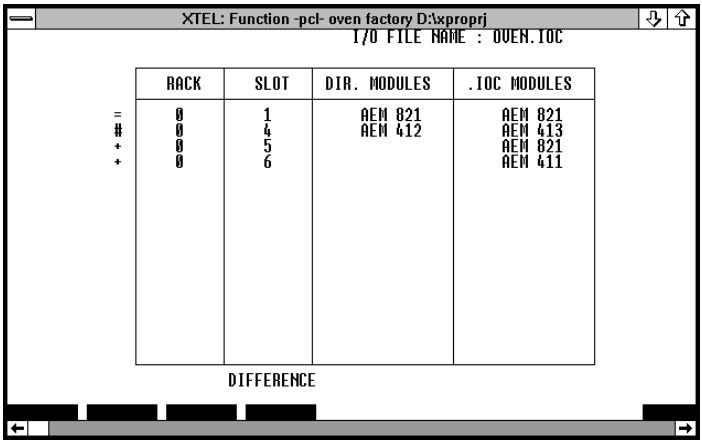
[PACK] Compacts the dedicated PCL field. This action lets the user recover the memory spaces left open for example by previous configuration deletions,

[../..] Only displayed if the configuration comprises more than 16 TSX AEM modules. This dynamic soft key lets the user move between groups of modules.

[UPDATE] Any modification of the module slot, adding or deleting a TSX AEM module in the I/O configuration generated using XTEL-CONF, is indicated in the AEM directory by an asterisk at the start of the line describing the module.
The [UPDATE] key that is only displayed in this case, lets the user update the directory to match the new PL7-3 I/O configuration.



[DIFF] This key displays the differences between the configuration of the TSX AEM modules as stored in the PCL directory and the current configuration of the TSX AEM modules.
In Connected mode, the current configuration of the TSX AEM modules corresponds to the configuration stored in the PLC.
In Local mode, the current configuration of the TSX AEM modules corresponds to the I/O configuration defined in XTEL-CONF.
This key is only displayed if a difference is found (adding, deleting or modifying a module).



Keys in the margin outside of the table indicate

= Identical,
+ One or more modules added,
- One or more modules removed,
Different module type.

If a configuration comprises more than 16 modules, additional dynamic soft keys are displayed:

[TOP] Accesses the first module on the first page of the directory,

[BOT] Accesses the first module on the last page of the directory,

[PREVPAGE] Accesses the first module on the previous page of the directory,

[NEXTPAGE] Accesses the first module of the next page in the directory.

4.1 Configuration Mode

```
OPERATING  MODES
0  - CONFIGURATION
1  - THRESHOLDS
2  - DEBUG
3  - TRANSFER AEM
4  - DOCUMENTATION
```

The Configuration mode lets the user enter or modify the configuration parameters for all of the channels of a module. When a configuration is created, all of the parameters take a default value. The default values may not always be ideal for all applications, therefore the user must always check all of the values before validating the configuration.

A detailed description of each parameter is provided in the documentation supplied with each module. In addition, the on-line documentation assists the user when making selections.

The Configuration mode screen is accessed from the PL7-PCL program primary window:

- Select the working memory (refer to Section 3),
- Pressing < → > lets the user access the Mode Selection screen,
- Enter a TSX AEM module and application number using the [AEM] and [APPLI] or [AEM/APP] dynamic soft keys. If the AEM file is used, select a file name using the [FILE] dynamic soft key),
- Select 0 - CONFIGURATION then press <Enter> to validate.

A specific screen is displayed for each type of TSX AEM module selected. As an example, the screen shown below corresponds to the configuration parameters of a TSX AEM 821 module.

```
XTEL: Function -pcl- oven factory D:\xproprj
AEM821  TER:0.L     AEM:0.L.0.0        AEM:0    APPLI:4 PAGE:1

  Parameters              Values          Limits
INPUT RANGE             4/20 mA     [ -10/10V , ... , 4/20 mA ]
SCAN MODE               NORMAL          [ NORM , SIMP ]
FUNCTION MODE           AUTO            [ SYNC , AUTO ]


CHANNEL 0                           [ INHIB. , VALID. ]
 . Type of scaling      USER    [ INPUT , NORM , USER ]
 . Square root          Y               [ Y,N ]
 . B.P. exceeded        Y               [ Y,N ]
 . Filter               N               [ Y,N ]
 . Upper limit          +10000      -32000  : +32000
 . Lower limit          -450        -32000  : +32000

A LINE              AEM 821 DISP. CONF
AP. NAME  TOP  BOT  MODIFY          PREVPAGE NEXTPAGE  HELP
```

Depending on the type of TSX AEM module and the number of channels declared, the configuration screen will comprise 1 to 5 pages. Each page is split into three columns:

Parameters For the parameters,

Values Lists the value of each parameter. This field must be filled in by the user,

Limits Displays the possible choices or the limits that apply to each parameter. This is the display field that is displayed when the [HELP] dynamic soft key is pressed.

Dynamic soft keys

[AP.NAME] Lets the user enter the configuration name (up to 16 alphanumeric characters),

[TOP] Displays the first page and places the cursor at the start of this page,

[BOT] Displays the last page and places the cursor at the start of this page,

[MODIFY] Modifies the value of the parameter selected by the cursor, or lets the user access it for modification (displays dynamic soft keys or a data entry line),

[COPY] Copies the configuration of the selected channel to another channel or to all channels (when the "*" wildcard is selected),

[HELP SYN] When SYNC operating mode is selected (TSX AEM 821 module used in Sync mode). This key displays a help screen that is specific to this mode. For more information on the Sync mode, refer to Divider B, Section 5.

[PREVPAGE] Displays the previous page,

[NEXTPAGE] Displays the next page,

[HELP] Displays help information in the third column relative to the parameter selected by the cursor.

4.2 Threshold Mode

OPERATING MODES
0 - CONFIGURATION
1 - THRESHOLDS
2 - DEBUG
3 - TRANSFER AEM
4 - DOCUMENTATION

This mode lets the user display and modify the thresholds of a configuration in the selected working memory.

Threshold modification can only be performed if the module was previously configured.

The Threshold mode screen is accessed from the PL7-PCL program primary window:

- Select the working memory (refer to Section 3),
- Pressing < → > lets the user access the Mode Selection screen,
- Enter a TSX AEM module and application number using the [AEM] and [APPLI] or [AEM/APP] dynamic soft keys. If the AEM file is used, select a file name using the [FILE] dynamic soft key),
- Select 1 - THRESHOLDS then press <Enter> to validate.

A specific screen is displayed for each type of TSX AEM module selected. As an example, the screen shown below corresponds to the configuration parameters of a TSX AEM 821 module.

XTEL: Function -pcl- oven factory D:\xproprj

AEM821 TER:0.L AEM:0.L.0.0 AEM:0 APPLI:4

	THRESHOLD 0	THRESHOLD 1	VALIDITY ZONE
CHANNEL 0	-124	+9000	-450 / +10000 USER
CHANNEL 1	0	+9000	0 / +10000 NORM
CHANNEL 2	-1	+1	-1 / +1 USER
CHANNEL 3	0	+5000	0 / +10000 NORM
CHANNEL 4	-1	+1	-1 / +1 USER
CHANNEL 5	+6000	+20000	+4000 / +20000 uA
CHANNEL 6	+5000	+18000	+4000 / +20000 uA
CHANNEL 7	+200	+1000	0 / +10000 NORM

R LINE AEM 821 THRESHOLD

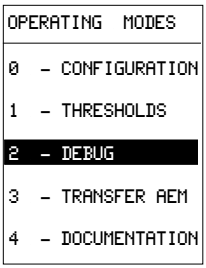
MODIFY

The "VALIDITY ZONE" column indicates the possible limit values for each of the thresholds depending on how the channels are configured.

[MODIFY] Lets the user modify the threshold selected by the cursor.

4.3 Debug Mode

4.3-1 Mode Presentation



The Debug mode lets the user modify the bits and words of the module discrete I/O or register interface. It can only be accessed if the AEM memory is selected.

A detailed description of each of the parameters is provided in the documentation supplied with the modules.

The Sync mode for TSX AEM 821 modules is described in Divider B, Section 5.

The Debug mode screen is accessed from the PL7-PCL program primary window:

- Select the AEM memory (refer to Section 3),
- Pressing < → > lets the user access the Mode Selection screen,
- Enter a TSX AEM module and application number using the [AEM] and [APPLI] or [AEM/APP] dynamic soft keys,
- Select 2 - DEBUG,
- Pressing < → > lets the user access function selection,
- Select the required function, then press <Enter> to validate.

4.3-2 Status/Commands Screen

This screen displays all of the information and commands available for the module's discrete I/O and register interfaces. These are displayed as symbols that indicate the status of bits: bits at 1 are displayed in reverse video (or with increased brightness).

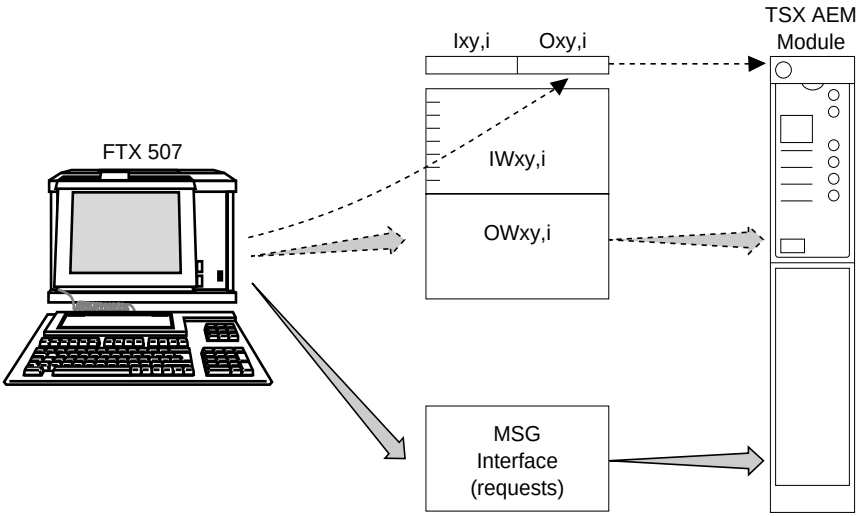
A plain language message is displayed in the data entry line to comment the bit or word selected by the cursor.

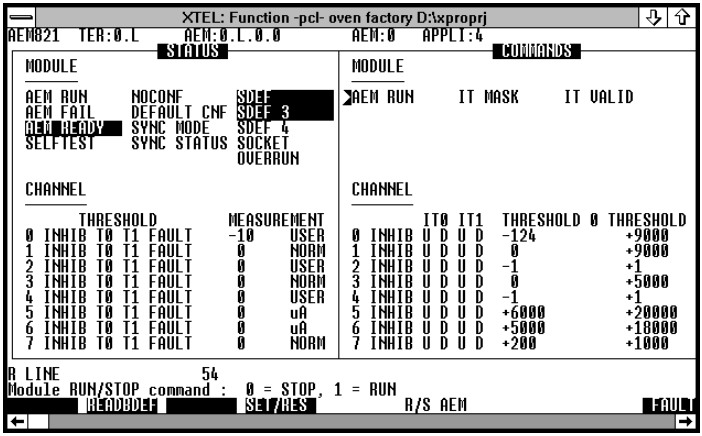
The left part of the screen (STATUS) displays the information provided by the module on the discrete I/O (Ixy,i) and register (IWxy,i) interfaces (operating mode, module and channel faults).

The right part of the screen (COMMANDS) displays the commands sent to the module via the discrete I/O (Oxy,i) and register (OWxy,i) interfaces.

Any modification of a command bit or a numerical value results in the sending of a request directly addressed to the module via the message interface. The program will then update the discrete I/O and register command interfaces so that their data corresponds to the actual module status.

This mechanism means that it is possible to debug the module while the PLC is stopped.





[READBDEF] Lets the user acknowledge faults and perform a new fault read,

[SET/RES] Lets the user modify the status of the command bit selected by the cursor,

[MODIFY] Lets the user modify the value of the parameter selected by the cursor,

[R/S AEM] Lets the user select module RUN or STOP,

[TRIM] Lets the user access the trim screen for TSX AEM 1601 and 1602 modules (refer to Divider B, Sub-section 5.2),

[CALIB] Lets the user access the calibration screen for TSX AEM 1601 and 1602 modules (refer to Divider B, Sub-section 5.2),

[FAULT] Lets the user display the fault display screen.

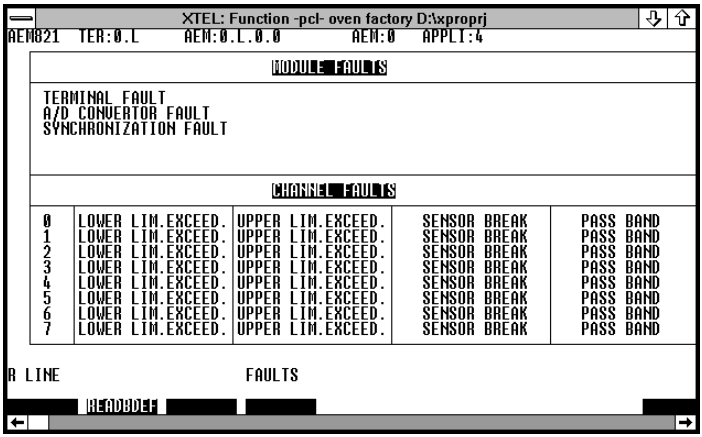
The fault bits that are specific to the Sync mode (SYNC MODE, SYNC STATUS and OVERRUN) are described in Divider B, Sub-section 5.1.

4.3-3 AEM Faults Screen

This screen displays a list of all the fault bits of the module and their status:

- The module fault bits and the results of the self-tests are displayed in the upper part of the screen,
- The application fault bits are displayed in the lower part of the screen,

Regardless of the type of fault, all of the bits at 1 are displayed in reverse video (or overbrightness).



[READBDEF] Lets the user acknowledge all fault bits and causes a new read.

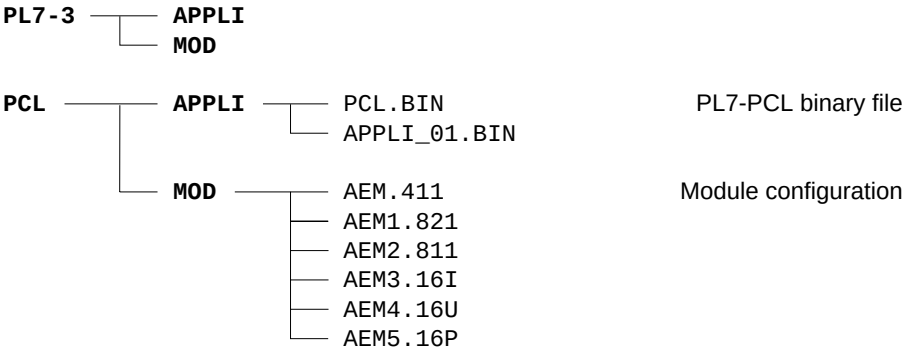
4.4 Transfer Mode

4.4-1 PL7-PCL Files

B

The PL7-PCL program files are designated by a name of up to eight characters, followed by a three character extension that identifies the file type. These files are stored in the various software workshop sub-directories.

The application files are stored at station level, in the PCL sub-directory:



The PCL directory can be accessed at station level and comprises two sub-directories:

- The APPLI sub-directory comprises the PCL.BIN file and any back-up directories generated in TSX/PMX FILE mode using the STORE command,
- The MOD sub-directory which includes the files in which the TSX AEM module configurations are stored. Each file is the image of a configuration available for downloading to a module. Each application generates a .AEM file where AEM takes the value 411, 412, 413, 811, 821, 16I, 16U, 16P or 12T, depending on the type of TSX AEM module selected for use.

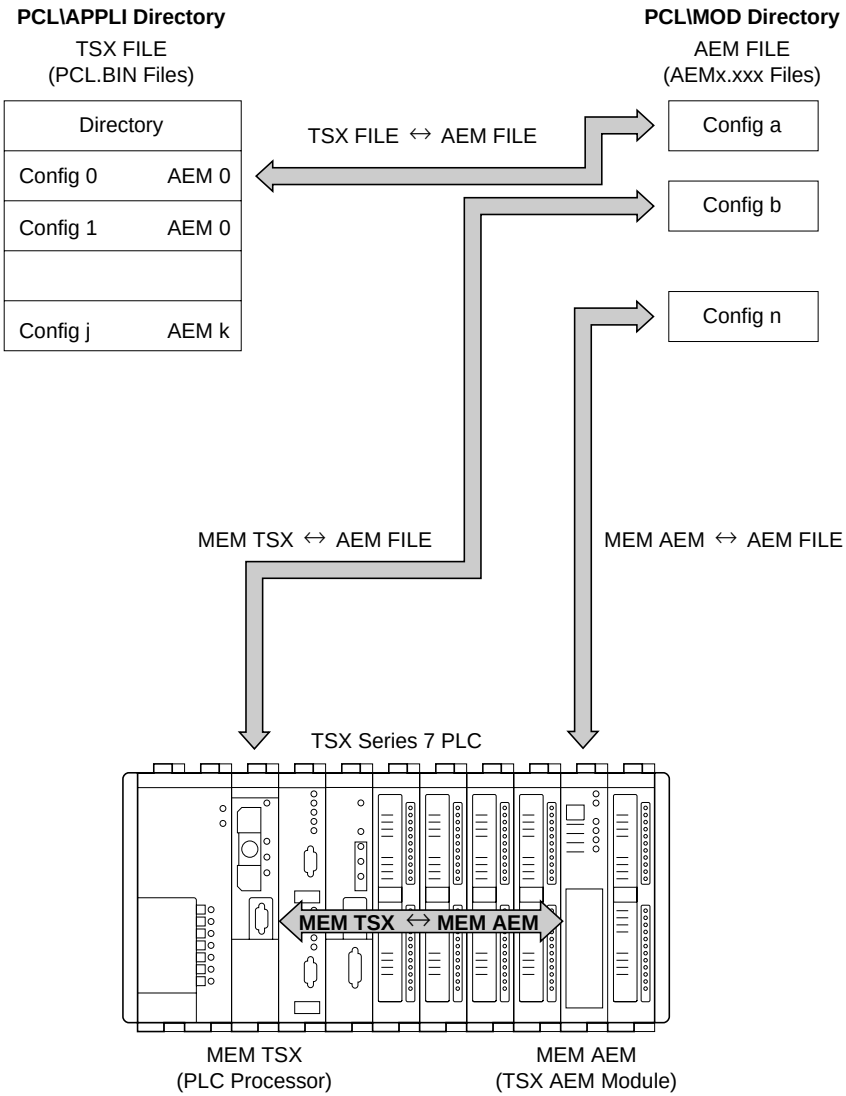
The complete set of files that form the PCL directory is generated by the PL7-PCL function.

In the remainder of this section:

- TSX/PMX FILE corresponds to the files in the PCL\APPLI directory,
- AEM FILE corresponds to the files in the PCL\MOD directory.

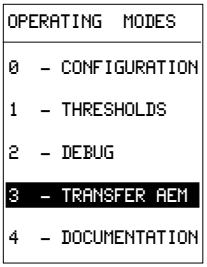
4.4-2 Transfer Options

The various options supported by the Transfer mode are described below:



The Transfer mode only applies to a TSX AEM configuration in the dedicated PCL field. Transfers between the TSX file and the TSX memory are performed using the [STA -> DSK] and [DSK -> STA] dynamic soft keys.

4.4-3 Using the Transfer Mode



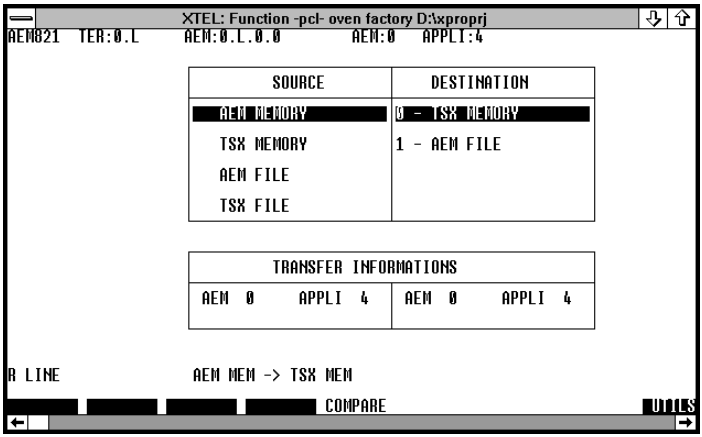
The Transfer mode can be accessed from the primary window of the PL7-PCL program:

- Select the source memory that contains the application to transfer (refer to Section 4 - Configuration Mode),
- Access the Mode Selection screen using command < → >,
- Define the configuration to transfer: Enter a TSX AEM module number and an application number using the [AEM] and [APPLI] (or [AEM/APP]) commands or enter a file name using the [FILE] command,
- Select the Transfer mode, which will display the Destination column,
- Access target (destination) memory selection using command < → >,
- Select the target (destination) memory and press <Enter> to validate.

Dynamic soft key functions

[FILE]	Lets the user enter the back-up file name if the selected target memory is an AEM file,
[AEM]	Lets the user select the number of the working module if the selected target memory is the AEM or TSX memory,
[APPLI]	Lets the user select the number of the working configuration if the selected target memory is the AEM or TSX memory,
[AEM/APP]	Lets the user select the number of the working module and configuration if the selected target memory is the AEM or TSX memory,

Transfer screen example



The upper table displays the selected source and target (destination) memories. The target (destination) memory selection can still be modified using the cursor up and cursor down keys or the equivalent keys on the number pad.

The lower frame displays the address or the name of the source (left column) and target (destination) (right column) applications.

[COMPARE] Compares the contents of the source memory with the contents of the target (destination) memory,

[UTILS] Lets the user access the utility functions available for the source memory,

<Enter> The first time <Enter> is selected, the configuration is read from the source memory. The second time <Enter> is pressed starts the transfer between the source and target (destination) memories.

4.5 Documentation Mode

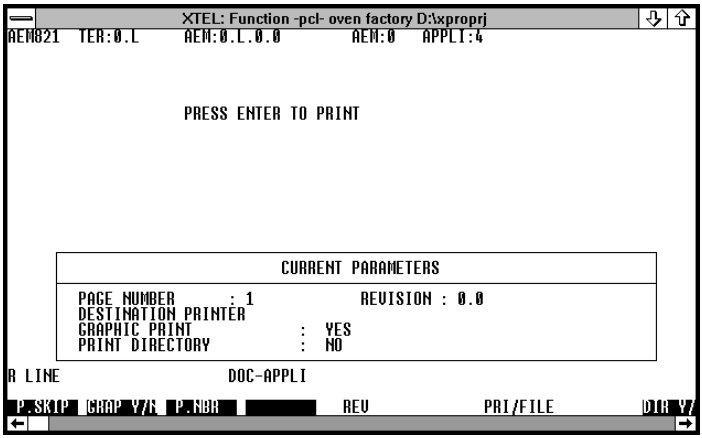
4.5-1 General

```
OPERATING  MODES
0  - CONFIGURATION
1  - THRESHOLDS
2  - DEBUG
3  - TRANSFER AEM
4  - DOCUMENTATION
```

This mode lets the user print to a printer or to a file all or part of a TSX AEM application (configuration and thresholds). When the user selects an output to a file, the file obtained can be used later by XTEL-DOC.

This mode is accessed from the PL7-PCL primary window:

- Select the working memory (refer to Section 3),
- Access Mode Selection using the < → > command,
- Enter a TSX AEM (1) module number and an application number (1) using the [AEM] and [APPLI] (or [AEM/APP]) commands or enter a file name using the [FILE] command,
- Select the DOCUMENTATION mode, then press <Enter> to validate.



(1) The "*" wildcard character validates all of the applications in the selected module. Entering AEM = * and APPLI = * lets the user document all of the applications stored in the PLC memory.

Dynamic soft key functions

[P.SKIP] Lets the user immediately skip one page,

[GRAP Y/N] Defines the type of printer: Graphic (Yes) or ASCII (No). This selection is displayed in the CURRENT PARAMETERS frame,

[P.NBR] Lets the user enter the number of the first page of the documentation file. This number is displayed under PAGE NUMBER in the CURRENT PARAMETERS frame,

[REV] Lets the user enter an optional revision level for the documentation file. This number is displayed under REVISION in the CURRENT PARAMETERS frame,

[PRI/FILE] Lets the user define the output required: printer or xxx.DOC file. The selection is displayed in the CURRENT PARAMETERS frame.

[FILE] Lets the user enter the name of the xxx.DOC documentation file, when output to file is selected,

[DIR Y/N] Lets the user select whether or not to print-out the directory. The selection made is displayed in the CURRENT PARAMETERS frame.

<Enter> Prints the documentation file with the parameters defined in the CURRENT PARAMETERS frame.

Important

When output to disk is selected, the output file will be located in:

- The PCL\APPLI directory if the print directory option is requested ([DIR Y/N] dynamic soft key),
- In the PCL\MOD directory if the print directory option was not selected.
  In both cases, the file name is followed by the .DOC extension.

To ensure that the file generated in this way is usable at a later stage by XTEL-DOC, two conditions must be met:

- The file must be located in the PCL\APPLI directory ([DIR Y/N] dynamic soft key),
- The file must be generated with the graphic printout option selected ([GRAP Y/N] dynamic soft key).

4.5-2 Print-out Page Examples

XPROPRJ\PROCESSOVEN PC:

Parameters	Values	Limits
INPUT RANGE	4/20 mA	[-10/10V , , 4/20 mA]
SCAN MODE	NORMAL	[NORM , SIMP]
FUNCTION MODE	SYNC	[SYNC , AUTO]
SCAN PERIOD	50 ms	1 : 1000
CHANNEL 0	VALID	[INHIB. , VALID.]
• Type of scaling	USER	[INPUT , NORM , USER]
• Square root	Y	[Y,N]
• B.P. exceeded	N	[Y,N]
• Upper limit	+2000	-32000 : +32000
• Lower limit	0	-32000 : +32000

Parameters	Values	Limits
CHANNEL 1	VALID.	[INHIB. , VALID.]
• Type of display	NORM	[INPUT , NORM , USER]
• Square root	N	[Y,N]
• Exceed B.P.	N	[Y,N]
CHANNEL 2	VALID.	[INHIB. , VALID.]
• Type of scaling	USER	[INPUT , NORM , USER]
• Square root	N	[Y,N]
• B.P. exceeded	N	[Y,N]
• Upper limit	+10000	-32000 : +32000
• Lower limit	0	-32000 : +32000

Application		Application	Application name	object	rev	date	page
DISK	PAGE	REGUL 3.821		APPLI	0.0	13/03/91	2-1
TELEMECANIQUE		AEM 821					2

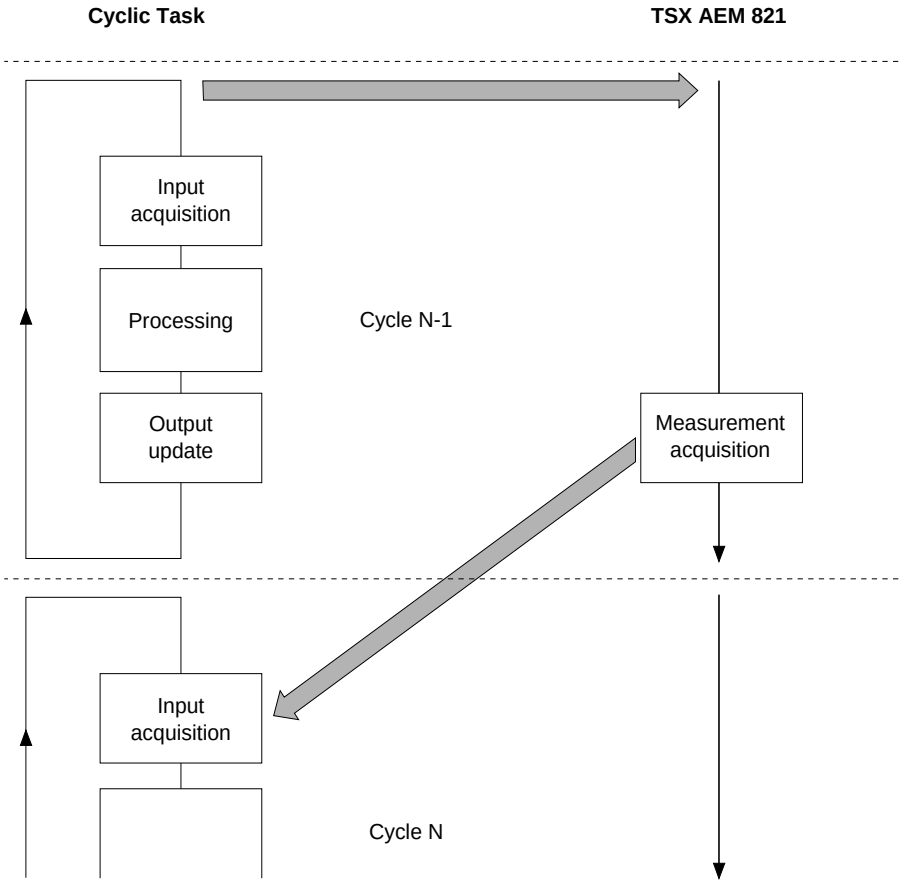
5.1 Using the TSX AEM 821 Module in Synchro Mode

5.1-1 General

The synchro mode is specific to the TSX AEM 821 module and lets the user synchronize measurement acquisition over the period of the task where they are used. This mode should be reserved for cases where the control loop sampling period cannot exceed 150 ms.

Principle of operation

At the start of each cycle, the TSX AEM 821 module receives an order that triggers its processing. This requires calculation of the instant of input data acquisition as closely as possible to the start of the next cycle. This mechanism lets the user obtain input values that are as up to date as possible for any given cycle N.



5.1-2 Using Synchro Mode

Precautions for use

When using synchro mode, always respect the following conditions:

- Declare its use when configuring the TSX AEM 821 module, (in Configuration Mode, "Operating Mode" parameter, value "SYNC". For more information refer to Divider B, Sub-Section 5.1-3),
- Declare the IT task in the PL7-3 configuration, even if it is not used elsewhere,
- The IT must have an execution time that is less than 3 ms,
- Program the EXEC ANALD instruction corresponding to the TSX AEM 821 module in the task where the module is declared so that it is scanned once and once only,
- Assign an ANALD OFB to each TSX AEM 821 module and only to it,
- The module measurement acquisition period (in Configuration mode, "Scan Period" parameter) must match the period of the task in which the module is declared. It must be greater than the duration of an acquisition cycle + 5 ms to avoid causing an OVERRUN error.
  Reminder: The duration of an acquisition cycle is 6 ms + 2.5 ms * N, where N is the number of valid channels.

Error handling (synchro error)

If any of the precautions above are ignored, a SYNCHRO ERROR occurs (indicated by the setting to 1 of bit 2 of status word STATUS0 of the ANADG OFB assigned to the TSX AEM 821 module) and the setting of a bit of the register interface that is visible in Debug Mode.

As long as this error is present, no measurement acquisition takes place. The user must therefore ensure that no synchro error is present before attempting to use the measurements.

To eliminate this error, check that all of the precautions for use listed above are always respected.

Error handling (channel overrun error)

When the processing of the measurements from the valid channels exceeds the scan time of the TSX AEM 821 (defined in Configuration Mode, Parameter "Scan Period"), the module goes into a channel overrun error condition.

This error is indicated by setting to 1, bit 3 of status word STATUS0 in the ANADG OFB assigned to the TSX AEM 821 module and by setting a register interface bit that is visible in Debug mode.

As long as this error is present, no measurement acquisition takes place. The user must therefore ensure that no synchro error is present before attempting to use the measurements.

To eliminate this error, first inhibit unused channels, then increase the TSX AEM 821 module sampling time (defined in Configuration Mode, "Scan Period").

Important

If it is necessary to increase the module scan period to prevent this error condition, the user should also change the task time defined. For correct synchro mode operation, the scan time and the task time must be identical.

5.1-3 Synchro Mode Impact on Configuration Mode

Selecting Synchro mode requires setting two additional configuration parameters (1):

- **OPERATING MODE**, that lets the user select between:
  - AUTO, an autonomous mode where the module performs cyclic data acquisition,
  - SYNCHRO, where the module synchronizes a data acquisition cycle with the task in which it is declared,
- **SCAN PERIOD** that **must** be identical to the period of the task in which the module is declared. This parameter is only accessible if Synchro Mode is selected.
  Filtering is not available when Synchro mode is selected.

5.1-4 Synchro Mode Impact on Debug Mode

Selecting Synchro mode causes additional information to appear (1):

- In the Status screen:
  - SYNC MODE is displayed in reverse video if the module is operating in Synchro mode (image of bit IWxy,2,3),
  - SYNC STATE normally displayed in reverse video is the indicator showing correct operation of the synchronization mechanism. It is no longer displayed if a synchronization error occurs (image of bit IWxy,2,1),
  - OVERRUN is displayed in reverse video if the module is in an overrun error condition (image of bit IWxy,2,2),
- In the Error screen
  - SYNCHRONIZATION ERROR is displayed in reverse video as soon as an error occurs and returns to normal when [READBDEF] is selected to read the fault bits if the error condition has actually ended (image of bit 64 of the fault bit string).

(1) In relation to the configuration parameters defined in the TSX AEM 821 User's Manual (TSX D23 006E).

5.2 Calibrating TSX AEM 1601 and 1602 Modules

5.2-1 General

The TSX AEM 1601 and TSX AEM 1602 are preset at the factory and tested prior to delivery.

The quality of the components used means that any error caused by component aging remains within the specified accuracy tolerances. However, to compensate for any drift that may occur over time or to meet the requirements of users that normally perform periodic recalibration, it is possible to recalibrate the module using PL7-PCL version V5.0 software.

There are two possible adjustment procedures that meet two different requirements:

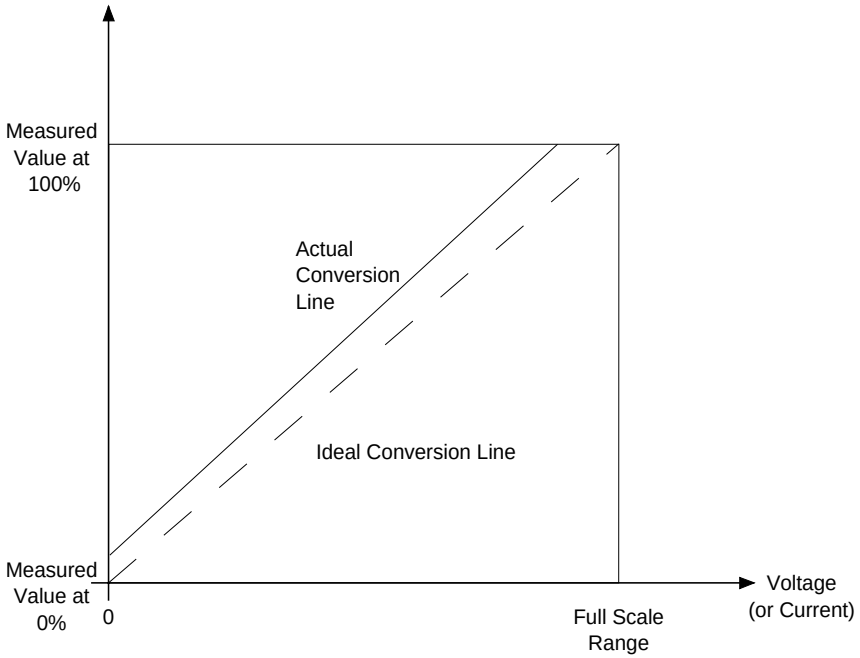
- A standard recalibration procedure where the value of the offset and gain are adjusted,
- A trim procedure that forces the measurement value.

Typical applications: Equalizing the values obtained from various devices connected to the same sensor (e.g. display unit and regulator system).

5.2-2 Calibration Procedure

Principle

A correction is applied at two points on the scale: at zero (offset adjustment) and at the full scale value (gain adjustment).



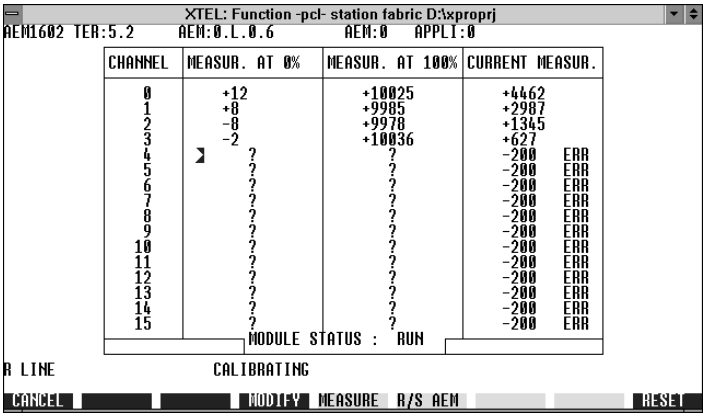
Simply send the module the values read for point 0 and full scale range. The module itself will the perform the corrections required to output values that correspond to the ideal conversion diagram.

Conditions

Recalibrating the module requires a voltage generator for TSX AEM 1601 modules or a current generator for TSX AEM 1602 modules. Its resolution/precision must be at least equal to that of the module, i.e. 4000 points/0.2% (a resolution 10 times higher is recommended).

Accessing the recalibration screen

From the SETUP screen, select [CALIB] to access the screen shown below:



This screen lets the user set the zero point and the full scale range for each of the 16 module channels. The adjustment range for both the zero point and the full scale range is restricted to ± 2% of the full scale range.

Note
With TSX AEM 1602 modules, calibration can only be performed on the 0-20 mA range.

Dynamic function keys

[CANCEL]	Cancels the selection made with the cursor,
[MODIFY]	Lets the user modify the value selected by the cursor,
[MEASURE]	Copies the current measurement value to the value field selected by the cursor,
[R/S AEM]	Starts or stops the module (Run or Stop),
[RESET]	Resets the module to its factory settings.

Calibration procedure

First set the module to Run.

1. Select the channel to calibrate, using the ↑ and ↓ keys,
2. Move the cursor to the MEASUR. AT 0% column,
3. Apply the voltage or current level corresponding to zero (for the 0-10 V range, simply short the two connectors for the channel),
4. Select the MEASURE. key. This copies the CURRENT MEASUR. value to the MEASUR. AT 0% column,
5. Place the cursor in the MEASUR. AT 100% column,
6. Apply the voltage or current corresponding to 100% of full scale range and let the measurement value stabilize,
7. Select the MEASURE. key. This copies the CURRENT MEASUR. value to the MEASUR. AT 100% column,
8. Repeat steps 1 to 7 for each of the 16 channels,
9. Press <Enter> to validate all of the values entered (the module is now recalibrated),
10. Reset the module to Run.

Simplified calibration procedure

The previous calibration procedure lets the user calibrate each of the 16 channels separately. This lets the user allow for the entire data acquisition circuit from the sensor to the module.

It is also possible to follow a simplified and faster calibration procedure, where a single channel is calibrated as described above and the newly determined offset and full scale range values are simply copied to the other channels. To follow this procedure:

1. Adjust the zero level for channel 0 and note the current measurement value,
2. Move the cursor to channel 1 and using the [MODIFY] key, enter the previously noted value. Follow the same procedure to set the zero point for channels 2 to 15,
3. Adjust the full scale range (100%) value for channel 0 and not the current measurement value,
4. Move the cursor to channel 1 and using the [MODIFY] key, enter the previously noted value. Follow the same procedure to set the full scale range for channels 2 to 15,
5. Press <Enter> to validate all of the settings,
6. Reset the module to Run.

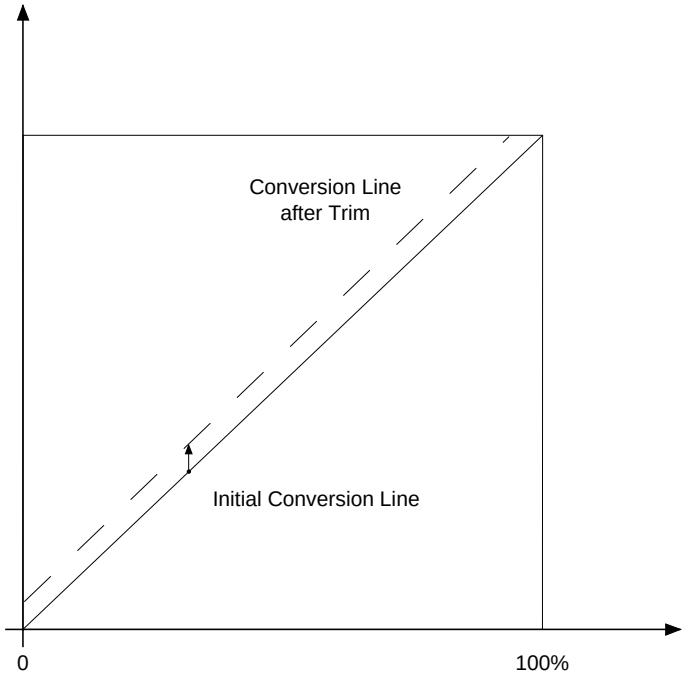
Note

For the module to accept the new values, it must be stopped. The user will be asked to confirm the new values by pressing <Enter>.

5.2-3 Trim Procedure

Principle

Trim implies deliberately "modifying" the measurement value so that it is the same as that provided by another measurement device taken as a reference.



For a given point, the user gives the module the required value (that measured by another device). The measurement shift determined in this way is then applied to the entire conversion diagram.

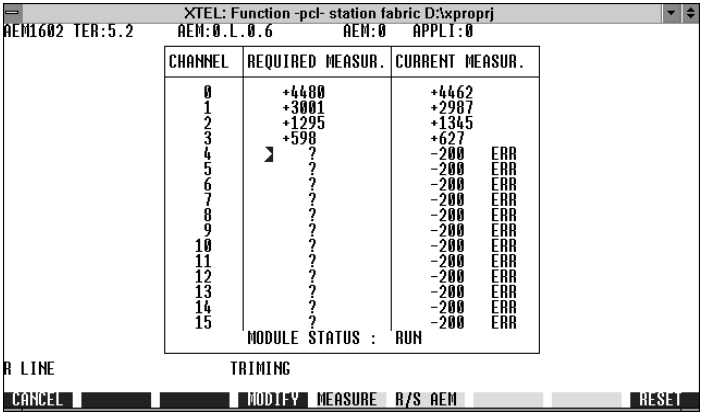
Alignment conditions

Unlike calibration, setting the alignment does not require a generator as a reference. Simply use a measurement device connected to the same sensor as a reference.

If the square root feature is used normally, it must be disabled.

Accessing the trim screen

From the SETUP screen, select [TRIM] to access the screen shown below:



This screen lets the user modify the current measurement value for the 16 module channels. The adjustment range is again restricted to ± 2% of full scale range.

Dynamic function keys

[CANCEL] Cancels the selection made with the cursor,

[MODIFY] Lets the user modify the value selected by the cursor,

[R/S AEM] Starts or stops the module (Run or Stop),

[RESET] Resets the module to its factory settings.

Trim procedure

First set the module to Run.

1. Select the channel to adjust, using the ↑ and ↓ keys,
2. Apply the voltage or current level corresponding to the selected operating point,
3. Select the [MODIFY] key and enter the required value for the selected point,
4. Repeat steps 1 to 3 for each channel to adjust,
5. Press <Enter> to validate all of the values entered.
   The module will now Stop after confirmation from the user,
6. Reset the module to Run.

C

C

1.1 Presentation

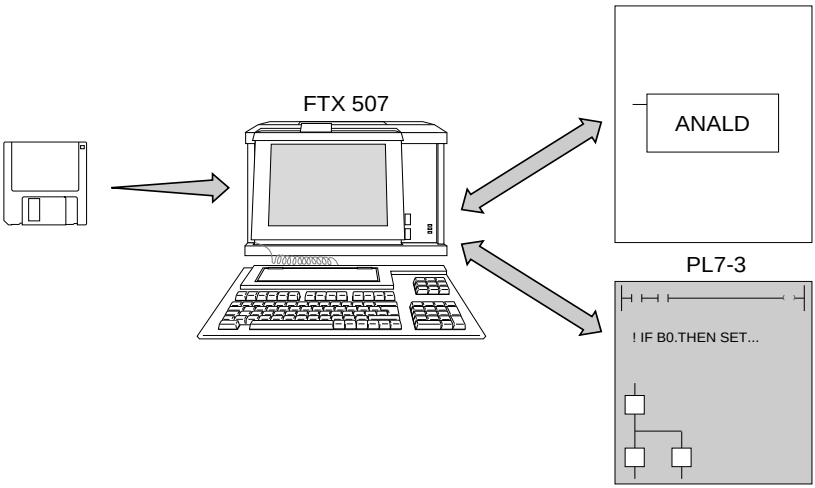
The PCL family Optional Function Blocks (OFBs) are an extension of the PL7-3 programming language and complement the PL7-PCL program. There are 3 of these Optional Function Blocks :

- the ANALDi OFB is used to configure or reconfigure modules when the application is running (after a power outage, change of module, etc). This operation is performed using a configuration saved in the PLC memory,
- the ANADGi OFB is used to combine the error data from a TSX module,
- the PCL OFB is used to create PID type process control loops on the PLCs.

These function blocks are available in this PCL OFB program, like PL7-PCL, in the packs.

To use the PCL family OFBs in an application, the user must first:

- Ensure that the PCL icon is present at station level. If this is not the case even after program installation, then it was not declared at station level. Refer to the PL7-PCL program installation procedure (Part A, Section 1),
- Declare the type of OFB in the PL7-3 configuration,
- Define the number of OFBs to use,
- Program the OFBs in PL7-3.



1.2 Configuring the OFBs

Before using an OFB in an application program, the user must first declare the type and number of OFBs in PL7-3 configuration mode.

To do this :

- access OFB configuration mode in PL7-3,
- select, from the PCL family, the types of OFB which will be useful (among ANALD, ANADG and PID). When several versions of the same OFB are offered (e.g. ANALD V4.6 and ANALD V6.0), select the most recent version (highest number),
- then define, for each type of OFB selected, the number of OFBs to use.

For more information, refer to the PL7-3 Operating Modes User's Manual .

1.3 Programming the OFBs

The PCL family OFBs can be programmed in any program module in Ladder Diagram language (using an operation block) or in Literal language. In both cases the syntax used is the same:

EXEC OFBi(In1;...;Inn=>Out1;...;Outm)

OFBi	OFB type and number,
In	Input objects,
Out	Output objects,
=>	Separator between input and output parameters,
;	Separator between parameters.

The OFBs are programmed in PL7-3, in PROGRAM mode :

- enter the instruction according to the syntax described above, specifying :
  - the type and number of the OFB,
  - the variables assigned to the input parameters,
  - the variables assigned to the output parameters.

  It is not always necessary to use (wire) all the I/O. Certain parameters take a fallback value by default.
- initialize each constant of the OFB.

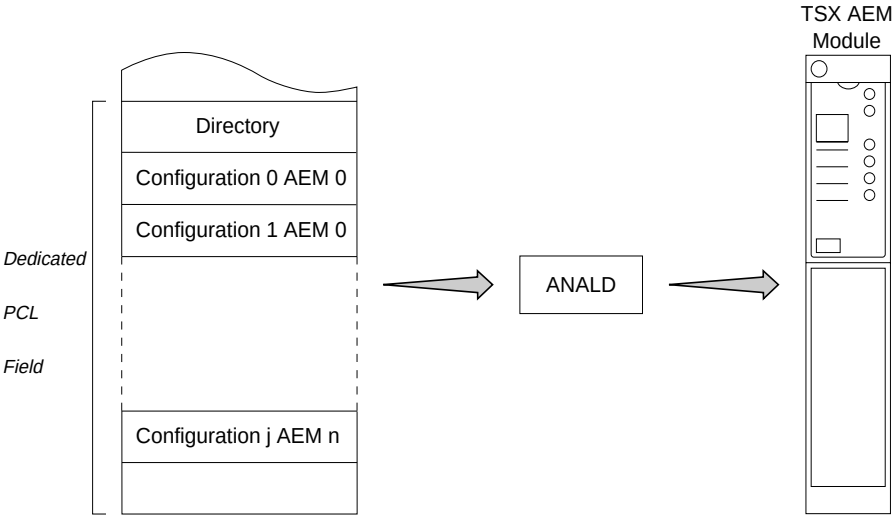
These operations are explained in the PL7-3 operating modes user's manual.

The IF, THEN, and ELSE instructions determine conditional execution of the OFBs (for example after a hot or cold restart) :

```
IF (SY0+SY1) THEN RESET B0
IF NOT B0 THEN EXEC ANALD1 (W12;=>); SET B0
```

2.1 General

The ANALD OFB lets the user, on request, transfer a configuration from the dedicated PCL field in the PLC memory to a TSX AEM module:



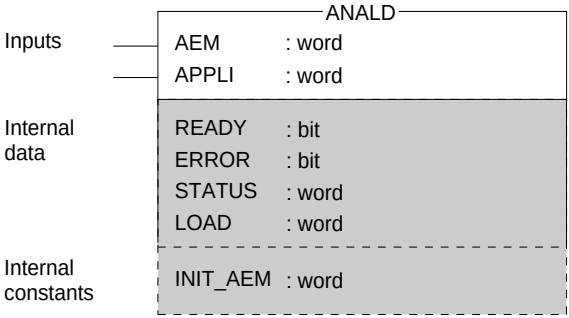
Once the configuration has been downloaded, the OFB sets the module to Run.

Notes

- the TSX AEM 1613 module is only accepted from OFB ANALD version V5.0 or higher,
- the TSX AEM 1212 module is only accepted from OFB ANALD version V6.0 or higher.

2.2 ANALD OFB Presentation

The ANALD OFB has two input parameters, an internal constant (defined during the programming phase) and internal data (used during program execution). It does not have any outputs.



The internal data can be accessed by the program via its symbol or variable. E.g. ANALD1, STATUS.

2.3 Parameter Description

Input parameters

Parameter	Type	Access	Description
AEM	word	(2)	Contains the logical number of the TSX AEM module to which the OFB is assigned. On cold restart or reconfiguration of the PLC, it is automatically reinitialized with the contents of the I_AEM internal constant.
APPLI	word	(2)	Specifies the number of the application to transfer. It is initialized by default to 10. It must be assigned an immediate value or a word type PL7-3 variable that contains the number of the application to transfer. If this parameter is not initialized, the default value (10) means that the OFB cannot be used as it corresponds to an application number that is outside of the range allowed (0 to 8).

C

Internal data

Parameter	Type	Access	Description
READY	bit	(1)	Set to 0 during the transfer, this bit changes to 1 once the transfer is complete.
ERROR	bit	(1)	This bit changes to 1 if the transfer is unsuccessful. It is reset to 0 after the next correct transfer.

Parameter	Type	Access	Description
STATUS	word	(1)	This word identifies the cause of an unsuccessful transfer by setting the corresponding bit to 1 (refer to Sub-section 2.4).
LOAD	bit	(2)	When this bit is set to 1, it starts the transfer of the configuration whose number is specified in APPLI to the corresponding TSX AEM module. Its effect is equivalent to executing the OFB via the EXEC command. It is used to force a configuration from an adjustment terminal. It has no effect when a TSX AEM 821 module is used in Synchro mode.

(1) Read by program and by adjust (Adjust mode etc.),
(2) Read by program and by adjust (Adjust mode etc.),
Written by adjust (Adjust mode etc.),
(3) Read by adjust (Adjust mode etc.),
Written in Program mode.

Internal constants

Parameter	Type	Access	Description
I_AEM	word	(3)	This word specifies the number of the AEM module to which the OFB is assigned. Its value is between 0 and 63 (its default value is 64 so that the OFB cannot be used unless this parameter is initialized).

Summary of OFB status depending on the status of ERROR and READY bits

ERROR	READY	OFB Status
0	0	Transfer in progress
0	1	Transfer correctly completed
1	1	Transfer unsuccessful (the cause is found in STATUS)
1	0	Status normally impossible

(1), (2) and (3) refer to Sub-Section 2.3.

2.4 Error List

STATUS internal data

Bit 0	=	1	:	TSX AEM module failure
Bit 1	=	1	:	Transfer not possible (STOP command refused)
Bit 2	=	1	:	IT task not configured or synchronization period different
Bit 3	=	1	:	Do not transfer a conf. with synchro (AEM 821) in adjust mode
Bit 4			:	Not significant
Bit 5	=	1	:	Module missing
Bit 6	=	1	:	AEM parameter missing from directory
Bit 7	=	1	:	AEM modules directory not defined or incoherent
Bit 8	=	1	:	Module type and I/O configuration incompatible
Bit 9	=	1	:	Application APPLI missing from directory or incoherent
Bit 10	=	1	:	Application refused by module
Bit 11			:	Not significant
Bit 12	=	1	:	Transfer cancelled by power break or software error
Bit 13	=	1	:	OFB version incompatible with directory
Bit 14	=	1	:	Communication error (exchange impossible with module)
Bit 15	=	1	:	System error (inadequate software PLC version, ...)

Note
Bits 2 and 3 only apply to TSX AEM 821 modules used in Synchro mode.

2.5 Using the ANALD OFB

The ANALD OFB must be called-up after a cold or a hot restart or a module replacement. It can also be called-up on request and operates like a standard PL7-3 function block:

```
! IF (SY0 + SY1) THEN RESET B1
! IF NOT B1 + IWxy,i,D THEN EXEC ANALD0(...==>); SET B1 (with i = 1
for TSX AEM 4xx modules and i = 2 for TSX AEM 8xx modules) starts
the load procedure
```

Simply test the internal data READY (bit ANALDi,READY) to determine if the load procedure is complete. Configuration loading can also be run from Sysdiag by setting the LOAD internal data to 1.

Important:

The OFB must be called-up in the task in which the module is configured.

For TSX AEM 821 modules used in Synchro mode, it is necessary to have one OFB per module. In addition, the transfer is refused if the request is from an adjustment tool (LOAD bit).

2.6 Operating Modes - Performance Levels

2.6-1 Operating Modes

The management of module operating modes is fully user transparent. When a transfer request is made, the OFB checks:

- That the PCL function is defined for the station,
- That the directory is valid (module logical number and application number),
- Module presence and that it is ready to run (module operating correctly and self-test procedure complete).

Once these checks are performed, the OFB will:

- Stop the module,
- Send the configuration and the threshold table to the module,
- Define inhibited channels,
- Send a RUN command to the module without checking that the command is accepted.

Reaction to a power break/return

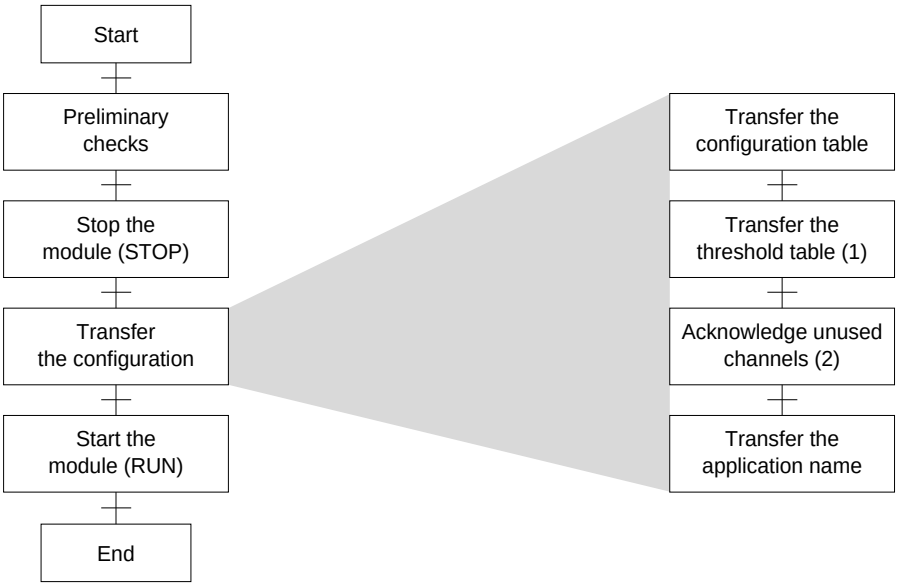
If a transfer was in progress when the power break occurred, the OFB will switch to the following state:

- bit ANALDi,ERROR = 1,
- bit 12 of status variable = 1.

Reaction to a cold restart

The parameters are reinitialized with the default values. The contents of I_AEM (internal constant) is transferred to the TSX AEM module (input parameter).

2.6-2 Internal Operating Diagram



(1) The mechanism used depends on the type of module selected:
- Register interface (OWxy,3 to 6) for TSX AEM 4.. modules,
- Message interface (requests 2 and 4) for TSX AEM 8.. modules.

(2) Via register OWxy,1 that defines the:
- Channels used by the TSX AEM 4.. modules,
- Channels inhibited for TSX AEM 8.. modules.

For further details on register interfaces, refer to the specific User's Manual for the modules.

To load a configuration, first stop the TSX AEM module. Any data present on its inputs will not be accepted while loading is in progress.

2.6-3 Performance Levels

Loading a configuration from PMX (PLC) memory to the TSX AEM module memory requires at least 7 master task cycles.

ANALD OFB memory occupation

Program field	Data field	Constants field
2504 words regardless of the number of uses	264 words per use	8 words per use

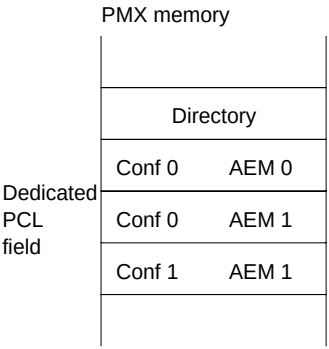
ANALD OFB execution time

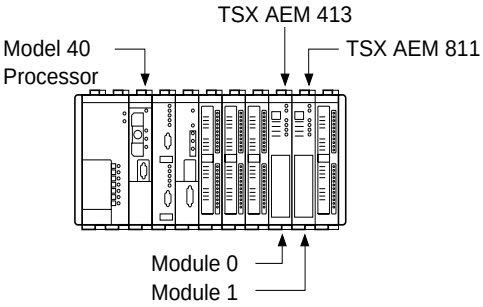
TSX 47-40/67-40	TSX 87-40	TSX 107-40
3 ms	1.2 ms	0.9 ms

2.7 Example

In a configuration comprising two TSX AEM modules.

Module 0 (slot 5) always executes the same application while module 1 (slot 6) can execute two different applications (the applications in fact only differ in the values used in the threshold tables).





The TSX AEM modules are declared AUX0.

The programming described below corresponds to the following processing:

- On a cold or a hot restart, transfer configuration 0 from TSX memory to the AEM memory of the two modules,
- On receipt of an operator command, transfer configuration 1 to module 1.

Each module is assigned an ANALD OFB (ANALD0 to module 0 and ANALD1 to module 1).

C

Programming

Bit B0 is used to detect a cold restart (a cold restart resets all bit to 0).

MAST task

```
! IF SY1 THEN RESET B0

< SET TASK AUX0
! IF NOT CTRL4,R THEN START CTRL4
```

AUX0 task

```
! IF NOT B0 THEN    EXEC ANALD0(;0=>);
                    EXEC ANALD1(;0=>);
                    SET B0

! IF RE(I1,0) THEN EXEC ANALD1(;1=>)
```

Possible variation for module 1:

```
! IF NOT B0 THEN 0 → W60; JUMP L10

! IF RE(I1,0)THEN 1 → W60
              ELSE JUMP L20

! L10 : EXEC ANALD1(;W60=>)

! L20 : Program continues
```

Possible variation for automatic loading when a module is changed:

```
! IF NOT B0 + IW5,1,D THEN EXEC ANALD0(;0=>)

! IF NOT B0 + IW6,2,D THEN EXEC ANALD1(;0=>)

! SET B0

! IF RE(I1,0) THEN EXEC ANALD1(;1=>)
```

In this program the AEM input parameter is initialized, on cold restart, with the value of the I_AEM internal constant. This supposes that the I_AEM internal constant was first initialized with the number of the module to which the OFB is assigned.
If this possibility is not required, specify the module number as an input parameter. The program will read:

```
! IF NOT B0 THENSET B0;
                EXEC ANALD0(0;0=>);
                EXEC ANALD1(1;0=>);
                             |   |
                             |   |_____ Application number,
                             |_________ Module number.
```

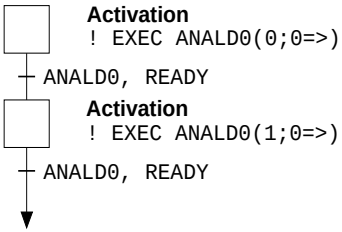
```
! IF RE(I1,0) THEN EXEC ANALD1(1;1=>)
```

It is possible to use a single OFB for the two modules EXCEPT IF ONE OF THEM IS A TSX AEM 821 MODULE USED IN SYNCHRO MODE.
The configuration must then be designed to transfer the application first to module 0 then to module 1:

```
! IF NOT B0 THEN        EXEC ANALD0(0;0=>);
                SET B0; SET B2
```

```
! IF B2.ANALD0,READY THEN  EXEC ANALD0(1;0=>);
                          RESET B2
```

This gives the following results in Grafcet:



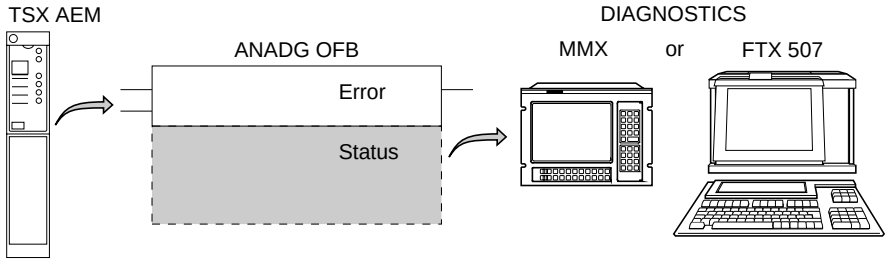
3.1 General

The ANADG OFB combines the error data from a TSX AEM module:

- Module related errors found when running the self-tests:
  - Module absent or failed,
  - Different module or I/O codes,
  - Terminal block error.
- Application errors related to each channel:
  - Upper or lower limits exceeded,
  - Sensor failure or connection breakage,
  - Synchronization failure when a TSX AEM 821 module is used.

The ANADG OFB is primarily intended for use with diagnostic applications (e.g. APPLIDIAG, DIAG, etc.).

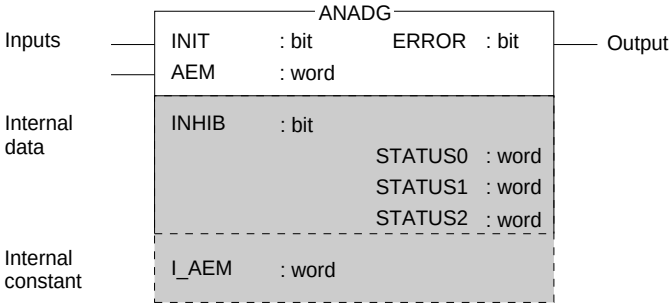
For more information on these programs, refer to the corresponding documentation.



Notes
- the TSX AEM 1613 module is only accepted from OFB ANALD version V5.0 or higher,
- the TSX AEM 1212 module is only accepted from OFB ANALD version V6.0 or higher.

3.2 ANADG OFB Presentation

The ANADG OFB has two input parameters, an output parameter and an internal constant (defined during the programming phase) and internal data (used during execution).



3.3 Parameter Description

Inputs

Parameter	Type	Access	Description
INIT	Bit	(2)	When set to 1, this bit reinitializes the OFB. The ERROR output and the STATUS variables are set to 0. It can be read by the ANADGi,INIT symbol.
AEM	Word	(2)	It comprises the logical number of the TSX AEM module to which the OFB is assigned. On PLC cold restart or reconfiguration, it is automatically initialized with the contents of the I_AEM internal constant. It can be read by the ANADGi,AEM symbol.

Internal data

Parameter	Type	Access	Description
INHIB	Bit	(4)	When this bit is at 1 module status monitoring is inhibited, the ERROR output and the STATUS variables are set to 0. This bit can be read or written by the ANADGi,INHIB symbol.
STATUS0	Word	(1)	This word comprises errors assigned to the module. It can be read by the ANADGi,STATUS0 symbol.
STATUS1 **STATUS2**	Word	(1)	These words comprise the application errors assigned to each channel. They can be read by the ANADGi,STATUS1 or ANADGi,STATUS2 symbols.

Output

Parameter	Type	Access	Description
ERROR	Bit	(1)	This bit changes to 1 when an error occurs. It can be read by the ANADGi,ERROR symbol.

Internal constants

Parameter	Type	Access	Description
I_AEM	Word	(3)	This word specifies the TSX AEM module to which the OFB is assigned. It takes a value between 0 and 63 (its default value is 64 which means that the OFB cannot be used if this parameter is not initialized).

(1) Read by program and adjustment (Adjust mode),
(2) Read by program and adjustment (Adjust mode),
Written by adjustment (Adjust mode),
(3) Read by adjustment (Adjust mode),
Written in program mode,
(4) Read by program and adjustment (Adjust mode),
Written by program and adjustment (Adjust mode).

3.4 Error List

STATUS0 Internal Data

Bit 0	=	1	:	TSX AEM module faulty or failure
Bit 1	=	1	:	Terminal block fault
Bit 2	=	1	:	Synchronization fault (AEM 821 synchronous mode)
Bit 3	=	1	:	Channel Overrun (AEM 821 synchronous mode)
Bit 4 to Bit 10				Not significant
Bit 11	=	1	:	Module type and I/O configuration incompatible
Bit 12	=	1	:	AEM module missing
Bit 13	=	1	:	Directory access error (does not exist, incoherent, etc.)
Bit 14	=	1	:	Communication error (exchange with the module not possible)
Bit 15	=	1	:	System error (inadequate software PLC version, ...)

STATUS1 Internal Data

Bit 0	=	1	:	Lower limit exceeded on channel 0
Bit 1	=	1	:	Upper limit exceeded on channel 0
Bit 2	=	1	:	Sensor break on channel 0
Bit 3				Not significant
Bit 4	=	1	:	Lower limit exceeded on channel 1
Bit 5	=	1	:	Upper limit exceeded on channel 1
Bit 6	=	1	:	Sensor break on channel 1
Bit 7				Not significant
Bit 8	=	1	:	Lower limit exceeded on channel 2
Bit 9	=	1	:	Upper limit exceeded on channel 2
Bit 10	=	1	:	Sensor break on channel 2
Bit 11				Not significant
Bit 12	=	1	:	Lower limit exceeded on channel 3
Bit 13	=	1	:	Upper limit exceeded on channel 3
Bit 14	=	1	:	Sensor break on channel 3
Bit 15				Not significant

STATUS2/STATUS3/STATUS4 Internal Data

	STATUS		
	2	3	4
Bit 0 = 1 : Lower limit exceeded on channel	4	8	12
Bit 1 = 1 : Upper limit exceeded on channel	4	8	12
Bit 2 = 1 : Sensor break on channel	4	8	12
Bit 3 Not significant			
Bit 4 = 1 : Lower limit exceeded on channel	5	9	13
Bit 5 = 1 : Upper limit exceeded on channel	5	9	13
Bit 6 = 1 : Sensor break on channel	5	9	13
Bit 7 Not significant			
Bit 8 = 1 : Lower limit exceeded on channel	6	10	14
Bit 9 = 1 : Upper limit exceeded on channel	6	10	14
Bit 10 = 1 : Sensor break on channel	6	10	14
Bit 11 Not significant			
Bit 12 = 1 : Lower limit exceeded on channel	7	11	15
Bit 13 = 1 : Upper limit exceeded on channel	7	11	15
Bit 14 = 1 : Sensor break on channel	7	11	15
Bit 15 Not significant			

C

3.5 Using the ANADG OFB

Executing the OFB

The ANADG OFB must be called for execution only once after PLC cold restart or reconfiguration.

The module monitoring function is automatically run cyclically. It is up to the user to ensure that the instruction that calls for execution of the OFB is only found once by the PLC program. Therefore this instruction should be conditional on an event that will only be true for a single PLC cycle.

Executing the ANADG OFB

Once the OFB is called-up, it runs continually in the PLC monitoring task. To stop (inhibit) this execution, set the ANADGi INHIB input bit to 1 by program or during debug operations.

Programming

Given the internal operation of the OFB (1), is not necessary to assign a PL7-3 variable to the ERROR output as it can be read directly by the ANADGi ERROR symbol.

For the OFB to run after a cold or hot PLC restart.

```
! IF SY1 THEN RESET B0
```

```
! IF NOT B0 THEN EXEC ANADGi(;W0=>); SET B0
```

With
B0 = Cold or hot restart detection bit (set to 0 on a cold restart),
W0 = TSX AEM module number,

Fault acknowledgment

All of the errors that occur on the module are stored. The ANADGi,INIT input must be set to 1 to acknowledge the errors indicated by STATUS0, STATUS1 and STATUS2 and then the OFB must be reinitialized. When an error is found, the OFB continues to monitor the module and indicate error information.

If the ANADG OFB is used along with diagnostics software (e.g. APPLIDIAG, SYSDIAG, etc.), the ANADGi,INIT input is controlled directly by the diagnostics software. However to acknowledge errors from the PLC application and to take account of how the OFBs operate, as described in (1), it is necessary to execute the ANADG OFB with the INIT input set to 1, which is possible when it is programmed as shown below:

```
! IF B1 THEN EXEC ANADGi(B1; W0=>); RESET B1
```

where
B1 = error acknowledgement command,
W0 = AEM number,

If this program line is combined with the one that executes the OFB on power return (or on a cold restart), the following instructions are required:

```
! IF SY1 THEN RESET B0; RESET B1
```

```
! IF NOT B0 + B1
          THEN EXEC ANADGi(B1; W0=>); RESET B1
```

(1) The input/output parameters are only transferred from/to the assigned PL7-3 variables when the EXEC ANADG instruction is scanned.

When the ANADG OFB is used, a PL7-3 variable assigned to the ERROR output is only refreshed once.

3.6 Operating Modes - Performance Levels

3.6-1 Operating Modes

When the OFB is called-up for execution, it checks that:

- The PCL function is defined for the station,
- The directory exists and is valid (module logical number),
- The module is present and operational (module OK and self-tests complete),
- The type of module is the same as that defined in the directory.

The ANADG OFB then reads the register interface to detect application errors.

C

3.6-2 Performance Levels

The modules are monitored approx. every 200 ms. This time may rise to a second if the PLC processor load is considerable.

Execution and response times

The system response time depends on the PL7 application. It varies from 1 to 5 master task cycles.

ANADG OFB memory occupation

Program field	Data field	Constants field
1752 words regardless of the number of times it is used	136 words for each use	8 words for each use

ANADG OFB execution time

TSX 47-40/67-40	TSX 87-40	TSX 107-40
2.5 ms	1 ms	0.8 ms

D

D

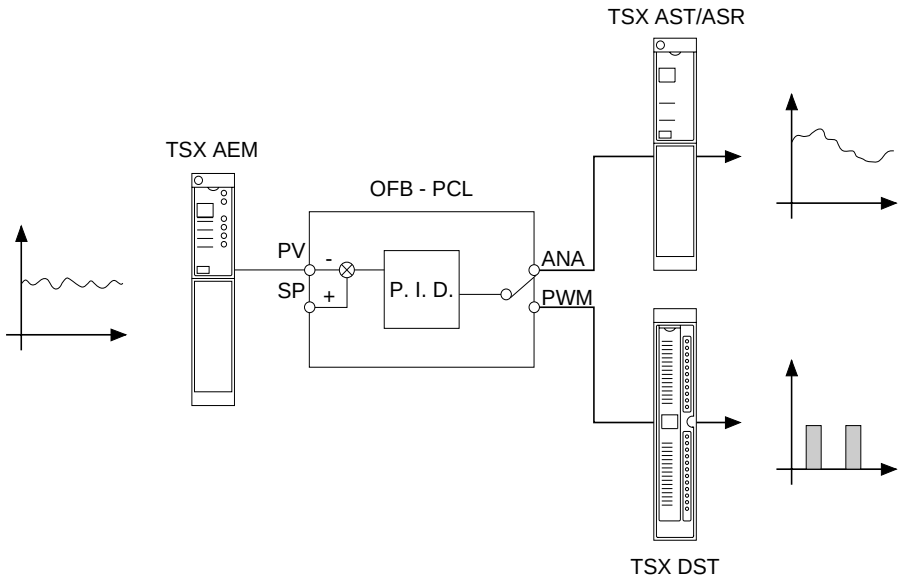
1.1 General

The PCL OFB supports PID process control loops on TSX Series 7 Model 40 PLCs. There is no limit to the number of process control loops that can be run by a PLC but for best performance the following numbers should not be exceeded:

V5 level PLC	V4 level PLC	Number of loops
TSX 47-40	TSX 47-40	16
	TSX 67-40	16
TSX 67-40	TSX 87-40	32
TSX 87-40/107-40	TSX 107-40	64

Like the other OFBs, the PCL OFB is an extension of the PL7-3 programming language. It works from a process variable supplied by a TSX AEM analog input module and generates an output that can be:

- Analog, applied to the process by a TSX AST or TSX ASR output module,
- Duration modulated, sent to the process by a discrete output module such as a TSX DST.



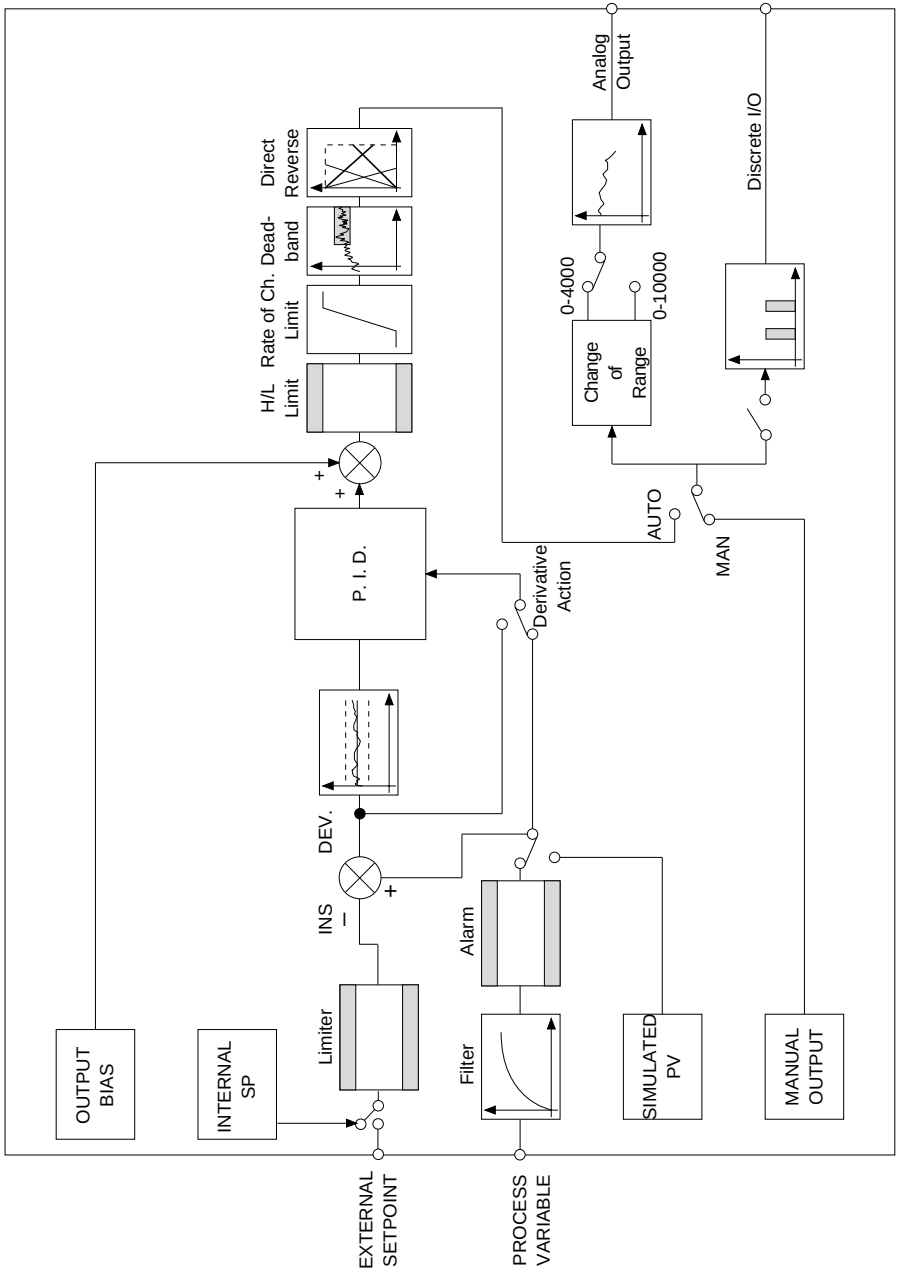
The PCL OFB works from variables (process variable, setpoint, deviation, output), expressed in a 0 - 10000 format.

1.2 Features

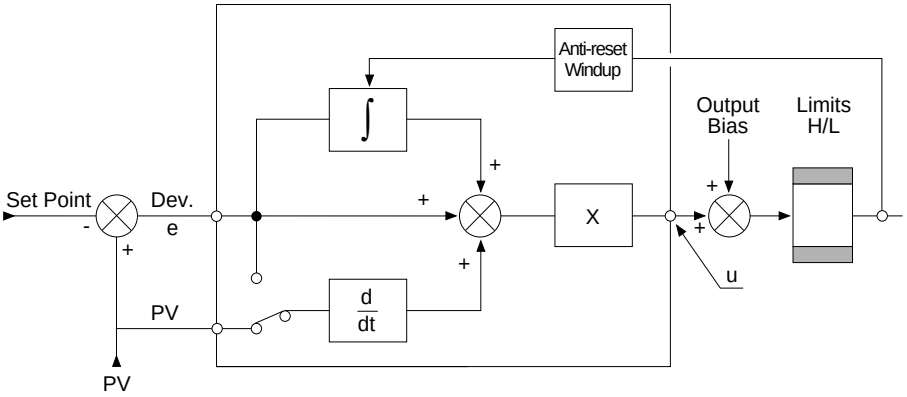
The PCL OFB includes most of the features normally supported by conventional PID process control loops. It corresponds to a mixed layout corrector comprising the following functions:

- Digital filter on process variable,
- Derivative action applied to the process variable or deviation,
- Direct or reverse action,
- Output range 0-4000 or 0-10000,
- High and low alarms on the process variable with hysteresis,
- High and low alarms on the deviation with hysteresis,
- High and low limitation of the setpoint,
- High and low limitation of the output signal,
- Anti-reset windup,
- Selection of manual and automatic modes,
- Selection of local and remote setpoints,
- Selection of internal and external process variables (for debugging),
- Limitation of output rate of change,
- Output bias,
- Deadband,
- Continuous or pulse width modulated output.

1.2-1 Diagram


Analog Output
Discrete I/O
Direct Reverse
Dead-band
Rate of Ch. Limit
H/L Limit
0-4000
0-10000
Change of Range
AUTO
MAN
P. I. D.
Derivative Action
DEV.
INS
Alarm
Limiter
Filter
OUTPUT BIAS
INTERNAL SP
SIMULATED PV
MANUAL OUTPUT
EXTERNAL SETPOINT
PROCESS VARIABLE

Detailed description of the PID corrector



A mixed structure corrector is used. Its transfer function, in the case of a derivation of the error is:

$$\frac{u(p)}{e(p)} = KP\left[1 + \frac{1}{TI \times p} + \frac{TD \times p}{1 + (TD/KD) \times p}\right]$$

with KP : Proportional gain
TI : Integral time
TD : Derivative time

The expression 1 + (TD/KD) x p gives a "spread" of the derivative action. The value of KD (maxmum gain on the derivative action) is set to 10.

1.2-2 Digital Process Variable Filter

A low pass type filter is used. Its equation is:

$$EFn = \alpha * EFn\text{-}1 + (1-\alpha) * EBn$$

- EFn is the filtered input value at time n,
- α is the filtering constant (α = T_FILT/T_FILT + T),
  - T_FILT is the filtering constant,
  - T is the sampling period,
- EBn is the raw input value at time n.

This function is inhibited for T_FILT = 0 (default value).

1.2-3 Process Variable or Derivative Deviation Action

The derivative action can apply to the process variable or to the deviation.

The type of derivative action is selected by bit PV_DEV :

PV_DEV = 0: Derivative action on the process variable (default value),
PV_DEV = 1: Derivative action on the deviation.

1.2-4 Direct or Reverse Action

Reminders:

Direct action:

An increase in the process variable causes a corresponding increase in the output signal (Figure 1).

Reverse action:

An increase in the process variable causes a corresponding decrease in the output signal (Figure 2).

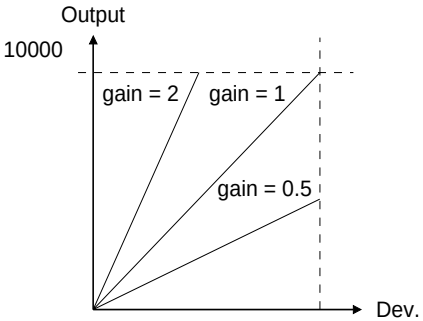


Fig 1
Direct Action

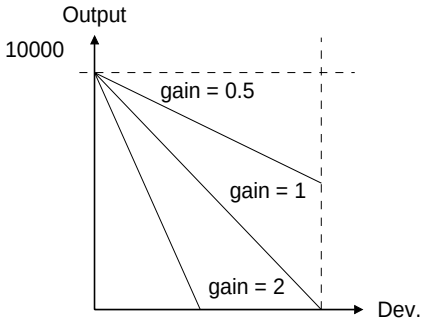


Fig 2
Reverse Action

The choice of the type of action to use is made via the DIR_REV bit:

DIR_REV = 0: Direct action,
DIR_REV = 1: Reverse action (default value).

1.2-5 Analog Output Range

To make it easier to use devices with 4000 point resolution, the OFB has a parameter that lets it provide an output value in 0 - 4000 range format.

The OUTRANGE bit is used to select the output range:

OUTRANGE = 0: Analog output in 0 - 4000 range (default value),
OUTRANGE = 1: Analog output in 0 - 10000 range.

> The analog output value is expressed by default in the 0 - 4000 range. The output range selected must be coherent with that selected at output module level.

1.2-6 Process Variable High and Low Alarms

The process variable used is continually compared with two thresholds:

- High threshold: PV_HL,
- Low threshold: PV_LL.

The thresholds are programmable digital values expressed in the same format as the process variable (0 - 10000). By default these values are 0 for the low threshold and 10000 for the high threshold.

If the process variable used is external to the valid interval defined by the thresholds, an alarm bit is set to 1 in status word STATUS0 (refer to Divider D, Sub-Section 4.4) and the output bit ERROR is set to 1 (refer to Divider D, Sub-section 1.3-3).

Hysteresis

The comparison for each threshold is performed with a hysteresis factor (h) of 0.5% of the full scale range (i.e. 50).

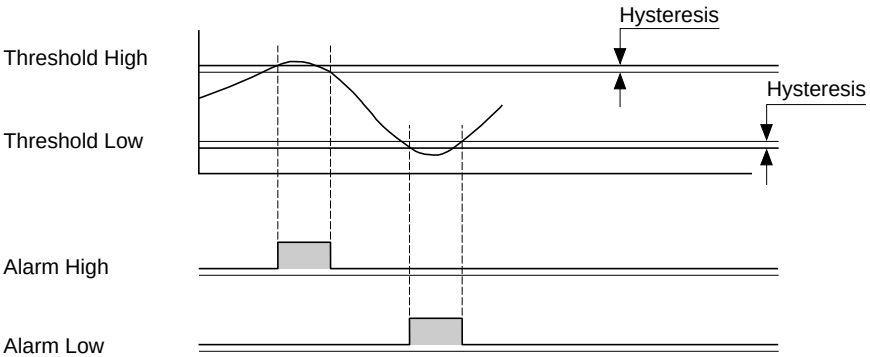
1.2-7 Deviation High and Low Alarms

In the same way as for the process variable value, two thresholds are defined to monitor the deviation between the actual process variable and the preset setpoint (DEV_HL and DEV_LL).

These thresholds are programmable digital values that are expressed in the same format as the deviation (-10000 +10000). By default these values are set to -10000 for the low threshold and +10000 for the high threshold.

If the deviation exceeds the limits defined by the high and low thresholds, an alarm bit is set to 1 in status word STATUS0 (refer to Divider D, Sub-Section 4.4) and the output bit ERROR is set to 1 (refer to Divider D, Sub-section 1.3-3).

The comparison is performed with a hysteresis factor (h) of 0.5% of the full scale range, i.e. 100 for a range of 20000.



1.2-8 Setpoint High and Low Limitation

Variations in the setpoint are restricted to two limit values (SP_MAX and SP_MIN).

These limits are user programmable digital values expressed in 0 - 10000 format.

Their default values are:
- 0 for the lower limit,
- 10000 for the higher limit.

Processing of these limitation values is performed with the setpoint used in the algorithm, i.e. based on the internal or external setpoint.

The setpoint used is compared with the high and low limitation values. If a limitation is exceeded, the setpoint takes the limitation value. If this occurs, an alarm bit is reset to 1 in status word STATUS0 (refer to Divider D, Sub-Section 4.4).

1.2-9 Output Signal High and Low Limitation

The output signal from the algorithm is restricted to the limitation values (OUT_MAX and OUT_MIN).

These limitations are user programmable digital values that are expressed in 0 - 10000 format.

Their default settings are:
- 0 for the low limit,
- 10000 for the high limit.

Processing of these limitation values is performed with the output value calculated by the algorithm, before output rate of change limitation, deadband, direct/reverse and format actions.

The calculated output signal value used is compared with the high and low limit values. If a limitation is exceeded, the setpoint takes the limitation value. If this occurs, an alarm bit is reset to 1 in status word STATUS0 (refer to Divider D, Sub-Section 4.4).

1.2-10 Anti-Reset Windup

The PCL OFB is equipped with an anti-reset windup mechanism that effects the integral action and restricts variations after a major change to the setpoint (or start-up using a low process variable). It also ensures smooth on the fly transitions from manual to automatic modes.

1.2-11 Smooth Manual/Automatic Mode Transition

Automatic mode → Manual mode

On transition from automatic to manual mode, the manual output value is automatically aligned with the calculated output value to avoid a sudden change.

Manual mode → Automatic mode

On transition from manual to automatic mode, there are various options:

- If the setpoint is local or remote, the integral action is present and the transition is performed automatically without any sudden changes,
- If the setpoint is local, the integral action is null and the OFB recalculates the local setpoint to obtain a smooth transition,
- If the setpoint is remote, the integral action is null and the OFB recalculates the local setpoint. The transition is smooth if this setpoint is used to progressively reset itself to match the external setpoint.

1.2-12 Selecting a Local or Remote Setpoint

Selection of the local/remote setpoint is performed by a bit that lets the algorithm operate with:

- A local setpoint that can be modified by the user via a programming terminal,
- A remote setpoint supplied by the PL7-3 application.

This approach means that the setpoint can follow a rate of change and support cascaded loops.

The SP_RSP bit is used to select local or remote setpoints:
SP_RSP = 0: Local setpoint (default value),
SP_RSP = 1: Remote setpoint.

1.2-13 Selecting an Internal or External Process Variable

To simplify debugging of a control loop application, a simulated process variable can be used by the control algorithm in place of the correct process variable.

This internal process variable (PV_SIMUL) lets the system run with an open loop and therefore test the algorithm directly by analyzing the output obtained as a function of the required input. This function is especially useful during the debug and adjust phases of a PL7 application.

An internal or external process variable value is selected by bit 0 of the Command word:

Bit 0 = 0: Simulated process variable,
Bit 0 = 1: Process variable (default value).

1.2-14 Output Rate of Change Limitation

The variation of the output between two sample cycles can be restricted to the value:

$$|Sn - Sn\text{-}1| \leq OUTRATE$$

The OUTRATE variable comprises a user programmable digital value that is expressed in 0 - 10000 format.

Its default value is 10000, disabling the limiting action.

This operation can be inhibited by forcing bit 5 of the Command word to 0.

1.2-15 Deadband

To avoid premature wear on the actuators, the algorithm includes a deadband (DBAND).

If the difference between the calculated output and the last applied output is less than the deadband value, the output remains unchanged.

The deadband is expressed in 0 - 10000 format.

Its default value is 0 so that it is disabled.

1.2-16 Output Bias

In pure proportional control applications (without integral action), there remains a degree of error between process variable and setpoints.

To compensate for this error, the OFB has the OUTBIAS output variable to shift the output in order to compensate for the error.

The OUTBIAS variable is a value expressed in 0 - 10000 format.

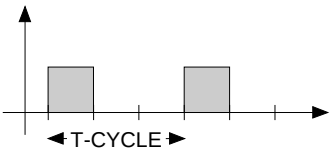
Its default value is 5000.

1.2-17 Width Modulated Output

The algorithm can be used either to control an analog output or a width modulated output.

The modulated output is a direct function of the calculated output and the modulation period as the ratio between modulated output activation time and modulation period corresponds to the percentage of the analog output sent.

Example: Modulation corresponding to an output of 33%.



As the modulated output is updated in the OFB, the output activation time must be a multiple of the period of the task that contains the OFB. This restriction sets the modulation resolution: It is the ratio task period/modulation period.

For example, if the maximum acceptable resolution is 5% and if the control loop is running in a 500 ms auxiliary task, the minimum modulation period is 10 seconds.

The modulation period (T_CYCLE), is expressed in tenths of a second. The default value is 20 seconds (T_CYCLE = 200).

The modulation is selected by setting the OUT_TYPE bit to 1 (default value = 0).

(1) The OFB includes an adjustment system to process as best possible, values that are not multiples of the task period.

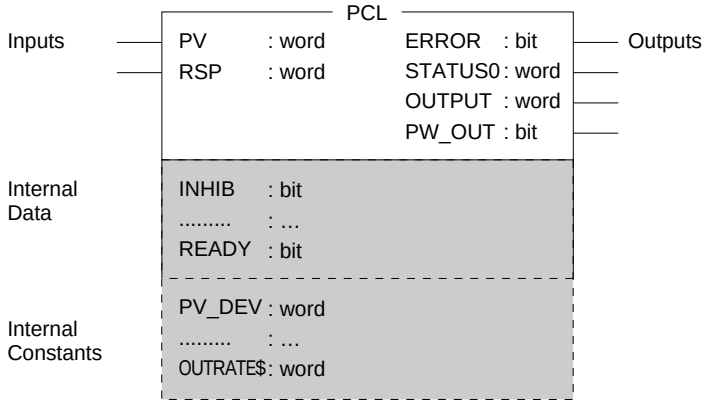
1.3 PCL OFB Description

1.3-1 General

The PCL OFB operates in the same way as all other Optional Function Blocks.

It comprises:

- Two input parameters,
- Four output parameters.
- Twenty one internal parameters (defined during the programming phase),
- Thirty one internal data (used during execution).



1.3-2 Input Parameters

Parameter	Type	Access	Description
PV	word	(1)	Process variable. Minimum value: 0, Maximum value: 10000. (PV = Process Variable).
RSP	word	(1)	Remote process control loop setpoint. Minimum value: 0, Maximum value: 10000. (RSP = Remote Set Point).

(1) Read by program and adjustment.
(2) Read by program and adjustment, Written by adjustment.
(3) Read by program and adjustment, Written by program and adjustment.
(4) Fall back value defined by internal constants.

1.3-3 Output Parameters

Parameter	Type	Access	Description
ERROR	bit	(1)	At 1 indicates that a limit or a threshold was exceeded. Reading STATUS0 lets the user determine the affected limit or threshold.
STATUS0	word	(1)	OFB operation report. Each bit corresponds to an error and is reset to 0 only when the cause of the error ends. For a detailed description of its contents refer to Divider D, Sub-Section 1.3-9.
OUTPUT	word	(1)	Analog output. It can be the result of the algorithm calculation (in Auto mode) or the value of the manual output (in Man mode). Depending on the user selection (OUTRANGE bit), it is expressed in 0 - 4000 or 0 - 10000 format.
PW_OUT	bit	(1)	PID logic output where the "form ratio" is the image of the analog value.

Note
The OUTPUT analog output is always calculated. The OUT_TYPE bit (defined as an internal constant) lets the user set-up the duration modulation output.

(1), (2) (3) and (4) refer to Sub-Section 1.3-2.

1.3-4 Internal Data - Commands

The tables below list all of the internal variables of PCL OFB commands that can be accessed by the user in read or write modes.
On a PLC cold restart, all of these variables are initialized either with their default values or with the fall back values defined by the internal constants.

Parameter	Type	Access	Description
INHIB	bit	(3)	Set to 1, this bit inhibits the OFB alarms by forcing the ERROR bit to 0. Default value: 0.
SP	word	(2)	PID local setpoint. Minimum value 0, maximum value 10000.
OUT_MAN	word	(3)	PID manual output value. Minimum value 0, maximum value 10000.
SP_RSP	bit	(3)	Type of setpoint used, internal (SP) or remote (RSP). Default value: 0 (internal setpoint).
MAN_AUTO	bit	(3)	PID operating mode, manual (MAN) or automatic (AUTO). Default value: 0 (manual).
DIR_REV	bit	(2)	PID corrector action, direct (0 - 10000 output range) or reverse (10000 - 0 output range) (4).
KP	word	(3)	PID corrector gain multiplied by 100. Minimum value: 1, maximum value: 3000 (4).
TI	word	(3)	PID corrector integral time expressed in tenths of a second. Minimum value: 0, maximum value: 20000 (4).
TD	word	(3)	PID corrector derived time expressed in tenths of a second. Minimum value: 0, maximum value: 10000 (4).
T_FILT	word	(3)	Digital filter constant time expressed in hundreds of a second. Minimum value: 0, maximum value: 32767 (4).
PV_HL	word	(3)	Process variable high threshold. Minimum value: 0, maximum value: 10000 (4).
PV_LL	word	(3)	Process variable low threshold. Minimum value: 0, maximum value: 10000 (4).
DEV_HL	word	(3)	High threshold on calculated deviation. Minimum value: 0, maximum value: +10000 (4).
DEV_LL	word	(3)	Low threshold on calculated deviation. Minimum value: -10000, maximum value: 0 (4).
SP_MAX	word	(3)	High limit on setpoint used. Minimum value: 0, maximum value: 10000 (4).

(1), (2) (3) and (4) refer to Sub-Section 1.3-2.

D

Internal Data - Commands (continued)

Parameter	Type	Access	Description
SP_MIN	word	(3)	Low limit on setpoint used. Minimum value: 0, maximum value: 10000 (4).
OUT_MAX	word	(3)	High limit on output. Minimum value: 0, maximum value: 10000 (4).
OUT_MIN	word	(3)	Low limit on output. Minimum value: 0, maximum value: 10000 (4).
T_OFB	word	(2)	PCL OFB processing period expressed in tenths of milliseconds. Its true value is always automatically adjusted to remain an integer multiple of the period of the task in which the OFB is executed. If for example T_OFB declared in 800 ms and the period of task AUX0 is 300 ms, the real T_OFB is 900 ms. Minimum value: 2, maximum value: 32767 (4).
T_CYCLE	word	(2)	Pulse width modulation period expressed in tenths of a second. Minimum value: 2, maximum value: 32767 (4).
DBAND	word	(3)	Output variation after which the algorithm sends a new action (dead band). If the output variation is less than this value, the action remains unchanged. Maximum value: 10000 (4).
OUTBIAS	word	(3)	Static error compensation in the absence of any integral action. Minimum value: 0, maximum value: 10000 (4). In pure proportional (Ti = 0) and in reverse output modes, the OUTBIAS must be set to 10000.
OUTRATE	word	(3)	Output variation limit between two module sampling cycles. Minimum value: 0, maximum value: 10000 (4).
PV_SIMUL	word	(2)	PID corrector internal value used when setting up the control loop application. Minimum value: 0, maximum value: 10000.
FORCE	bit	(3)	At 1, this bit forces algorithm execution in the next cycle. Default value: 0.
COMMAND	word	(3)	Determines the PID operating mode. Each bit selects a PID function, the image of which is found in the output variables STATUS0 and STATUS1. The functions that are accessible from this word are process variable selection and activate or inhibit alarms (refer to Divider D, Sub-Section 4.4).

(1), (2), (3) and (4) refer to Sub-Section 1.3-2.

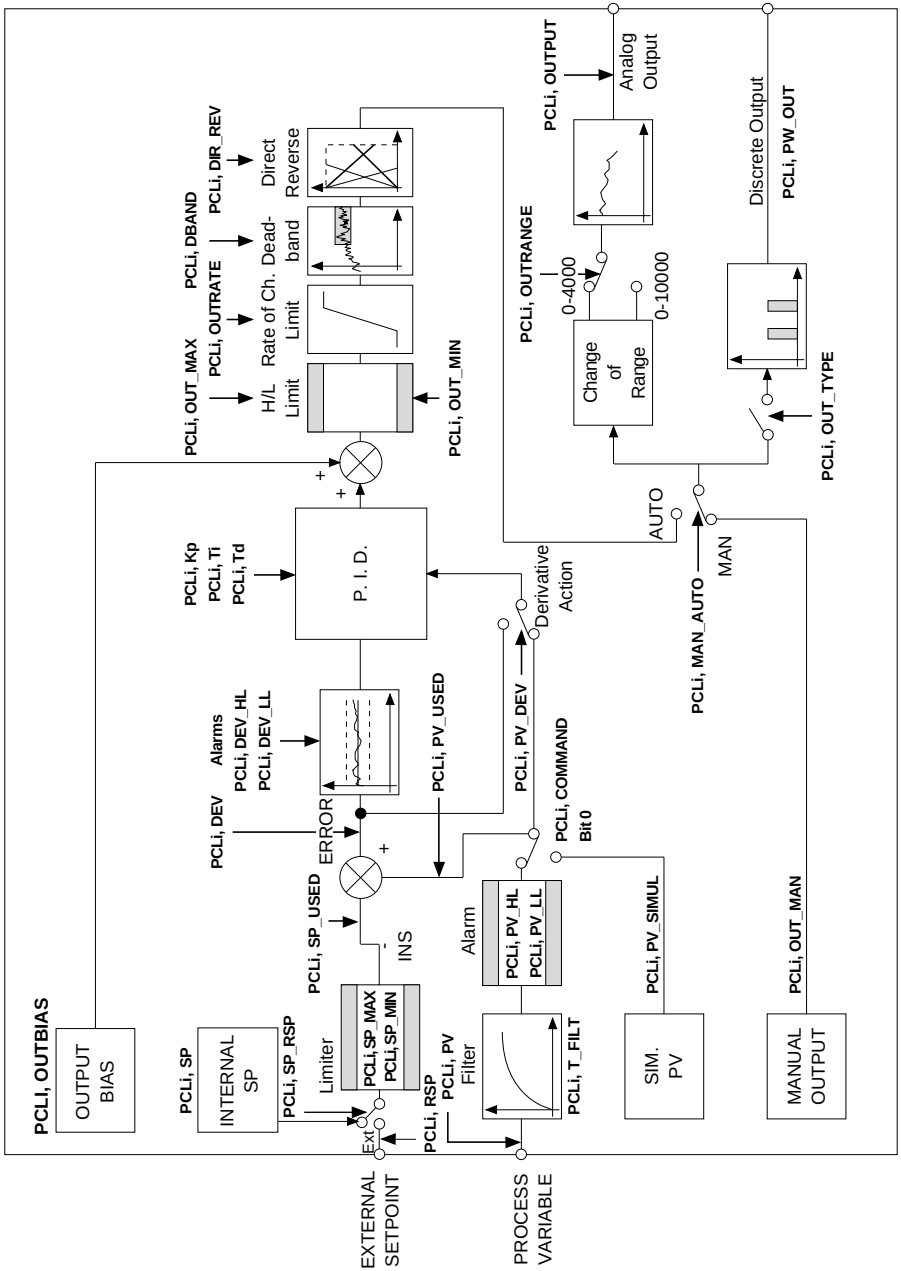
1.3-5 Internal Data - Information

The tables below present all of the PCL OFB data internal variables accessible to the user in read.
On a PLC cold restart, all of these variables are initialized with their default values.

Parameter	Type	Access	Description
STATUS1	word	(1)	OFB operation report. Each bit of this parameter correspond to a PID state. For a detailed description of its contents, refer to Divider D, Sub-Section 4.4.
PV_USED	word	(1)	Process variable value used in the algorithm. Minimum value: 0, maximum value: 10000.
SP_USED	word	(1)	Setpoint used in the algorithm. Minimum value: 0, maximum value: 10000.
DEV	word	(1)	Deviation (process variable - setpoint). Minimum value: -10000, maximum value: +10000.
READY	bit	(1)	This bit is linked to the internal counter that handles PCL OFB execution sequencing. It is set to 1 when the counter indicates that the OFB will be executed in the next cycle. This function lets the user link a number of actions to run (affecting the process variable or setpoint) when the OFB is actually executed by the system.

(1), (2) (3) and (4) refer to Sub-Section 1.3-2.

1.3-6 Links Between the Diagram and OFB Data



1.3-7 Internal Constants - Structure Variables

The internal constants comprise all of the PID corrector structure selection variables.

Parameter	Type	Access	Description
PV_DEV	bit	(1)	Type of deviation action, on the process variable or the deviation. Default value = 0 (derived from the process variable value).
OUT_TYPE	bit	(1)	Set-up the analog output. Default value = 0 (analog output).
OUTRANGE	bit	(1)	PID corrector analog output range, 0 - 4000 or 0 - 10000. Default value = 0 (0 - 4000 format output).
DIR_REV$	bit	(1)	PID corrector type of action, direct (0 - 10000 format) or reverse (10000 - 0 format). Default value = 1 (reverse action).

Note
Any modification to the PV_DEV, OUT_TYPE and OUTRANGE parameters is immediately accepted while any modification to the DIR_REV$ parameter or to any one of the initialization values described later will only be accepted after a cold restart (bit SY0).

(1), (2) (3) and (4) refer to Sub-Section 1.3-2.

1.3-8 Internal Constants - Initialization Values

The internal constants also comprise all of the internal data initialization values (fall back values used after a cold restart).

By convention, the names of the initialization variables are identical to those of the corresponding internal data with a distinctive $ suffix.

Parameter	Type	Access	Description
KP$	word	(2)	PID corrector gain multiplied by 100. Default value: 100 (gain = 1), Minimum value: 1, maximum value: 3000.
TI$	word	(2)	PID corrector integral time expressed in tenths of a second. Default value: 0 (no integral action), Minimum value: 0, maximum value: 20000.
TD$	word	(2)	PID corrector derevative time expressed in tenths of a second. Default value: 0 (no derevitive action), Minimum value: 0, maximum value: 10000.
T_FILT$	word	(2)	Digital filter time constant expressed in hundreds of a second. Default value: 0 (no digital filter), Minimum value: 0, maximum value: 32767.
PV_HL$	word	(2)	Process variable high level threshold. Default value: 10000 (no high level threshold), Minimum value: 0, maximum value: 10000.
PV_LL$	word	(2)	Process variable low level threshold. Default value: 10000 (no low level threshold), Minimum value: 0, maximum value: 10000.
DEV_HL$	word	(2)	Calculated error high level threshold. Default value: +10000 (no high level threshold), Minimum value: 0, maximum value: 10000.
DEV_LL$	word	(2)	Calculated error low level threshold. Default value: -10000 (no low level threshold), Minimum value: -10000, maximum value: 0.
SP_MAX$	word	(2)	High limit on setpoint used. Default value: 10000 (no high limit). Minimum value: 0, maximum value: 10000.
SP_MIN$	word	(2)	Low limit on setpoint used. Default value: 0 (no low limit). Minimum value: 0, maximum value: 10000.
OUT_MAX$	word	(2)	High limit on output. Default value: 10000 (no high limit). Minimum value: 0, maximum value: 10000.

(1), (2) (3) and (4) refer to Sub-Section 1.3-2.

Internal Constants - Initialization Values (continued)

Parameter	Type	Access	Description
OUT_MIN$	word	(2)	Low limit on output. Default value: 0 (no low limit). Minimum value: 0, maximum value: 10000.
T_OFB$	word	(2)	PCL OFB processing period expressed in tenths of milliseconds. Its true value is always automatically adjusted to remain an integer multiple of the period of the task in which the OFB is executed. If for example T_OFB declared as 800 ms and the period of task AUX0 is 300 ms, the real T_OFB is 900 ms. Default value: 30 (period = 300 ms). Minimum value: 2, maximum value: 32767.
T_CYCLE$	word	(2)	Width modulation period expressed in tenths of a second. Default value: 0 (period = 20 ms). Minimum value: 2, maximum value: 32767.
DBAND$	word	(2)	Output variation after which the algorithm sends a new action (dead band). If the output variation is less than this value, the action remains unchanged. Default value: 0. Minimum value: 0, maximum value: 10000.
OUTBIAS$	word	(2)	Static error compensation in the absence of any integral action. Default value: 5000. Minimum value: 0, maximum value: 10000.
OUTRATE$	word	(2)	Output variation limit between two module sampling cycles. Default value: 10000. Minimum value: 0, maximum value: 10000.

(1), (2) and (3) refer to Sub-Section 1.3-2.

1.3-9 Status and Command Words

STATUS0

This word provides a report on OFB operation. Each bit of this parameter corresponds to an error and is reset to 0 only when the cause of the error is resolved.

Bit 0 : System error (inadequate software PLC version, ...)
Bit 1 = 1 : Low level process variable alarm
Bit 2 = 1 : High level process variable alarm
Bit 3 = 1 : Low level deviation alarm
Bit 4 = 1 : High level deviation alarm
Bit 5 = 1 : Low setpoint limit reached
Bit 6 = 1 : High setpoint limit reached
Bit 7 = 1 : Low output limit reached
Bit 8 = 1 : High output limit reached
Bit 9 = 1 : Low output limit exceeded in manual mode
Bit 10 = 1 : High output limit exceeded in manual mode
Bit 11 = 1 : Output rate of change limit reached.
Bit 12 = 1 : Output deviation in the deadband.
Bit 13 : Not significant.
Bit 14 : Not significant.
Bit 15 : Not significant.

D

STATUS1

This word provides a report on OFB operation. Each bit of this parameter corresponds to a PID state.

Bit 0 : 0, PID in manual mode
1, PID in automatic mode
Bit 1 : 0, Direct action
1, Reverse action
Bit 2 : 0, Derivative action on process variable
1, Derivative action on deviation
Bit 3 : 0, Local setpoint
1, Remote setpoint
Bit 4 : 0, Internal process variable
1, External process variable
Bit 5 : 1, Filtered process variable
Bit 6 : 1, Pulse width modulated output used
Bit 7 : 1, Overrun
Bit 8 :
to : Not significant.
Bit 15 :

Command word

This word is used to determine the PID operating mode. Each bit selects a PID function the image of which is in the Status output variable.

Bit 0 : 0, Local process variable used,
1, Remote process variable used,

Bit 1 : 0, Measurement low threshold disabled,
1, Measurement low threshold enabled,

Bit 2 : 0, Measurement high threshold disabled,
1, Measurement high threshold enabled,

Bit 3 : 0, Error low threshold disabled,
1, Error low threshold enabled,

Bit 4 : 0, Error high threshold disabled,
1, Error high threshold enabled,

Bit 5 : 0, Output rate of change limitation disabled,
1, Output rate of change limitation enabled.

By default this word is initialized at 63 (H'3F') corresponding to:

- External process variable usage,
- Process variable and deviation checks enabled,
- Limitation of output rate of change enabled.

1.4 Reaction to a PLC Power Return

1.4-1 Hot Restart (1)

The PCL OFB restarts with the following states:

- MAN, LOCAL mode (internal setpoint),
- Output at 0,
- Setpoints and adjustment values are identical to those used prior to the power break.

Changeover to AUTO mode, and when necessary to using an EXTERNAL setpoint is controlled by the program.

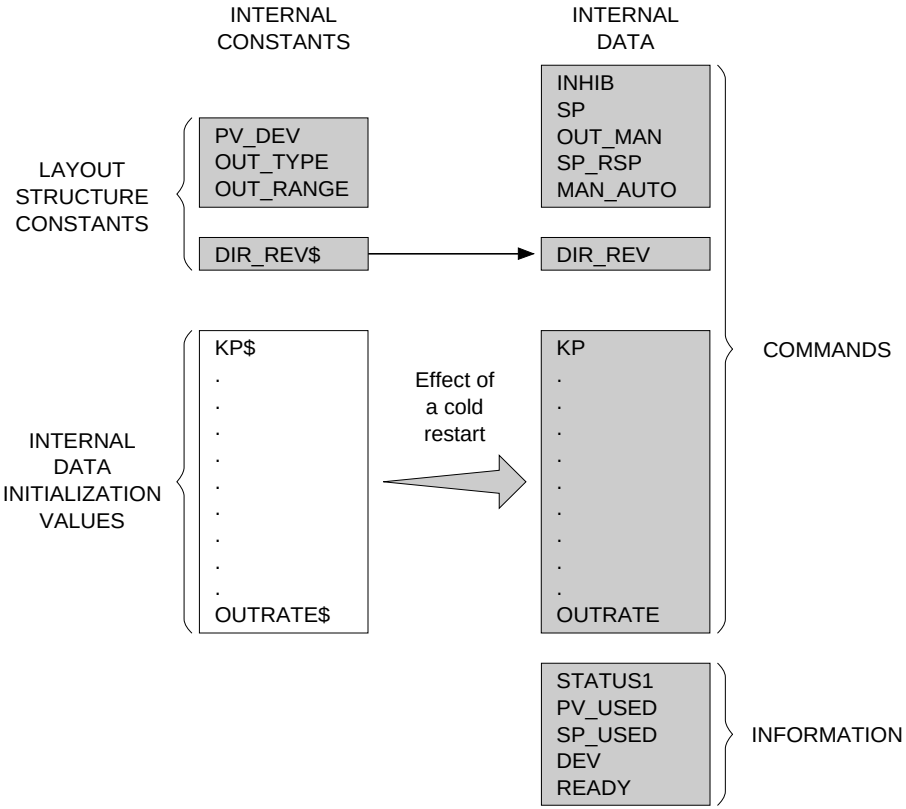
1.4-2 Cold Restart

The PCL OFB is initialized in the following state:

- MAN, LOCAL mode (internal setpoint),
- Output set to 0,
- Setpoint aligned with the measurement value (refer to the note),
- Adjustment values equal to the default value defined in the INTERNAL CONSTANTS (where applicable),

Note

This usually results in a set point value of 0 given that TSX AEM modules output a null measurement value during the self-test process.

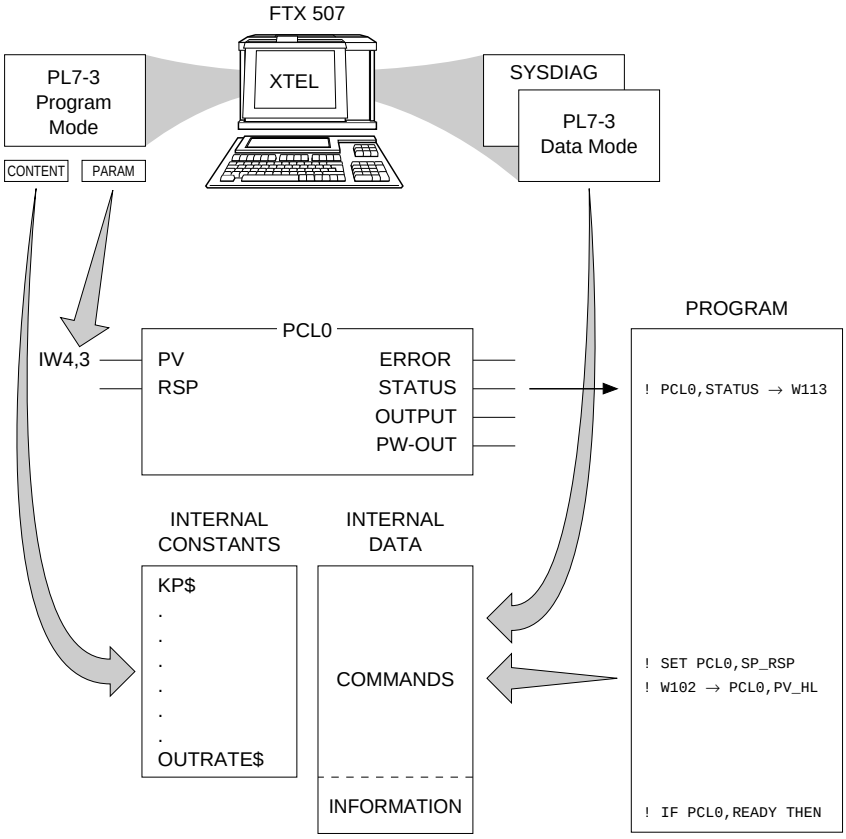


Shaded areas identify the values used by the PCL OFB

(1) To define the meaning of the terms “hot restart” and “cold restart”, refer to the PL7-3 Reference Manual.

1.5 Accessing Variables

- **The Input/Output parameters** cannot be directly modified from a terminal. To modify an input parameter value, it is essential to assign a PL7-3 variable,
- **The internal constants** can only be modified by PL7-3, either in Program mode or in Constants mode,
- **Internal data (commands)** can be modified from a terminal by PL7-3 in Data mode or with SYSDIAG software.
  Internal data can also be modified from the PLC program (e.g. SET PCL0,SP_RSP; W102 → PCL0,PV_HL).
- All of the I/O parameters, all internal data and all internal constants can be read either from the terminal or from the PLC program (e.g.: PLC0,STATUS → W110; IF PLC0, READY THEN ...).



1.6 Performance Levels

PCL OFB memory requirements

Program Field	Data Field	Constants Field
3376 words regardless of the number of times it is used	64 words each time it is used	24 words each time it is used

PCL OFB execution time

TSX 47-40/67-40	TSX 87-40	TSX 107-40
2.5 ms	1 ms	0.8ms

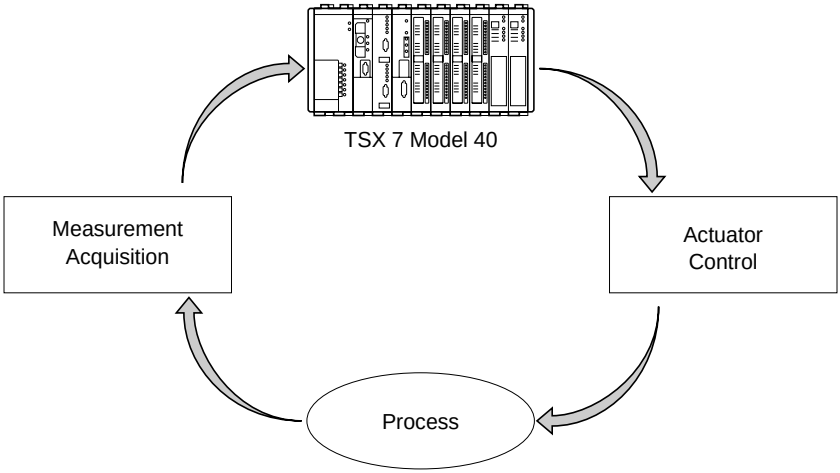
D

2.1 General

Reminders:

Once all of the preliminary (hardware and software) configuration operations have been performed, creating a control loop application requires writing a program corresponding to:

- Measurement acquisition by the sensors,
- PID algorithm execution,
- Sending commands to the actuators.



2.2 Measurement Acquisition

The 4, 8, 12 or 16 channel TSX AEM analog input modules perform the conversion from electrical input level signal to a 0 - 10000 standard format ready for direct processing by the PCL OFB.

Eight types of module cover the range of standard applications most often encountered in the acquisition of continuous input level signal:

- TSX AEM 411 4 isolated high level channels (voltage or current input),
- TSX AEM 412 4 isolated low level channels (thermocouple or voltage input),
- TSX AEM 413 4 isolated low level channels (Pt 100 probe or voltage),
- TSX AEM 811 8 isolated high level channels (voltage or current input),
- TSX AEM 821 8 high level high speed channels (voltage or current input),
- TSX AEM 1601 16 non isolated high level channels (voltage input),
- TSX AEM 1602 16 non isolated high level channels (current input),
- TSX AEM 1212 12 isolated low level channels (thermocouple or voltage input),
- TSX AEM 1613 16 non isolated low level channels (Pt100 probe).

D

The choice of an input module depends on the type of input sensors used with it.

Using the measurements

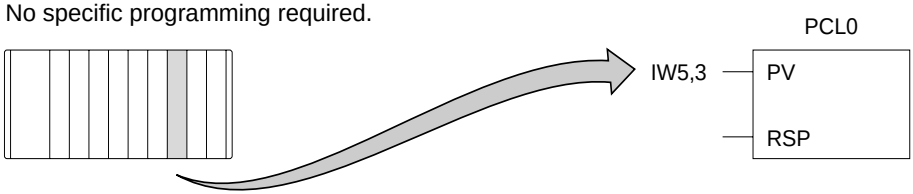
How the measurements are used depends on the type of module used. A quick reminder on measurement data acquisition methods is given below. For more information on accessing these measurements, refer to the appropriate user's documentation:

- For TSX AEM 411/412/413 modules:
  TSX AEM User's Manual (TSX D43 727), Section 7,
- For TSX AEM 811 modules:
  TSX AEM 811 User's Manual (D23 001E), Section 7,
- For TSX AEM 821 modules:
  TSX AEM 821 User's Manual (TSX D23 006E), Section 4,
- For TSX AEM 1601/1602 modules:
  TSX AEM 1601/1602 User's Manual (TSX DM AEM 16E), Section 4,
- For TSX AEM 1212 modules:
  TSX AEM 1212 User's Manual (TSX DM AEM 1212E), Section 4,
- For TSX AEM 1613 modules:
  TSX AEM 1613 User's Manual (TSX DM AEM 1613E), Section 4.

Brief reminders on measurement acquisition

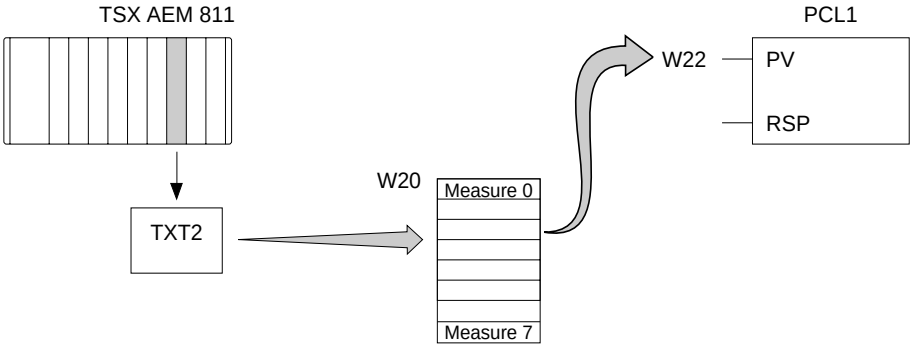
TSX AEM 4xx or TSX AEM 811/821 modules with up to 4 channels:

No specific programming required.



TSX AEM 811 module with more than 4 channels:

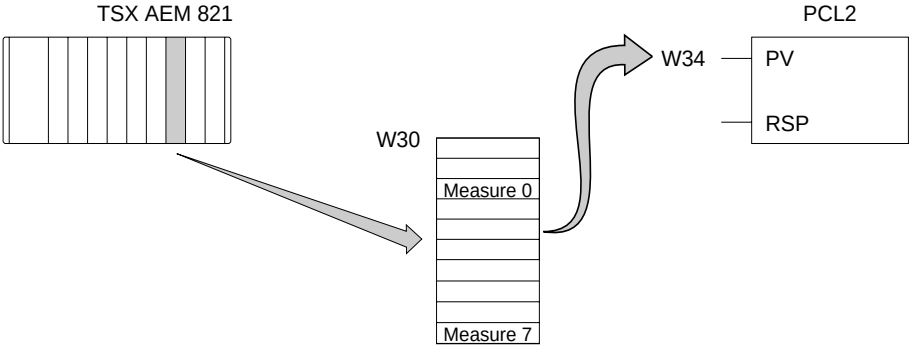
Programming:
Master task, run text block: **EXCHG TXT2**
Auxiliary task, run OFB: **! EXEC PCL1(W22....).**



TSX AEM 821 module with more than 4 channels:

Auxiliary task programming:

```
! READEXT(I5;W30;W50)
! EXEC PCL2(W34....)
```



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2.3 PCL OFB Programming

The PCL OFB structure lets the user easily place control loop functions in the sequential program and take advantage of all of the features of the PL7-3 programming language to create traditional control loop applications.

The PCL OFB is programmed like any other standard PL7-3 function block in one of the periodical tasks in the PLC, in the selected program module.

Parameter assignment (reminders)

- **I/O parameters:**
  The PCL OFB I/O parameters must be assigned to PL7-3 variables. The PV and OUTPUT parameters are always required, all others are optional.
  They can be read but not written in Data mode. Any change in assignment must be performed in Program mode.
- **Internal data:**
  Internal data can be read and written:
  • From the programming terminal in Data mode,
  • By program.
- **Internal constants:**
  The internal constants can be accessed in Program mode or in Constants mode.

Syntax:

EXEC PCLi(measurement;external instruction=>error bit;word status0;analog output; discrete output).

PCL OFB execution must not be conditional.

Single loops

```
! L10 : EXEC PCL1(IW4,3;W15=>B12;W8;OW7,3;)
```

With:

- IW4,3 = TSX AEM module measurement value,
- W15 = External instruction value,
- B12 = Error bit,
- W8 = Status word status0,
- OW7,3 = Analog output.

Cascade loops

The cascade is obtained by stringing PCL OFBs together. Execution of the OFB representing the external loop precedes that of the OFB representing the internal loop. There are two ways to program a cascade loop:

- Directly, leaving open the action of the preceding block but setting the instructions for the following block:

```
! L10 : EXEC PCL1(IW4,3;W15=>B12;W8;;)
! L20 : EXEC PCL2(W20;PCL1,OUTPUT=>B22;W90;OW6,3;)
```

  Attention, in Debug mode, the open output PCL1 cannot be displayed in real-time.

- Indirectly, using a variable linked to the action of the preceding block and the instruction value of the following block:

```
! L10 : EXEC PCL1(IW4,3;W15=>B12;W8;W13;)
! L20 : EXEC PCL2(W20;W13=>B22;W90;OW6,3;)
```


2.4 Updating Outputs

The control signal to the process is sent either using TSX ASR analog output module (continuous output from the PID) or using TSX DST discrete output modules (PID width modulation).

If the analog output solution is selected, the user can select one of the modules listed below:

- TSX ASR 200: 2 isolated channels, 12 bit resolution (bipolar voltage or current),
- TSX ASR 401: 4 isolated channels, 11 bit resolution + sign (voltage ± 10 V),
- TSX ASR 402: 4 isolated channels, 12 bit resolution (4 - 20 mA current range with power supply),
- TSX ASR 403: 4 isolated channels, 12 bit resolution (4 - 20 mA, current range and external power supply),
- TSX AST 800: 8 channels, voltage (± 10 V) or current (4-20 mA or 0-20 mA with power supply) operation, isolated from the PLC bus, 12 bit resolution + sign,
- TSX AST 200: 2 channels, unipolar or current operation, isolated from the PLC bus, 8 bit resolution.

The choice of an input module depends on the type of input sensors used with it.

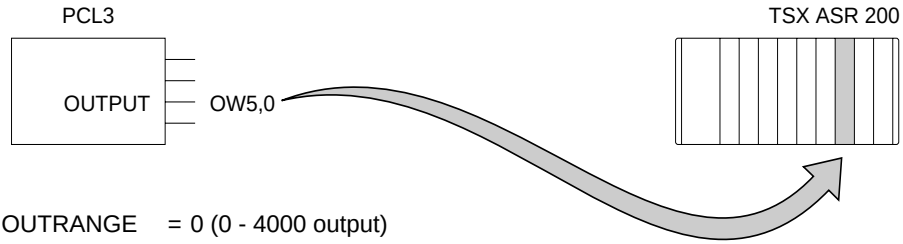
For more information on using these modules, refer to the appropriate TSX AST/ASR Analog Output Modules User's Manual (TSX D23 007 E), Sections 3 and 4.

Brief reminders on analog output updating

TSX ASR 200 module

Programming:

```
! EXEC PCL3(W100;=>;;OW5,0;)
```

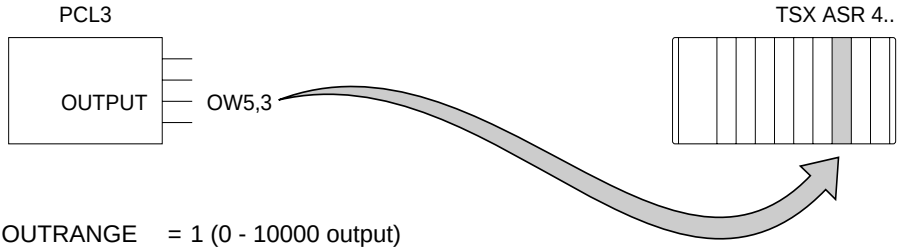


OUTRANGE = 0 (0 - 4000 output)

TSX ASR 4.. module

Channel 0 programming:

```
! H'00F0' → OW5,1
! EXEC PCL3(;=>;;OW5,3;)
```

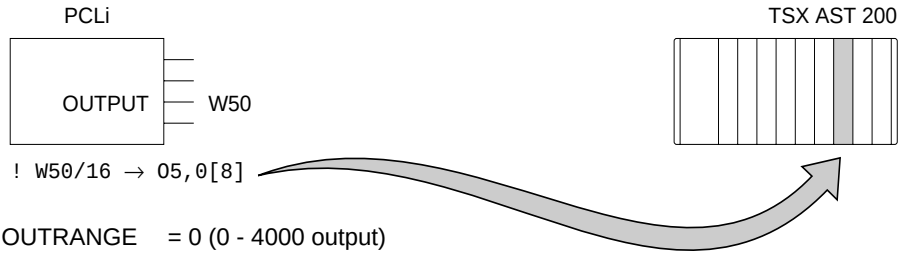


OUTRANGE = 1 (0 - 10000 output)

TSX AST 200 module

Programming:

```
! EXEC PCLi(;=>;;W50;)
```



OUTRANGE = 0 (0 - 4000 output)

2.5 Debug - Adjust

All of the parameters of the PCL OFB can be displayed in the PL7-3 Debug and Data modes.

It is thus possible to display a list of the OFB internal parameters and to modify their associated values in order to adjust the process control loop. These operations are described in the PL7-3 Operating Modes user's manual.

2.6 Suggestions for Use

To obtain quality control loop results, always select the:

- Measurement acquisition rate for TSX AEM modules,
- Sampling period (OFB parameter T_OFB) compatible with the process constant.

Measurement acquisition rate
The acquisition time is generally 100 ms per channel.
For the TSX AEM 821 module, it is 6 ms +2.5 ms per channel.
For the TSX AEM 1212, it is 130 ms for each group of 2 channels, or 910 ms for 12 channels used.

Determining the T_OFB parameter
The T_OFB parameter contains the PCL OFB sampling period value.

The default value (300 ms) covers most of the possible applications where the process has a response time of a few seconds. If a fast process must be controlled (time constant of around a second), the value of T_OFB may be reduced. If the process is very slow, the T_OFB parameter can be increased.

Reminder: T_OFB is automatically adjusted to the closest possible multiple of the period of the task in which the OFB is executed.

The value of T_OFB must be selected according to the process allowing for the following rule:

T_OFB ≤ time constant / 10

Example:
For a process with a time constant of 5 seconds, T_OFB must not exceed 1 second.

If the OFB is in a 300 ms auxiliary task and the user imposes parameter T_OFB at 1 second, the OFB automatically calculates the new T_OFB value at 900 ms (the multiple of 300 ms closest to 1 second).

Selecting the task for the control loop

It is up to the user to select the task. It is recommended that the AUX0 task be reserved for such applications.

Important

The PCL OFB works from measurements provided by the TSX AEM modules. However, when the PLC is powered-up the modules perform a self-tests sequence that last a few second, during which time the measurement values are not significant.

It is up to the user to eliminate the risk of using these erroneous measurement values (e.g. by maintaining the PLC OFB in manual mode until the module has completed its self-test phase).

3.1 Introduction

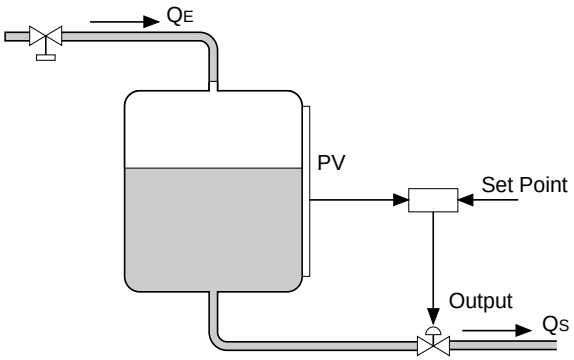
The two examples described here are intended to assist the user in learning how to use this program and cover two aspects:

- In the first example (Sub-section 3.2), accent is placed on the simplicity of a typical application where optimum use is made of default values that apply to most applications,
- In the second example (Sub-section 3.3), a more complex application is described, based on the assembly of simple loops. A wide range of different inputs are covered to show their specific nature in extreme cases (slow or fast). This illustrates the application of mechanisms that are only useful in specific cases.

3.2 Simple Example: Single Loop Application

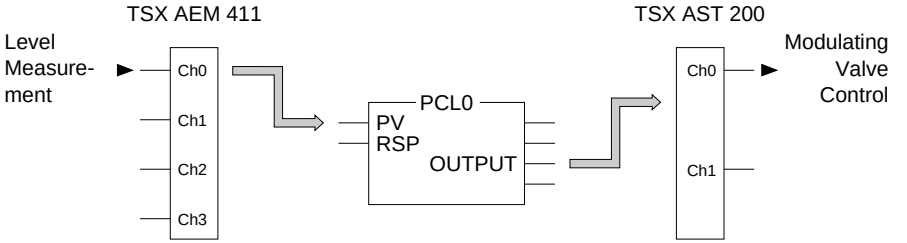
3.2-1 Description

Maintaining a constant level in a tank by acting on the output flow:



The level measurement is obtained from a pressure sensor operating over a 4 - 20 mA range giving a variation from 0 to 100%. The output flow is controlled by a modulating valve also operating over a 4 - 20 mA range. The flow control is always active as long as the measurement remains valid. If the PLC is stopped, the output retains its state. The solenoid valve on the input closes if the tank level exceeds a threshold of 90%. The instruction is supplied by an operator input from a terminal (XBT or equivalent). The excursion range is restricted to 20% to 80%.

3.2-2 Setting up the Control Loop



Accepting that a TSX AST 200 (256 points resolution) module is compatible with the precision level required.

(Using this module allows the use of a TSX P 47-410 PLC processor that only supports a single intelligent I/O module).

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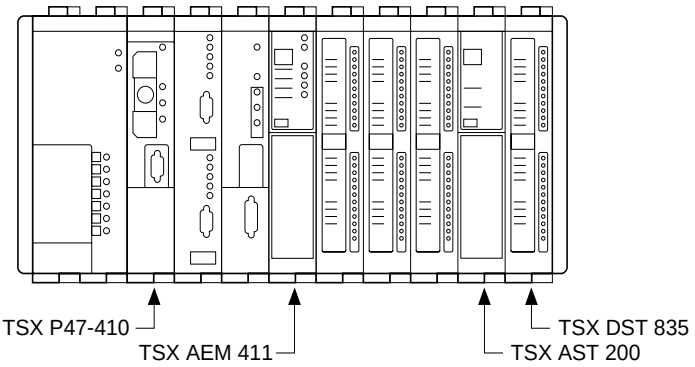
3.2-3 Hardware Configuration

The hardware configuration comprises two output modules and an intelligent module:

- A TSX DST 835 module to control the solenoid valve,
- A TSX AST 200 module to control the modulating valve,
- A TSX AEM 411 for level measurement.

The hardware configuration described above is located in the PLC rack as shown below:

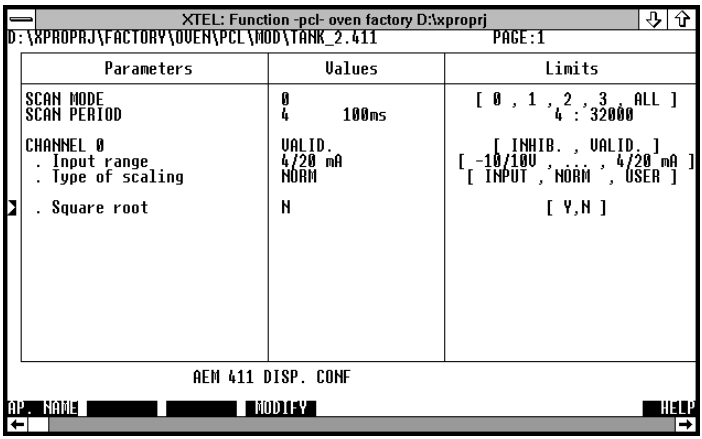


3.2-4 TSX AEM 411 Module Configuration

Only channel 0 is used.

A minimal scan period is selected (400 ms).

The measurement value is expressed in standard format (0 - 10000) for compatibility with the PCL OFB format.



3.2-5 TSX AST 200 Module Configuration

Channel 0, configured for 4 - 20 mA range operation is assigned to modulating valve control.

The TSX AST 200 module uses data expressed in 0 - 255 range format. Therefore the value supplied by the OFB (in 0 - 4000 range format) must be divided by 16.

3.2-6 Suggested Processing

The PCL0 OFB is assigned to the level control loop. It is run in task AUX0 to take maximum advantage of the processor multi-task structure.

The task period can be set at 100 ms, period at which the measurement value available to IW2,3 is refreshed by the TSX AEM 411 or at 300 ms, period at which the PID algorithm is executed when there are no modifications to the T_OFB parameter.

If the measurement value is valid (module OK, etc.), the algorithm is executed normally to respect the instructions supplied by the operator: Auto Mode, Set Point value. If the measurement value is invalid, the output is forced to 0: Manual Mode, Parameter OUT_MAN = 0.

The measurement value provided by the TSX AEM 411 module is available on each cycle of task AUX0 in register IW2,3. The output from the OFB is applied to the TSX AST 200 module on each cycle of the AUX0 task.

Detection that the maximum threshold (90%) has been exceeded is ensured by the OFB (information available from 2 of output parameter PCL0,STATUS0).

The outputs retain their state in the event of a PLC stoppage by setting to 0 bit SY8. By default this bit is set to 1, forcing outputs to 0 when the PLC is stopped.

The TSX AEM 411 module is reconfigured as soon as the default configuration takes effect, especially after any power break/return.

Programming the MAST task

< Set task AUX0

```
! IF NOT CTRL4,R THEN START CTRL4
```

< Select output operation

```
! RESET SY8
```

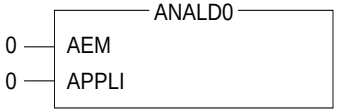
Configuring task AUX0 dedicated to process control loops

The modules in slots 2, 6 and 7 of the basic rack are assigned to task AUX0 when the rack is configured in XTEL-CONF (Module Configuration).

Programming task AUX0

< Configure TSX AEM 411 module

```
! IF IW2,1,D THEN EXEC ANALD0(0;0=>)
```



< Test measurement validity

```
! IF IW2,0,C.NOT IW2,1,8.NOT I2,S
    THEN SET PCL0,MAN_AUTO;SET PCL0,SP_RSP
    ELSE RESET PCL0,MAN_AUTO;0 → PCL0,OUT_MAN
```

< Process the level process control loop

```
! EXEC PCL0(IW2,3;W100=>;W110;W101;)
```

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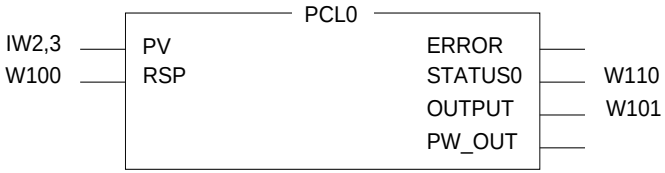
Detailed description of the PCL OFB

OFB I/O parameters:



W100 contains the set point.

OFB internal constants. In the table below, only internal constants specific to the example are shown. The others, (gain, etc.) are left for the user to define:

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IDENT	TYPE	VALUE	MIN	MAX
PV_HL$	word	9000	0	10000
SP_MAX$	word	8000	0	10000
SP_MIN$	word	2000	0	10000
OUTBIAS$	word	0	0	10000

Programming task AUX0 (continued)

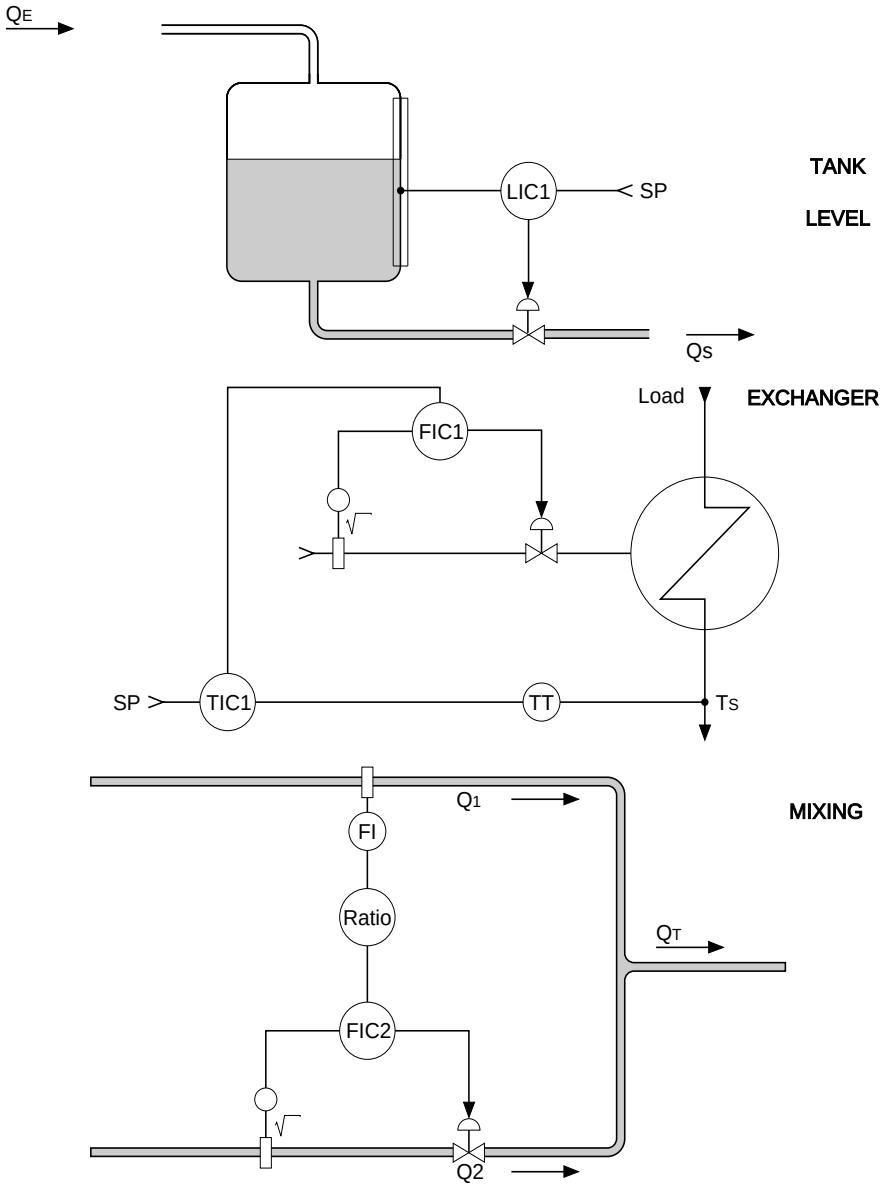
< Output scaling
! W101/16 → O6,0[8]

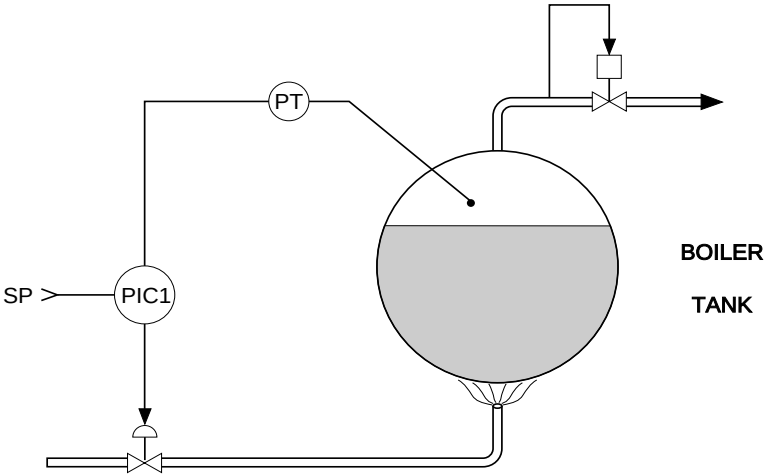
< Input flow valve control; Close if level > 90%
! W110,2 → O7,0

3.3 Complex Example: Multiple Loop Application

3.3-1 Application Description

In an installation comprising five process control loops:





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Tank level

The tank level is controlled by acting on the output flow.

The measurement value is taken from a transmitter that provides a 4 - 20 mA level signal over a range of 0 - 100 %. The scan period required is 1 second.

The modulating valve is controlled by a 4 - 20 mA signal.

Level control operates continually as long as the measurement remains valid.

Exchanger

Cascaded control loops are used here. The internal loop FIC1 maintains the flow of liquid to match the set point provided by external control loop TIC1.

The flow measurement value comes from a differential pressure sensor. The signal provided by it is a quadratic function of the flow, requiring square root extraction before processing. The flow control loop runs continually with a scan period of 1 second.

The modulating valve is controlled by a 4 - 20 mA signal.

The temperature measurement is used between 100 and 300°C and is taken from a Pt 100 probe. The temperature control loop scan period is 5 seconds.

The cascaded loop is closed on command from the operator.

Mixing

The flow Q2 is tied to the flow Q1 to ensure that proportions are maintained.

The measurement values of Q1 and Q2 are taken from differential pressure sensors that provide a quadratic output signal in the 4 - 20 mA range.

The modulating valve is controlled in the 4 - 20 mA range.

The control system is started by an operator command.

The scan period is set to 50 ms, to compensate for even the slightest variations in flow on Q1.

Boiler tank

The pressure level inside the boiler tank is controlled by acting on the fuel flow.

The measurement value is taken from differential pressure sensor in the 4 - 20 mA range.

The fuel flow is controlled by a modulating valve operating in the 4 - 20 mA range.

The scan period is set to 50 ms.

A valve that operates independently of the PLC opens when the pressure exceeds a critical limit.

Note

For all control loops, the processing required when the PLC is stopped comprises forcing the outputs to 0. This processing is a default condition supported by the PLC (bit SY8 at 1).

Configuring the loops

Loop	FIC2	PIC1	LIC1	FIC1	TIC1
Gain	5.0	0.8	2.8	4.0	0.15
Ti	5	3	15	5	60
Td	2	0	0	0	5
Derevative Action PV/DEV	DEV	-	-	-	PV
Output DIR/REV	REV	REV	DIR	REV	REV
Process Variable	- Filtering	-	3 sec	1 sec	5 sec
High Alarm on Process Variable	-	60%	80%	-	250°C
Low Alarm on Process Variable	-	0	20%	-	-
High Alarm on Deviation	+5%	-	-	-	+5°C
Low Alarm on Deviation	-5%	-	-	-	-
Scan Period	50 ms	50 ms	1 sec	1 sec	5 sec
Output High Limit	-	80%	-	-	-
Output Low Limit	-	-	-	-	-
Rate of Change Limit	-	-	5%	-	-
Output Bias	-	-	-	-	-
Deadband	-	-	-	-	-

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3.3-2 Application Analysis

Analog I/O module selection

The modules used in the example were selected for two reasons:

- Because they correspond to the type of measurement to process (for example the FIC2 and PIC1 fast loops require a TSX AEM 821 fast input module while the temperature control loop requires a TSX AEM 413 module),
- And, for learning, in order to cover the entire TSX Series 7 range of analog modules and their processing features.

The table below summarizes the options available:

LOOP	MEASUREMENT		Acquisition Period	OUTPUT	
	Module Type	Specific Processing		Module Type	Format
LIC1	TSX AEM 811	-	1 s	TSX ASR 402	0-10000
FIC1	TSX AEM 811	S. Root extraction	1 s	TSX ASR 402	0-10000
TIC1	TSX AEM 413	Standard output	1 s	-	0-10000
FIC2	TSX AEM 821	Synchro mode (1) S. Root extraction	50 ms	TSX ASR 200	0-4000
PIC1	TSX AEM 821	Synchro mode (1)	50 ms	TSX ASR 200	0-4000

(1) This mechanism supports synchronization of measurement acquisition with the period of the task in which they are used (refer to Divider B, Section 5). This mode is only supported by the TSX AEM 821 module and should only be used where the control loop scan period cannot exceed 150 ms.

Selecting tasks assigned to control loops

Given the scan periods required for the FIC2 and PIC1 control loops, it is not possible to simply follow standard recommendations to use task AUX0 for control loops. These two fast control loops should be run in the master task (MAST) and if the required period were in the range 20 to 30 ms, the fast task (FAST) should be used).

For the other three control loops with slower scan times, there are various ways to configure them:

- In the master task (MAST), the one second loops will be executed every 20 cycles,
- In task AUX0 by setting its period to a value corresponding to the lowest scan period (i.e. 1 second).

The second option, with a lesser CPU time penalty was selected for the example.

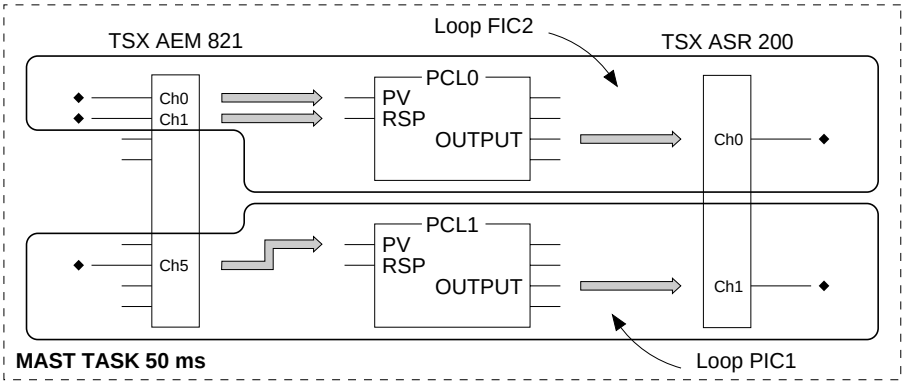
Control loop processing

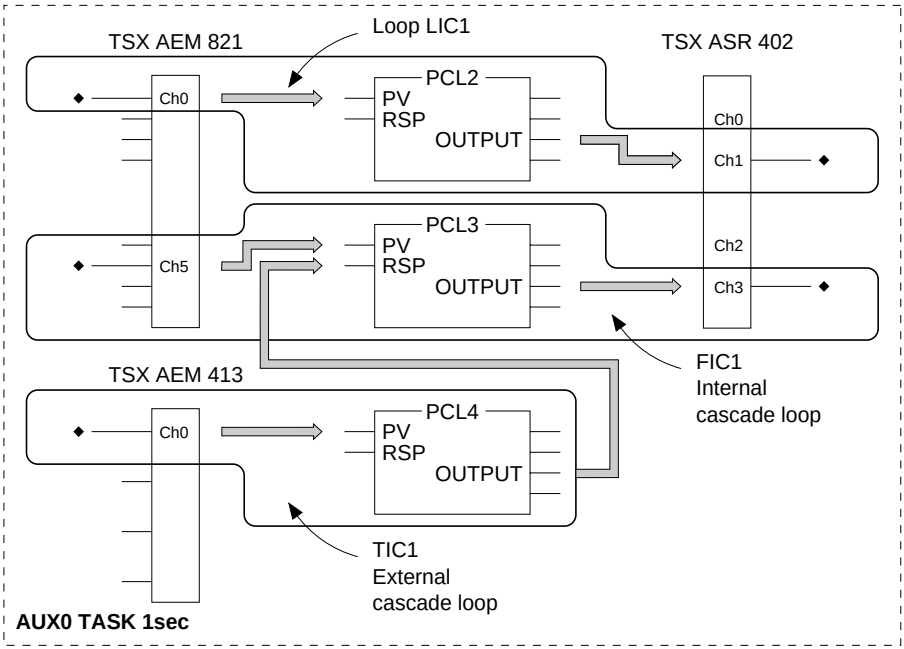
A PCL OFB is assigned to each loop.

A few lines of PL7-3 programming are required to handle additional control loop functions:

- Module configuration,
- Invalid measurement processing,
- Control loop set-up.

Diagram

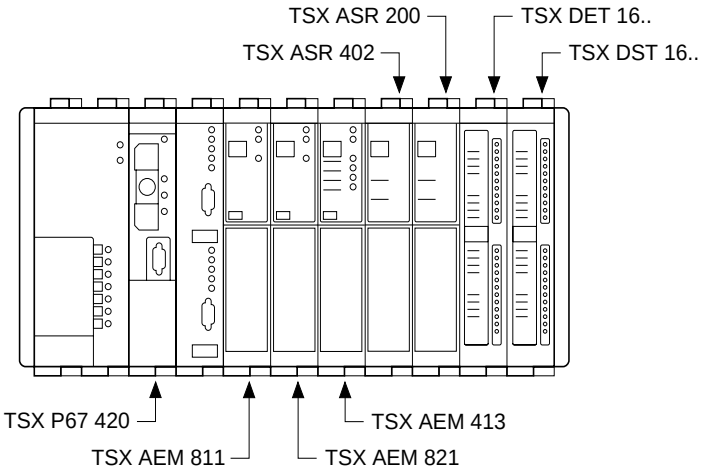

TSX AEM 821
Loop FIC2
TSX ASR 200
Ch0
Ch1
PCL0
PV
RSP
OUTPUT
Ch0
Ch5
PCL1
PV
RSP
OUTPUT
Ch1
MAST TASK 50 ms
Loop PIC1


TSX AEM 821
Loop LIC1
TSX ASR 402
Ch0
PCL2
PV
RSP
OUTPUT
Ch0
Ch1
Ch5
PCL3
PV
RSP
OUTPUT
Ch2
Ch3
FIC1
Internal
cascade loop
TSX AEM 413
Ch0
PCL4
PV
RSP
OUTPUT
TIC1
External
cascade loop
AUX0 TASK 1sec

D

3.3-3 Module Configurations

PLC overview:



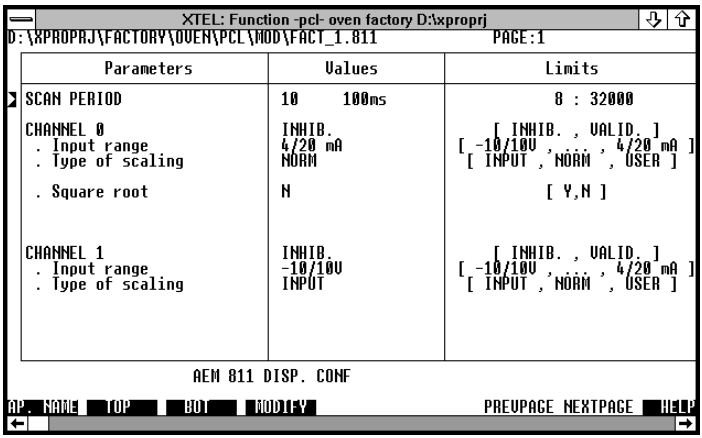
D

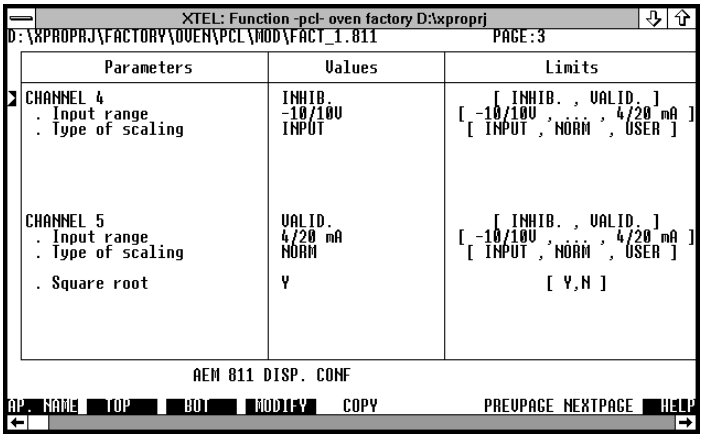
TSX AEM 811 software configuration

Only channels 0 and 5 are used.

The scan period is 1 second.

The measurement values are expressed in standard 0 - 10000 range format for compatibility with the PCL OFB format.





TSX AEM 821 software configuration

Only channels 0, 1 and 5 are used.

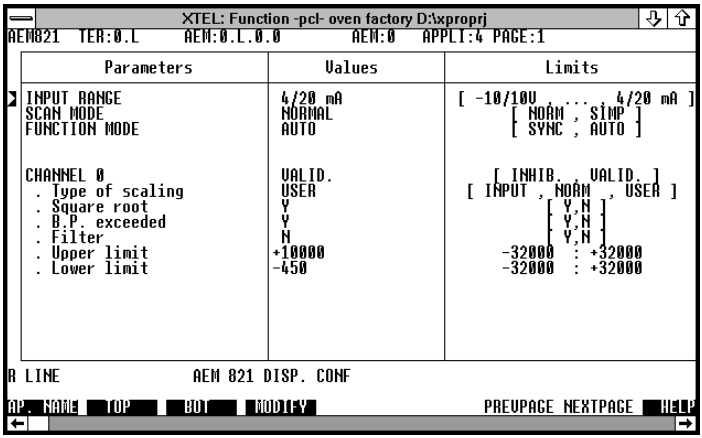
The module is set to run in Synchro mode.

> The scan period is 50 ms. It must always be set to the same value as the period of the task in which the module is declared.

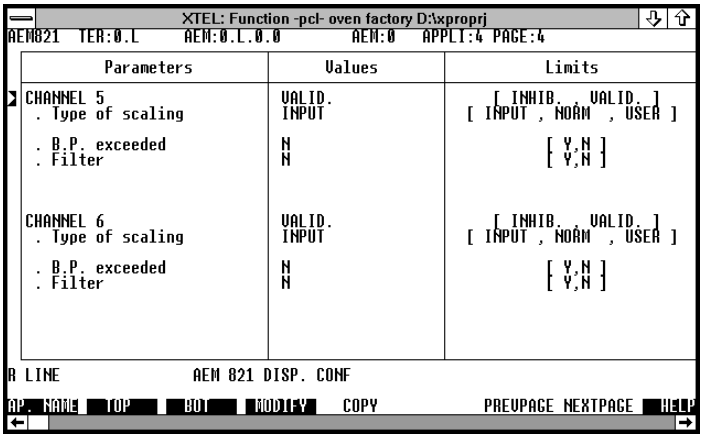
The measurement values are expressed in standard 0 - 10000 range format for compatibility with the PCL OFB format.

D

Channel 0 configuration (channel 1 is identical)



Channel 5 configuration



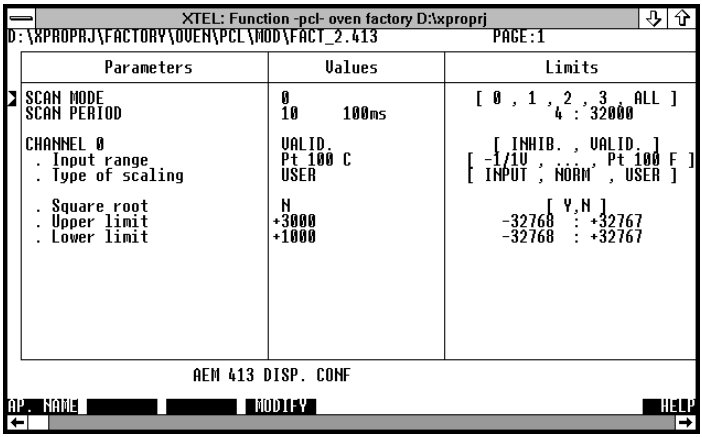
TSX AEM 413 software configuration

Only channel 0 is used.

The scan period matches that of the task in which the module is declared, i.e. 1 second.

The measurement must be expressed in 0 - 10000 range format for compatibility with PCL OFB format. This means that the user should specify "user units" with the following correspondence:

Measurement in degrees	Measurement in 0 - 10000
100	0
300	10000



TSX ASR 200 configuration

The two channels are configured for 4 - 20 mA. The TSX ASR 200 module working from data expressed in 0 - 4000 format is directly compatible with the PCL OFB output. The RESET/HOLD jumper should be set to RESET to force outputs to 0 in the event of PLC stoppage.

TSX ASR 402 configuration

Register OW4,1 is used.

If the user selects 0 - 4000 format (converter code), no additional programming is required. The PCL OFB and the TSX ASR 402 module default to this format.

If the user prefers to use 0 - 10000 standard format (for ease of use), the module must be configured to work with a "percentage of full scale range". To select this add the following program line:

! H'00F0' → OW4,1

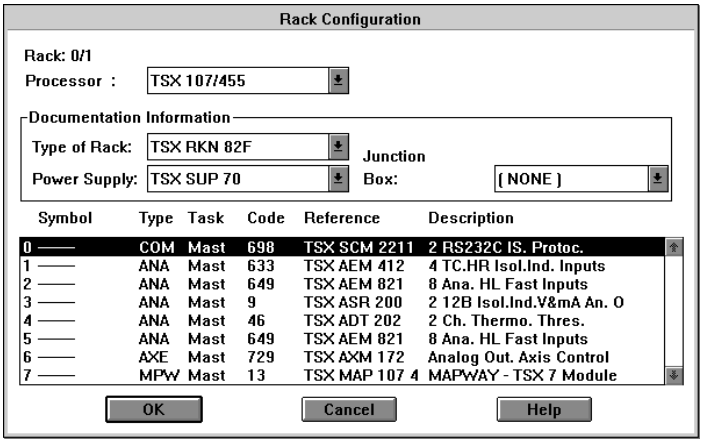
The OFB output must also be expressed in this format. To do so, set the OUTRANGE bit to 1 in the internal constants.

The latter solution is retained for the example (purely for educational reasons).

The OW4,0,E bit must be set to 0 to force the outputs to 0 when the PLC is stopped.

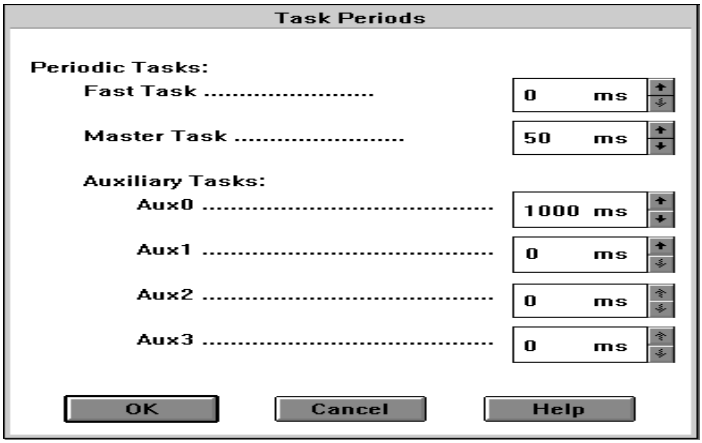
3.3-4 XTEL-CONF Configuration

I/O configuration



Because the TSX AEM 821 module is used in Synchro mode, the interrupt task must be declared, even if it is not used elsewhere.

Periodic task configuration



3.3-5 PL7-3 Configuration

Application configuration
The application should contain periodic tasks. Some SRs will be associated with the MAST task.

OFB configuration
PCL family OFBs are configured in PL7-3 as follows :

- 5 PCL function blocks,
- 5 ANALD function blocks,
- 5 ANADG function blocks.

PL7-3 variable assignment

W120[10]	:	TSX AEM 821 module measurement acquisition buffer,
W130	:	Used by the READEXT instruction (number of words to transfer),
W140[8]	:	TSX AEM 811 module measurement acquisition buffer, (assigned to text block TXT0),
W149	:	Value of ratio Q2/Q1 in % (FIC2 loop),
W150	:	FIC2 Set Point,
W151	:	PIC1 Set Point,
W152	:	LIC1 Set Point,
W153	:	FIC1 Set Point,
W154	:	TIC1 Set Point,
W155	:	TIC1 loop output,
DW160	:	Calculation variable,
I6,0	:	TIC1/FIC1 cascade closing order,
I6,1	:	FIC2 control loop closing order,
I6,2	:	Alarm acknowledgment,
O7,1	:	Alarm indicator,
TXT0	:	Text block used to acquire measurement from the TSX AEM 811 module,
PCL0	:	OFB assigned to loop FIC2,
PCL1	:	OFB assigned to loop PIC1,
PCL2	:	OFB assigned to loop LIC1,
PCL3	:	OFB assigned to loop FIC1,
PCL4	:	OFB assigned to loop TIC1.
OFB ANALD0		Assigned to TSX AEM 811 module,
OFB ANALD1		Assigned to TSX AEM 821 module,
OFB ANALD2		Assigned to TSX AEM 413 module.

3.3-6 Programming

MAST task programming

< Store power return

```
! IF SY1
          THEN RESET B0
```

< Load TSX AEM 821 module configuration (1)

```
! IF IW2,2,D + NOT B0
          THEN EXEC ANALD1(1;0=>);SET B0
```

< Start task AUX0

```
! IF NOT CTRL4,R
          THEN START CTRL4
```

< Acquire TSX AEM 821 module measurements (2)

```
! 10 →W130;READEXT(I2;W120;W130)
```

< Check the validity of flow measurements Q1 and Q2 (FIC2 loop)

```
! IF IW2,0,C.NOT IW2,1,8.NOT IW2,1,9.NOT I2,S
          THEN SET PCL0,MAN_AUTO;SET PCL0,SP_RSP
          ELSE RESET PCL0,MAN_AUTO;0  →  PCL0,OUT_MAN;SET O7,1
```

< Calculate FIC2 loop set point value

```
! IF I6,2
          THEN W123 → DW160;DW160*W149/100  →W150
          ELSE 0 → W150
```

< Process loop FIC2

```
! EXEC PCL0(W122;W150=>;;OW5,0;)
```

(1) The EXEC ANALD instruction synchronizes the TSX AEM 821 module to its task. For correct Synchro mode operation, the following conditions must always be observed:

- An ANALD OFB must be assigned exclusively to each module,
- The EXEC ANALD instruction must be executed in the task where the module is declared,
- The module scan period and the task cycle time must be identical,
- The interrupt task must be declared in the configuration even if it is no longer used.

(2) Acquisition mechanism only available from TSX AEM 821 modules allowing 8 measurements to read along with support for additional information (channel and threshold status). This mechanism only operates with TSX Model 40 PLCs version V4.3 or higher. If the number of measurements is less than 4, acquisition via the IW register interface is recommended.

MAST task programming (continued)

< Check validity of pressure measurement PIC1

```
! IF IW2,0,C.NOT IW2,1,D.NOT I2,S
         THEN SET PCL1,MAN_AUTO;SET PCL1,SP_RSP
         ELSE RESET PCL1,MAN_AUTO;0 → PCL1,OUT_MAN;SET O7,1
```

< Process control loop PIC1

```
! EXEC PCL1(W127;W151=>;;OW5,1;)
```

< Acknowledge error indicator

```
! IF RE(I6,2)
         THEN RESET O7,1
```

To assign the variables to the PCL0 and PCL1 OFB input and output parameters, we will refer to the FIC2 and PIC2 loop diagram. For the PCL0 OFB, we have for example :

It is then necessary to initialize the structural contents and the fallback values for each OFB.

AUX0 task programming

< Configure TSX AEM 811 and TSX AEM 413 modules

```
! IF IW1,2,D + NOT B1
          THEN EXEC ANALD0(0;0=>);SET B1
! IF IW3,2,D + NOT B2
          THEN EXEC ANALD2(2;0=>);SET B2
```

< Configure TSX ASR 402 module and set to RUN

```
! H'00F0'→OW4,1;SET OW4,0,C;RESET OW4,0,E
```

< Check validity of measurement LIC1

```
! IF TXT0,D.[TXT0,V=H'81'].IW1,0,C.NOT IW1,1,8.NOT I1,S
          THEN SET PCL2,MAN_AUTO;SET PCL2,SP_RSP
          ELSE RESET PCL2,MAN_AUTO;0  → PCL2,OUT_MAN;SET O7,1
```

< Process control loop LIC1

```
! EXEC PCL2(W140;W152=>;;OW4,4;)
```

< Check validity of measurement TIC1

```
! IF IW3,0,C.NOT IW3,1,8.NOT I3,S
          THEN SET PCL4,MAN_AUTO;SET PCL4,SP_RSP
          ELSE RESET PCL4,MAN_AUTO;0  → PCL4,OUT_MAN;SET O7,1
```

< Close/Open the cascade

```
! IF NOT I6,0
          THEN RESET PCL4,MAN_AUTO;W153  → PCL4,OUT_MAN
```

< Process control loop TIC1 (1)

```
! EXEC PCL4(IW3,3;W154=>;;W153;)
```

< Check validity of measurement FIC1

```
! IF TXT0,D.[TXT0,V=H'81'].IW1,0,C.NOT IW1,1,D.NOT I1,S
          THEN SET PCL3,MAN_AUTO;SET PCL3,SP_RSP
          ELSE RESET PCL3,MAN_AUTO;0  → PCL3,OUT_MAN;SET O7,1
```

< Process control loop FIC1 (1)

```
! EXEC PCL3(W145;W153=>;;OW4,6;)
```

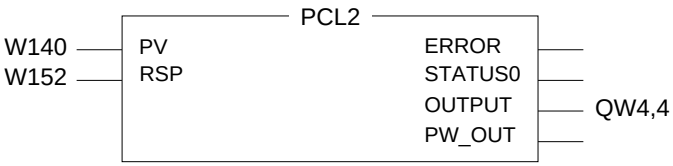
< Request measurement acquisition for the next cycle(2)

```
! 1 → TXT0,C;H'0100' → TXT0,M;EXCHG TXT0
```

(1) This order is imperative. TIC1, an external loop in the cascade, must be processed before internal loop FIC1.

(2) Using the message to acquire measurement values avoids the need to control the multiplexing mechanism specific to the register mode. In this example, we assume that the reception buffer for text block TXT0 is located at W140[8].

To assign the variables to the PCL2, PCL3 and PCL4 OFB input and output parameters, we will refer to the LIC1, FIC1 and PIC1 loop diagram. For PCL2, we have for example :



It is then necessary to initialize the structural contents and the fallback values for each OFB.

4.1 PID Parameter Set-up Method

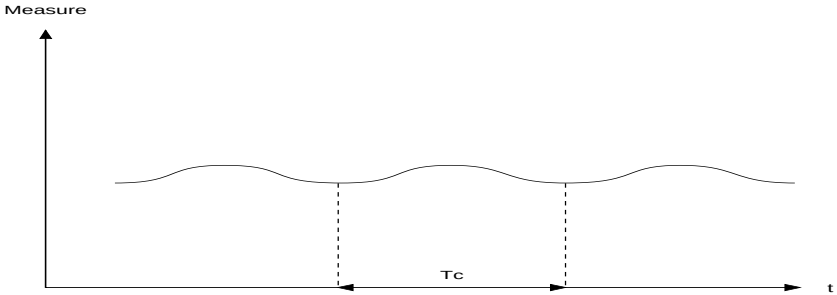
There are a number of ways to set up and adjust the parameters of a PID control loop. In this sub-section the Ziegler and Nichols method is described with two variations:

- Closed loop adjustment,
- Open loop adjustment.

Closed loop adjustment

The principle requires the use of proportional control (I = 0, D = 0) to excite the process by increasing the gain until it starts to oscillate after applying a step to the instruction value used by the PID corrector.

Once this is achieved, simply increase the value of the critical gain (Kpc) that caused the undamped oscillation and the oscillation period (Tc) to deduce the values required for an optimal setting of the regulation system.



Depending on the type of process control used (PID or Pi), the correction factors are set to the values listed below:

	Kp	**Ti**	**Td**
PID	$\frac{Kpc}{1.7}$	$\frac{Tc}{2}$	$\frac{Tc}{8}$
PI	$\frac{Kpc}{2.22}$	$\frac{Tc}{2}$	

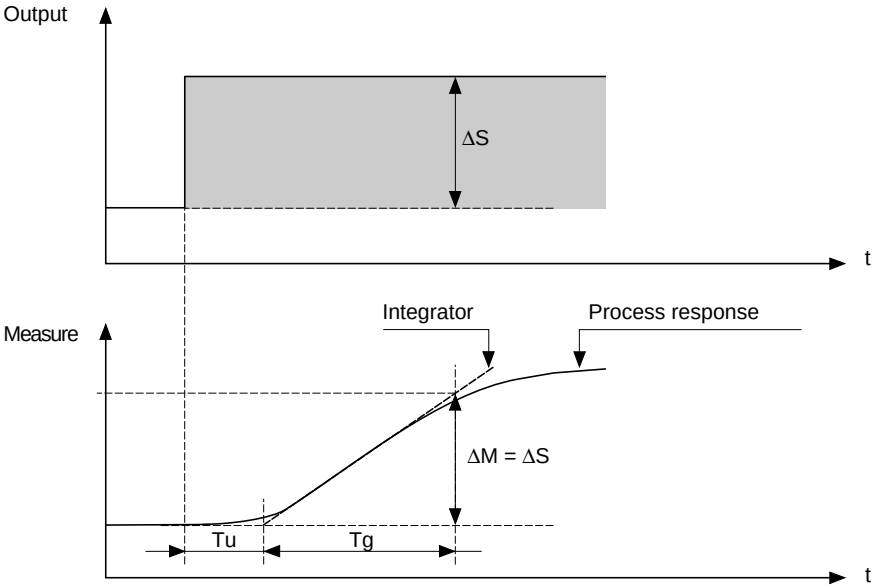
With:

- Kp = Proportional gain,
- Ti = Integral time,
- Td = Derivative time.

This type of adjustment ensures a highly dynamic control that may result in range overrun when a change of set point is made. If this occurs, reduce the gain value until the system reacts as required.

Open loop adjustment

With the process control system in manual mode, apply an increment to the output and consider the initial reaction of the process to that of a pure delay integrator.



The intersection of the line representing the integrator and the time axis determines the time value Tu.

The time value Tg is then defined as the time required by the controlled variable (measurement) to vary by the same amplitude (as a % of the full scale range) as the output from the process controller.

Depending on the type of process control used (PID or Pi), the correction factors are set to the values listed below:

	Kp	**Ti**	**Td**
PID	≤ 1.2 Tg/Tu	≥ 2 * Tu	0.5 * Tu
PI	≤ 0.9 Tg/Tu	3.3 * Tu	

This type of adjustment ensures a highly dynamic control that may result in range overrun when a change of set point is made. If this occurs, reduce the gain value until the system reacts as required.

The benefit from using this method come from it requiring no hypothese about the type or order of the process to control. It applies equally to stable or true integrator processes. It is especially useful when using slow processes (such as those found in glass manufacturing applications) as the user need only have the start of the answer in order to set the values of factors Kp, Ti and Td.

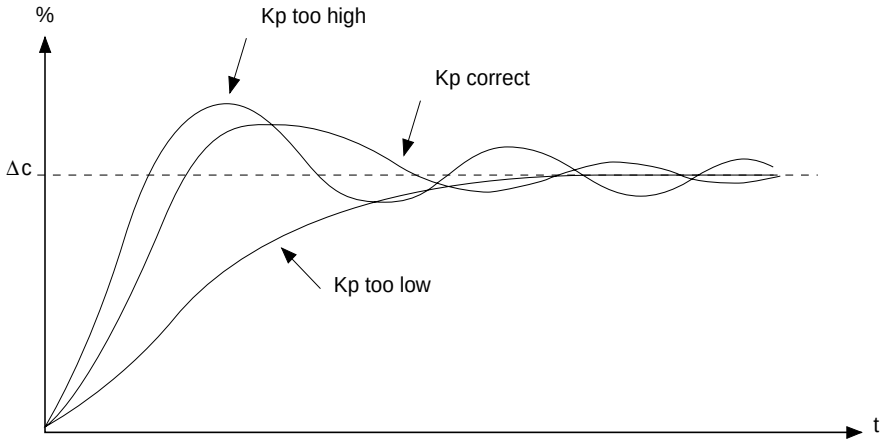
4.2 PID Parameter Influence and Effects

4.2-1 Proportional Action

Proportional action lets the user affect the response time of the process. The higher the gain, the faster the response time, the lower the static error (in purely proportional terms), but the more the stability is reduced.

Therefore a compromise must be found between speed and stability.

Influence of proportional action on the response of the process to a step:



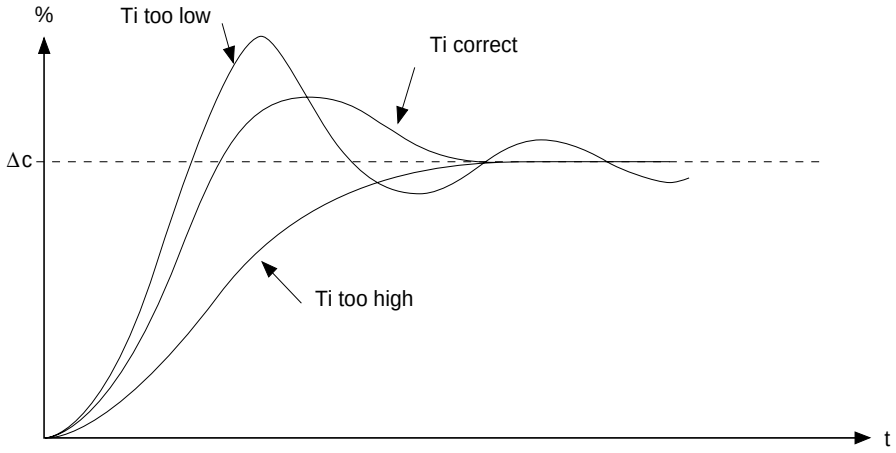
Note
These responses are those of an unstable process. For a stable process, the static error decreases when Kp increases.

4.2-2 Integral Action

The integral action lets the user cancel the static error (difference (error) between the measurement and instruction values). The higher the integral action (Ti reduced), the faster the response but the lower the stability.

Again a compromise must be found between speed and stability.

Influence of integral action on the response of the process to a step:



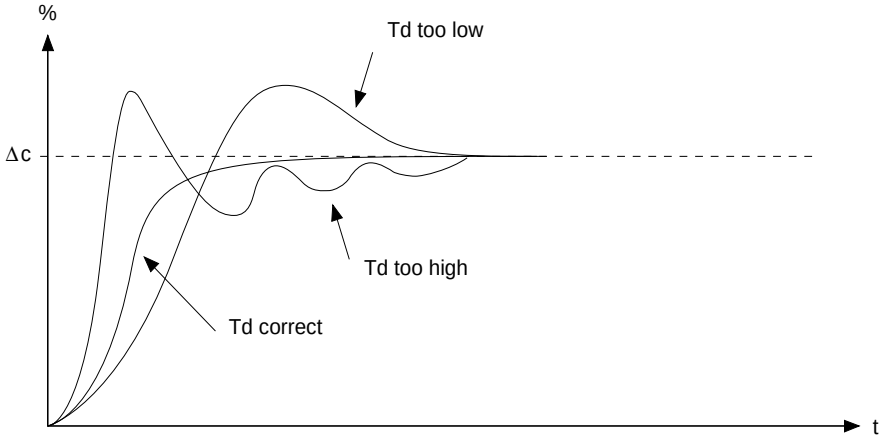
Reminder: Ti lower implies a higher integral action.

4.2-3 Derivative Action

The derivative action anticipates process response. It adds a term to the equation that takes into account the speed of error variation. This is used to anticipate by accelerating the response of the process when the error increases and slowing the response when the error diminishes. The higher the derivative action (Td high), the faster the response.

Again a compromise must be found between speed and stability.

Influence of derivative action on process response to a step:



4.3 PID Process Control Limits

If the process is compared with a pure delay first order of a transfer function:

$$H(p) = \frac{Ke^{-\tau p}}{1 + \theta p}$$

With:

- τ = Model delay,
- θ = Model time constant,

The performance level of the regulation system are a function of the ratio θ / τ.

PID process control is perfectly suited to the following condition:

$$\mathbf{2} \leq \frac{\theta}{\tau} \leq \mathbf{20}$$

For $\theta / \tau < 2$, i.e. fast process control loops (θ low) or for control systems with a high delay (τ high) PID control loops are unsuitable, more sophisticated algorithms are required. For $\theta / \tau > 20$, discrete control is adequate.

1.1 Introduction

PL7-PCL software can also be used to implement TSX AEM modules on TSX/PMX level V4 PLC stations.

In this case, the PL7-PCL software takes account of the model of the target station and displays V4 screens and menus (equivalent to PL7-PCL V4).

This appendix is intended as a reminder of V4 implementation and an indication of the changes in implementation of a V4 station ↔ V5 station.

1.2 Differences between PL7-PCL V4 and PL7-PCL V5 or V6

For PL7-PCL V4 software, it is necessary to first create a PL7-3 application containing at least the I/O configuration, ie. the xxx.APP and xxx.IOC files. With a V5 station, this operation is performed implicitly using the XTEL-CONF tool.

When the xxx.BIN file is modified, PL7-PCL V4 software calls up the XTEL-MEM tool in order to update the xxx.APP file. All modifications to a .BIN file must be integrated into the xxx.APP file using the XTEL-MEM tool.
For example, after modifying a module configuration, followed by a request to save using the **[STORE]** key, XTEL-MEM is run, after confirmation, and updates the xxx.APP file. This update is not required on a V5 station.

PL7-PCL V4 software is capable of handling several xxx.BIN applications in the X-TEL application database. To save an application or load it into the memory, it is therefore necessary to indicate the name of the PL7-PCL application, from its unique application version : PCL.BIN.

In **connected mode**, PL7-PCL V4 software has the following special soft keys :

[STORE] displays a screen which can be used to save the contents of the dedicated PCL field to disk, in the form of a xxx.BIN file, stored in the communication applications field.
This screen offers a **[FILE]** key, which can be used to modify the name of the target file.

The equivalent operation in V5 is **[STA -> DSK]** which transfers the application from the PLC to PCL.BIN.

[RETRIEVE] displays a screen which can be used to transfer the contents of a xxx.BIN file previously saved to disk into the dedicated PCL field in the PLC memory.
This screen also offers the **[FILE]** key and can be used to modify the name of the file containing the 'application.

The equivalent operation in V5 is **[DSK -> STA]** which transfers the PCL.BIN file to the PLC memory.

In **local mode** PL7-PCL V4 software has the following special soft keys :

[.BIN] is used to select the working configuration (.BIN files). By default, this is the name of the station.
This screen also offers the **[DIR.BIN]** key and allows the user to access the list of .BIN files which can be selected.

The equivalent operation in V5 is **[RETRIEVE]** which transfers an application file with any name to the PCL.BIN file.

[STORE] displays a screen which can be used to save the local application to disk, in the form of a xxx.BIN file, stored in the communication applications field.

The equivalent operation in V5 is **[STORE]** which can be used to transfer the PCL.BIN file to an application file with any name.

E

1.3 Implementing a V4 application

Methodology

The methodology offered in V4 is similar to that of later versions (see section 1.2 of part A). The main differences are as follows :

- the application structure is constructed in V4 using XTEL-MEM, to create a STATION.APP file,
- the I/O are configured by PL7-3. This generates a STATION.IOC file,
- the PL7-PCL application design handles a STATION.BIN file which is then integrated into the STATION.APP application file,
- the PL7-3 application design handles 2 files : STATION.BIN and STATION.APP.

Screen sequencing

The principles for screen sequencing and selection of operating modes are identical in versions V4 and V5 (see section 1.2 of part B).

Link to the PLC memory

When the PCL function is declared at station level, a dedicated field is created in the xxx.APP file by XTEL-MEM.

This field is empty, and will be filled by PL7-PCL, on condition that the xxx.APP file contains the PL7-3 I/O configuration, with the slots occupied by TSX AEM modules.

This dedicated field is identical in PL7-PCL V5 (see section 1.4 of part B), except that its image is saved in a xxx.BIN file and not in PCL.BIN.

E

Any level V4 application can be converted to a V5 or V6 level application, if the following operations are performed :

1 If the V4 application was already on the station when the V5 software was installed, it can be accessed directly. If it was saved on diskettes under a V4 software workshop, it must be retrieved under the V5 software workshop.

2 Create a V5 host station, and declare the PCL function.

3 From the PCL icon of the V5 host station, launch the Import function and import the following files :

`StationV4\PCL\APPLI\xxx.BIN` (compulsory) : application binary,

into the `StationV5\PCL\APPLI` directory,

then

`Station V4\PCL\MOD\xxx.411` to `xxx.16P` (optional),

into the `StationV5\PCL\MOD` directory.

4 Launch PL7-PCL in the V5 station and perform the following operations :

- from the **local / working memory** heading (depending on the function) select the **TSX / PMX** file to make the [RETRIEVE] command appear,
- activate the **[RETRIEVE]** command which provides access to the list of xxx.BIN files on the station,
- activate the **[DIR BIN]** command and select the xxx.BIN file imported previously,
- **<ENTER><ENTER>**, restores the xxx.BIN file to the V5 station.

5 Quit the PL7-PCL function.

To convert the rest of the application (which does not affect PCL), refer to the relevant tool and function manuals.

E

E