General Contents

Note to readers

Until PL7-PCL and PL7-PMS Version 5.0 software becomes available, TSX AEM 1613 modules are set-up using Text Blocks (for configuring and using the measurements).

Therefore the set-up procedures for V3 level PLCs and Model 40 V4 level PLCs is identical (as described in the Example in Sub-section 5.2).
As soon as PL7-PCL and PL7-PMS V5.0 software is available, the example in Sub-section 5.3 for V4 level PLCs will be enhanced.

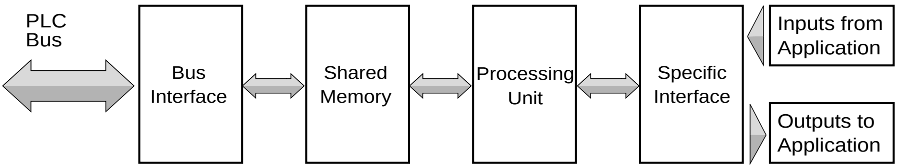
1.1 Intelligent Modules

1.1-1 Presentation

Intelligent modules are preprogrammed processor modules designed by Telemecanique for distributed processing applications.

The modules are designed as follows:

Structure of an intelligent I/O module



They comprise:

- An interface bus using standard communication modes between the PLC processor and the intelligent module:
  - Discrete interface,
  - Register interface,
  - Message interface.
- A shared memory in which data is stored, accessible to both the intelligent module and the PLC processor,
- A processing unit comprising a processor and operating software,
- I/O specific to the module.

1.1-2 Using the Module

Intelligent modules simplify the user program by providing a dedicated processor and preprogrammed functions.

As these functions are configured by the user, use of the intelligent modules requires knowledge of PL7-3 programming software and PL7-PCL or PL7-PMS (1) software, where necessary. It may be necessary to refer to the appropriate User's Documentation for additional information.

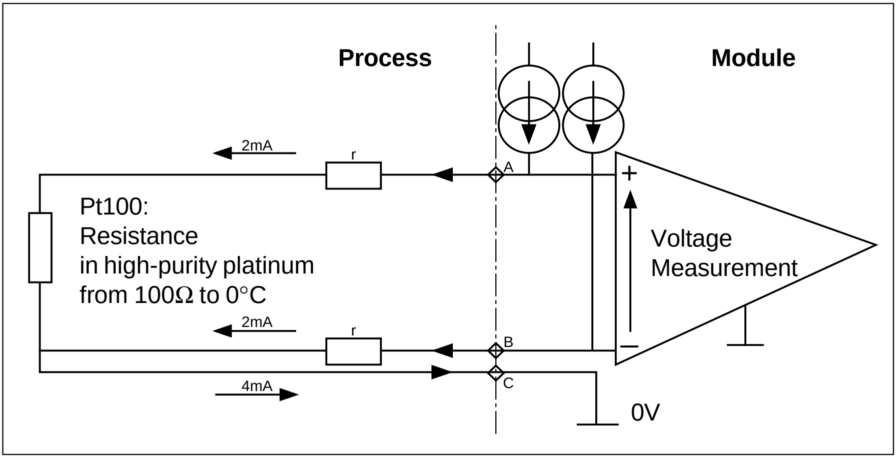
(1) Version V5.0 or higher.

1.2 TSX AEM 1613 Module

1.2-1 Description

General

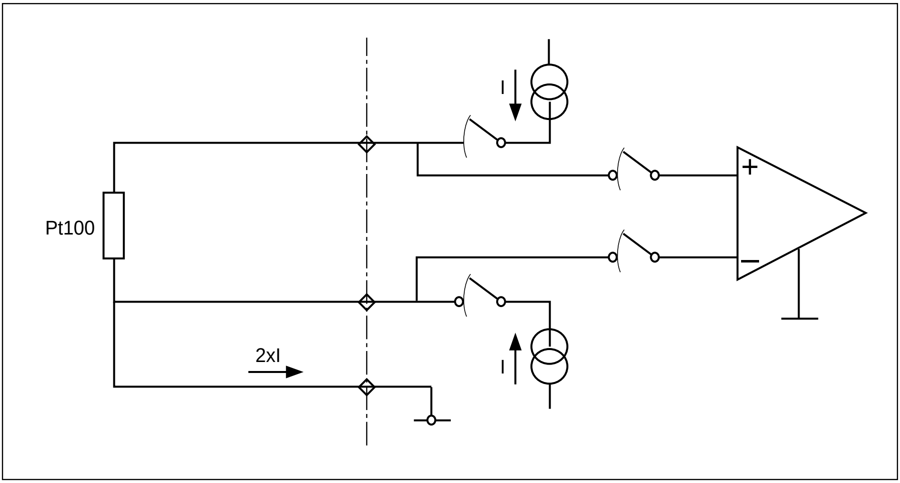
The TSX AEM 1613 is an **analog input module** with 16 low level inputs for 3-wire Pt100 probes. When used with these probes, the module will perform monitoring and temperature measurement functions or control continuous processes.



The measurement principle is an application of Ohms law. A 2 mA current is injected into the probe and the resulting voltage is measured on its terminals. To compensate for the resistance of the connection wiring, a compensation technique is used to remove the effect of the voltage drop on the line. An identical current is injected into the two wires, the third wire is used to transfer the currents to 0V.

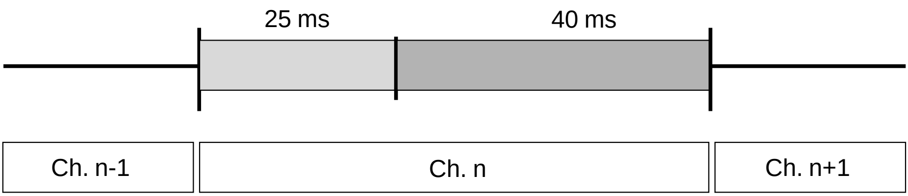
With the same resistance level on both wires and the current generators paired with a precision of 1/10000, the voltage on the terminals of the operational amplifier will be identical to that on the probe terminals.

The module comprises a single pair of current generators that are common to all 16 channels. A multiplexing system allows successive connection of each of the 16 probes to the current generators and to the measurement amplifier.



For a single channel, the acquisition time is 65 ms divided into:

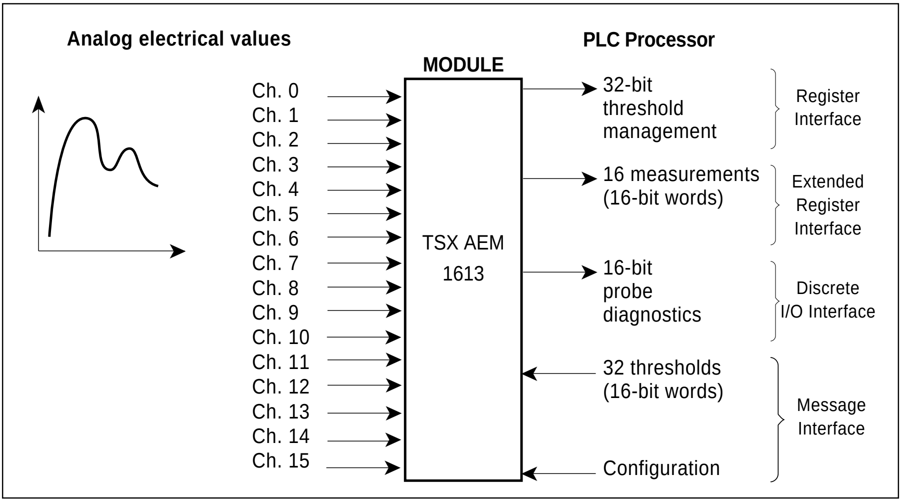
- 25 ms to establish the current level in the probe,
- 40 ms for conversion.



Functions
In addition to Analog/Digital conversion, this module supports the following functions:

- Input range selection (select a range **for each channel**),
- Check for input range overflow for the declared range,
- Linearization of sensor data,
- Output scaling: conversion of measurements into physical or "user range" units,
- Threshold management.

Input/Output



Process → Module exchanges

The module acquires analog electrical values directly from the Pt100 probes.

Module → PLC Processor exchanges:

- Measurements: Analog input levels converted into digital values,
- Threshold detection information: bits set according to the thresholds,
- Diagnostic information: bits indicating probe status channel by channel,
- Report on module operation and sensor monitoring.

PLC Processor → Module exchanges:

- User programmed thresholds,
- Configuration: programmed before any attempt is made to set module operating characteristics.

Characteristics

The main characteristics of the TSX AEM 1613 module are:

Characteristics	**TSX AEM 1613**
Number of channels	16
Analog/Digital conversion	8192 points / 13-bits
Module cycle time	1.3s (16 channels, normal mode)
Signal digital filtering	1s to 256s (1st order parametering, 5 values)
Isolation between inputs and PLC	1500V (2000V eff for 1minute)
Max. overvoltage allowed on inputs	30V
Linearization	**Automatic**
Standards	CEI 65A- DIN 43 760
Pt100 Input / Scale - 50°C +150°C	
Current on probe	2mA pulsed
Resolution	0.05°C
Max. error	0.4°C
Pt100 Input / Scale 0°C +400°C	
Current on probe	2mA pulsed
Resolution	0.1°C
Max. error	0.8°C
Pt100 Input / Scale - 60°F +300°F	
Current on probe	2mA pulsed
Resolution	0.1°F
Max. error	0.7°F
Pt100 Input / Scale +30°F +750°F	
Current on probe	2mA pulsed
Resolution	0.2°F
Max. error	1.4°F
Ohms Input / Scale 75Ω 250Ω	
Current on probe	2mA pulsed
Resolution	0.03Ω
Max. error	0.4Ω

Safety

The inputs are protected against industrial interference and are **electronically isolated** from each other and from the internal PLC voltages. A grounding circuit uncouples the common reference for the channels.

Ease of use

The analog module requires no external power supply. Since the configuration is entirely defined by software and the functions are preprogrammed, the module is particularly easy to use.

Operating convenience

The modules and the terminal blocks can be inserted and removed while the system is powered-up. The PLC processor is continuously informed of the operating status of the module, and the user program can access all data for processing, if required.

1.2-2 External Appearance

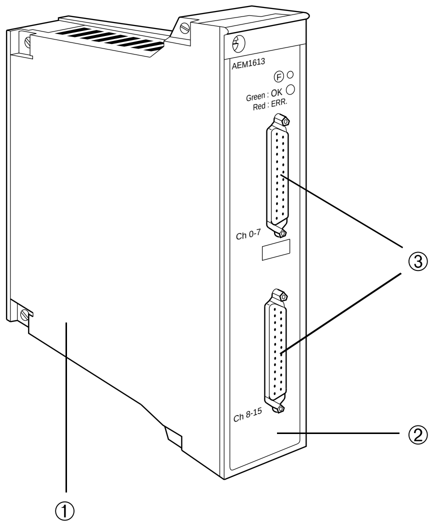
The TSX AEM 1613 module is a single height format device. It must be installed in PLC racks equipped with a complete I/O bus.

The module comprises the following elements:

① A metal case that protects the electronic circuits and provides protection against radiated interference,

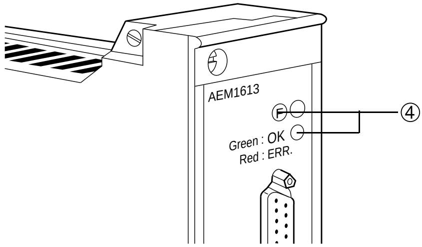
② A front panel,

③ Two 25-point SUB-D type female connectors.



The front panel comprises:

④ 2 LEDs which show the presence of power, correct module operation and channel connection errors.

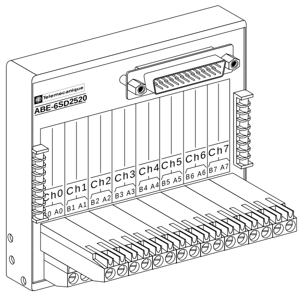


The rear panel of the module comprises:

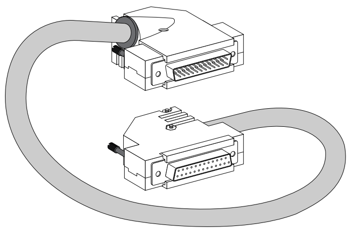
- The standard factory-coded locating devices that prevent errors when inserting or changing a module,
- An optional user-coded locating device.

The TSX AEM 1613 module is used with pre-prepared wiring elements:

⑤ Pre-prepared wiring interface ABE-6SD2520, used to connect cables from the Pt100 probes to a screw type terminal block.



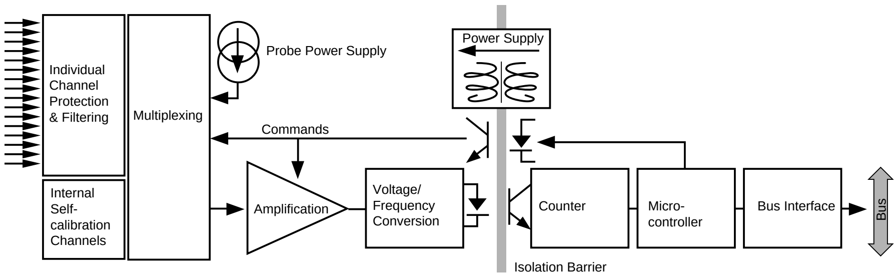
⑥ ABF-S25S301 connection cable with a 25-point SUB-D connector (3 meter length), for connection between a 25-point SUB-D connector on the TSX AEM 1613 module and the ABE-6SD2520 pre-prepared wiring interface.



Sub-Section		**Page**

2.1 Hardware Structure

The diagram below shows the hardware structure of the TSX AEM 1613 module:



Input stage: This comprises an overvoltage protection circuit and a filter on each channel to eliminate high frequency noise.

Multiplexer: The solid state multiplexer sequentially switches the channels to be converted. The number of operations is unlimited.

Amplifier: Amplifies the input voltages.

Analog/Digital converter: This VFC (Voltage Frequency Converter) converter combines the advantages of a double ramp converter (signal integration) with frequency transmission (simplified serial link).

Isolated serial connection : The complete analog measurement circuit is at the input reference voltage and is isolated from the PLC bus. The serial link is isolated by photocouplers. In the microprocessor, a counter circuit converts the frequency into a digital value (counting over 40 ms in 50Hz mode using a quartz crystal to control the time base). In parallel, the microprocessor controls the amplifier gain changes and the changes of multiplexer channel.

Processing: The micro-controller also manages the interface with the PLC, and corrects the analog measurements, based on correction factors calculated from the internal calibration circuits as well as setting the thresholds and tests.

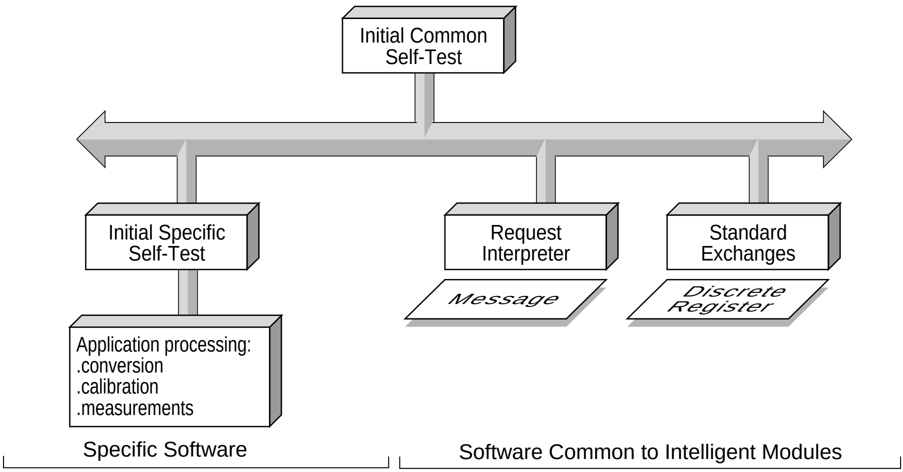
The bus interface carries data exchanges with the PLC processor: transmission of analog measurements, reception of the configuration, etc.

2.2 Software Structure

2.2-1 General

The software structure of the TSX AEM 1613 module is in two parts:

- A common part, identical to all intelligent modules, which manages the data exchanges with the PLC processor
- A specific part which manages sampling (sequencing, conversion, correction of analog measurements, processing of measurements) and specific self-tests.



2.2-2 Data Exchanges with the PLC Processor

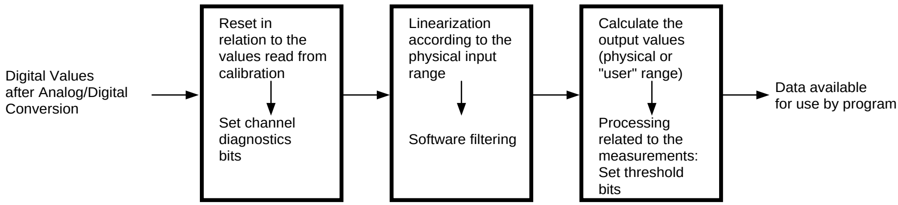
The software manages the standard interfaces:

- Discrete interface for transmitting channel fault data,
- Register interface for transmitting status data and threshold bits,
- Message interface for writing the configuration, reading the analog measurements, reading the fault bit strings, writing thresholds, etc,
- Extended register interface for transmitting measurement data and channel faults (supported by TSX/PMX Model 40 PLCs).

2.2-3 Measurement Processing

The micro-controller performs the following processing:

- Linearizes the raw conversion value,
- Scales the linearized value (physical or "user" scale),
- Sets the thresholds,
- Tests for range overshoot and limits the value, if exceeded,
- Tests for sensor break.



2.2-4 Measurement Sampling

The module cycle time depends on its operating mode, defined during configuration. This mode is a combination of two parameters:

"50Hz" and "60Hz" modes

- "50 Hz": conversion is performed over 40 ms or two 50Hz periods. This ensures that interference caused by the 50Hz supply is rejected as fully as possible.
- "60 Hz": conversion is performed over 50 ms or three 60Hz periods. This ensures that interference caused by the 60Hz supply is rejected as fully as possible.

"normal" and "controlled" modes

- "normal": the time taken to establish the current in the probe is 25 ms prior to the start of conversion.
- "controlled": this mode allows simulation of a Pt100 probe using a calibration device. Off the shelf calibration devices usually have a fairly long response time when supplied with pulsed current. The time required to establish the current in the probe is 550 ms prior to the start of conversion.

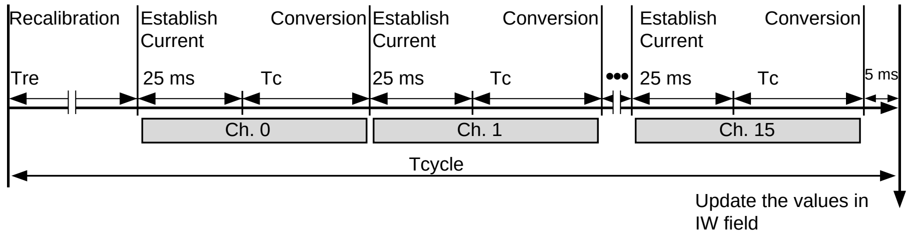
"50 Hz" or "60Hz" mode is selected when the configuration is set.
Switching between "normal" and "controlled" modes (and vice-versa) is performed via the register interface using an additional command word.

The 13-bit resolution is the same in all operating modes.
Software filtering does not change the cycle time.

"50Hz" and "60Hz" normal modes

			"50 Hz" Normal Mode	"60 Hz" Normal Mode
Conversion cycle duration		T_{cycle}	(65 ms x n ch.) + 260 ms	(75 ms x n ch.) + 300 ms
with	Recalibration time	Tre	255 ms	295 ms
	Conversion time	Tc	40 ms	50 ms

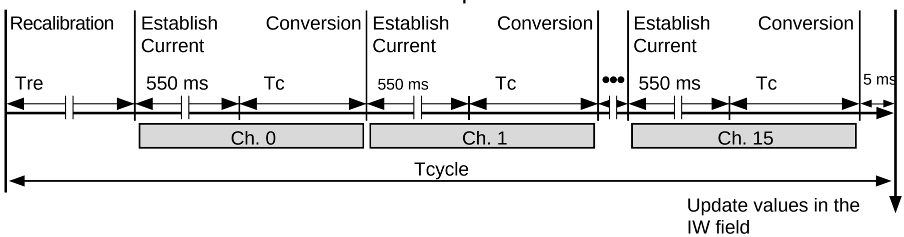
For 16 channels the measurements are sequenced as follows:



"50Hz" and "60Hz" control modes

			"50 Hz" Control Mode	"60 Hz" Control Mode
Conversion cycle time		T_{cycle}	(590 ms x n ch.) + 260 ms	(600 ms x n ch.) + 300 ms
with	Recalibration time	Tre	255 ms	295 ms
	Conversion time	Tc	40 ms	50 ms

For 16 channels the measurements are sequenced as follows:



Accessing measurement values from the user program

The measurements are available to the user via the message interface and the extended register interface (available with TSX/PMX Model 40 or higher processors).

Resolution

The resolution of the measurement value sent to the PLC processor is the same in all operating modes and is software "calibrated" (refer to Sub-section 2.3-2).

2.3 Types of Processing Available

2.3-1 Monitoring for Range Overshoot

The input range defines the normal limits of operation for the sensor connected to the input.

The declaration of the input range has two principle functions:

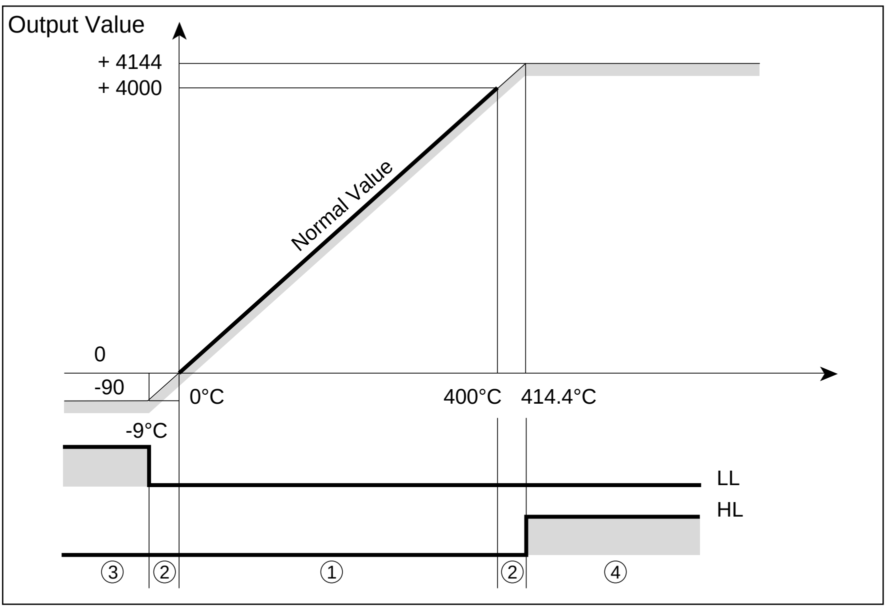
- The setting of the error detection limits, which detect range overshoots,
- Calculations for scaling.

The following table gives the range numbers (to be entered during configuration) and the corresponding normal usage scales, as well as the lower range overshoot limit LL and the higher range overshoot limit HL.

Range Number	Range	Lower Limit LL	Higher Limit HL
1	-50°C / 150°C	-65.6°C	157.2°C
2	0°C / 400°C	-9°C	414.4°C
3	-60°F / 300°F	-86°F	315°F
4	30°F / 750°F	15.8°F	777.9°F
5 (*)	75Ω / 250Ω	74.1Ω	252Ω

(*) This range can be used as an Ni100 or Cu68 input range. The linearization and conversion tables used to obtain an output expressed as a temperature must be placed in the PLC memory.

Example: Declared range 0/400°C with scaling calculation output in physical units.



① The measured value is within the declared full scale input range:

LL	=	0	The module supplies the exact value between 0 and +4000
HL	=	0	

② The measured value is within the extended full scale range which solves problems of sensor dispersion:

LL	=	0	The module supplies the exact value between -90 and 0
HL	=	0	or between 4000 and 4144

③ The measured value is below the LL limit (- 9°C), an overshoot fault is detected and a fault data bit is sent to the user program:

LL	=	1	The module supplies a value limited to -90
HL	=	0	

④ The measured value is below the HL limit (+414.4°C), an overshoot fault is detected and a fault data bit is sent to the user program:

LL	=	0	The module supplies a value limited to +4144
HL	=	1	

The user can access these fault bits via the Read BDEF request.

The discrete I/O interface also indicates the channels where an overshoot was detected (1 bit per channel).

Wire or sensor breakage

If the wiring (wire breakage or short-circuit) or the sensor is faulty, the module will detect a fault.

It is not possible to distinguish a large range overrun (beyond the values given below), from a sensor failure or a wire breakage.

However, the module will continue to interpret the values that it measures, by considering them as a short-circuit or an open circuit.

Test validation conditions

If the electrical level as measured by the module is less than the lower limit of the selected range, the module will declare a short-circuit on this input:

Range	Lower Limit	Corresponding Electrical Level
-50°C / +150°C	-65.6°C	74.1Ω
0°C / 400°C	-9°C	96Ω
-60°F/ 300°F	-86 °F	74.1Ω
30°F/ 750°F	15.8°F	96Ω
75Ω / 250Ω	74.1Ω	74.1Ω

If the electrical level measured by the module exceeds the higher limit of the selected range, the module will declare a wire breakage on this input:

Range	Higher Limit	Corresponding Electrical Value
-50°C / +150°C	157.2°C	160Ω
0°C / 400°C	414.4°C	252Ω
-60°F/ 300°F	315°F	160Ω
30°F/ 750°F	777.9°F	252Ω
75Ω / 250Ω	252Ω	252Ω

The test is performed permanently on all of the inputs declared in the configuration.

When a fault is detected, the module will:

- Set the LL or HL bit to 1 (BDEF fault bit string) for the corresponding channel,
- Set the "channel fault" bit of the discrete I/O interface to 1.

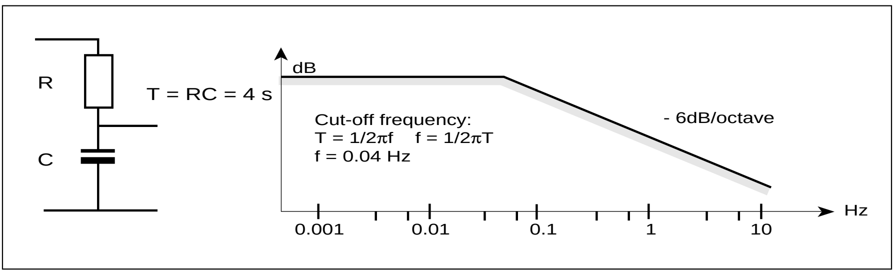
2.3-2 Measurement Filtering

The module supports digital filtering for each channel.

Therefore the user can select a first order digital filtering for each channel with a time constant of 4, 16, 64, or 256 seconds.

The digital filtering performed is the same as that of a RC couple.

Example:
If a time constant of 4 seconds is selected.
The module will perform processing on the measurement value that is equivalent to:



Application

The table below gives, for each time constant, the recommended minimum response time for the process that the channel is connected to.

Time constant	Minimum process response time	
T = 4 s	Tr > 20 s	
T = 16 s	Tr > 80 s	or 1 mn 20 s
T = 64 s	Tr > 320 s	or 5 mn 20 s
T = 256 s	Tr > 1280 s	or 21 mn 20 s

2.3-3 Measurement Scaling

The TSX AEM 1613 module has two modes that can be used to scale measurement values: the "physical range" mode and the "user range" mode.

"Physical Range" Mode

This mode provides the user program with the measurement values in physical units that are coherent with the input range, according to the following conventions:

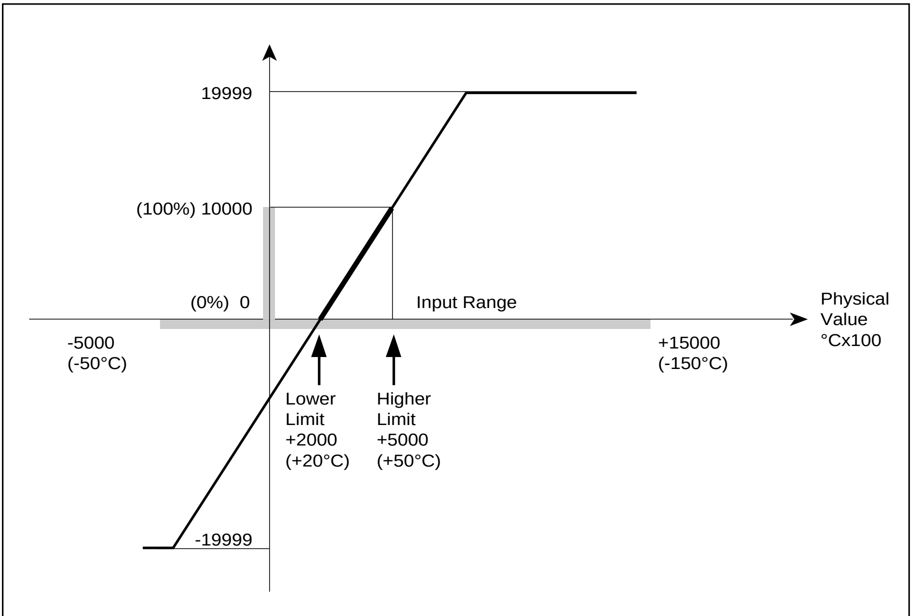
Range	Unit	Lower Limit Output	Higher Limit Output	Output Resolution
-50°C / +150°C	°Cx100	- 5,000	+ 15,000	0.05°C
0°C / 400°C	°Cx10	0	+ 4,000	0.1°C
-60°F/ 300°F	°Fx10	- 600	+ 3,000	0.1°F
30°F/ 750°F	°Fx10	+ 300	+ 7,500	0.2°F
75Ω / 250Ω	Ωx100	+ 7,500	+ 25,000	0.03Ω

"User Range" Output

This mode provides the user program with the measurement values as a percentage of the scale configured by the user in physical units within the selected range.

The "user range" can be configured channel by channel. The measurement values provided by the module are between 0 and 10,000 (or 0% and 100% of the range specified by the user in physical units).

Example:
To set 0% for 20°C and 100% for 50°C, the -50/+150°C range will be used.
The channel will be configured to make 0 (0%) correspond to the value of + 2,000 (+20°C) and 10,000 (100%) correspond to the value of + 5,000 (+50°C).



The values set for triggering the LL and HL bits depend on the range selected and on the variation of the selected "user range".

If any limit overshoot occurs, the user range provides values that are proportional within the range] -200 %, 0 % [and] 100 %, 200 %[. In the example below, -200 % corresponds to a temperature of -40° C, and + 200 % a temperature of +80 ° C.

2.3-4 Threshold Detection

Two thresholds are defined for each channel.
The thresholds are programmable numerical values (expressed in the measurement unit corresponding to the type of scaling selected) that are set by the user and sent to the module via the message interface.

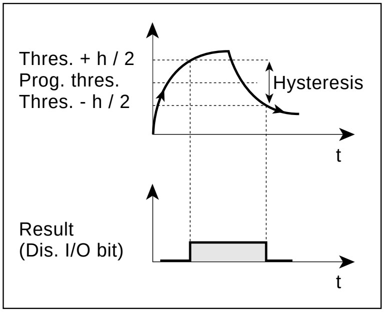
The result of threshold detection is provided on 2-bits that can be used by program, they are set to 1 when the measurement value exceeds the corresponding threshold (refer to Sub-section 4.3).

Comparisons are performed between the channel measurement value and the thresholds 0 and 1, each time a new input value is acquired. When a channel is not used, the results of the comparisons made are forced to 0.

The comparison performed for each threshold automatically compensates for hysteresis (h) equal to 0.5% of the declared scale. The value with which the measurement is compared depends on whether the analog input signal is rising or falling:

- For a rising input signal, the detection bit is set to 1 when the measurement is greater than the threshold plus h/2,

- For a falling input signal, the detection bit is set to 1 when the measurement is less than the threshold minus h/2.



The table below gives the hysteresis value depending on the selected input range and scaling:

	Ranges				
Scaling	-50/+150°C	0/+400°C	-60/+300°F	+30/+750°F	75/250Ω
Physical	100	20	18	36	163
User	50	50	50	50	50

2.4 Dialog with the PLC

2.4-1 General

There are four types of data exchange with the PLC processor via the complete I/O bus:

- Discrete I/O interface, with address Ixy,i
- Register interface, with address I/OWxy,i
- Message interface
- Extended register interface (READEXT instruction)

x = Rack number
y = Slot number in the rack
i = See later in this document

For each of these data exchanges there are corresponding data objects which can be utilized by the user program. The extended register interface is only available on TSX/PMX Model 40 processors.

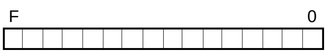
2.4-2 Discrete I/O Interface

TSX AEM 1613 modules have a 16 input discrete interface.

The user can access 16 bit objects as well as the fault bit via the program.

Data exchanges are systematically performed during each task cycle in which the module is configured.

The interface indicates the status of the 16 fault bits, one for each channel. At 1 they indicate that the corresponding channel has an input value that is outside of the valid range defined by the higher (HL) and lower (LL) limits.

Ixy 

Ixy,0	Fault bit channel 0
Ixy,1	Fault bit channel 1
Ixy,2	Fault bit channel 2
Ixy,3	Fault bit channel 3
Ixy,4	Fault bit channel 4
Ixy,5	Fault bit channel 5
Ixy,6	Fault bit channel 6
Ixy,7	Fault bit channel 7

Ixy,8	Fault bit channel 8
Ixy,9	Fault bit channel 9
Ixy,10	Fault bit channel 10
Ixy,11	Fault bit channel 11
Ixy,12	Fault bit channel 12
Ixy,13	Fault bit channel 13
Ixy,14	Fault bit channel 14
Ixy,15	Fault bit channel 15

Where x = Rack number; y = Slot number.

2.4-3 Register Interface

The TSX AEM 1613 module comprises eight input word registers and eight output word registers. Data exchanges are performed systematically during each PLC cycle.

8 input register words (words read by the PLC)	**8 output register words** (words written by the PLC)
F 0	F 0
IWxy,0 Standard status word	OWxy,0 Standard control word
IWxy,1	OWxy,1 Additional control word
IWxy,2 Additional status word	OWxy,2
IWxy,3	OWxy,3
IWxy,4	OWxy,4
IWxy,5	OWxy,5
IWxy,6 Threshold bits 0	OWxy,6
IWxy,7 Threshold bits 1	OWxy,7

Four input registers are used: IWxy,0 and IWxy,2. They provide two status words which give the operating status (module operating modes, etc.), IWxy,6 and IWxy,7 provide the 32 threshold bits (refer to Sub-section 4.3-2).

bit	**IWxy,0 Standard status word**	**IWxy,2 Additional status word**
0	-	1= Control mode 0= Normal mode
1	-	-
2	1= Reset message system (text block)	-
3	1= Module ready (self-test complete)	-
4	1= Module failure or save failure	-
5	-	-
6	1= Acquisition, conversion or save failure error	-
7	1= Application or save failure error	-
8	1= Module failure (blocking error)	-
9	1= Initial self-test in progress	-
A	1= Terminal block error	
B	1= Awaiting config. 0= Module configured	-
C	1= Module running 0= Module stopped	-
D	-	1= Default conguration
E	-	-
F	-	-

Two output registers are used: OWxy,0 and OWxy,1. They are the module command words (RUN/STOP command, etc.).

bit	OWxy,0 Standard status word	OWxy,2 Additional status word
0	-	1= Controlled mode 0= Normal mode
1	-	-
2	1= Reset message system (text block)	-
3	-	-
4	-	-
5	-	-
6	-	-
7	-	-
8	-	-
9	-	-
A	-	-
B	-	-
C	1= Module running 0= Module stopped	-
D	-	-
E	-	-
F	-	-

2.4-4 Extended Register Interface

The extended register interface is used to transfer the 16 module measurements to the PLC processor. The transfer is initiated by the user program by executing the READEXT instruction.

Wi	Channel Status
Wi + 1	Mesurement Ch. 0
Wi + 2	Mesurement Ch. 1
Wi + 3	Mesurement Ch. 2
Wi + 4	Mesurement Ch. 3
Wi + 5	Mesurement Ch. 4
Wi + 6	Mesurement Ch. 5
Wi + 7	Mesurement Ch. 6
Wi + 8	Mesurement Ch. 7
Wi + 9	Mesurement Ch. 8
Wi + 10	Mesurement Ch. 9
Wi + 11	Mesurement Ch. 10
Wi + 12	Mesurement Ch. 11
Wi + 13	Mesurement Ch. 12
Wi + 14	Mesurement Ch. 13
Wi + 15	Mesurement Ch. 14
Wi + 16	Mesurement Ch. 15

Note
This exchange mode is only available on TSX/PMX Model 40 PLCs.

The contents of the first word (Wi) is identical to that of the discrete I/O interface.

2.4-5 Message Interface

The message interface is used to transfer data tables between the module and the PLC processor. The transfer is programmed via a CPL text block and is initiated by the user program.

This type of dialog is used to:

- Write the configuration,
- Re-read the configuration,
- Read the measurements and their associated faults,
- Write the threshold values,
- Re-read the threshold values.

Data specific to each transfer is organized into internal words (Wi) or constant words, CWi, (for transmission only).

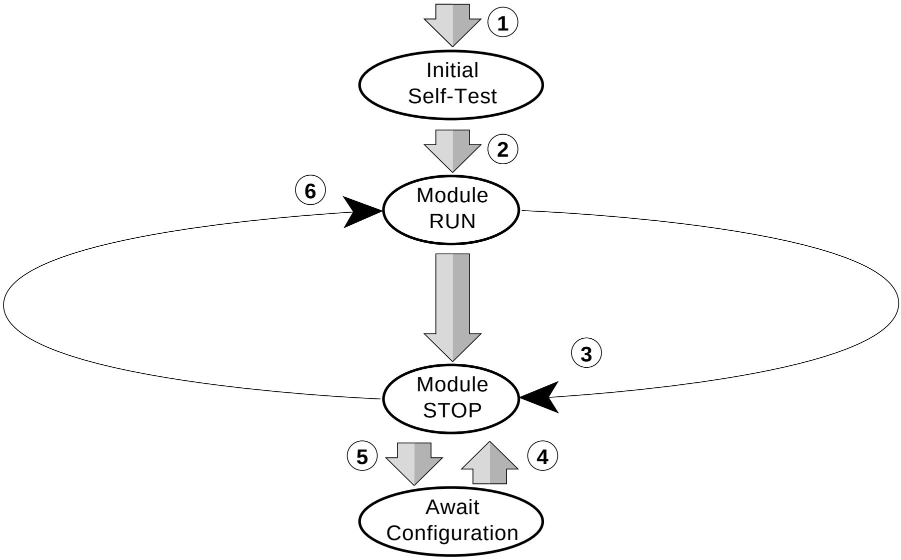
A more detailed description of programming using the message interface is given in the sections relating to each exchange:

- Configuration (Section 3),
- Reading measurements (Sub-section 4.1),
- Writing thresholds (Sub-section 4.3),
- Processing faults (Sub-section 4.4-1),
- Additional requests (Sub-section 4.4-2).

2.5 Module Operating Modes

2.5-1 Description

The diagram below illustrates TSX AEM 1613 module operating modes.



On power-up, initialization request or after a power-break, the module runs an initial self-test procedure ①.

If no fault is detected during this procedure, the module then goes to RUN or STOP mode (depending on the value of the standard control word) using the default configuration.

To use the module under application conditions, it must be configured. To do this the user must program the following:

- Set the module to STOP ③,
- Send the configuration via the message interface ⑤,
- Reset the module to RUN ⑥.

If the configuration received is faulty or incomplete, the module waits until a valid configuration is received ⑤.

The use of configuration loading OFBs provided with TXT L PL7 PCL and TXT L PL7 PMS (1) program packages (only for use with TSX/PMX Model 40 PLC processors) simplifies the programming of loading operations for the user.
Once configured and running (module running), the module is ready to sample measurements.
Standard discrete data, register and extended register data are exchanged during each task cycle in which the module is configured.

(1) Version 5.0 or higher.

2.5-2 Controlling the Operating Modes

The user has access to a control register word which is used to force the module into the required operating mode.

The status register words give information on the operating mode of the module:
- Initial self-test,
- RUN/STOP module,
- Awaiting configuration ④ ,
- Operating with the default configuration.

2.5-3 Module Reaction to a Power Break

The TSX AEM 1613 module does not have a protected memory. All data is lost (including the configuration and the threshold values), when the module is disconnected from the power supply provided by the PLC.

The module must therefore be reconfigured and the threshold values reprogrammed in the event of:

- A cold restart (SY0 = 1),
- A hot restart, when the power supply reserve has been exhausted,
- When the module is installed in the PLC.

The various types of restart are described in the appropriate PL7-3 Reference Manuals.

Additional status word bit (IWxy,2,D) indicates when the module is operating with the default configuration. This bit can thus be used to detect the loss of the configuration, and to request that the configuration specific to the application is transferred again (refer to the example in Section 3).

2.5-4 Effect of Faults on the Operating Modes

When an acquisition or conversion fault is detected on the module, it changes to STOP mode, and remains in this mode until the fault disappears.

When an application (sensor or wiring) fault is detected, the module continues to operate in RUN mode.

3.1 Principle

3.1-1 General

Configuration data lets the user adapt the modules to a given application. Selection of the most suitable configuration simplifies the programming required to make use of the measurements provided by the modules. This data defines the operating mode of the module and of each of its channels.

Configuring a module comprises:

- Defining the operating characteristics of the modules,
- Coding these characteristics, in hexadecimal codes or decimal values,
- Transferring the codes and values to the module via a program.

Reminder

The "traditional" method of setting-up TSX AEM 1613 modules, the only means of set -up available for V3 level PLCs (TSX P43-30/67-20/87-30), is covered in Sub-sections 3.1 to 3.4. The is also the only method that can be used by systems without PL7-PCL and PL7-PMS V5 level software.

The recommended set-up method for TSX/PMX Model 40 PLCs and TXT L PL7 PCL/PMS software is given in Sub-section 3.5.

3.1-2 Configuration Data

Configuration data comprises:

- The operating mode
- The type of processing for each channel

Zone 1	Operating Mode
Zone 2	Configuration Ch. 0
Zone 3	Configuration Ch. 1
Zone i + 2	Configuration Ch. i
Zone 17	Configuration Ch. 15

Configuration data should be coded in a word table located in the W (internal words) zone via a program or in the CW (constant words) zone.

3.1-3 Default Configuration

The TSX AEM 1613 module has a default configuration which enables it to operate immediately when powered-up.

The main function of the default configuration is to test the wiring. It is described in detail in Sub-section 3.3.

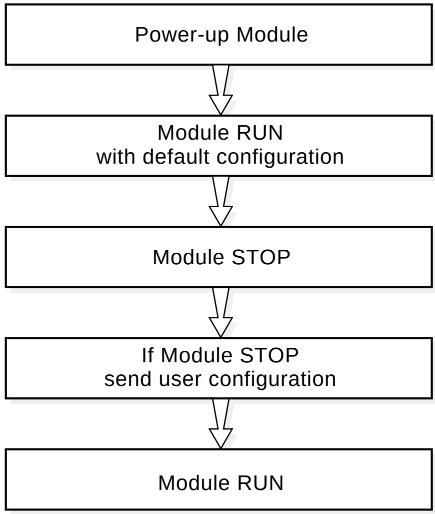
The default configuration is replaced by the user configuration as soon as it is transmitted by the user program.

3.1-4 Transmission of Configuration Data

Once the configuration data has been coded and stored, it must be transmitted to the module.

The configuration data is transmitted from the PLC memory to the module memory via a program (using a CPL text block).

The following procedure must be used to transmit the configuration:
- Stop the module (STOP),
- Wait until the module has stopped,
- Send the configuration via a CPL text block,
- Restart the module (RUN).



Note: The configuration may be lost if there is a power break or if the module is removed from its slot. If this happens, the configuration must be sent again.

3.1-5 Bits Associated with the Configuration

Two bits, in the standard and additional status words (and which can be accessed via a program) are associated with module configuration:

IWxy,0,B: At state 1 this bit indicates that the module is awaiting configuration (in the event of an invalid configuration being received).

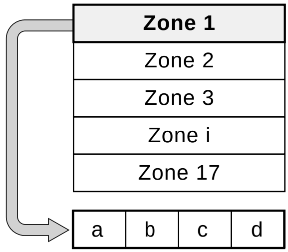
IWxy,2,D: At state 1 this bit indicates that the module is operating with the default configuration.

3.2 Parameters

3.2-1 Operating Mode

The operating mode is coded in a word (zone 1):

- **4-bit group a** : Always at 0
- **4-bit group b** : Filtering
  - 0 or 1: 50 Hz
  - 2 : 60 Hz
- **4-bit group c** : Identifier
  - Value H'A'
- **4-bit group d** : Always at 0



3.2-2 Configuring the Channels

The configuration of a channel (zone 2 for channel 0 to zone 17 for channel 15) is coded in three words.

Word 1: Configures the channel:

- **4-bit group a**: The filtering constant
  - 1 : 4s
  - 2 : 16s
  - 3 : 64s
  - 4 : 256s
  - 0 : filtering not used

Note: All other values cause the configuration to be rejected and set bit IWxy, 0, B to 1.

Zones 2 to 17

1	a	b	c	d
2	Value for 100 % (for user range)			
3	Value for 0 % (for user range)			

- **4-bit group b**: The input range
  - 1 : -50/+150°C range
  - 2 : 0/400°C range
  - 3 : -60°F/+300°F range
  - 4 : +30°F/+750°F range
  - 5 : 75/250Ω range
  - 0 : channel not used

Note: All other values cause the configuration to be rejected and set bit IWxy, 0, B to 1.

- **4-bit group c**: Type of scaling
  - H'B' : physical range
  - H'C' : user range

- **4-bit group d**: Channel number
  - from 0 to F

Words 2 and 3: These words must in all cases be sent to the module but are only significant if the module is parametered for user range operation.

• **If word 2 > Word 3**
These words indicate the values (expressed in the physical range) that define the limits to user scaling
- Word 2 = physical value corresponding to 100%,
- Word 3 = physical value corresponding to 0%.

• **If word 2 ≤ word 3**
The module will wait for a valid configuration (bit IWxy, 0, B to 1).

Zones 2 to 17

1	a	b	c	d
2	Value for 100 %			
3	Value for 0 %			

3.3 Default Configuration

The module has a default configuration which is mainly used to check for correct operation and correct connection.

The default configuration is operational as soon as the module is powered up.

Additional status word bit IWxy,2,D indicates whether the module is operating with this configuration:

IWxy,2,D = 1 → Default configuration

With the default configuration, the module operates in 50 Hz mode, the 16 channels are configured identically:
- Input range -50/+150°C,
- No filtering,
- Physical unit scaling.

Zone 1	0	1	A	0
Zones 2 to 17	0	1	B	Ch. Nbr
	0			
	0			

If there is a power break or the module has been removed and replaced, the configuration is lost and is replaced by the default configuration.

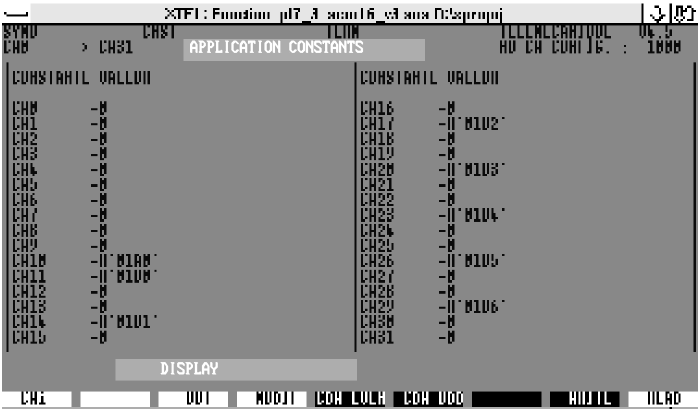
If the default configuration is acceptable for a channel, there is no need to retransmit the configuration.

3.4 Loading the Configuration

3.4-1 Entering Data

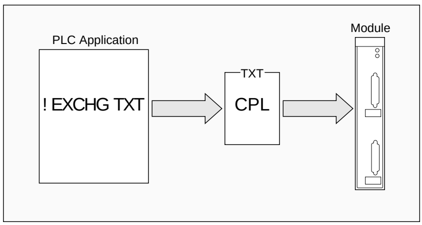
When the module configuration data has been defined and the corresponding codes determined, the codes must be stored in the PLC memory before they can be transferred to the module.
This can be performed in the W zone, but it is preferable to use the CW zone.

The screen below shows an example of a configuration.
Hexadecimal codes are preceded by the letter H.



3.4-2 Transferring the Configuration to the Module

When the configuration data has been stored in the PLC memory, it must be transferred to the module memory. For this, the user must program a transmission reception text block.



Text block characteristics

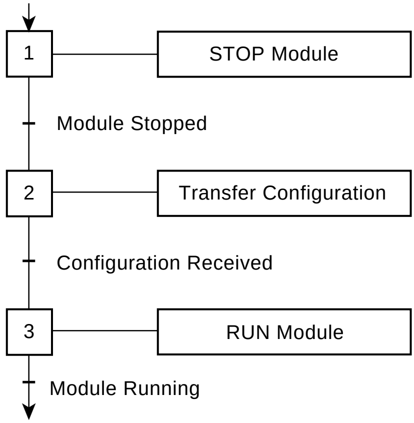
- TXTi,M : H' . . 63' — The configuration concerns the module system
  - Slot number
  - Rack number
- TXTi,C : H'0040' — Request code informing the module that configuration data is being sent.
- TXTi,L : 98 — Transmission table length, corresponding to the number of bytes in the table that contains the configuration data: 98 bytes.

The confirmation report, TXTi,V, sent back by the module can be used after the data exchange to check that the data has been transmitted correctly. It is H'FE' if the data exchange is correct, and H'FD' if not.

Programming the transfer

The transfer should be programmed in the following way:

- Stop the module by setting control register bit OWxy,0,C to 0,
- Check that the module has stopped by testing that status word bit IWxy,0,C is at 0,
- Then transfer the configuration. To do this, generate a rising edge on the S input of the text block,
- To check that the transfer has been successful:
  - Check that TXTi,E is at 0,
  - Check that TXTi,V is H'FE'.
- If the configuration has been successfully received, reset the module to Run mode by setting the control register word bit OWxy,0,C to 1.
  Bit IWxy,0,C should then change to 1.



3.4-3 Checking the Configuration

The configuration is not accepted by the module if:

- The length of the configuration is incorrect,
- The syntax is incorrect (code not defined),
- The selections made in the configuration are incompatible,
- The module is running (set to Run).

Transmission of an incorrect configuration

Transmission of an incorrect configuration causes the status word bit IWxy,0,B "awaiting configuration" to change to 1. The module then awaits a new configuration and the previous correct configuration remains in its memory.

3.5 Configuring the Module Using PL7-PCL or PL7-PMS Software

3.5-1 General

Setting-up a TSX AEM 1613 module is simplified by using PL7-PCL or PL7-PMS (1) software, providing:

- An operator guide program which enables the user to enter module configuration parameters from an X-TEL workstation (input ranges, type of scaling, etc).
  For this, it presents all the parameters in the form of a table with the type, limits and definition of each parameter.
  This program also provides for:
  - Transfers of the parameters between the module, PLC, disk or diskette.
  - Print-outs of the parameters.
  - Display of parameter changes (measurement of each channel, operating modes, faults, etc).

  It uses the dedicated zone technique supported by TSX/PMX Model 40 PLCs.
- Two optional function blocks (OFB) specific to the processing of analog measurements which have been added to the other PL7-3 function blocks:
  - **ANALD** (2) for loading the module configuration following a power break or when a module has been replaced.
  - **ANADG** (2) used to monitor for faults which may occur on modules while operating (for example terminal block fault) or on applications controlled by these modules (for example sensor break). Faults detected in this way are formatted for use by the APPLIDIAG program (in the Software Workshop) or the DIAG program (when using MONITOR 37).

Restrictions

PL7-PCL software can only by used on Model 40 PLCs, version 4.3 or higher. PL7-PMS software can only be used on PMX type PLCs.

(1) Only version V5.0 or higher of PL7-PCL and PL7-PMS software is compatible with TSX AEM 1613 modules. Configuring TSX AEM 1613 modules using this software is therefore only available to users of X-TEL or MINI X-TEL V5 level Software Workshops.

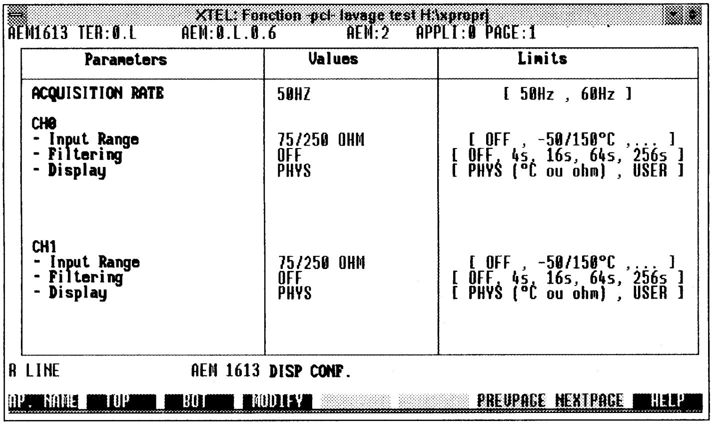
Product references
TXT L PL7 PCL V5, TXT L PL7 PMS V5 or TXT L PL7 PMS2V5.

(2) ANALD for PL7-PCL, AEMLD for PL7-PMS and PL7-PMS2.
ANADG for PL7-PCL, AEMDG for PL7-PMS and PL7-PMS2.

3.5-2 Configuration Mode

Configuration mode lets the user enter the required for module operation, from a menu. For more information on the operating modes of PL7-PCL and PL7-PMS software, refer to the appropriate user's documentation.

Configuration screen


XTEL: Fonction -pcl- lavage test H:\xproprj

AEM1613 TER:0.L AEM:0.L.0.6 AEM:2 APPLI:0 PAGE:1

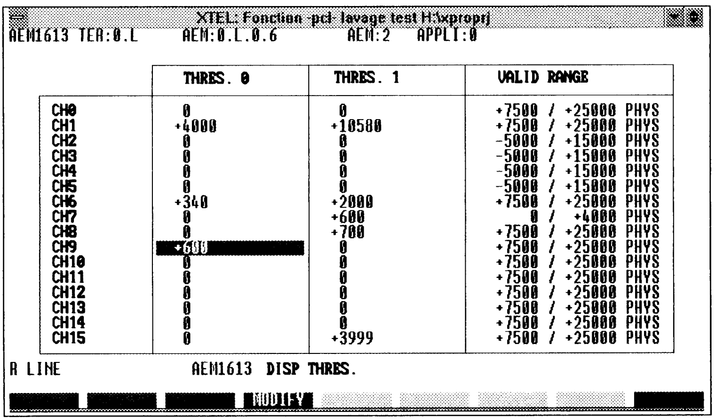
Parameters	Values	Limits
ACQUISITION RATE	50HZ	[50Hz , 60Hz]
CH0		
- Input Range	75/250 OHM	[OFF , -50/150°C ,...]
- Filtering	OFF	[OFF, 4s, 16s, 64s, 256s]
- Display	PHYS	[PHYS (°C ou ohm) , USER]
CH1		
- Input Range	75/250 OHM	[OFF , -50/150°C ,...]
- Filtering	OFF	[OFF, 4s, 16s, 64s, 256s]
- Display	PHYS	[PHYS (°C ou ohm) , USER]

R LINE AEM 1613 DISP CONF.

OP. NAME TOP BOT MODIFY PREVPAGE NEXTPAGE HELP

3.5-3 Threshold Mode

This mode lets the user view and modify thresholds.
Modification is only possible if the module was previously configured.


XTEL: Fonction -pcl- lavage test H:\xproprj

AEM1613 TER:0.L AEM:0.L.0.6 AEM:2 APPLI:0

	THRES. 0	THRES. 1	VALID RANGE
CH0	0	0	+7500 / +25000 PHYS
CH1	+4000	+10580	+7500 / +25000 PHYS
CH2	0	0	-5000 / +15000 PHYS
CH3	0	0	-5000 / +15000 PHYS
CH4	0	0	-5000 / +15000 PHYS
CH5	0	0	-5000 / +15000 PHYS
CH6	+340	+2000	+7500 / +25000 PHYS
CH7	0	+600	0 / +4000 PHYS
CH8	0	+700	+7500 / +25000 PHYS
CH9	+600	0	+7500 / +25000 PHYS
CH10	0	0	+7500 / +25000 PHYS
CH11	0	0	+7500 / +25000 PHYS
CH12	0	0	+7500 / +25000 PHYS
CH13	0	0	+7500 / +25000 PHYS
CH14	0	0	+7500 / +25000 PHYS
CH15	0	+3999	+7500 / +25000 PHYS

R LINE AEM1613 DISP THRES.

MODIFY

4.1 Using the Measurements in Message Mode (V3 Level PLCs)

This operating mode is the only one accessible to TSX Series 7 V3 level PLCs (TSX P47-30/67-20/87-30).

4.1-1 Accessing the Measurements

In message mode the measurements are transmitted in 16 internal words (Wi) in response to the request "Read measurements".

This request is programmed using a CPL type text block in transmit/receive mode, with the following characteristics:

- Request code : TXTi,C = 1
- Address : TXTi,M = H'xy00' (where x = Rack nbr. and y = Slot nbr.)
- Reception table: Wi[16] table of 16 words (32 bytes) containing the 16 measurements (where Wi = channel 0 measurement, Wi+ 1 = channel 1 measurement, and so on, to Wi+ 15 = channel 15 measurement).
- It is not necessary to define a transmission table.

Confirmation reports: TXTi,V = H'81' if exchange correct, or H'FD' if incorrect.
TXTi,S = 32 bytes if exchange correct (TXTi,E = 0).

Note:
If the module is stopped, the measurements transmitted are not actual measurements, but the last measurements acquired before the module was stopped.

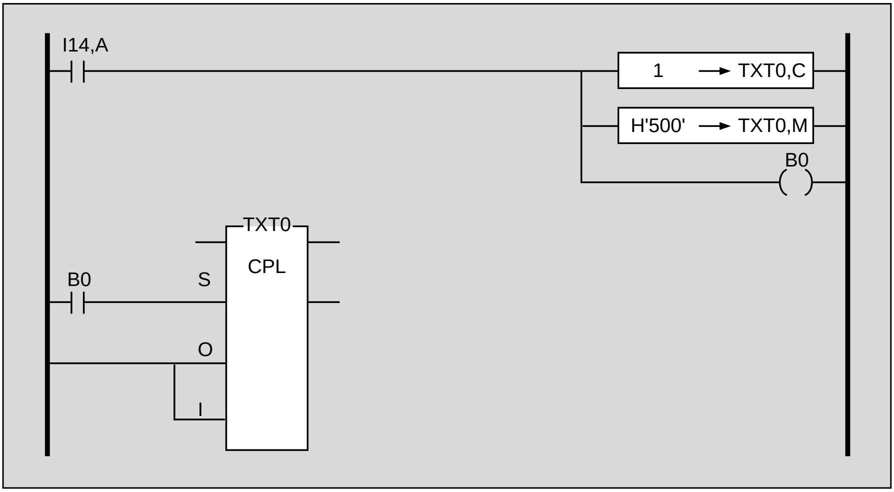
Conditions for validity and the digital-analog correspondence of the measurements are identical to those for accessing measurements in extended register mode (refer to Sub-section 4.2).

4.1-2 Example

In this example, a CPL type text block with direct addressing is used.

```
2/ 5/ 86 0 :0     CONF                                 TELEMECANIQUE
    NUMBER OF TEXT BLOCS  N/MAX : 2 /64

N0 NET/LOCAL  TYPE  ADDRESSING MODES  ADDR RECEPTION
                                      BUFFER    LENGTH (byte)
0   LOCAL     CPL        DIRECT        W100          0
1   LOCAL     CPL       INDIRECT       W20
```

The measurement reception table W100[16] is defined in PL7-3 Cofiguration mode. Measurements are transferred each time input I14,A changes from state 0 to state 1.



4.2 Using the Measurements in Extended Register Mode (V4 Level PLCs)

4.2.1 Accessing the Measurements

This new fast data exchange mode is only available with TSX/PMX Model 40 processors, version 4.3 and higher. In this mode, measurements are transmitted by immediate reading of 17 internal words (Wi):

Wi	Channel Status
Wi + 1	Measurement Ch. Ø
Wi + 2	Measurement Ch. 1
Wi + 15	Measurement Ch. 14
Wi + 16	Measurement Ch. 15

This data exchange mode is programmed in PL7-3, using the immediate read instruction READEXT (Ixy; Wi; Wj), where:

- Ixy Geographical address of the TSX AEM module
- Wi Start of the table
- Wj= 17 Length of the table in number of words

Note

The extended register data exchange mode is only active if the module is in RUN mode. If the module is stopped, the measurements transmitted are the last measurements acquired before the module was stopped.

4.2-2 Conditions for Measurements to be Valid

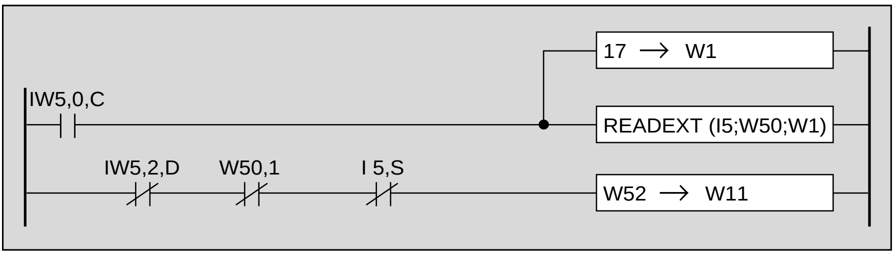
The digital values effectively represent the measurements expected from the analog measurements, provided the following conditions are met:

Conditions	Status	Consequences
Module running	IWxy,0,C = 1	If the module is stopped, the values read are the last values received before the module was stopped
Module configured	IWxy,2,D = 0	If not configured, the module takes the default configuration. The measurements will not be made in the expected units.
Input values are within limits of the extended zone, with correct sensor and wiring	Wi, k = 0 (k = 0 at H'10') Wi = destination address of the Readext exchange	If the channel is faulty the measurement the read is incorrect.
Module operating correctly and terminal block locked	Ixy,S = 0	When this bit is at 1, the module changes to STOP.

Example:

The actual measurement for channel 1 is only used if the module is OK, configured, and if no channel fault is detected.

The module is in slot 5 in the rack. The measurement is stored in W11. W11.



4.3 Using Thresholds

The TSX AEM 1613 supports the detection of two programmable thresholds per channel (refer to Sub-section 2.3.4). This function is run in two phases:
- Transmission of thresholds to the module,
- Processing the results of threshold detection.

4.3-1 Transmission of Thresholds to the Module

The thresholds must be transmitted to the module via the message interface, using two specific requests: write threshold 0 request (channels 0 to 15), write threshold 1 request (channels 0 to 15).

These two requests are programmed using the CPL text block in transmission reception mode, with the module stopped or running and the following characteristics set:

- Request code: TXTi, C = 2 (for 0 thresholds), TXTi, C = 4 (for 1 thresholds)
- Address: TXTi,M = H'xy00' (with x = rack number; y = slot number)
- Transmission table: TXTi,L = 32

CWi(16) or Wi(16) comprising the threshold values to enter in constant or data mode by program, with:
  - (C)Wi = Threshold channel 0,
  - (C)Wi+1 = Threshold channel 1,
  - ...
  - (C)Wi+15 = Threshold channel 15,
- No reception table need be defined.

Threshold values

The values of the thresholds must be between +32,767 and -32,768 but is restricted to the valid measurement range in the selected scaling range.

Thresholds are expressed in the measurement unit defined by the type of scaling: in physical units or in user defined units, depending on the selection made when the configuration was selected.

By default, or after a power-break, the threshold bits for each channel are set to 0. The threshold values must be returned to the modules (refer to Sub-Section 2.5-3).

4.3-2 Threshold Detection Results

The user has access by program to the 32 threshold detection bits:

Bit			
IWxy,6,0	Meas. Ch. 0 > Thres. 0	IWxy,6,8	Meas. Ch. 8 > Thres. 0
IWxy,6,1	Meas. Ch. 1 > Thres. 0	IWxy,6,9	Meas. Ch. 9 > Thres. 0
IWxy,6,2	Meas. Ch. 2 > Thres. 0	IWxy,6,A	Meas. Ch. 10 > Thres. 0
IWxy,6,3	Meas. Ch. 3 > Thres. 0	IWxy,6,B	Meas. Ch. 11 > Thres. 0
IWxy,6,4	Meas. Ch. 4 > Thres. 0	IWxy,6,C	Meas. Ch. 12 > Thres. 0
IWxy,6,5	Meas. Ch. 5 > Thres. 0	IWxy,6,D	Meas. Ch. 13 > Thres. 0
IWxy,6,6	Meas. Ch. 6 > Thres. 0	IWxy,6,E	Meas. Ch. 14 > Thres. 0
IWxy,6,7	Meas. Ch. 7 > Thres. 0	IWxy,6,F	Meas. Ch. 15 > Thres. 0

IWxy,7,0	Meas. Ch. 0 > Thres. 1	IWxy,7,8	Meas. Ch. 8 > Thres. 1
IWxy,7,1	Meas. Ch. 1 > Thres. 1	IWxy,7,9	Meas. Ch. 9 > Thres. 1
IWxy,7,2	Meas. Ch. 2 > Thres. 1	IWxy,7,A	Meas. Ch. 10 > Thres. 1
IWxy,7,3	Meas. Ch. 3 > Thres. 1	IWxy,7,B	Meas. Ch. 11 > Thres. 1
IWxy,7,4	Meas. Ch. 4 > Thres. 1	IWxy,7,C	Meas. Ch. 12 > Thres. 1
IWxy,7,5	Meas. Ch. 5 > Thres. 1	IWxy,7,D	Meas. Ch. 13 > Thres. 1
IWxy,7,6	Meas. Ch. 6 > Thres. 1	IWxy,7,E	Meas. Ch. 14 > Thres. 1
IWxy,7,7	Meas. Ch. 7 > Thres. 1	IWxy,7,F	Meas. Ch. 15 > Thres. 1

x = Rack number; y = Slot number.

The bit assigned to one of the thresholds of a channel will be set to 1 when the measurement value on the appropriate channel exceeds the programmed threshold value plus half of the hysteresis value. It is set to 0 when the measurement value on the appropriate channel falls below the programmed threshold value minus half of the hysteresis value.

The hysteresis value depends on the scaling selected (refer to Sub-Section 2.3.4).

Note: When a channel is not used, the threshold detection bits assigned to it are forced to 0.

4.3-3 Modifying the Threshold Values

The threshold values can be modified:

- When the module is stopped. When the application allows it, this is the recommended procedure. This avoids any interpretation errors affecting the detected thresholds (new or old threshold values).
- When the module is running. In this case, threshold detection with new values is only taken into account:
  - When the response to the request sent by the text block has been received, TXTi,D reset to 1 and report TXTi,V = H'FE',
  - After a sampling cycle of all 16 channels.

The selection of the moment when the results of the threshold detection are taken into account (if this is important for the application), is up to the user.

The loading and modification of thresholds can be performed by text block from the application program (refer to the Additional Programming Information sub-section), or from the terminal using PL7-PCL or PL7-PMS set-up software.

4.4 Additional Programming Information

4.4-1 Fault Processing (Optional)

The user can use a program to accurately identify faults occurring on a TSX AEM 1613 module or in its external environment.

Type of faults

Faults which occur on a TSX AEM 1613 module can be divided into three categories, according to their seriousness and their effect on module operation:

- **Blocking faults:**
  This type of fault corresponds to a failure detected in the module processor the interface with the bus. The module processor is inhibited and no data exchange is possible on the bus.

- **Module acquisition and conversion faults:**
  These faults are caused by:
  - The electronic circuits in the module that perform the acquisition and conversion of measurements,
  - An absent terminal block.
  The measurement values are no longer valid and the module is forced to stop.

- **Application faults:**
  These faults correspond to failures caused by the external environment of the module (range overshoot, sensor failure, etc.). They may occur on one channel only, while the other channels continue to operate correctly. The faulty channel is indicated to the user.

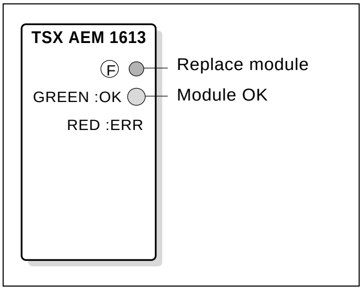
Fault detection

There are a number of methods of fault identification available to the user:

- Indicator LEDs
- Fault bits
- Status words
- Fault bit string (BDEF).

Indicator LEDs

LED	State	Fault
F	On	Blocking fault
OK	On Green	No fault
OK	On Red	Channel fault
OK	Off	Module fault



Fault bits

Fault bit	Access	State	Fault
Ixy,S (*)	By program	1	• Module fault (blocking or acquisition and conversion), • Exchange fault with the PLC, • Declared code is different from code 652 in the I/O configuration • Module absent

(*) This bit informs the PLC (I/O indicator lamp on the processor) that there is a fault on the module. It changes to 1 as soon as a fault appears and returns to 0 when it disappears.

Status words

Fault bit	Fault
IWxy,0,4	General fault or its memorization. Combines IWxy,0,6 and IWxy,0,7.
IWxy,0,6	Acquisition and conversion fault or its memorization.
IWxy,0,7	Application fault (sensors and wiring) or its memorization.
IWxy,0,8	Blocking fault, module absent or incorrect code.
IWxy,0,A	Terminal block fault (*).

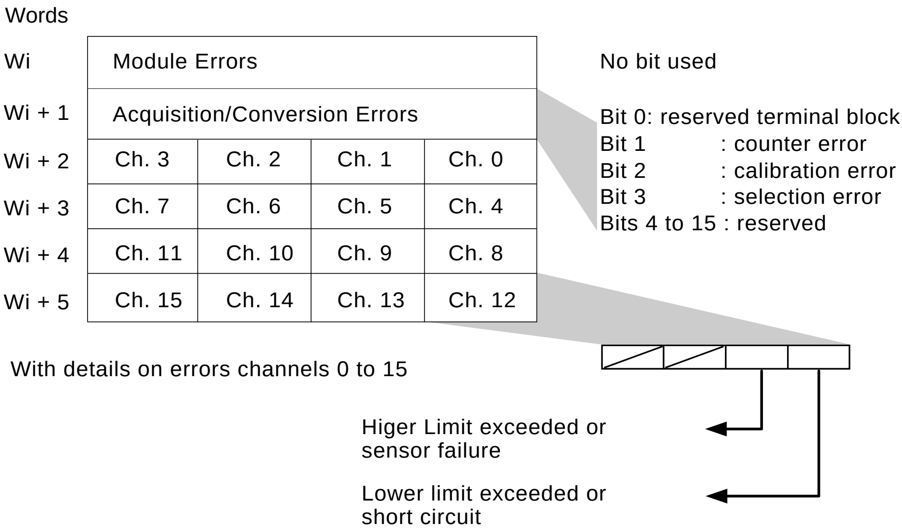
(*) A terminal block fault is generated by unplugging:

- One of the two 25-pin male SUB-D connectors when 16 channels are used,
- The 25-pin male SUB-D connector when only a single group of 8 channels is used (a missing connector on the other group has no effect).

Reminder: A terminal block fault forces the module to stop.

Fault bit string BDEF

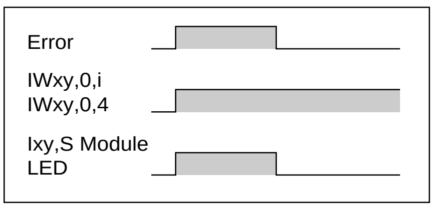
This string of 96 bits in the module can be transferred to the Wi internal word field via the message interface. (Request H'47'). It takes up 6 words.



Programming without reading the fault bit string

When a fault disappears, bits IWxy,0,4 and IWxy,0,i (i = 6 or 7) remain at 1.
The fault is permanently memorized until the module is re-initialized.

However, the indicator lamps and the fault bit Ixy,S change state as soon as the fault disappears.

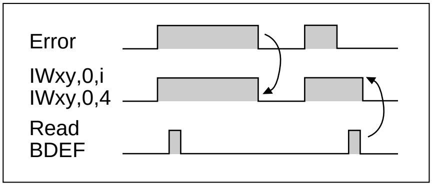


For this reason, bits IW,xy,0,i (i = 6 or 7) should not be used in programming.

Programming and reading the fault bit string

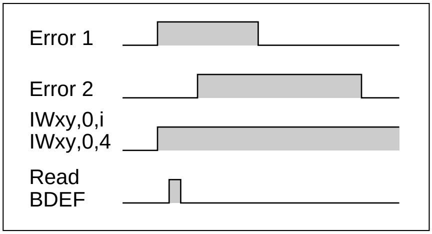
The fault bit string is read via the text block. It is optional and its main purpose is the accurate location of faults.
The content of the bit string is described on the preceding pages.

The action of reading the fault bit string (BDEF) acknowledges a fault detected by bits IWxy,0,4, and IWxy,0,i (i = 6 or 7), after it has disappeared, whether the reading takes place before or after the disappearance of the fault.



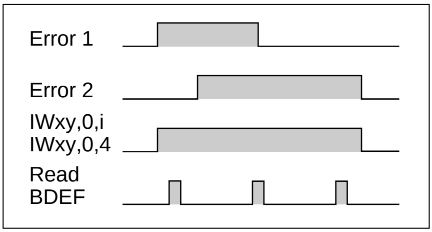
IWxy,0, bit 4,6 and 7 change to zero:

- When the fault disappears, if they have been acknowledged by reading the fault bits.
- When the fault bits are read after the fault has disappeared.



The message read after detection of fault nbr. 1 will not contain fault nbr. 2.

The user will not be informed of the second fault IWxy,0,4 and IWxy,0,i = 1, (i = 6 or 7) until the first fault has disappeared. Thus fault nbr. 2 can only be acknowledged after a new reading of the fault bit string.
It is therefore necessary to sample the fault bit string continuously to detect the appearance or disappearance of new faults.



How the received bit string is used depends on the user's requirements. The user may simply wish to keep the bits in internal words and read them in Adjust or Data modes on the programming terminal. Or the user may wish to store them in word tables so that the condition of faults can be displayed.

4.4-2 Additional Requests

In addition to loading the configuration, the PLC processor can exchange various data with the module, using the CPL text function block.

List of request codes

Request function	TXTi,C (hex.)	TXTi,M (hex.)	TXTi,V (hex.)	Nbr. of bytes written	Nbr. of bytes read	Module Status
Write 0 thresholds	2	xy00	FE/FD	32	0	RUN/STOP
Read 0 thresholds	3	xy00	83/FD	0	32	RUN/STOP
Write 1 thresholds	4	xy00	FE/FD	32	0	RUN/STOP
Read 1 thresholds	5	xy00	85/FD	0	32	RUN/STOP
Write configuration	40	xy63	FE/FD	98	0	STOP
Read configuration	41	xy63	71/FD	0	98	RUN/STOP
Read fault bit string BDEF	47	xy63	77/FD	0	12	RUN
Write application name	49	xy63	FE/FD	1 to 20	0	RUN/STOP
Read application name	4A	xy63	7A/FD	0	1 to 20	RUN/STOP
Read module version	F	xy63	3F/FD	0	27	RUN/STOP

4.4-3 Re-reading the configuration

Re-reading the configuration consists of transferring the configuration data from the module memory to the PLC memory. The configuration is read as a whole.

For this, the user must program a transmit/receive text block.

Characteristics of the text block

The text block should have the following characteristics:

- CPL type: To enable exchange between the user program and the module.
- Request code : TXTi,C = H'41'
- Address and channel number: TXTi,M = H'xy63'
- It is not necessary to define a transmission table. TXTi,L = 0
- The reception table length must be 98 bytes to be able to receive the whole configuration.

4.5 Summary - Setting-up a TSX V3/TSX/PMX Model 40 PLC Configuration

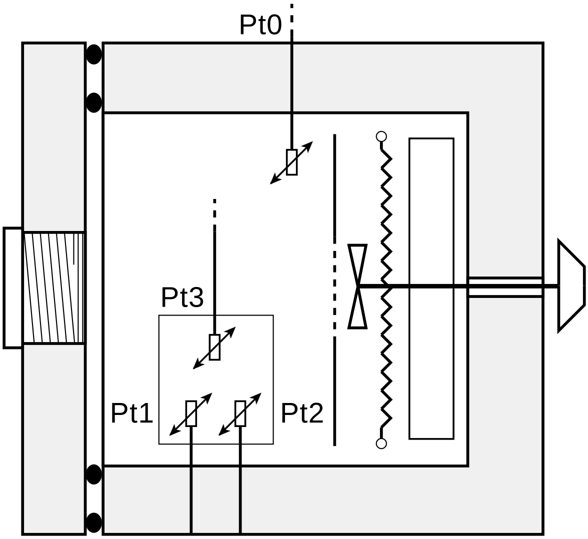
Design/Operation Step	Required Optional	V3 Configuration	V4 Configuration PL7-PCL/PMS (1)
Create configuration	R	PL7-3 Constant Mode	PL7-PCL PL7-PMS Configuration Mode
Load configuration	R	TXT Block Request Code H'40' Channel Nbr. H'63'	OFB ANALD (PL7-PCL software) OFB AEMLD (PL7-PMS software)
Write application name	O	TXT Block Request Code H'49' Channel Nbr. H'63'	PL7-PCL PL7-PMS Configuration Mode
Set module to RUN	R	Set bit OWxy,0,C to 1	Supported by ANALD or AEMLD OFB
Read measurements	R	TXT Block Request Code 1 } Channel Nbr. 0 }	READEXT Instruction
Read channel status	R	Discrete Interface Ixy,i }	
Read fault bit string	O	TXT Block Request Code H'47' Channel Nbr. H'63'	PL7-PCL PL7-PMS Debug Mode
Read configuration	O	TXT Block Request Code H'41' Channel Nbr. H'63'	PL7-PCL PL7-PMS Configuration Mode
Read application name	O	TXT Block Request Code H'4A' Channel Nbr. H'63'	PL7-PCL PL7-PMS Configuration Mode
Identify the module	O	TXT Block Request Code H'0F' Channel Nbr. H'63'	PL7-PCL PL7-PMS All Modes
Debug		PL7-3 Data Mode	PL7-PCL PL7-PMS Debug Mode

(1) Version V5.0 or higher.

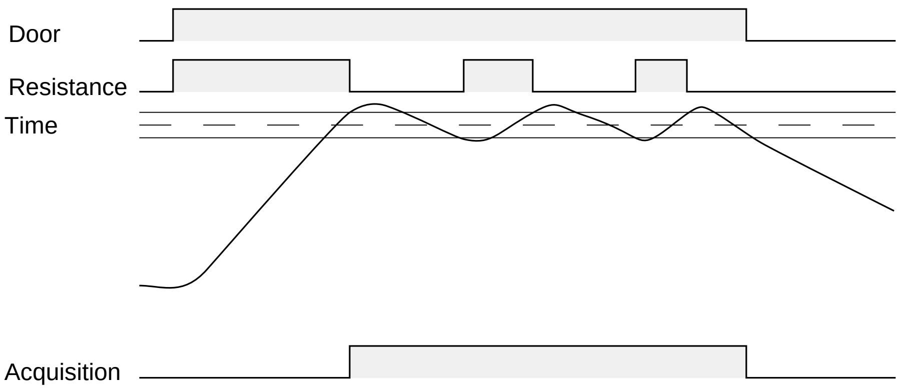
Sub-Section **Page**

5.1 Description

The application described in this example checks the temperature dissipation of electronic devices subject to a burn-in cycle in an oven. Each oven has a Pt 100 probe that measures the oven temperature, controlled using discrete I/O logic. Three probes are used to measure the temperature of points in the devices where the highest levels of heat dissipation occurs. In order to justify the use of a TSX AEM 1613 module, let us assume that four ovens must be monitored.



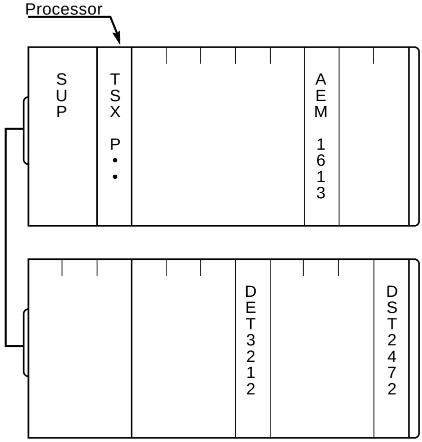
The oven temperature check requires that the door be closed. The temperature must be held at 80° ±3°C. The acquisition of "hot spot" temperature measurements only takes place once the oven reaches 80° for the first time after closing the door. It will stop as soon as the door is opened.



To avoid accidental hardware destruction, the oven heater resistance is shut-off in the following cases:
- Oven temperature measurement probe failure,
- TSX AEM 1613 module failure.

Hardware Configuration

The assumption is made that control of the four ovens is part of a larger system that justifies the use of the configuration shown below:



The TSX AEM 1613 module is located in slot 5 of the basic rack. The channels are assigned as shown in the table below.

	Oven 1	Oven 2	Oven 3	Oven 4
Oven Temperature	Ch. 0	Ch. 4	Ch. 8	Ch. 12
Point Nbr. 1	Ch. 1	Ch. 5	Ch. 9	Ch. 13
Point Nbr. 2	Ch. 2	Ch. 6	Ch. 10	Ch. 14
Point Nbr. 3	Ch. 3	Ch. 7	Ch. 11	Ch. 15

Channels 8 to 11 of the TSX DET 3212 input module in slot 3 of the extension rack are connected to the position switches that detect the closing of the oven doors.
Channels 16 to 19 of the TSX DST 2472 output module in slot 7 of the extension rack control the oven heater resistances.
Channels 20 to 23 of this module control an indicator that is lit when an error caused the cycle to be stopped.

TSX AEM 1613 module configuration

All 16 channels are configured in the same way:

- 50Hz operating mode,
- -50 / +150°C input range,
- No filtering,
- Physical range scaling (in hundreds of degrees).

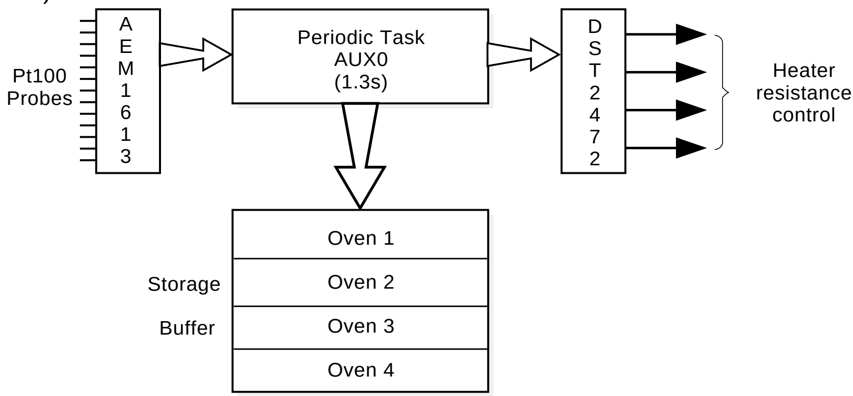
Note

How the configuration parameters are encoded and transferred to the module depend on the type of PLC processor selected (text block for V3 level PLCs - refer to Sub-section 5.2, or OFBs for V4 level and higher PLCs - refer to Sub-section 5.3).

The configuration is systematically reloaded each time a power break occurs or when the module is plugged into the rack. These two situations are tested by setting the "Module Ready" bit (IW5, 0, 3) to 1 at the end of the self-test cycle.

Suggested processing

The acquisition speed is 1.3 seconds (for 16 channels in 50Hz mode) it is usual to adopt an identical time period for processing. Task AUX0 will be used for processing (for acquiring the measurements, monitoring the oven and storing the hot spot temperatures).



To use the processing capacity built-into the module, the threshold data provided by TSX AEM 1613 data is used to control the heating resistances.

Threshold monitoring is performed with hysteresis of 0.5% of the full scale input range, or 1°C when the -50/+150°C range is selected, requiring that the following values be defined to ensure rigorous measurement results:

- 82°C (or 8200) for the higher threshold,
- 78°C (or 7800) for the lower threshold.

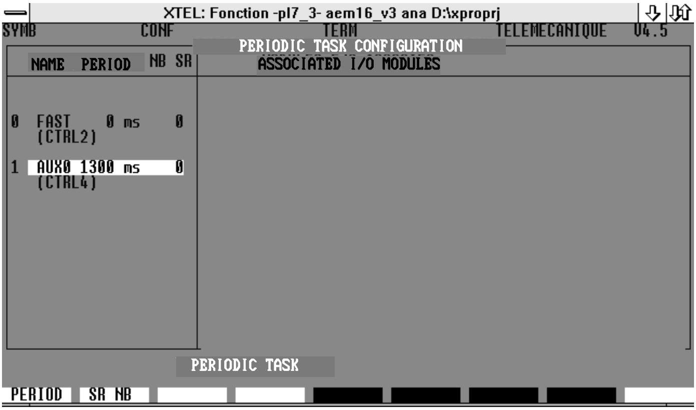
Note

In the example, no allowance is made for problems related to the size of the storage buffers, nor for using the measurement values stored in these buffers.

5.2 Implementing on a V3 PLC (TSX P47-30/67-20/87-30)

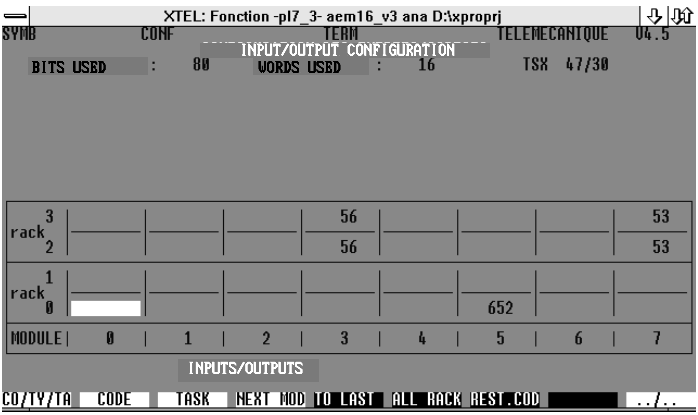
TSX AEM 1613 module configuration codes are entered using PL7-3 in Constants Mode. The PLC memory is transferred to the module memory via a text block (using request code H'40').
The threshold tables are also entered in Constants mode and transferred via a text block (request codes 2 and 4).
Measurements are read by text block (request code 1).

Configuring the periodic tasks (PL7-3 Configuration Mode)



Entering the application I/O configuration

Enter the codes corresponding to the modules used.



Entering the configuration parameters and threshold tables for the TSX AEM 1613 module

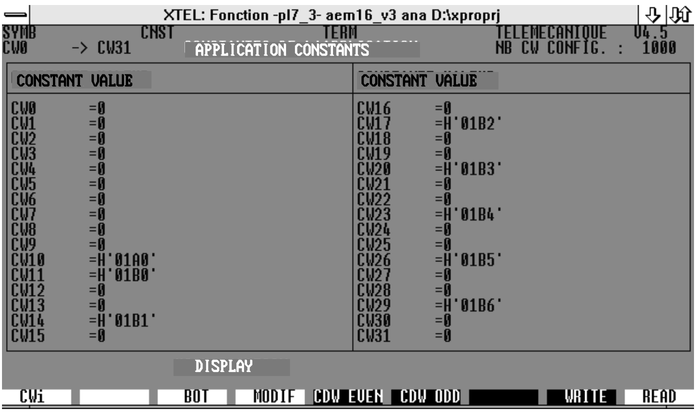
These are entered using PL7-3 in Constant Mode.

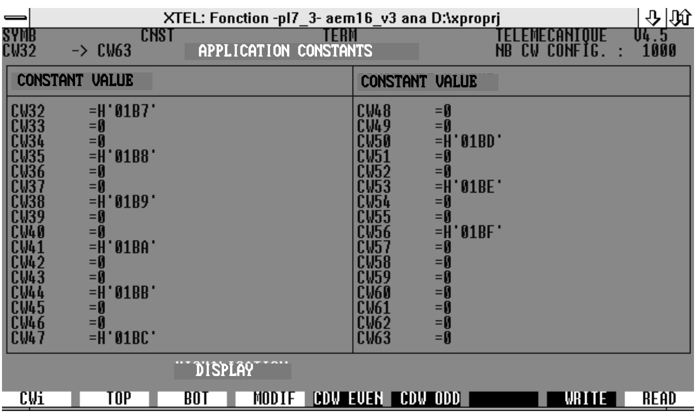
Using:

- 49 words from CW10 for the configuration,
- 16 words from CW64 for the table of 0 thresholds,
- 16 words from CW80 for the table of 1 thresholds.

1 - Configuration parameters

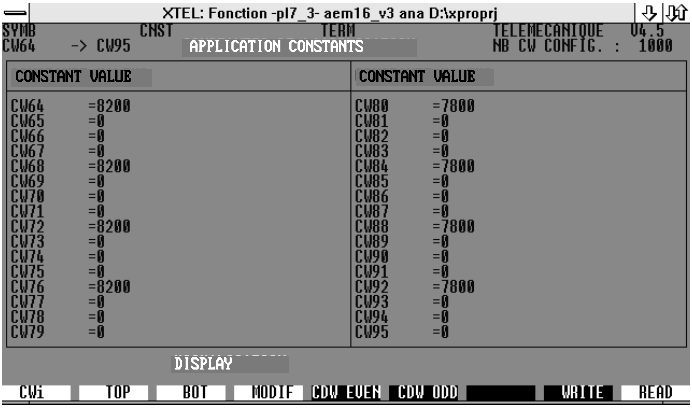
Common parameters	:	H'01A0'	:	50Hz mode
Parameters for Ch. i	:	H'01Bi'	:	No filter/Range -50/+150°C/ Physical unit scaling/Channel Nbr.
		0	:	Not used for physical unit scaling
		0	:	Not used for physical unit scaling
		with i	:	Channel number (0 to F)





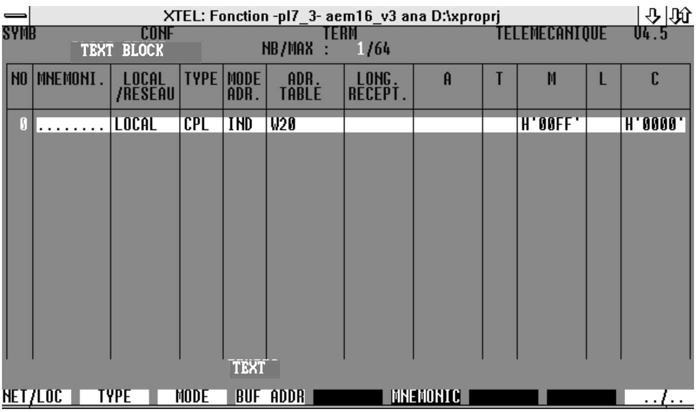
2 - Threshold values

Only channels 0, 4, 8, 12 are affected
Threshold 0 = 8200 ; Threshold 1 = 7800



Text block assignment

TXT0 is used to load the configuration and the threshold tables and the measurement readings.



PL7-3 variable assignments

CW10 to CW58	:	Configuration parameters
CW64 to CW79	:	0 threshold table
CW80 to CW95	:	1 threshold table
W20 [6]	:	Buffer assigned to text block TXT0 (indirect addressing)
W40 [16]	:	Buffer for measurement readings from the TSX AEM 1613 module (TXT1 text block buffer)
W1 to W4	:	Index used by the storage buffers
W1000[1000]	:	Buffer for storing temperature measurements from oven 1
W2000[1000]	:	Buffer for storing temperature measurements from oven 2
W3000[1000]	:	Buffer for storing temperature measurements from oven 3
W4000[1000]	:	Buffer for storing temperature measurements from oven 4

I23,8	:	Indicator light oven 1 closed
I23,9	:	Indicator light oven 2 closed
I23,A	:	Indicator light oven 3 closed
I23,B	:	Indicator light oven 4 closed
O37,0	:	Control heater resistance oven 1
O37,1	:	Control heater resistance oven 2
O37,2	:	Control heater resistance oven 3
O37,3	:	Control heater resistance oven 4
B0	:	Store TSX AEM 1613 test in progress bit
B1	:	Status heater control device oven 1
B2	:	Status heater control device oven 2
B3	:	Status heater control device oven 3
B4	:	Status heater control device oven 4
B5	:	Oven 1 open during warm-up phase
B6	:	Oven 2 open during warm-up phase
B7	:	Oven 3 open during warm-up phase
B8	:	Oven 4 open during warm-up phase

Programming the Master task (MAST)

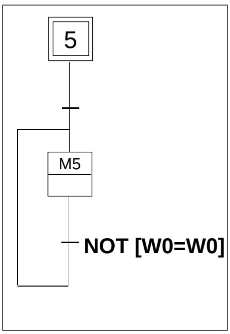
The configuration of the TSX AEM 1613 module and the threshold tables is systematically reloaded after a power-break or when the module is plugged into the rack. The common event in both of these situations is the "module ready" bit (IW5, 0, 3) changing from 0 to 1. The Grafcet sequence described below will also reload the configuration and the threshold tables on a cold restart.

PRL

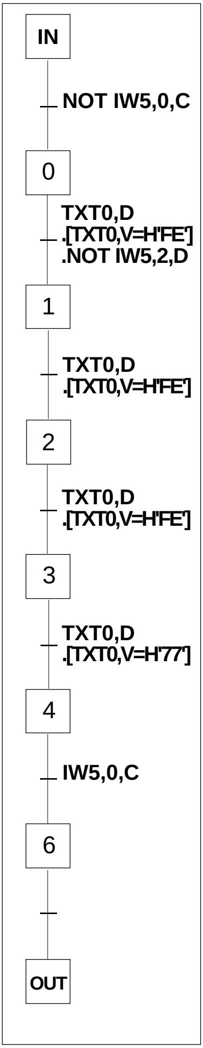
Is used to detect events that justify reloading the configuration and the threshold tables.

```
 START AEM CONFIGURATION SEQUENCE
!       IF IW5,0,3.NOT B0
                THEN RESET TXT0;H'FFDF'→SW8;SET SY24;SET X5

!       IW5,0,3→B0
 DISABLE TASK AUX0 IF AEM MODULE NOT READY
!       IF NOT IW5,0,3
                THEN RESET CTRL4

!EOP
```

CHART



XM5: Load the configuration and thresholds



ACTIVATE Stop the module
```
! 0 → OW5,0 → OW5,1 → OW5,2 ; 0 → W23[3]
```

ACTIVATE Load the configuration
```
! H'0563' → TXT0,M; H'40'→ TXT0,C; 1 → W20;
  10 → W21; 98 → W22; EXCHG TXT0
```

ACTIVATE Load 0 threshold table
```
! H'0500' → TXT0,M; 2 → TXT0,C; 1 → W20;
  64 → W21; 32 → W22; EXCHG TXT0
```

ACTIVATE Load 1 threshold table
```
! 4 → TXT0,C; 80 → W21; EXCHG TXT0
```

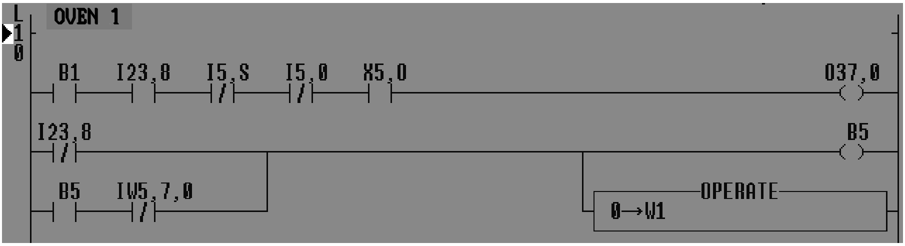
ACTIVATE Read fault bit string (to ack.)
```
! H'0563' → TXT0,M; H'0047'→ TXT0,C; 0 → W22;
! 26 → W24; 12 → W25; EXCHG TXT0
```

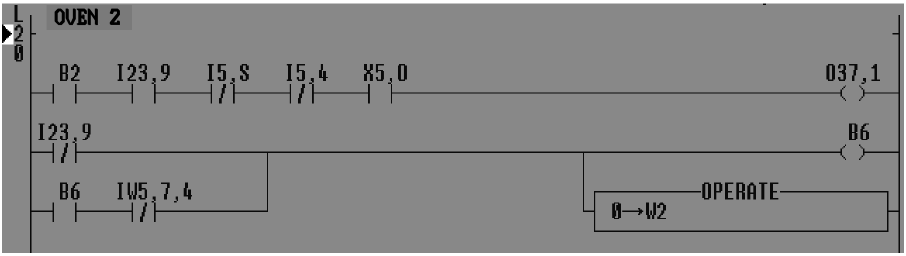
ACTIVATE Start module (set to RUN)
```
! SET OW5, 0, C
```

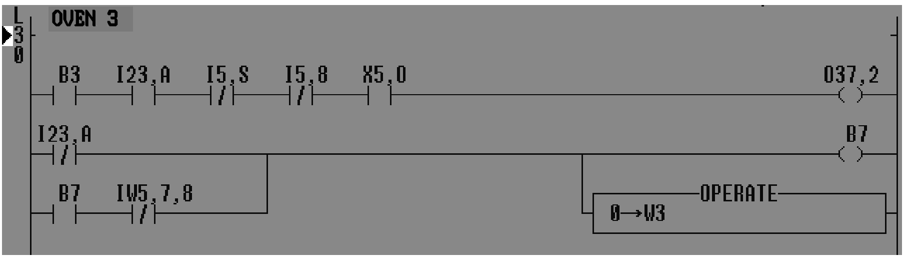
ACTIVATE
```
Run task AUX0
! START CTRL4
< ACQUIRE 1st MEASUREMENT CYCLE
! 40→W24; 32→W25; H'0500'→TXT0,M; 1→TXT0,C;
  EXCHG TXT0
```

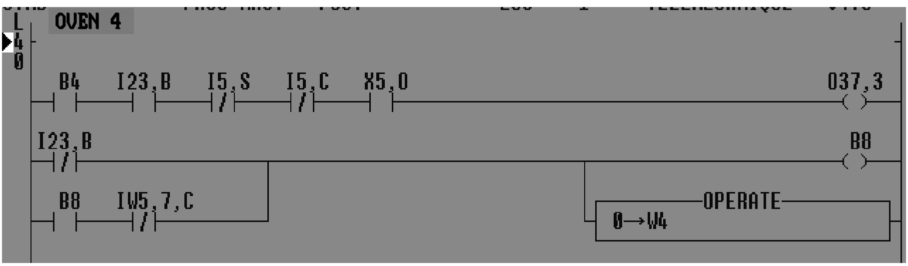
POST

Manage oven heater control systems and doors.









Subroutine SR0

```
< Request acquire next measurement cycle
! EXCHG TXT0
```

Task AUX0

Ensures the control of oven temperature using discrete logic and buffers the hot point measurements.

```
 <*****PROCESS OVEN 1*****>
!L10   :
<TEMPERATURE CONTROL
!        IF IW5,6,0
                   THEN RESET B1

!        IF NOT IW5,7,0
                   THEN SET B1
<STORE MEASUREMENTS HOT POINTS
!        IF NOT B5
                   THEN W41→W1000(W1);W42→W1001(W1);W43→W1002(W1);W1+3→W1

!        IF [W1>997]
                   THEN 0→W1
```

```
<*****PROCESS OVEN 2*****>
!L20   :
 <TEMPERATURE CONTROL
!        IF IW5,6,4
                   THEN RESET B2

!        IF NOT IW5,7,4
                   THEN SET B2
 <STORE MEASUREMENTS HOT POINTS
!        IF NOT B6
                   THEN W45→W2000(W2);W46→W2001(W2);W47→W2002(W2);W2+3→W2

!        IF [W2>997]
                   THEN 0→W2
```

Task AUX0 (continued)

```
 <*****PROCESS OVEN 3*****>
!L30   :
 <TEMPERATURE CONTROL
!       IF IW5,6,8
                 THEN RESET B3

!       IF NOT IW5,7,8
                 THEN SET B3
 <STORE MEASUREMENTS HOT POINTS
!       IF NOT B7
                 THEN W49→W3000(W3);W50→W3001(W3);W51→W3002(W3);W3+3→W3

▶!      IF [W3>997]
                 THEN 0→W3
```

```
 <*****PROCESS OVEN 4*****>
!L40   :
 <TEMPERATURE CONTROL
!       IF IW5,6,C
                 THEN RESET B4

!       IF NOT IW5,7,C
                 THEN SET B4
 <STORE MEASUREMENTS HOT POINTS
!       IF NOT B8
                 THEN W53→W4000(W4);W54→W4001(W4);W55→W4002(W4);W4+3→W4

▶!      IF [W4>997]
                 THEN 0→W4
```

5.3 Implementing on a V4 Level PLC

A TSX Series 7 Model 40 PLC can be programmed in the same way as a V3 level PLC (refer to Sub-section 5.2).

However, it is preferable to use PL7-PCL or PL7-PMS (1) software for improved ease-of-use when setting-up TSX AEM 1613 modules. In addition TSX Series 7 Model 40 PLCs support an improved mechanism for returning measurement values (using the READEXT instruction).

(1) Setting-up TSX AEM 1613 modules requires the user of version V5.0 of PL7-PCL or PL7-PMS programs. This version is currently under development. It should be available during the 4th. quarter of 1993.

6.1 Selecting the Slot and Locating Devices

Hardware

3-digit decimal code defined by 3 female locating devices at the rear of the module. — TSX AEM 1613: 652

Software

Entered when configuring the I/O via a terminal. — TSX AEM 1613: 652

Location (slot)

TSX AEM 1613 modules are installed in PLC racks with the complete bus. TSX AEM 1613 modules require a PLC processor version ≥ V3. — TSX RKN ●●

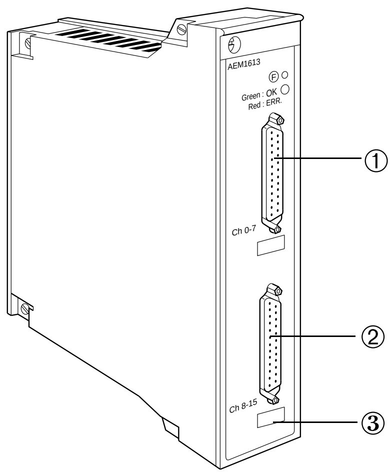
6.2 Connecting the Module

6.2-1 Description

① 25-point female Sub-D type connector for connecting channels 0 to 7.

② 25-point female Sub-D type connector for connecting channels 8 to 15.

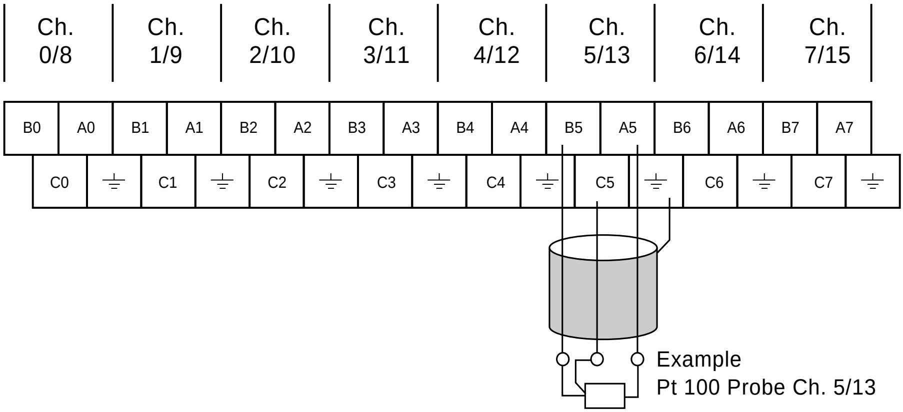
③ Blank labels, available for user identification.



To simplify connection of Pt 100 probes to TSX AEM 1613 modules, a complete connection set is available to move terminal block connections into the enclosure, where required. This connection set comprises the following hardware for each group of 8 channels:

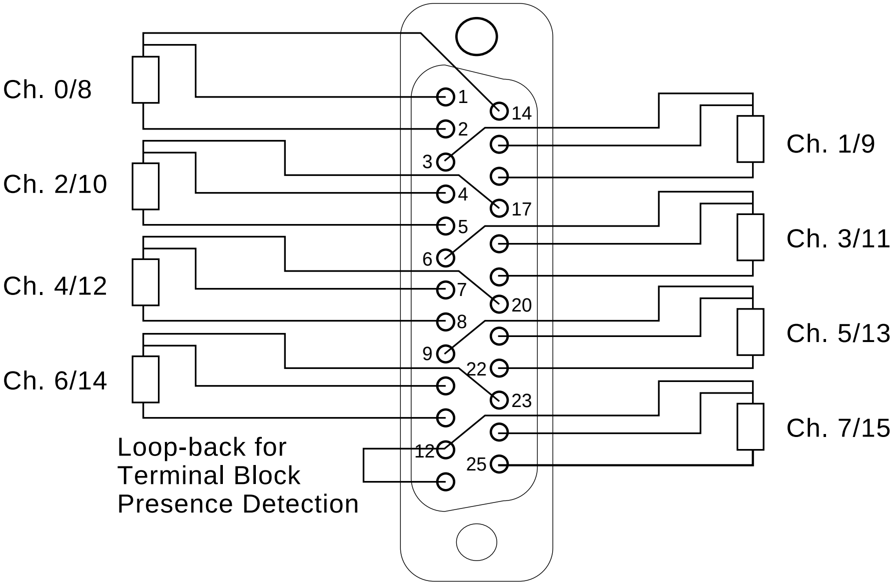
- 1 ABE-6SD2520 connector block for connecting 8 probes (3 wires + shield),
- 1 Multi-pair ABF-S25S301 cable (length 3 meters) for connecting the connection block to the 25-point Sub-D connector on the module.

ABE-6SD2520 connection block description



The use of this connection kit is strongly recommended, but is not required. The diagram on the next page details the pin arrangement for users who prefer to connect the probes directly to the module without using the connection block.

Connection diagram for Channels 0-7 and 8-15 of the TSX AEM 1613 module



Points 12 and 13 **must** be connected together.

Note
This type of connection requires the use of two 25-pin Sub-D male connectors **not supplied** with the module. It does not support shield connection.

Correspondence between TSX AEM 1613 / ABE-6SD2520 connection points

Channels	**0/8**			**1/9**			**2/10**			**3/11**		
Sub-D contacts	1	2	14	15	16	3	4	5	17	18	19	6
ABE block	B0	A0	C0	B1	A1	C1	B2	A2	C2	B3	A3	C3
Channels	**4/12**			**5/13**			**6/14**			**7/15**		
Sub-D contacts	7	8	20	21	22	9	10	11	23	24	25	12/13
ABE block	B4	A4	C4	B5	A5	C5	B6	A6	C6	B7	A7	C7

6.2-2 Connection Principles

It is advisable to take the following precautions to protect the signal from induced outside noise in serial mode and from common mode noise:

Type of cable

> Given the importance that variations in line impedance levels can have, depending on the distance, the wires used must be selected so that the line resistance RL < 20 Ω.

For example: using wire with a cross-section of 0.22 mm^2 allows connections over 200 meters max.

Cable screening

Twisted pair cables with separate screening should be used for connecting the connector block and the sensors.
The cable screening should be connected to the PLC earth (ground) through the terminals reserved for this purpose on the ABE-6SD2520 connector block.
The shielding can be connected at both ends (connector block and sensor) if the installation site has a suitable grounding network (grounding network using 35 mm^2 cross-section cable).

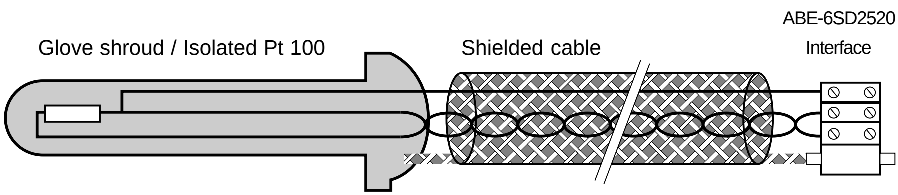
6.2-3 Referencing Channel Inputs and Sensors

The TSX AEM 1613 module has 16 inputs which have a common point but are isolated in relation to the PLC bus.

For safety reasons, the module has a capacitor between the channel reference voltage and ground. This ensures that any brief spikes are absorbed.

It is preferable to use "floating" sensors (not referenced to ground).

Example below: wiring of a floating sensor.



7.1 Power Consumption

Power supply for the module is provided by the PLC.

Power Supply	Typical Consumption	Maximum Consumption
5 V	500 mA	650 mA
+ 12 VL	11 mA	15 mA

7.2 Input Characteristics

General Characteristics	
Number of channels	16
Analog/Digital conversion	8192 points / 13 bits
Module cycle time	**260ms+65ms/channel** (normal mode 50Hz)
Conversion method	Voltage → Frequency
Calibration	Automatic
Hardware input filtering	2 ms
Digital signal filtering	From 1 to 256secs. (1st order parametering, 5 values)
50Hz input rejection (serial mode)	**> 60dB**
Max. recalibration error	0.1%
Max. non-linearity	0.1%
Line impedance compensation	Up to 40Ω (double current source principle)
Temperature drift	25 ppm/°C
Isolation between inputs and PLC	1500V (2000V eff for 1 minute)
Max. overvoltage allowed on inputs	30V
Standards	CEI 65A- DIN 43 760

Pt100 input / - 50°C +150°C scale	
Current in the probe	2mA pulsed
Unit	1/100 °C
Measurement format (input range)	- 5,000 to + 15,000
Resolution	0.05°C
Max. error	0.4°C
Linearization	**Automatic**
Range overrun indication	≤-65.6°C or ≥157.2°C

Pt100 input / 0°C +400°C scale	
Current in the probe	2mA pulsed
Unit	1/10 °C
Measurement format (input range)	0 to + 4,000
Resolution	0.1°C
Max. error	0.8°C
Linearization	**Automatic**
Range overrun indication	≤-9°C or ≥414.4°C

Pt100 input / - 60°F +300°F scale	
Current in the probe	2mA pulsed
Unit	1/10 °F
Measurement format (input range)	- 600 to + 3,000
Resolution	0.1°F
Max. error	0.7°F
Linearization	**Automatic**
Range overrun indication	≤ - 86°F or ≥315°F

Pt100 input / +30°F +750°F scale	
Current in the probe	2mA pulsed
Unit	1/10 °F
Measurement format (input range)	+ 300 to + 7500
Resolution	0.2°F
Max. error	1.4°F
Linearization	**Automatic**
Range overrun indication	≤-15.8°F or ≥777.9°F

Ohms input / 75Ω 250Ω scale	
Current in the probe	2mA pulsed
Unit	1/100Ω
Measurement format (input range)	7.500 to 25,000
Resolution	0.03Ω
Max. error	0.4Ω
Range overrun indication	≤74.1Ω or ≥252Ω

8.1 Index