Contents

1.1 Description

1.1-1 General

The TSX AXT 2 00 is an input module with two up/downcounting channels that is designed for use with Telemecanique's TSX 47/67/87 programmable logic controllers (PLCs).

1.1-2 Functions

Upcounting

The TSX AXT 2 00 module has two identical but independent channels which can count pulses with frequencies up to 2 KHz. This maximum rate of counting is directly linked to the scan time of the user program, (see Sub-section 2.3).

Upcounting and Up/downcounting

Each channel has an up/downcounting discriminator that increments or decrements the counter according to the counting direction.

Application Examples

. Counting of parts,
. Positioning of a mobile,
. Measurement of velocity and frequency,
. Measurement of length,
. Measurement of flow,
. Computing a mobile's position,
. Movement control and monitoring,
. etc.

1.1-3 Design

Protection

The input channels are protected against industrial noise and are isolated from each other and from the internal voltages of the PLC.

Easy Use

The 5 VDC or 24 VDC inputs are compatible with discrete devices, such as proximity detectors and limit switches, and incremental encoders. The high-performance configuration mode and its related software are easy to implement (see Section 2).

Easy Operation

The module and its connectors can be installed and removed with the power on. The PLC processor is continuously informed of the module status and the user program can access any information for subsequent processing.

1.2 Physical Description

1.2-1 TSX AXT 2 00 Module

The TSX AXT 2 00 module can be installed in any slot designed for PLC configuration inputs/outputs. The TSX AXT 2 00 module is composed of:

① A metal case which protects the components physically and against radiated electrical noise.

② An opening which gives access to the two upcounting/downcounting discriminator switches for each channel.

③ One fault LED (F) for each channel, which comes on when the counting capacity is exceeded.

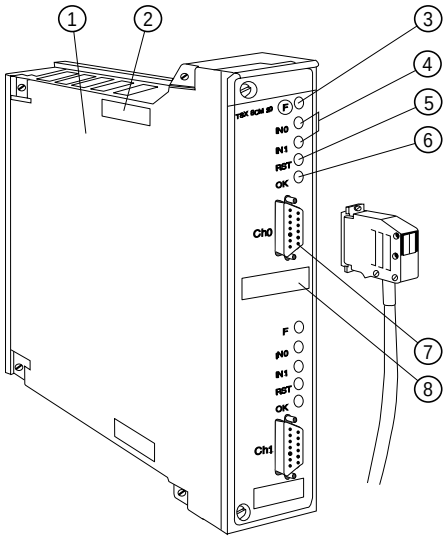
④ Two LEDs per channel indicating the logic states of the two counting inputs (In0 and In1).

⑤ One LED per channel indicating the logic state of the reset input (RST).

⑥ One LED per channel indicating the logic state of the inhibit input (INH).

⑦ One socket connector for each channel (9-pin Sub-D type).

⑧ One blank label per channel for the user's identifying marks.



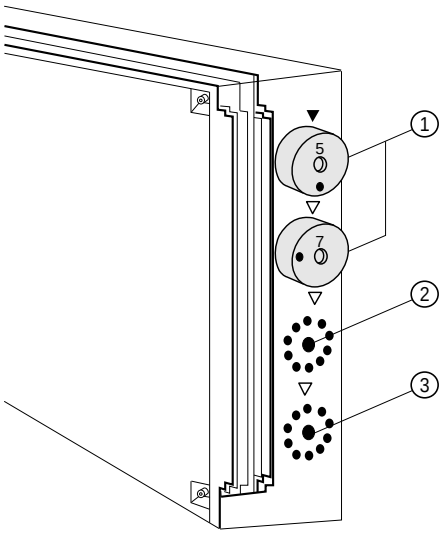
1.2-2 Locating Devices

The rear of the module is equipped with:

① Factory-coded locating devices, which prevent the risk of error when modules are installed.

② Locations for a second set of locating devices (optional), which can be coded by the user to distinguish between modules of the same type but which are configured or adjusted differently (e.g. with different discriminator switch settings).

③ A device that centres the module.



1.3 Initiation

1.3-1 Equipment Required

For this initiation exercise in the use of the TSX AXT 2 00 module, the following equipment is required:

. One TSX AXT 2 00 module and one TSX CAC 04 connector kit,

. One TSX 47-10/20 PLC version V3 or higher (*),

. One TSX RAM 8/16/32 8 memory cartridge,

. One programming terminal,

. Three pushbuttons (or 2-wire type sensors),

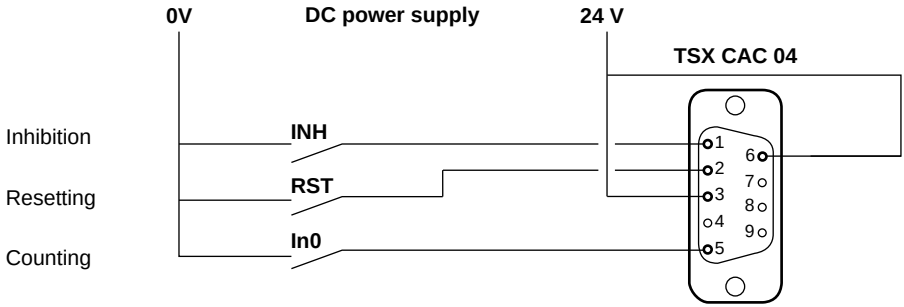
. One 24 VDC power supply.

(*) This initiation exercise can be conducted in the same way on TSX 67/87 PLCs (refer to subsection 2.5-5).

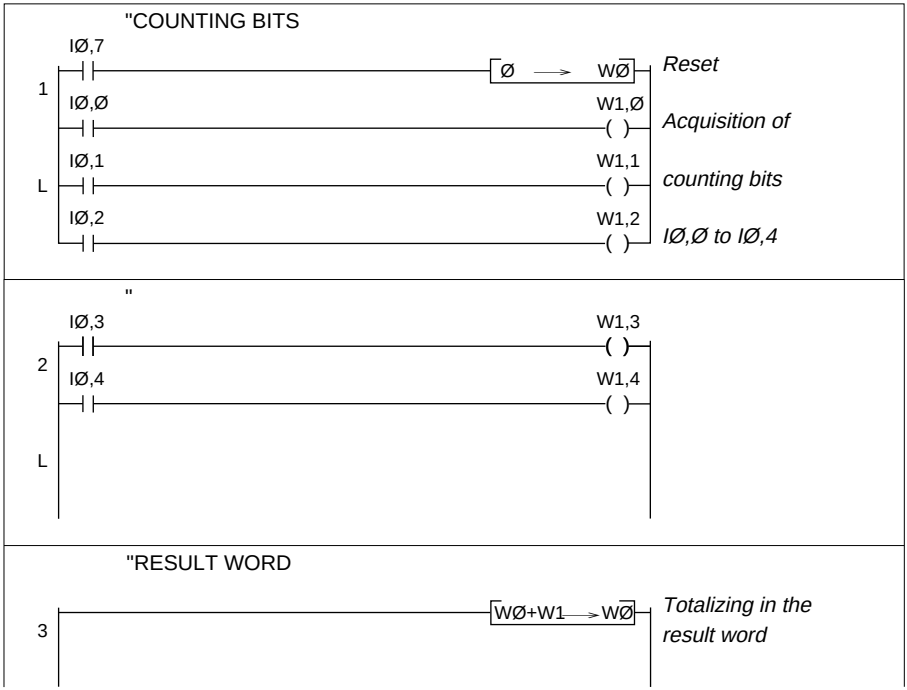
1.3-2 Preparation of Hardware and Programming

1. Prepare the TSX 47 PLC and its programming terminal.
2. Check that the discriminator switches on the TSX AXT 2 00 module are set to OFF. (See Sub-section 3.2 of this manual).
3. Install the TSX AXT 2 00 module in slot 0 of rack 0.

   If the module is installed in another slot, the bit addresses used in the program must be modified accordingly.
4. Connect the 3 pushbuttons (INH, RST and In0) and the 24 VDC power supply to the TSX CAC 04 connector as shown in the wiring diagram below.
5. Plug this connector into the upper socket (i.e. the socket of Channel 0) on the front of the TSX AXT 2 00 module.

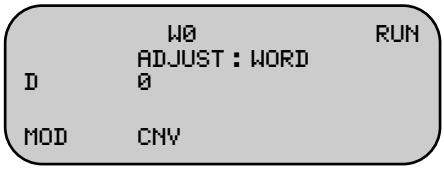


6. Enter the Ladder language program below in the Master task.



1.3-3 Module Operation

1. Select the DEBUG mode and switch to RUN.
2. Select the ADJUST mode on the terminal and request the display of internal word W0 in decimal.



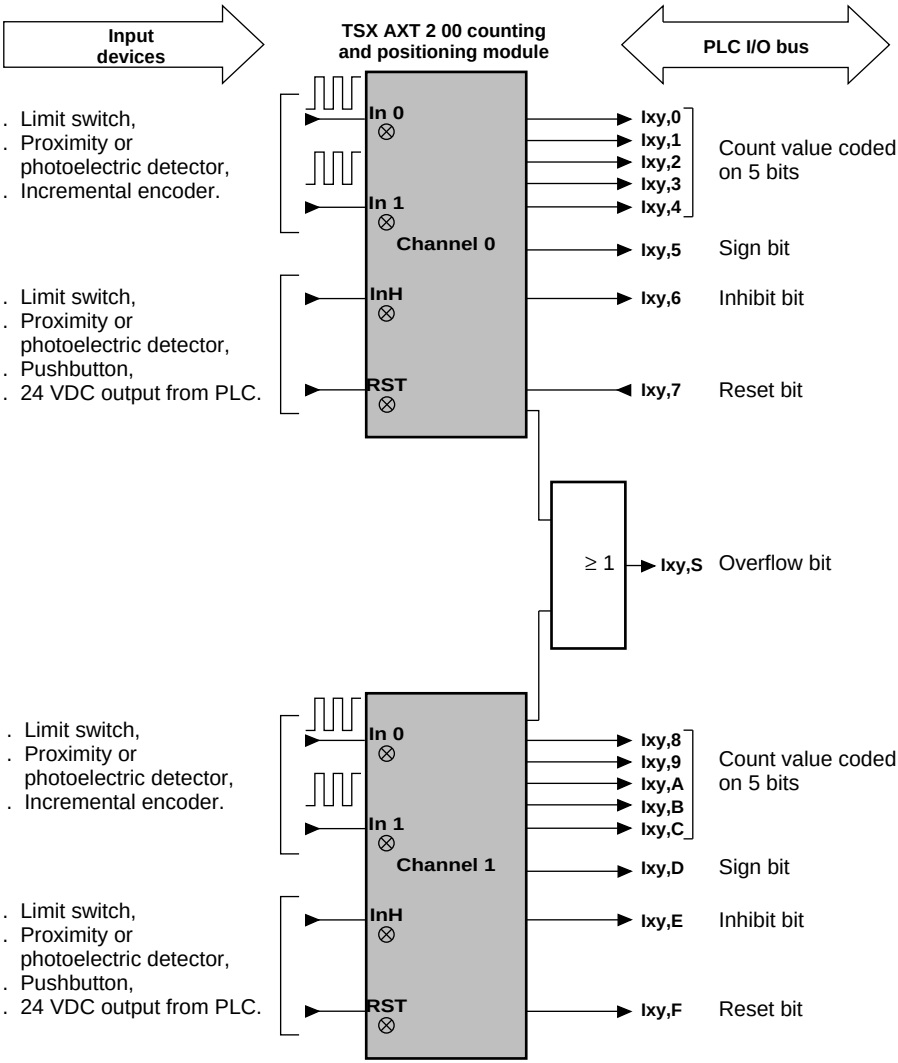
The display opposite appears:

3. Actuate the pushbutton connected to the counting input In0 several times: on each rising edge, the internal word W0 is incremented by one unit.
4. While continuing to actuate the pushbutton connected to input In0, actuate the INH pushbutton to set the inhibit input to state 1: the internal word W0 stops being incremented.
5. Actuate the pushbutton connected to the reset input RST: the internal word W0 is reset to zero.

Note:
The front panel LEDs marked In0, INH, RST indicate the states of the corresponding inputs.

2.1 Architecture

2.1-1 Block diagram



2.1-2 Counting Functions

Inputs In0 and In1: 5 VDC and 24 VDC

On each channel, the module counts the pulses (rising edge) received on the counting inputs In0 and In1. The value of the count is coded on 5 bits which can be accessed by the user program.

. **For upcounting applications, the discriminator is not utilized** and only input In0 is used.

. **For up/downcounting applications, the discriminator is utilized** and both inputs (In0 and In1) are used and connected to the device(s) that output the 90° out-of-phase signals.

These inputs are designed for incremental encoders; however, for applications not requiring as much precision, two devices such as proximity detectors may be used.

Up/Downcounting Discriminator

The discriminators are activated or deactivated by two switches on the module.

The discriminator detects the phase-shift between the two signals In0 and In1. A phase-shift of plus 90° between these two signals causes the count value to be incremented, whereas a phase-shift of minus 90° causes the count value to be decremented.

Reset Input RST: 24 VDC

This input can be connected to a 24 VDC device, or to the zero reference output of an incremental encoder. When the signal fed to this input goes high (state 1), the counting bits are reset to zero.

Inhibit Input INH: 24 VDC

This input can be connected to a 24 VDC device. When the signal fed to this input goes high (state 1), the counting is inhibited and stopped.

Fault light F

This fault light comes on when the counting capacity of the TSX AXT 2 00 module has been exceeded (overflow). In normal operation the light is unlit.

The fault can be cleared by setting the reset input RST to 1. The fault is also cleared automatically when the PLC is powered up.

Note:
The 5 or 24 VDC power for the input devices must be supplied by the user. It is not supplied by the TSX AXT 2 00 module.

2.2 Principle of Counting

The TSX AXT 2 00 module has two independent input channels Ch0 and Ch1. Each of these channels has two counting inputs In0 and In1. Each channel can perform, independently of the other, the upcounting and downcounting functions.

2.2-1 Counting Bits

The module processes the count pulses. The PLC CPU can access the count values, which are coded on five bits, called counting bits, as follows:

. Channel 0 (Ch0)	**Ixy,0**	**Ixy,1**	**Ixy,2**	**Ixy,3**	**Ixy,4**
. Channel 1 (Ch1)	**Ixy,8**	**Ixy,9**	**Ixy,A**	**Ixy,B**	**Ixy,C**

Example of upcounting only

Only counting input In0 is used and the discriminator must be set to OFF.

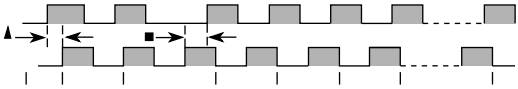
Counting input	**In0**	**In0**									
Count value			0	1	2	3	4	28	29	30	31
Channels	**Ch0**	**Ch1**									
Counting	**Ixy,4**	**Ixy,C**	0	0	0	0	0	1	1	1	1
bits	**Ixy,3**	**Ixy,B**	0	0	0	0	0	1	1	1	1
	Ixy,2	**Ixy,A**	0	0	0	0	1	1	1	1	1
	Ixy,1	**Ixy,9**	0	0	1	1	0	0	0	1	1
	Ixy,0	**Ixy,8**	0	1	0	1	0	0	1	0	1

In this case, the sign bit of each channel (Ixy,5 or Ixy,D) is always at 0.

The maximum and minimum values that can be coded on the five counting bits are 0 and +31 respectively.

Example of Up/Downcounting

Both counting inputs In0 and In1 are used and the discriminator must be set to ON.

Counting inputs	**In0**	**In0**							
	In1	**In1**							
Count value			0	1	2	1	0	-1	-2	-32
Channels	**Ch0**	**Ch1**								
Sign bit	**Ixy,5**	**Ixy,D**	0	0	0	0	0	1	1	1
Counting bits	**Ixy,4**	**Ixy,C**	0	0	0	0	0	1	1	0
	Ixy,3	**Ixy,B**	0	0	0	0	0	1	1	0
	Ixy,2	**Ixy,A**	0	0	0	0	0	1	1	0
	Ixy,1	**Ixy,9**	0	0	1	0	0	1	1	0
	Ixy,0	**Ixy,8**	0	1	0	1	0	1	0	0

The maximum values that can be coded on the five counting bits are + 31 and - 32.

▲ phase shift of + 90° or π/2 ■ phase shift of - 90° or π/2

2.2-2 Dialogue with the PLC

The counting and sign bits of the TSX AXT 2 00 module acquired by the PLC CPU are updated implicitly at the start of the task as follows:

. Master task

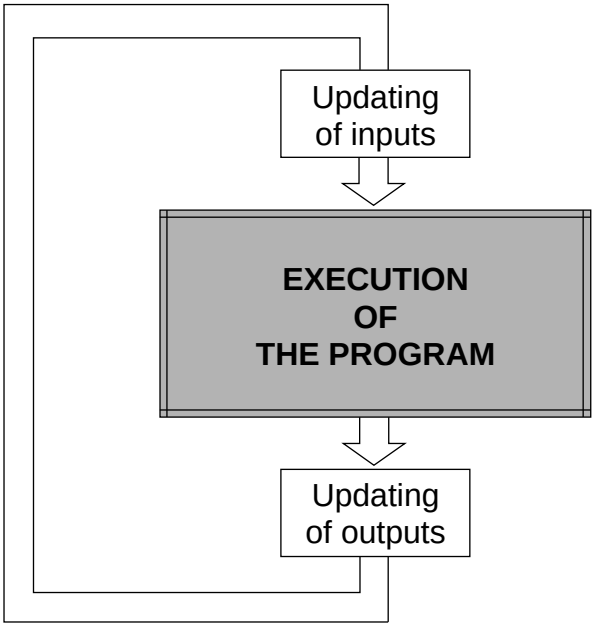
If the module is programmed in the Master task, the counting bits are updated at the same time as the other inputs, as shown opposite.

. Fast task

If the module is programmed in the Fast task (*), the counting bits are updated at the start of the Fast task.

(*) For the TSX 47-10/20, only one TSX AXT 2 00 module can be declared in the Fast task.

The updating of the counting bits by the CPU automatically reinitializes the TSX AXT 2 00 module by setting the counting and sign bits to 0.



However, during updating of the counting bits by the CPU, the incoming pulses on the counting inputs In0 and In1 continue to be counted by the module, and are updated by the CPU at the start of the next scan cycle.

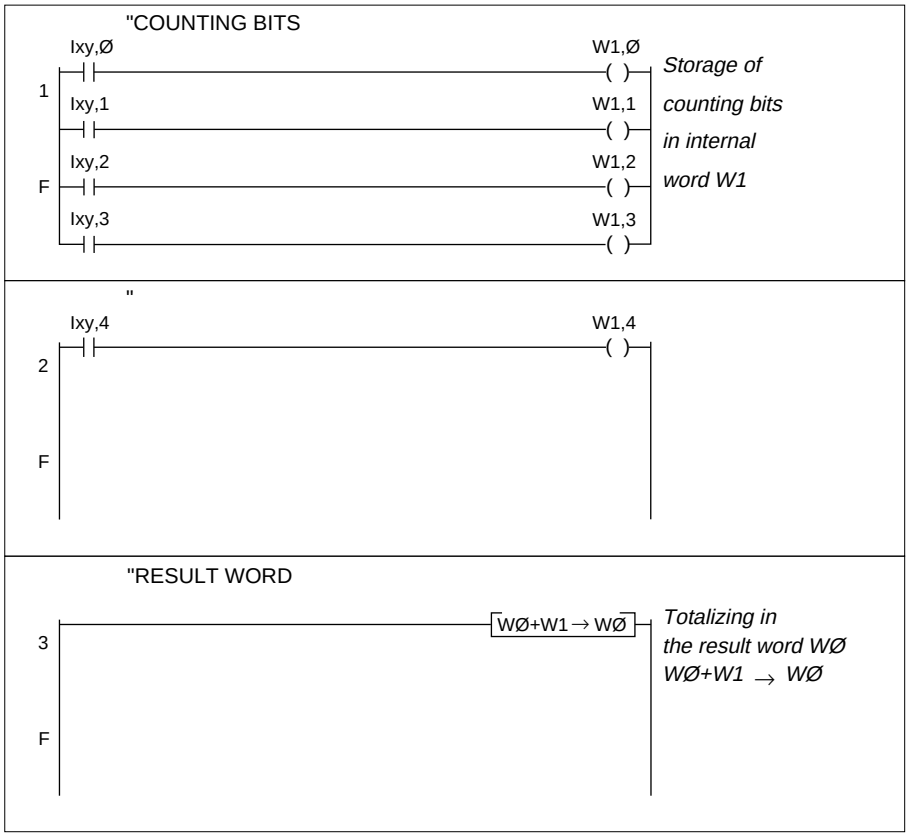
Behaviour after a Power Restart

After an immediate, cold or hot power restart, the CPU automatically runs all or part of the configuration self-tests (depending on the type of restart). Throughout this time, the counting and sign bits are kept at state 0 irrespective of the states of the inputs In0 and In1 on the TSX AXT 2 00 module.

During the first scan cycle of the task in which the module is configured, the counting value is zero: the counting and sign bits are in state 0.

2.2-3 Effect on User Program

On each scan of the task in which the module is configured, the user program must therefore store the counting bits transmitted when the inputs were updated and compute their sum.



Important:

The "RESULT WORD" contact network must be independent and downstream of the "COUNTING BITS" contact network.

2.3 Maximum Counting Rate

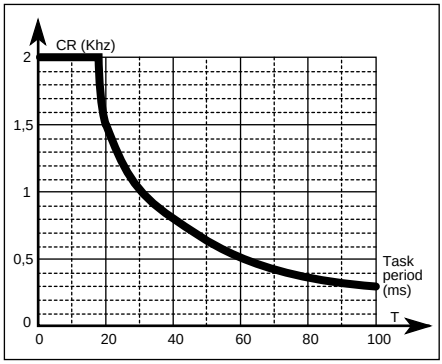
2.3-1 Maximum Frequency of Pulse Reception

To define the maximum pulse counting rate, the frequency at which the TSX AXT 2 00 module is updated by the PLC CPU must be known.

. If this period is ≤ 15 ms, the maximum rate is 2 Khz,
. If this period is > 15 ms, the maximum rate is defined by the curve below.

To avoid exceeding the counting capacity of the module, the PLC must update the states of the counting bits before the module has received more than 31 input pulses (see Sub-section 2.4-3).

The maximum counting frequency thus depends directly on the period of the task in which the module is programmed.



The curve above is therefore defined by the formula:

$$CR\ max. = \frac{31}{T} \quad for\ T > 15\ ms$$

T : The period between input updates (in ms), which is the same as:

. the period of a Fast or periodical task,

. the user program scan time of the Master task of TSX 47-J/10/20 PLCs.

CR : The counting rate of the CPU (in Khz).

Example:

For a period (T) of 60 ms, the maximum counting rate of the module is:

$$CR\ max. = \frac{31}{60} = 0.52\ Khz\ or\ 520\ Hz$$

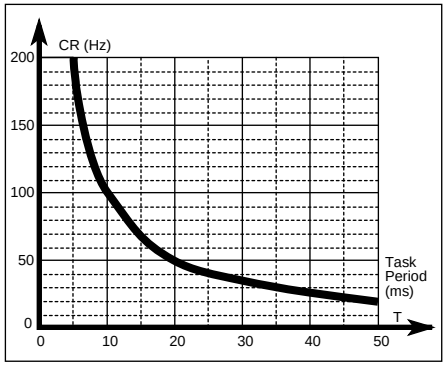
2.3-2 Effect of Counting Accuracy on the Maximum Counting Rate

Counting Accuracy To Within 1 Pulse

If the application requires counting accuracy to within 1 pulse (e.g. comparison of a set point value with the count value to within 1 pulse), the counting rate of the module must not exceed the values given in the curve below:

To obtain counting accuracy to within 1 pulse, each channel of the TSX AXT 200 module must not receive more than 1 pulse in the period between two input updates by the CPU.

The counting rate required to obtain maximum accuracy therefore depends directly on the period of the task in which the module is programmed.



The curve above is therefore defined by the formula:

$$CR\ max. = 1000\ \frac{1}{T}$$

T = The period between input updatings (in ms), which is the same as:
- the period of a Fast or periodical task,
- the user program scan time of the Master task of TSX 47-J/10/20 PLCs.

CR = The counting rate of the module (in Hz) for a counting accuracy to within 1 pulse.

Counting Accuracy To Within n Pulses

For applications that require less accuracy (e.g. comparison of a set point value with a count value to within n pulses), the formula below is used:

$$CR\ max. = 1000\ \frac{N + 1}{T}$$

n = The required degree of accuracy expressed in number of pulses.

Example:

For a counting accuracy to within 3 pulses in a module programmed in a Fast task with a period of 10 ms, the maximum counting rate is:

$$CR\ max. = 1000\ \frac{3 + 1}{10} = 400\ Hz,\ or\ 400\ pulses\ per\ second.$$

2.4 Additional Functions

2.4.1 Inhibit Input INH

When this input is set to 1, the counting bits are frozen until the next reading of the module. As long as the inhibit input INH remains at 1, the pulses received on the counting inputs In0 and In1 are not counted.
The state of the inhibit input INH can be read by the user program by testing the following bits:

Ixy,6 for Ch0,
Ixy,E for Ch1.

2.4-2 Reset Input RST

When this input is set to 1, the count value is immediately reset to zero. The counting, sign and overflow bits are also set to 0. As long as the reset input RST remains at 1, the pulses received on the counting inputs In0 and In1 are not counted.

The state of the reset input RST can be read by the user program by testing the following bits:

Ixy,7 for Ch0,
Ixy,F for Ch1.

The reset input RST has priority over the inhibit input INH. If the inhibit input INH is already at 1, the counting, sign and overflow bits are immediately reset to zero when the reset input RST goes to 1.

Note:
The counting and sign bits can also be simply reset to zero when the module is implicitly updated at the start of the task if these bits are not stored by the program during the same cycle.

2.4-3 Overflow Capacity Ixy,S

The maximum counting values of the module are + 31 and - 32. As the counter is reset to zero when the module's counting bits are updated (reinitialization), the counting capacity is exceeded if:

- The module receives more than 31 input pulses between readings of the counting bits by the CPU,
- The module receives more than 31 input pulses when the counting bits are not read by the CPU (for instance, when the PLC is stopped, or when the task in which the counting module is configured is not being executed).

Overflow bit Ixy,S:
- Is set to 1 when the counting capacity of one of the two channels (Ch0 or Ch1) is exceeded.
- Is reset to 0 after the cause of the overflow disappears, after the input RST is reset to 1, or on a power restart.

Fault light (F):
- Comes on when the counting capacity of the corresponding channel has been exceeded.

Note:
After an overflow, and before the fault has been acknowledged, the counting bits may have an incorrect value. If the application needs to use the overflow information, the overflow bit Ixy,S must be tested before the counting value is processed (*).

Counting input	**In0**	**In0**									
Counting value			29	30	31	31	31	0	0	1	2	3
Channels	**Ch0**	**Ch1**										
Counting bits	**Ixy,4**	**Ixy,C**	1	1	1	1	1	0	0	0	0	0
	Ixy,3	**Ixy,B**	1	1	1	1	1	0	0	0	0	0
	Ixy,2	**Ixy,A**	1	1	1	1	1	0	0	0	0	0
	Ixy,1	**Ixy,9**	1	0	1	1	1	0	0	0	1	1
	Ixy,0	**Ixy,8**	1	0	0	1	1	0	0	1	0	1
RST	**Ixy,7**	**Ixy,F**										
Overflow	**Ixy,S**											
Fault light	**(F)**	**(F)**										

(*) This bit should also be tested in the user program in order to avoid any transient functions when handling the module in the powered-up condition.

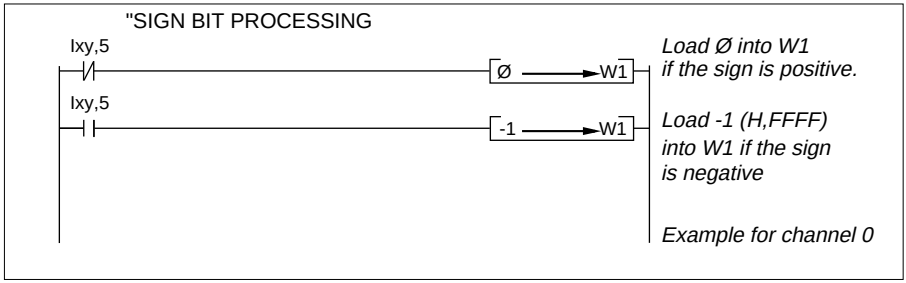
2.4-4 Processing the Sign Bit

To allow the PLC to interpret the TSX AXT 2 00 module's six counting bits in a 16-bit format, they must be converted by programming according to the value of the sign bit.

Sign bit at state 0 Before storing the counting bits, the internal word concerned (W1) must be initialized to 0.

Sign bit at state 1 Before storing the counting bits, the internal word concerned (W1) must be initialized to the decimal value of -1 (FFFF in hexadecimal).

These initializations are performed by inserting the two program lines below, immediately before the storage and summing of the counting bits.



Example: A counting value of **-7** is coded on the counting bits of Channel 0 as follows:

	5	4	3	2	1	0
Ixy,	1	1	1	0	0	1

The contact network above, inserted upstream of the counting bit read network, will convert the value of **- 7** from its 6-bit format into a 16-bit format.

	F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
W1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1

Note:
The 6 counting bits of the TSC AXT 2 00 and the 16 bits of the PLC are coded in signed binary notation. For further information, see Sub-section 6.1.

2.5 Programming the TSX AXT 2 00 Module

2.5.1 Principle of Programming

The programming of the TSX AXT 2 00 module depends on the application, but would normally include the following operations:

- Configuring the TSX AXT 2 00 module, usually in the Fast task,
- Configuring an output module in the Fast task (if appropriate),
- Programming activation of the Fast task in the Master task,
- Programming the Fast task as follows and in the following order:
  - ① Processing of the sign bit when up/downcounting is required,
  - ② Reading the counting bits,
  - ③ Summing the count value, allowing for any reset,
  - ④ Processing the result and inherent safety systems of the driven outputs.

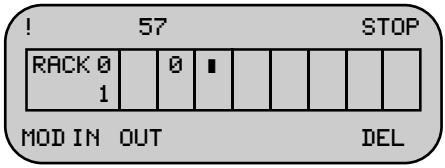
An example of the programming of TSX AXT 2 00 module in the Fast task of a TSX 47-20 PLC application on a TSX T407 terminal is given below.

2.5.2 Configuring in the Fast Task

Configuring the Module in the Fast Task

. Enter the code number of the TSX AXT 2 00 module (code 57) in the slot concerned.

. Assign the module to the Fast task by pressing the soft key IN.



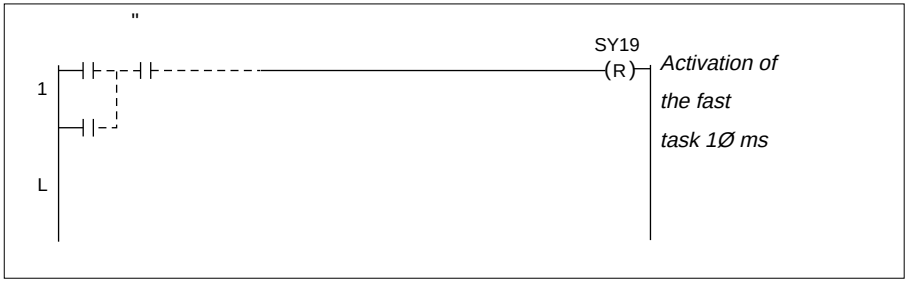
Configuring an Output Module in the Fast Task

. Enter the code number of the output module in the slot concerned.

. Assign the output module to the Fast task by pressing the soft key OUT.

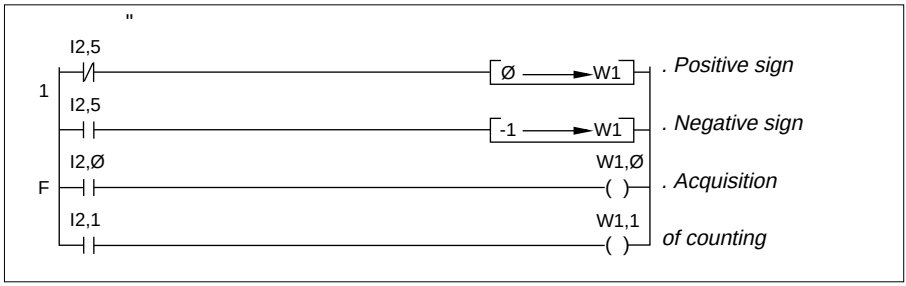
2.5-3 PL7-2 Program in Master Task

Activation of the Fast Task



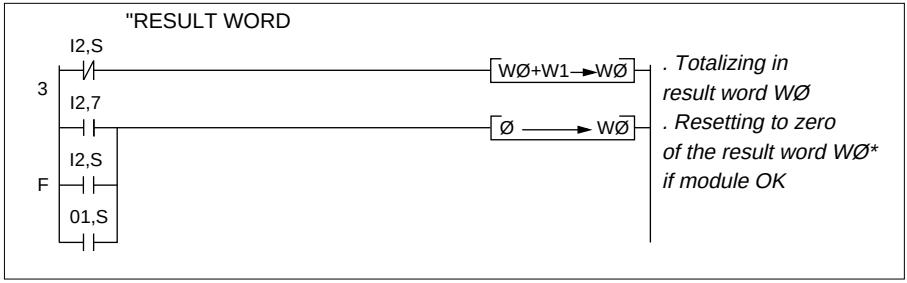
2.5-4 PL7-2 Program in Fast Task

Processing of the Sign Bit

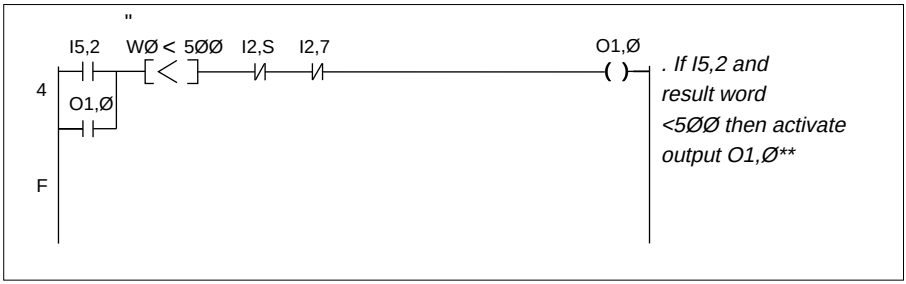


Reading of the Counting Bits

Summing the Counting Value



Processing the Result



* : Resetting the result word to zero is conditioned by setting to zero either the reset input RST (I2,7), the TSX AXT 2 00 module fault bit (I2,S), or the output module fault bit (O1,S).

** : Maintaining action O1,0 is conditioned by the absence of both reset input RST (I2,7) and fault bit (I2,S).

2.5-5 Equivalent PL7-3 Program

Ladder language

Although the previous examples were for TSX 47-10/20 PLCs, they also apply in PL7-3 (the PL7-3 networks have 7 lines instead of the 4 in PL7-2 contact networks).

Literal Language

The previous example is partly shown below in literal language.

. Master Task

```
<ACT_IVAT_ION_OF_FAST_TASK
!L1      START_CTRL2
```

. Fast task

```
<SIGN_BIT_PROCESSING
!L1      IF_NOT_I2,,5
                THEN_Ø → W1
                ELSE_-1 → W1
<ACQUISITION_OF_COUNTING_BITS_AND_TOTALIZING
!L2      I2,,0 → W1,,0 ; I2,,1 → W1,,1 ; I2,,2 → W1,,2 ;
         I2,,3 → W1,,3 ; I2,,4 → W1,,4 ; W0,+W1 → W0
```

2.6 Examples of Using PL7-2

2.6-1 Example 1: upcounting

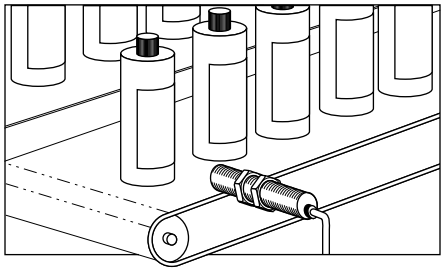
Application

Counting of parts on a conveyor belt.

A proximity detector connected to the counting input In0 is used to detect the presence of each part.

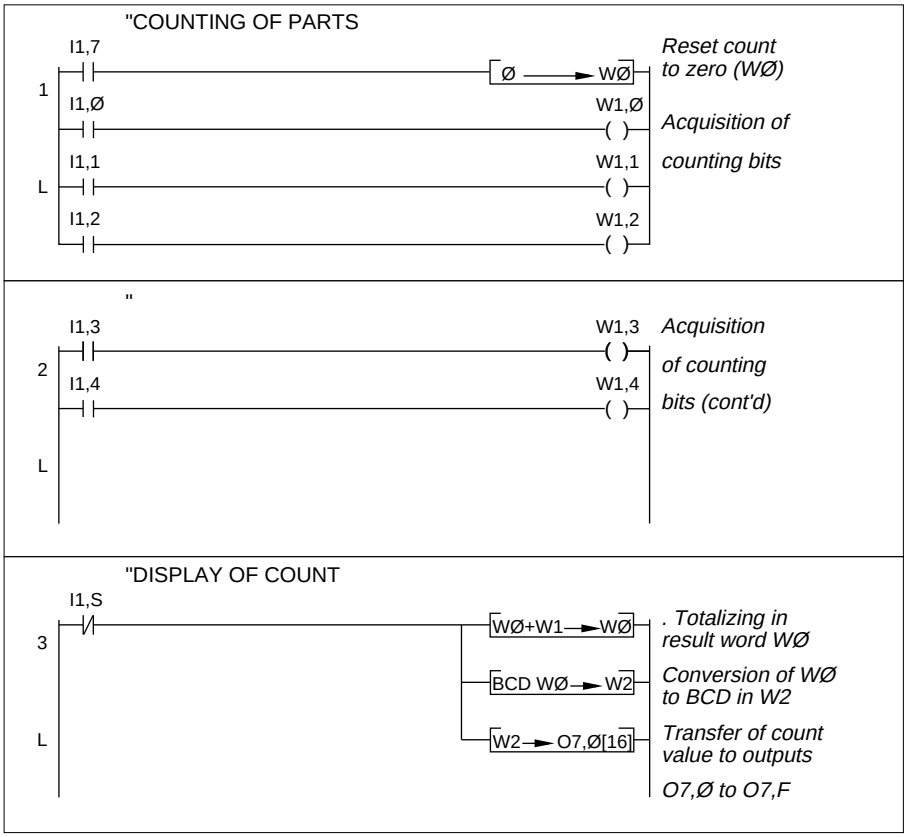
A pushbutton connected to the reset input RST (bit I1,7) is used to reset the count to zero when the counting starts.

The TSC AXT 2 00 module is installed in slot 1 of rack 0.



The count result is displayed in BCD by means of a 16-point output module installed in slot 7 of rack 0. In this example, only one input channel (Ch0) is used and its discriminator is set to OFF, since the application requires upcounting only.

Programming in the TSX 47-10/20 Master Task



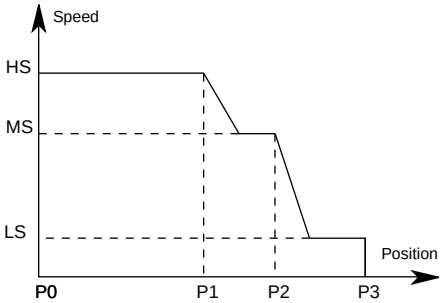
2.6.2 Example 2: positioning

Application

Positioning of a conveyor along an axis at three different speeds.

The diagram opposite shows the three required speeds (high, medium and low) of the conveyor according to its position.

The two speed reductions, from high to medium and from medium to low, must be made as the conveyor approaches the discharge point at which it must stop.



The PLC must deliver the speed control commands HS (high speed), MS (medium speed) and LS (low speed) to the conveyor motor according to the conveyor position and in relation to the set points P1, P2 and P3. These set points represent respectively the distance (in number of pulses) to the first and second speed reduction points and to the stopping point.

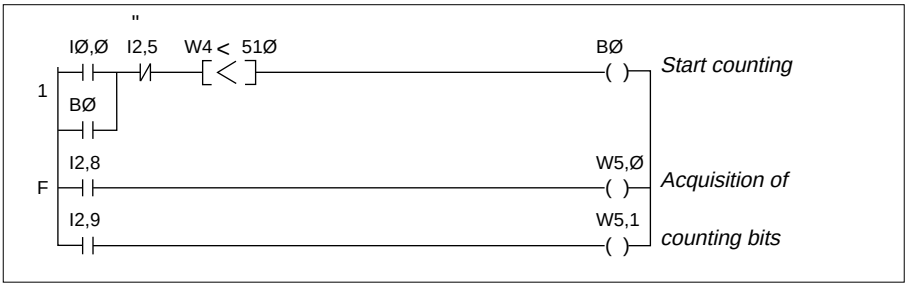
An optical encoder is coupled to the conveyor motor shaft and connected to input In0 of Channel 1 (Ch1).

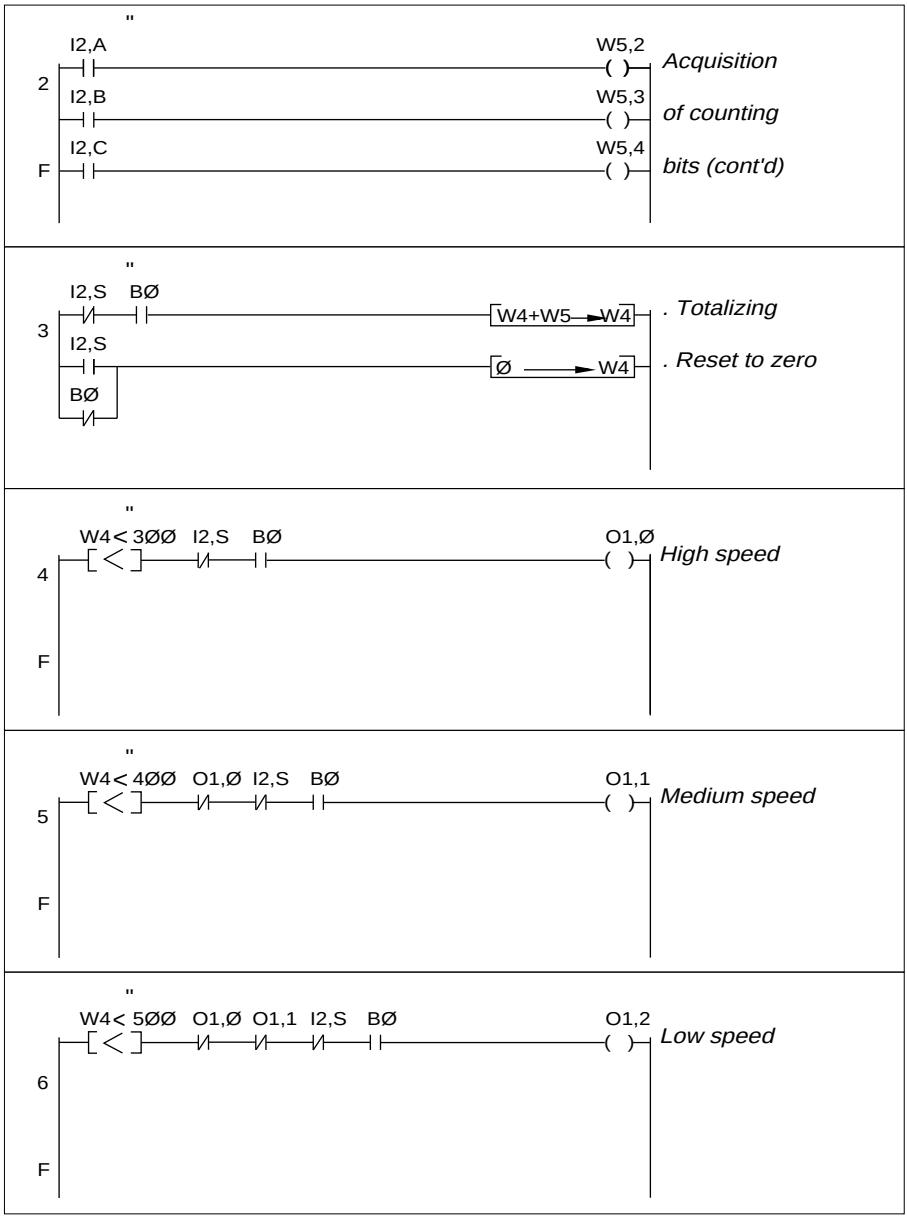
The TSX AXT 2 00 module is installed in slot 2 of rack 0. The discriminator is set to OFF.

The pulse rate at low speed necessary to stop the conveyor within an accuracy of one pulse depends on the period of the task in which the counting is performed (see Sub-section 2.3-2).

Example:
If the module is programmed in a Fast task with a period of 10 ms, the maximum pulse rate at low speed must be less than 100 Hz.

Programming in the TSX 47-10/20 Fast Task.





Note:
The Fast task must be activated in the Master task by setting SY19 to 0.

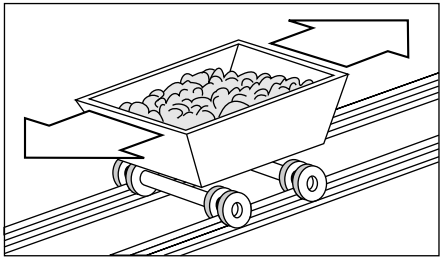
2.6-3 Example 3: position measurement (> 32767)

Application

Continuous monitoring of the position of a truck that moves forwards and backwards on rails, in relation to a datum point O.

An incremental encoder is coupled to the truck shaft and connected to Channel 1 (Ch1) inputs In0 and In1.

The TSX AXT 2 00 module is installed in slot 2 of rack 0 and the discriminator of Channel 1 is set to ON.



In conjunction with the PLC, the TSX AXT 2 00 module measures the truck position by upcounting or downcounting the pulses from the incremental encoder (e.g. one pulse may correspond to one cm).

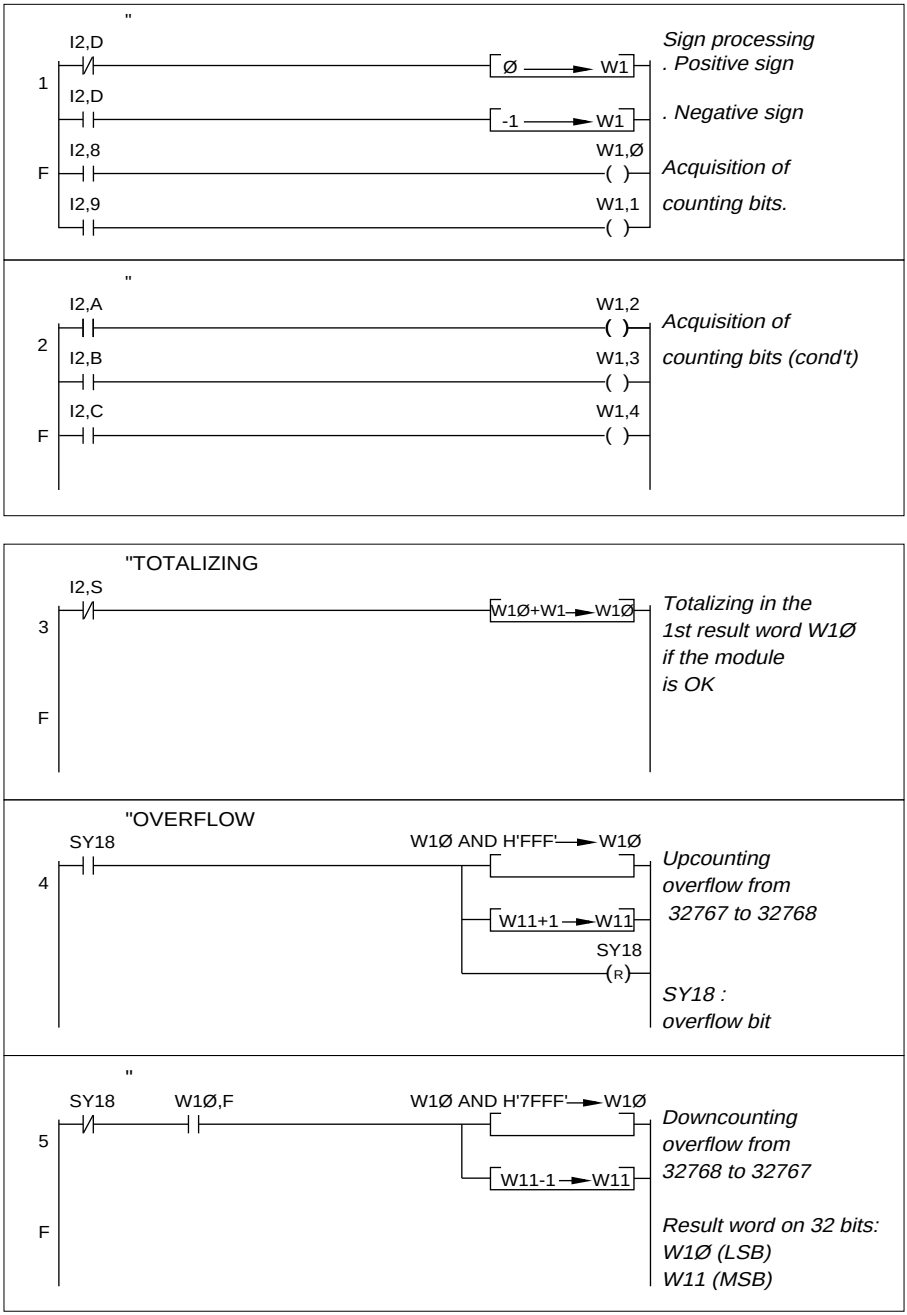
Since the truck movement can exceed 32767 (i.e. the capacity of a 16-bit word), the count must be summed on two result words (W10 and W11), which gives a counting capacity of 2 147 483 647.

Programming in the TSX 47-10/20 Fast Task

The counting program consists of 5 contact networks:

. Networks 1 and 2 processing sign bit and reading count bits,
. Network 3 summing count in first result word W10,
. Networks 4 and 5 processing overflow of first result word W10 (upcounting overflow from 32767 to 32768, or downcounting overflow from 32768 to 32767).

Note:
The Fast task must be activated in the Master task by setting SY19 to zero.


"
I2,D
Ø → W1
1
I2,D
-1 → W1
I2,8
W1,Ø
F
( )
I2,9
W1,1
( )
Sign processing
. Positive sign
. Negative sign
Acquisition of
counting bits.
"
I2,A
W1,2
( )
2
I2,B
W1,3
( )
I2,C
W1,4
F
( )
Acquisition of
counting bits (cond't)
"TOTALIZING
I2,S
W1Ø+W1 → W1Ø
3
F
Totalizing in the
1st result word W1Ø
if the module
is OK
"OVERFLOW
SY18
W1Ø AND H'FFFF' → W1Ø
4
Upcounting
overflow from
32767 to 32768
W11+1 → W11
SY18
(R)
SY18 :
overflow bit
"
SY18
W1Ø,F
W1Ø AND H'7FFF' → W1Ø
5
Downcounting
overflow from
32768 to 32767
W11-1 → W11
F
Result word on 32 bits:
W1Ø (LSB)
W11 (MSB)

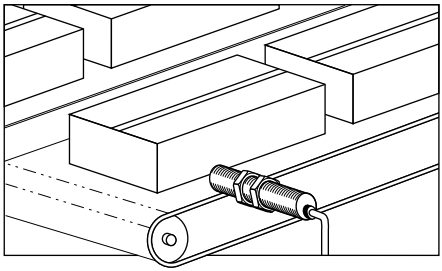
2.6-4 Example 4: length measurement

Application

Measurement of the length of parts on a conveyor belt.

An incremental encoder Cd is coupled to the conveyor shaft and is connected to input In0.

A proximity detector Dp (function 0), which goes low (state 0) whenever it detects a part, is connected to the inhibit input INH.

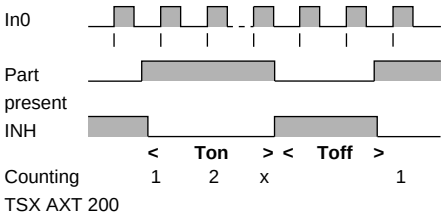


The length of each part must be between a minimum value (constant word CW2) and a maximum value (constant word CW3); otherwise the conveyor stops so that the out-of-tolerance part can be removed.

The TSX AXT 2 00 module is installed in slot 2 of rack 0. The discriminator is not involved in this type of operation as only Ch0 is used. A pushbutton connected to the input I0,7 is used to start the conveyor..

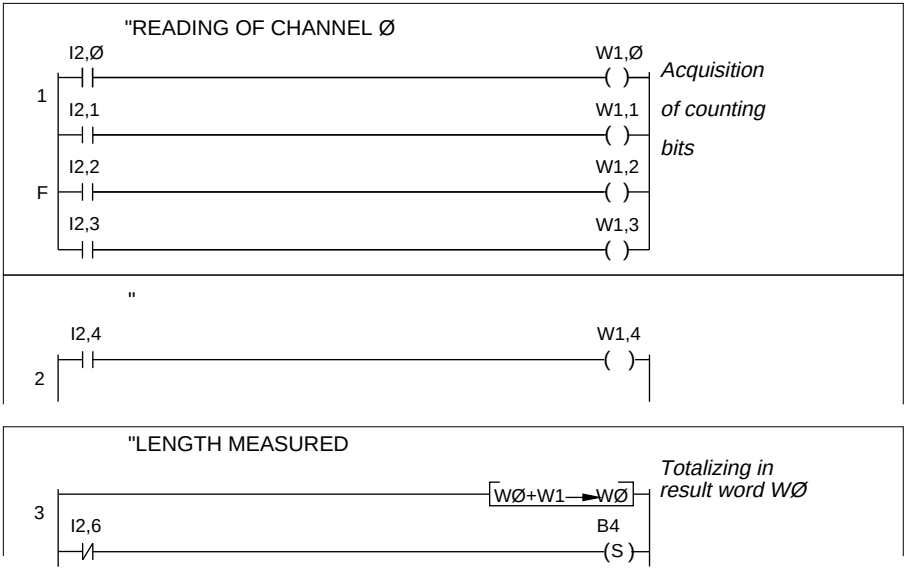
The counting and summing principle is the same as for the upcounting example given in Sub-section 4.2

The detector Dp is connected to input INH (bit I2,6). When it senses no part in front of it, the detector is at state 1 and counting is inhibited.
Conversely, as long as a part is detected, the counting is enabled and the length of the part is measured, e.g. 1 pulse = n tenths of an inch).

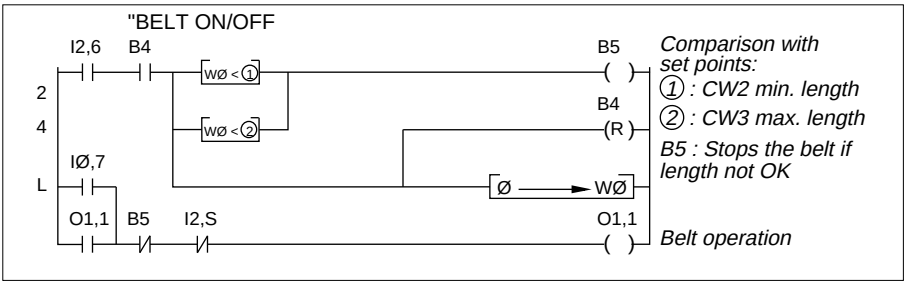


Note:
During the time **Toff** (interval between the detection of 2 consecutive parts), the CPU must compare the number of pulses counted during the time **Ton** with the minimum and maximum values contained in constant words CW2 and CW3.
If this comparaison is performed in the Master task, it is essential that:
Toff > T where Toff is the time between the detection of 2 consecutive parts
and T is the scan time (TSX 47 PLC) or the period (TSX 67/87 PLC) of the Master task.

Programming in the TSX 47-10/47-20 Fast Task



Programming in the Master Task (not shown: activation of the Fast Task, Reset SY 19)



3.1 Locating the Module

3.1-1 Possible Locations

The TSX AXT 2 00 module interfaces with the simplified discrete I/O bus (16-bit module on a simplified bus). It can therefore be located in any slot designed to receive I/O modules in TSX 47/67/87 PLCs.

Basic configuration	TSX 47-J	Slots 0-5
Basic configuration	TSX 47-10 TSX 47-20	Slots 0-7
Basic configuration (Single rack)	TSX 47-30 TSX 67-20	Slots 0-7
Basic configuration (Double rack)	TSX 87-30	Slots 0-7 and 10-17
Local extension configuration (Single rack)	TSX RCE 860	All slots
Remote extension configuration (Single rack)	TSX RCF 860	All slots

Note:
When the counting rate requires configuring the module in the Fast task, users are recommended to install the TSX AXT 2 00 and its associated output module in the basic rack of the PLC to optimize the read time of the counting bits.

3.1-2 Maximum Configuration

The TSX 47/67/87 PLCs can receive several TSX AXT 2 00 modules.

. **For TSX 47-10/20 PLCs:** The maximum number of TSX AXT 2 00 modules that can be installed depends on the number of TSX MPT/AEM/SCM modules configured.

Maximum Configuration	TSX AXT 200	TSX MPT 10	TSX AEM or TSX SCM
TSX 47-10/20:	3	0	0
or:	2	1	0
TSX 47-20:	1	1	1

In all cases only 1 TSX AXT 2 00 can be configured in the Fast task.

. **For TSX 67/87 PLCs:** First determine the power consumption for the 5V supply. Several TSX AXT 2 00 modules can be configured in the Fast task.

3.1.3 Locating Devices

	TSX 47-10/20	TSX 47-30/67/87
Hardware locating code Two-digit decimal code defined by two female locating devices on the rear of the module	57	57
Software locating code Entered when configuring the I/O on the programming terminal	57	57

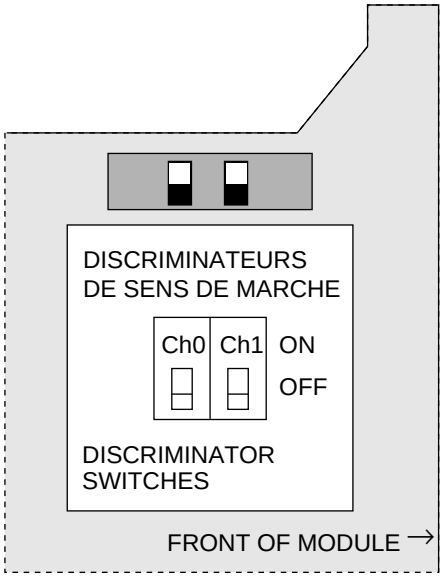
3.2 Preparing the Module

Preparing the TSX AXT 2 00 module consists of activating or deactivating the two channel discriminators (one for each channel).

The discriminators are activated or deactivated by two switches (one for each channel) located inside the case and accessible through an opening at the top left side of the module.

The discriminator is:

- activated when the switch is set to ON, i.e. pushed upwards.
- deactivated when the switch is set to OFF, i.e. pushed downwards.

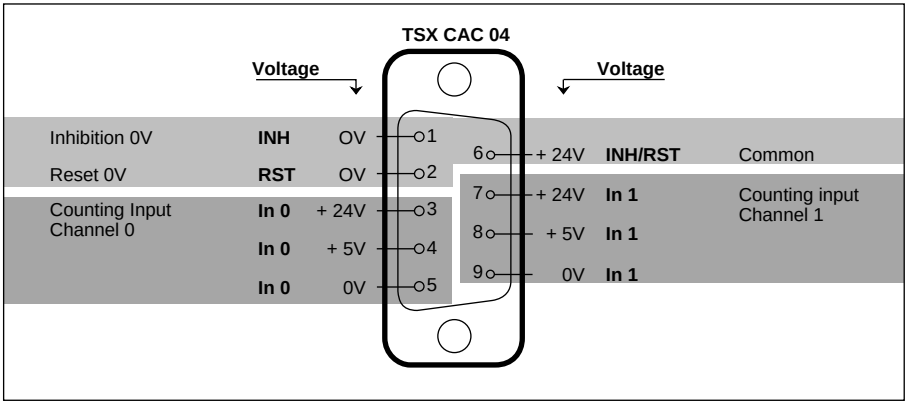


Note:
The module is delivered ex-factory with both its discriminator switches set to OFF.

3.3 Connecting the Module

3.3.1 Connector Pin-Out

The TSX AXT 2 00 module has two 9-pin sub-miniature type D connectors, which accept TSX CAC 04 male connectors of the same type.



3.3-2 Types of Sensors

Inputs INH and RST (pins 1, 2 and 6): The sensors connected to these inputs must be of the discrete 24 VDC type, such as limit switches and proximity detectors.

Inputs In0 and In1 (pins 3, 4, 5, 7, 8 and 9): The sensors connected to these inputs must be of the discrete 24 VDC type (as above), or a 5/24 VDC incremental encoder.

In all cases the sensors must be compatible with the characteristics of the inputs (see Sub-section 5.2).

The table below shows connection possibilities for 24 VDC sensors according to their technology, i.e. 2- or 3-wire, NPN or PNP (see the examples in the following pages).

Connection Possibilities

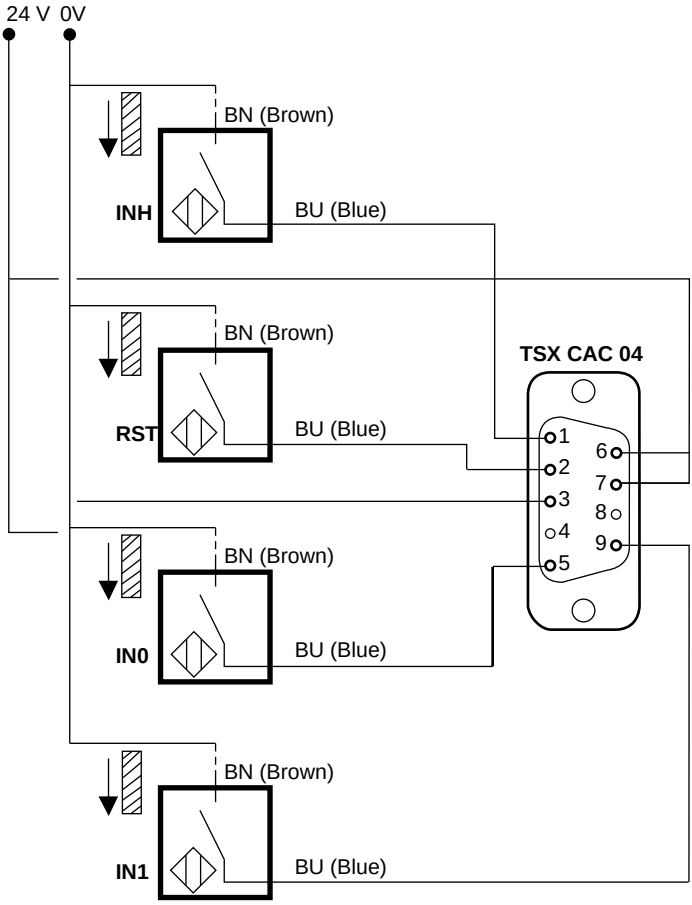
Type	**2-wire**			**3-wire**		
Output	**Non-polarized**	**Polarized**		**NPN**	**PNP**	
INH	X	X		X	X	
RST	X		X	X		X
In0	X	X	X	X	X	X
In1	X	X	X	X	X	X
Example	1		2	3	4	

Note:
The inputs In0 and In1 are independent of each other and of the INH and RST inputs. The In0 and In1 inputs can therefore receive any of the sensors shown in the table above.

The sensors connected to the RST and INH inputs (common to the +24 V) must be of the same type on the same channel. The only exception possible is a mix of 2-wire non-polarized types with 3-wire NPN types (see table above).

3.3.3 Example 1: Connection of 2-wire Non-polarized Sensors

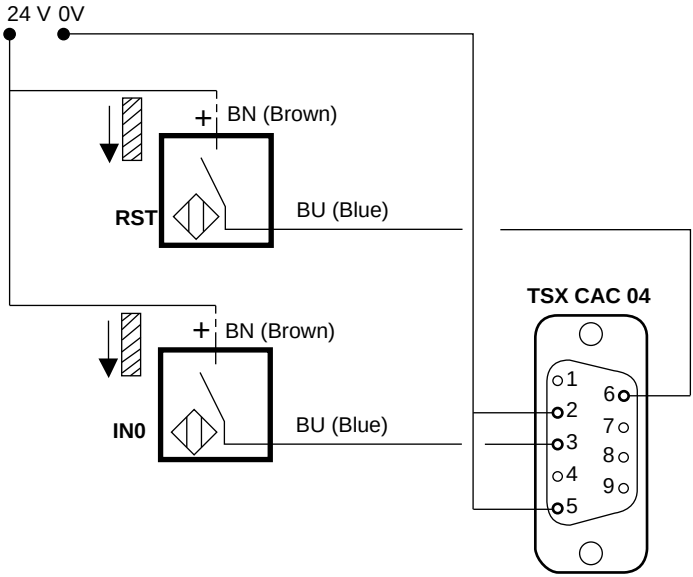
Up/downcounting: using inputs ***INH, RST, In0 and In1,***



With this type of sensor all 4 inputs can be connected. The sensors are commoned to the 0 V.

3.3-4 Example 2: Connection of 2-wire Polarized Sensors

Upcounting only: using inputs RST and In0



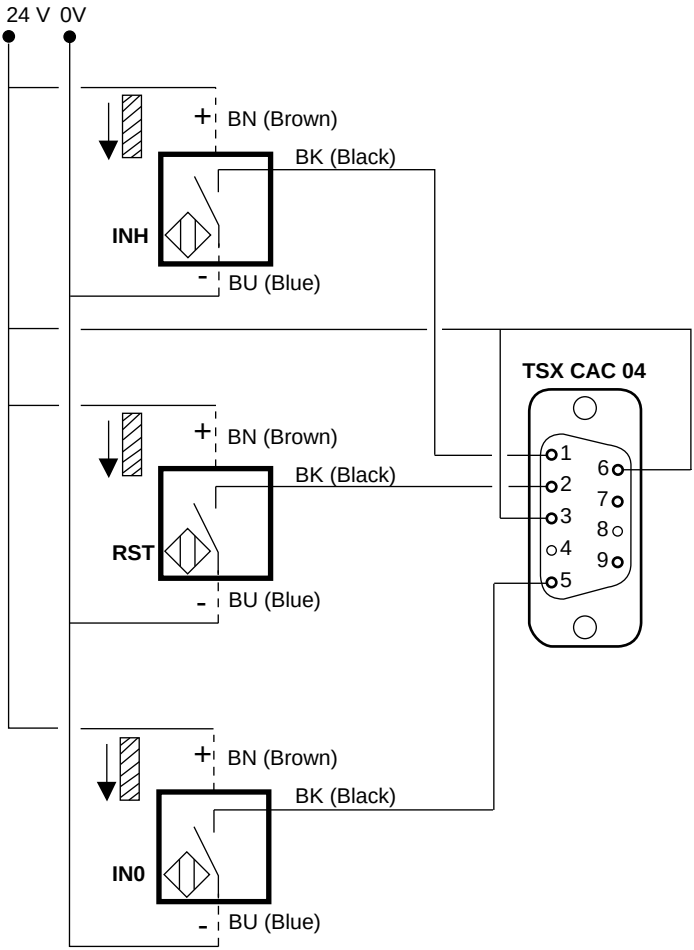
With this type of sensor only one of the 2 inputs RST or INH can be used (for INH use pin 1 instead of pin 2).

For up/downcounting the input In1 must be connected as follows:

. sensor + to the 24 V supply,
. sensor - to pin 7,
. 0 V supply to pin 9.

3.3.5 Example 3: Connection of 3-wire NPN Sensors

Upcounting only: using inputs ***INH, RST*** and ***In0.***



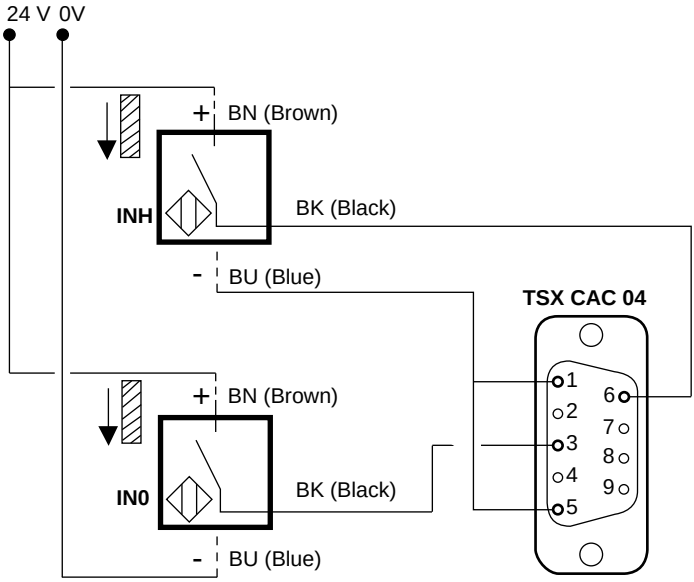
With this type of sensor all 4 inputs can be connected.

For up/downcounting, input In1 must be connected as follows:

. sensor + to the 24 V supply,
. sensor - to the 0 V supply,
. sensor output to pin 9
. 24 V supply to pin 7.

3.3-6 Example 4: Connection of 3-wire PNP Sensors

Upcounting only: using inputs ***INH*** and ***In0,***



With this type of sensor only one of the 2 inputs RST or INH can be used (for INH use pin 2 instead of pin 1).

For up/downcounting the input In1 must be connected as follows:
. sensor + to the 24 V supply,
. sensor - to the 0 V supply,
. sensor output to pin 7
. 0 V supply to pin 9.

3.3.7 Example 5: Connection of Incremental Encoders

The main purpose of inputs In0 and In1 is for the connection of an incremental encoder.

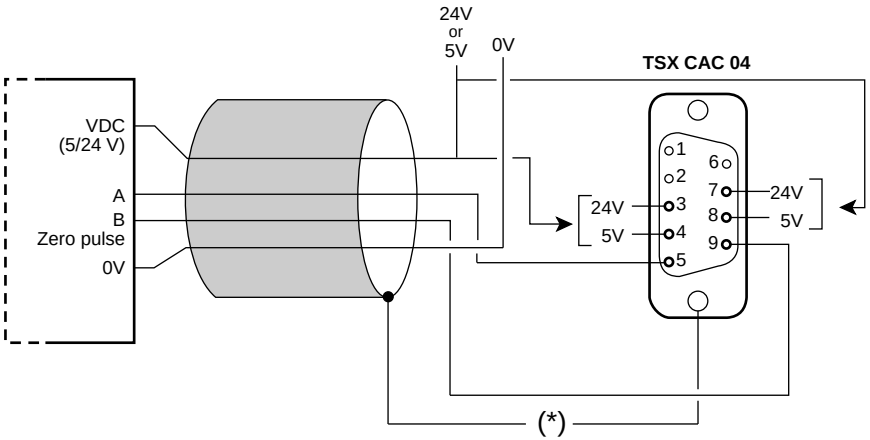
The encoders used must have NPN open collector or totem-pole outputs.

The Telemecanique range of rotary encoders includes TSX AXT 2 00 compatible incremental encoders XCC-H.. with the following types of output:

. NPN or PNP open collector,

. totem-pole.

Note:
Encoders with open collector outputs are generally suitable for distances of up to 30 meters (about 100 feet). Encoders with totem-pole outputs should be used for distances of up to 100 meters (about 100 yards).



Note:
The connection of inputs INH and RST is the same as in examples 1 to 4.

As indicated in the Installation Manuals for the TSX 47 and TSX 67/87 ("Grounding" Subsection), the 0 V of the sensor power supplies must be directly connected to the reference ground (**), i.e. the enclosure or chassis ground.

(*) This shielding is easily connected to the connector ground using the TSX CAC 04 connector kit with its plastic/metal cover.

(**) If the 0V of the sensor power supplies cannot be directly connected to the reference ground, an RC or GMOV circuit must be inserted.

3.3.8 General Wiring Principles

To protect the input signals from external noise induced in the series mode and from noise in the common mode, attention should be paid to the following points:

. connector for ground continuity,
. type of conductors,
. grounding of the cable shields,
. reference of the sensors' potential relative to ground,
. cable routing,
. connection of unused wires.

Mounting the Connectors

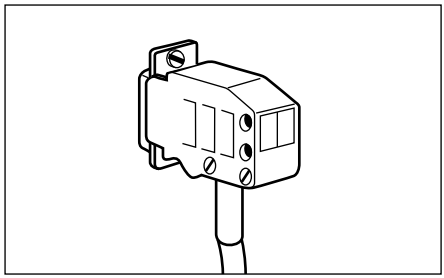
Each channel on the TSX AXT 2 00 module is connected through a sub-miniature type D male connector with 9 pins.

When plugged in, this connector must be secured by tightening the captive locking screws on the module's socket connector.

Each TSX CAC 04 connection kit consists of:

. 1 Sub-D connector with 9 soldering pins,

. 1 plastic/metal cover providing ground continuity.



Type of Conductors

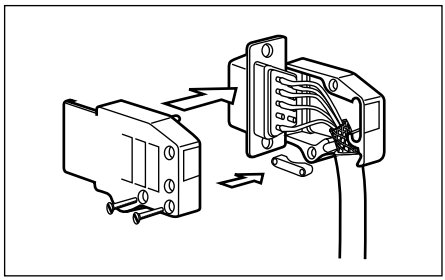
Use shielded twisted or shielded cable whose conductors have a minimum cross-section of 0.22 mm^2 (AWG 23).

Grounding the Cable Shields

The cable shields on each channel must only be connected to the PLC ground as follows:

. On each channel, twist the shields together so that they form a single strand.

. Clamp the shield under the cable clamp in the protective plastic/metal cover.



Note:
The TSX AXT 2 00 module ensures grounding continuity between the cable shielding and the PLC ground.

Referencing of Sensor Voltages

It is recommended to use "floating" sensors, i.e. whose voltages are not referenced to ground.

Cable Routing

Inside the enclosure, bundle the sensor wires connected to the TSX AXT 2 00 module separately and keep them well away from the wires of the discrete I/O modules (particularly relay output modules) and from power cables.

Outside the enclosure, avoid parallel routing over long distances, keep the sensor wires at least 20 cm (8 inches) away from other cables, and make sure that the cables cross at right angles.

Connection of Unused Wires

Never leave unused wires unconnected, but connect them to the cable shield (on PLC side) so that they will be connected to the PLC ground.

4.1 Checking Connections

4.1-1 Principle

Checking the connections consists in verifying that the signals delivered to the inputs of the TSX AXT 2 00 module are correctly transmitted to the processor of the PLC.

CAUTION:

Activated outputs can cause machine motion. Before checking the operation of the module, it is advisable to disable the power circuit:
. Remove the power fuses from the motor controls and cut off the power supply to all hydraulic and pneumatic components,
. Then power up the PLC.

A more exhaustive check of the input connections can be made by using an adjustment or programming terminal; however, in this case, the check can only be conducted after a user memory cartridge is installed in the PLC.

Note:
The cartridge must be initialized but need not contain a user program:
. cartridge for TSX 47 PLC,
. cartridge for TSX 67/87 PLCs: transfer of the default and I/O configurations into the cartridge.

. Activate each input and check that the corresponding indicator lights on the front of the module come on.
. For the RST and INH inputs, switch the PLC to RUN and check on the terminal screen that the corresponding bits change state (Ixy,6 and 7 or Ixy,E and F).

4.1-2 Example

Checking the inputs of a TSX AXT 2 00 module installed in slot 3 of a TSX 47 PLC:

. Set the TSX T407 terminal to the Adjust mode,
. Enter the address of one of the bits of the module (e.g. I3,6), the display opposite appears.

```
      I3,6     =1        RUN
     ADJUST:BITS
    FEDCBA9876543210    S
    .........*......    .
MOD     UNF  F:0 F:1
```

Note:
As the counting bits of Ch0 and Ch1 are continuously initialized, the display of these bits is not significant.

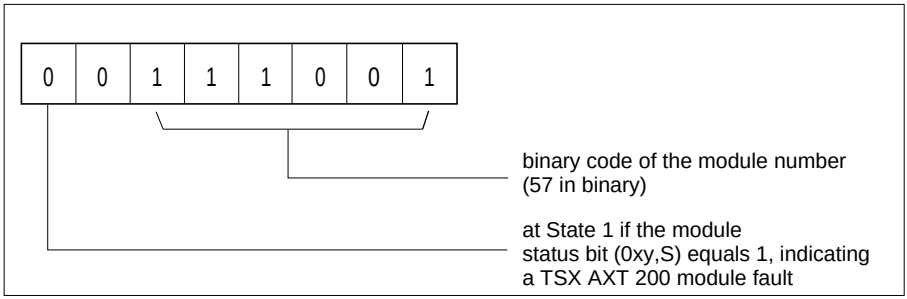
4.2 Troubleshooting

4.2-1 Reading a Status Word

The status word identifies the module and indicates its operating status.

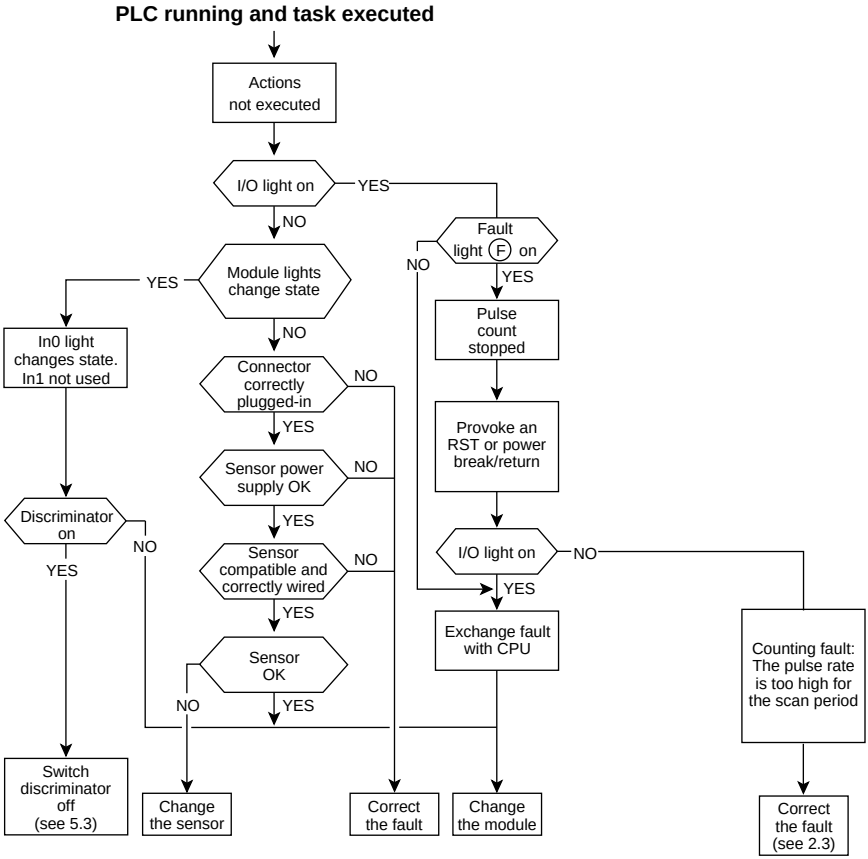
The status word is displayed by using the TSX T407 terminal in the Diagnostic mode. The status word cannot be read or modified by the program.

Status Word Structure



4.2-2 Troubleshooting Chart

The following troubleshooting chart assumes that the PLC and the other modules concerned in the counting and positioning function of the application (apart from the TSX AXT 2 00) are operating correctly.



Additional information concerning the Fault light (F) :

. This light comes on when the module is inserted in an energized PLC if the module is connected to the sensors and receiving counting pulses.

. If this light comes on when the module is configured in the Fast task of the TSX 47-J/47-10/20 PLCs, first check that this task is activated (system bit SY19 at 0).

5.1 Technical Characteristics

Nominal input values			
• Voltage		5 V (except RST and INH)	24 V
• Current		11 mA	17 mA
• Sensor power supply		4.7 to 7 V	19.2 to 30 V
Limit input values			
• at state 1,	voltage	3.75 to 7 V	11 to 30 V
	current	> 7 mA	> 7 mA
• at state 0,	voltage	-5 to 1.3 V	-25 to 3.2 V
	current	< 2 mA	< 2 mA
• Permissible inverse voltage		-5 V	-25 V
• Max. voltage during 1 mn		± 12 V	± 48 V
• Input impedance		415 to 490 Ω	1.3 to 1.5 KΩ
• Response times		from state 0 to 1 or state 1 to 0	
	In0 and In1	30 to 100 µs	30 to 100 µs
	INH and RST		50 to 250 µs
• Delay between In0 and In1		50 µs min.	50 µs min.
Dissipation per channel at state 1		0.055 W	0.4 W
Compatible with			
• proximity detectors		All Telemecanique types and CENELEC 2-wire polarized types or 3-wire NPN types (for other types see Sub-section 5.4)	
• incremental encoders		NPN open collector or totem pole types, minimum delay between the signals: 50 µs	
External lines			
• line resistance		< 30 Ω	< 300 Ω
• resistance to open circuit leak		> 30 KΩ	> 30 KΩ
Isolation			
• between channels		500 Vrms 50-60 Hz	
• between channels and bus		1500 Vrms 50-60 Hz	
• type		optical coupler	
Temperature			
• operating		0 to 60°C	
• storage		-45 to +85°C	
Consumption			
• on 5 VDC		380 mA max.	
• on 12 VDC		85 mA max.	

(*) If the module is removed with the PLC energized, fault bit Ixy,S must be tested by program to avoid incorrect counting operations which may be dangerous for the application.

5.2 Signed Binary Code

Introduction

Numbers are coded in signed binary. The TSX AXT 2 00 fast counting module counts the number of input pulses it receives and represents the value of the count in signed binary code on 6 bits (5 bits + sign).

Sign Bit

In signed binary code, **the most significant bit is always the sign bit.**

If this bit is at 0, the coded number is positive.
If this bit is at 1, the coded number is negative.

Interpretation of the 6 bits in Signed Binary Code

. *If the sign bit is at 0*, all the other bits are interpreted in straight binary.

Example: 31 in decimal is coded 0 1 1 1 1 1 in signed binary on 6 bits.

. *If the sign bit is at 1*, the value of the number in straight binary is obtained as follows:

1. By calculating the ones complement (C1), which is done by substituting 0 for 1 and 1 for 0 (except for the sign bit).
2. By calculating the true complement (Ct), which is done by adding 1 to the ones complement. The true complement then represents the value of the number in straight binary.

Example: 1 0 1 0 1 0 in signed binary on 6 bits.

Since the sign bit is at 1, the number is negative.

1. The ones complement : C1 = 1 0 1 0 1.
2. The true complement : Ct = C1 + 1 = 1 0 1 1 0 which is 22 in decimal.

The value of the number in decimal is therefore - 22.

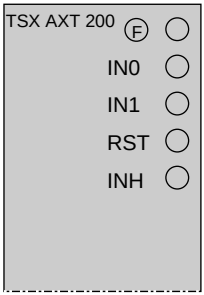
Signed Binary Code Table

The table below gives all the possible codings of the counting bits of the TSX AXT 2 00 module in signed binary code on 6 bits, i.e. all the possible values that can be expressed by the counting bits Ixy,0 to Ixy,5 (or Ixy,8 to Ixy,C) and their conversion to decimal (Ixy,5 or Ixy,D being the sign bit).

Note: **x and y** represent the rack number and slot number of the module.

Decimal value	*Ixy,5 Ixy,D*	*Ixy,4 Ixy,C*	*Ixy,3 Ixy,B*	*Ixy,2 Ixy,A*	*Ixy,1 Ixy,9*	*Ixy,0 Ixy,8*	*Decimal value*	*Ixy,5 Ixy,D*	*Ixy,4 Ixy,C*	*Ixy,3 Ixy,B*	*Ixy,2 Ixy,A*	*Ixy,1 Ixy,9*	*Ixy,0 Ixy,8*
0	0	0	0	0	0	0	-1	1	1	1	1	1	1
1	0	0	0	0	0	1	-2	1	1	1	1	1	0
2	0	0	0	0	1	0	-3	1	1	1	1	0	1
3	0	0	0	0	1	1	-4	1	1	1	1	0	0
4	0	0	0	1	0	0	-5	1	1	1	0	1	1
5	0	0	0	1	0	1	-6	1	1	1	0	1	0
6	0	0	0	1	1	0	-7	1	1	1	0	0	1
7	0	0	0	1	1	1	-8	1	1	1	0	0	0
8	0	0	1	0	0	0	-9	1	1	0	1	1	1
9	0	0	1	0	0	1	-10	1	1	0	1	1	0
10	0	0	1	0	1	0	-11	1	1	0	1	0	1
11	0	0	1	0	1	1	-12	1	1	0	1	0	0
12	0	0	1	1	0	0	-13	1	1	0	0	1	1
13	0	0	1	1	0	1	-14	1	1	0	0	1	0
14	0	0	1	1	1	0	-15	1	1	0	0	0	1
15	0	0	1	1	1	1	-16	1	1	0	0	0	0
16	0	1	0	0	0	0	-17	1	0	1	1	1	1
17	0	1	0	0	0	1	-18	1	0	1	1	1	0
18	0	1	0	0	1	0	-19	1	0	1	1	0	1
19	0	1	0	0	1	1	-20	1	0	1	1	0	0
20	0	1	0	1	0	0	-21	1	0	1	0	1	1
21	0	1	0	1	0	1	-22	1	0	1	0	1	0
22	0	1	0	1	1	0	-23	1	0	1	0	0	1
23	0	1	0	1	1	1	-24	1	0	1	0	0	0
24	0	1	1	0	0	0	-25	1	0	0	1	1	1
25	0	1	1	0	0	1	-26	1	0	0	1	1	0
26	0	1	1	0	1	0	-27	1	0	0	1	0	1
27	0	1	1	0	1	1	-28	1	0	0	1	0	0
28	0	1	1	1	0	0	-29	1	0	0	0	1	1
29	0	1	1	1	0	1	-30	1	0	0	0	1	0
30	0	1	1	1	1	0	-31	1	0	0	0	0	1
31	0	1	1	1	1	1	-32	1	0	0	0	0	0

Indicating Lights for Each Channel



"Count overflow" light

"Input 0 pulse" light

"Input 1 pulse" light

"Reset input" light

"Count inhibit input" light

General Characteristics

. Location: any slot for the I/O of TSX 47/67/87 PLCs (If the module is configured in the Fast task, only use the slots of the basic configuration).

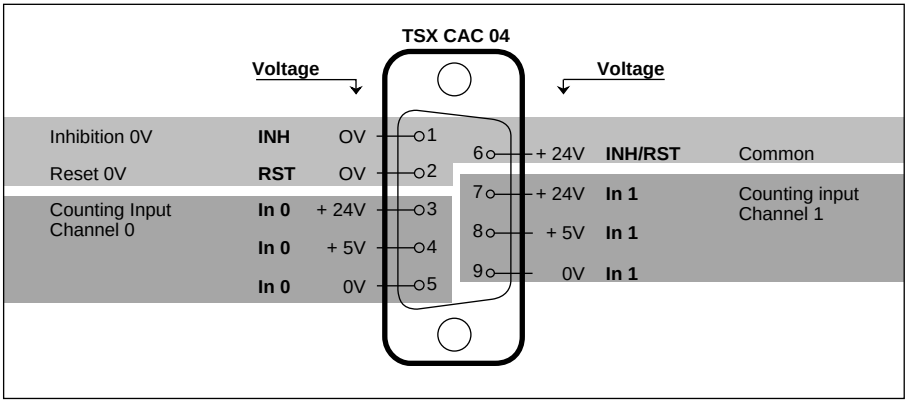
. Locating code (hardware and software): 57

. Effect of a power return: The self-tests are run,
The counting and sign bits = 0 during the self-tests and during the 1st restart cycle.

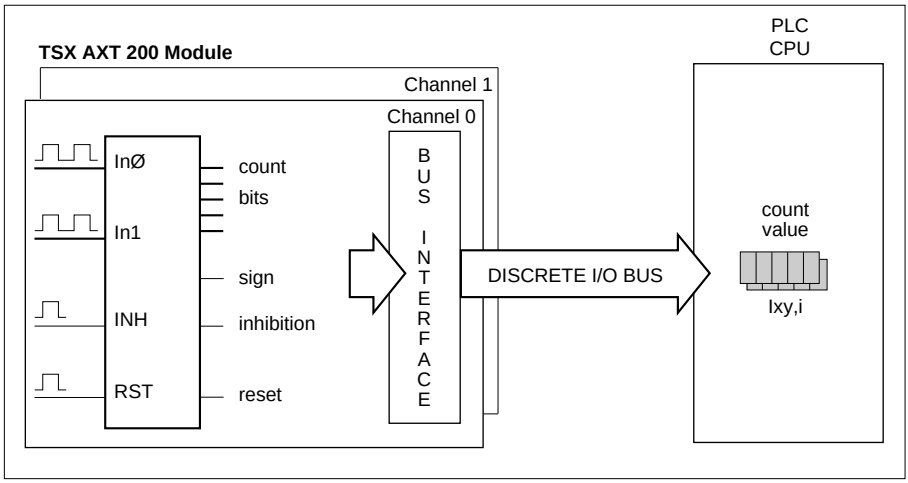
. Consumptions of 5 V and 12 V are 380 mA and 85 mA respectively.

Connections for Each Channel

Pin-out of male connector

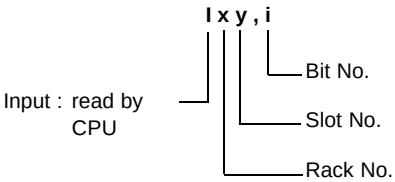


Block Diagram



Addressing

DISCRETE BITS



Ixy,s : counter overflow

Channel 1			Channel 0		
Ixy,8	order 1	coded value of count	**Ixy,0**	order 1	coded value of count
Ixy,9	order 2		**Ixy,1**	order 2	
Ixy,A	order 4		**Ixy,2**	order 4	
Ixy,B	order 8		**Ixy,3**	order 8	
Ixy,C	order 16		**Ixy,4**	order 16	
Ixy,D	sign 0 = +		**Ixy,5**	sign 0 = +	
Ixy,E	inhibition		**Ixy,6**	inhibition	
Ixy,F	reset		**Ixy,7**	reset	

Principle of Counting

- In0: upcounting pulse (discriminator OFF)
- In0/In1: up/downcounting pulse (discriminator ON)
- Counting values between 2 read operations of the inputs by the task in which the module is configured (Master or Fast):
  maximum = +31, minimum = 0 for upcounting, -32 for up/downcounting
- In each task cycle, the user program is responsible for storing the counting and sign bits for summing.
- Counting rate: depends on the counting bit read period (see pages 16 and 17).