

# Reference Manual

PL7 Micro/ Junior/Pro

Detailed description of  
Instructions and Functions

TLX DR PL7 40E eng V4.0

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## Related Documentation

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### At a Glance

This manual is in three volumes:

- Volume 1: Description of the PL7 software
    - General points
    - Ladder language
    - Instruction list language
    - Structured text language
    - Grafcet language
    - DFB function blocks
    - Function modules
  - Volume 2: Detailed description of instructions and functions
    - Basic instructions
    - Advanced instructions
    - Bit objects and system words
  - Volume 3: Appendices
    - Differences between PL7-2/3 and PL7 Micro/Junior
    - Quick reference
    - Reserved word list
    - Conforms to IEC standard 1131-3
    - Automation OLE server
    - Performance
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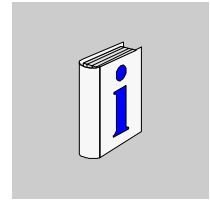
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## About the book



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### At a Glance

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|-----------------------|--|
| <b>Document Scope</b> | This manual describes the programming language instructions for Micro, Premium and Atrium PLCs.  |
| <b>Validity Note</b>  | The updated version of this publication takes into account the functionality of PL7 V4 . Nevertheless it can be used to install earlier versions of PL7. |
| <b>User Comments</b>  | We welcome your comments about this document. You can reach us by e-mail at <a href="mailto:TECHCOMM@modicon.com">TECHCOMM@modicon.com</a>               |
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# Standard instructions

# 1

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## Introduction

### Contents of this section

This chapter describes the standard instructions for PL7 language.

### What's in this Chapter?

This Chapter contains the following Sections:

Section	Topic	Page
1.1	Introduction to the PL7 instructions	15
1.2	Boolean instructions	16
1.3	Predefined function blocks	32
1.4	Numerical processing on integers	48
1.5	Program instructions	66

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# 1.1 Introduction to the PL7 instructions


## PL7 Instructions

### General

All PL7 languages use the same instruction set.

Boolean instructions and function blocks are represented differently according to the language.

**Example:** loading instruction

Instruction	Ladder language	Instruction list	Structured text
Loading		LD	:=

Digital instructions (arithmetic, logic, task, etc.) have similar representations.

This document gives a detailed description of all the instructions; these have been put into two sets for the sake of simplicity:

- the basic instructions (See *Standard instructions*, p. 13)
- the advanced instructions (See *Advanced instructions*, p. 79)

### Basic instructions

These comprise all the basic boolean instructions, the predefined function blocks, and the arithmetic and logic instructions on integers.

### Advanced instructions

These comprise instructions which address advanced programming needs. These instructions are of two types:

- PL7 language, these increase the possibilities for language processing using specific functions (manipulation of character strings, time management, etc.),
- tasks, these offer functions specific to the task to be processed, for example functions for the communication task:
  - `PRINT` to send a character string type message to a terminal or printer,
  - `SEND` to send a message to an application,
  - `PID` PID regulating function.

## 1.2 Boolean instructions

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### Introduction

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#### Aim of this section

This section describes the PL7 language boolean instructions

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#### What's in this Section?

This Section contains the following Maps:

Topic	Page
Bit object instructions	17
Definition of the main boolean objects	18
Loading instructions	19
Assign instructions	21
AND Logic Instruction	23
OR Logic Instruction	26
Exclusive OR Instructions	29

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## Bit object instructions

**Bits instructions** The following instructions apply to bit objects.

Designation	Function
:=	Assignment of a bit
OR	boolean OR
AND	boolean AND
XOR	boolean exclusive OR
NOT	Inversion
RE	Rising edge
FE	Falling edge
SET	Set to 1:
RESET	Set to 0:

### Bits table instructions

The following instructions apply to bits table objects.

Designation	Function
Table:= Table	Assignment between two tables
Table:= Word	Assignment of a word to a table
Word:= Table	Assignment of a table to a word
Table:= Double word	Assignment of a double word to a table
Double word: = Table	Assignment of a table to a double word
COPY_BIT	Copy of a bits table in a bits table
AND_ARX	AND between two tables
OR_ARX	OR between two tables
XOR_ARX	exclusive OR between two tables
NOT_ARX	Negation in a table
BIT_W	Copy of a bits table in a word table
BIT_D	Copy of a bits table in a double word table
W_BIT	Copy of a word table in a bits table
D_BIT	Copy of a double word table in a bits table
LENGHT_ARX	Calculation of the length of a table by the number of elements

## Definition of the main boolean objects













**Description** The following table describes the main boolean objects.

Bits	Description	Examples	Write access
Immediate values	0 or 1 (False or True)	0	–
Inputs/outputs	<p>These bits are the "logic images" of the electrical states of the inputs/ outputs.</p> <p>They are stored in the data memory and updated each time the task in which they are configured is polled.</p> <p><b>Note:</b> The unused input/output bits may not be used as internal bits.</p>	%I23.5 %Q51,2	No Yes
Internal	The internal bits are used to store the intermediary states during execution of the program.	%M200	Yes
System	The system bits %S0 to %S127 monitor the correct operation of the PLC and the running of the application program.	%S10	According to i
Function blocks	<p>The function block bits correspond to the outputs of the function blocks or DFB instance.</p> <p>These outputs may be either directly connected or used as an object.</p>	%TM8.Q	No
Word extracts	With the PL7 software it is possible to extract one of the 16 bits of a word object.	%MW10:X5	According to the type of words
Grafcet steps and macro-steps	The Grafcet status bits of the steps, macro-steps and macro-step steps are used to recognize the Grafcet status of step i, of macro-step j or of step i of the macro-step j.	%X21 %X5.9	Yes Yes

## Loading instructions





### Role

The following table describes the role of each of the instructions.

Ladder	Instruction list	Structured text	Description	Timing diagram
	LD	:=	Normally open contacts: contact made (result at 1) when the controlling bit object is at state 1.	Opérande  Résultat 
	LDN	:=NOT	Normally closed contacts: contact made (result at 1) when the controlling bit object is at state 0.	Opérande  Résultat 
	LDR	:=RE	Rising edge contacts: detect controlling bit object changing from 0 to 1. Setting the result to 1 takes 1 cycle to complete.	Opérande  Résultat 
	LDF	:=FE	Falling edge contacts: detect controlling bit object changing from 1 to 0. Setting the result to 1 takes 1 cycle to complete.	Opérande  Résultat 

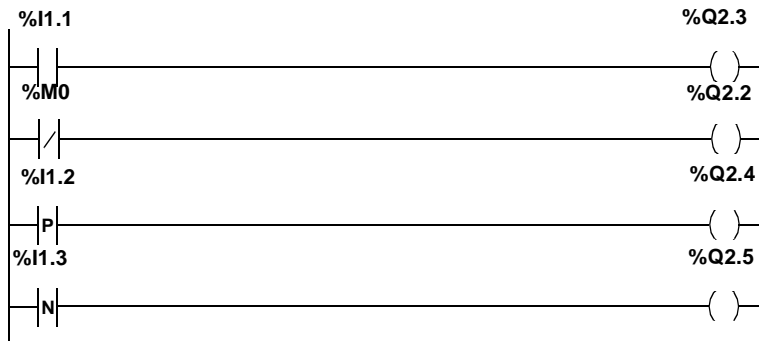
### Permitted operands

The following table gives a list of the operands used for these instructions.

Ladder	Instruction list	Structured text	Operands
	LD	:=	%I,%Q,%M,%S,%BLK,%*:Xk, %Xi, (True and False in instruction list or structured text)
	LDN	:=NOT	%I,%Q,%M,%S,%BLK,%*:Xk, %Xi, (True and False in instruction list or structured text)
	LDR	:=RE	%I,%Q,%M
	LDF	:=FE	%I,%Q,%M

**Example in ladder**

The following example shows how to program the loading instructions in ladder format.



**Example in instruction list**

The following example shows how to program the loading instructions in Instruction List language.

```
LD  %I1.1
ST  %Q2.3
LDN %M0
ST  %Q2.2
LDR %I1.2
ST  %Q2.4
LDF %I1.3
ST  %Q2.5
```

**Example in structured text**

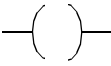

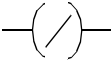

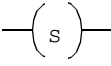

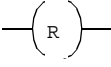

The following example shows how to program the loading instructions in structured text language.

```
%Q2.3 := %I1.1;
%Q2.2 := NOT %M0;
%Q2.4 := RE %I1.2;
%Q2.5 := FE %I1.3;
```

## Assign instructions

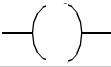
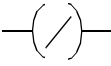
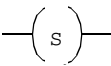
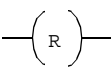
### Role

The following table describes the role of each of the instructions.

Language data	Instruction list	Structured text	Description	Timing diagram
	ST	:=	to the direct coils the associated bit object takes the value of the equation result.	Operand  Result
	STN	:=NOT	to the negated coils: the associated bit object takes the inverse value of the equation result.	Operand  Result
	S	SET	to the set coils: the associated bit object is set when the result of the equation is set	Operand  Result
	R	RESET	to the trigger coils: the associated bit object is clear when the result of the equation is set.	Operand  Result

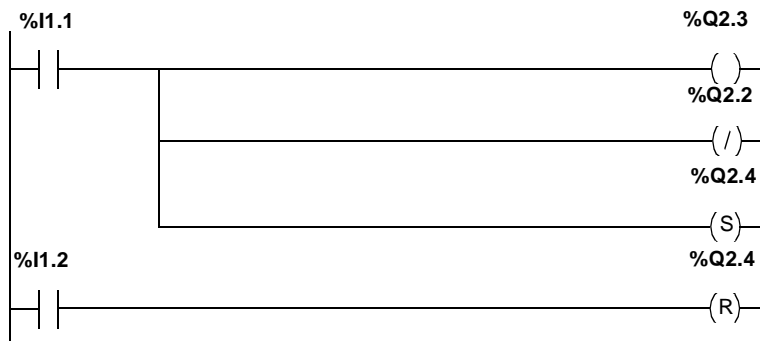
### Permitted operands

The following table gives a list of the operands used for these instructions

Language data	Instruction list	Structured text	Operands
	ST	:=	%I,%Q,%M,%S,%•:Xk
	STN	:=NOT	%I,%Q,%M,%S,%•:Xk
	S	SET	%I,%Q,%M,%S,%•:Xk,%Xi Only in the preliminary processing.
	R	RESET	%I,%Q,%M,%S,%•:Xk,%Xi Only in the preliminary processing.

**Example in language data**

The following example shows how to program the assign instructions in language data.



**Example in instruction list**

The following example shows how to program the assign instructions in instruction list language.

```
LD  %I1.1
ST  %Q2.3

STN %Q2.2

S   %Q2.4

LD  %I1.2
R   %Q2.4
```

**Example in structured text**

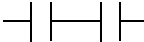
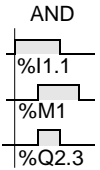

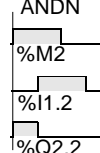

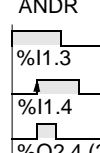

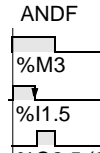
The following example shows how to program the assign instructions in structured text language.

```
%Q2.3 := %I1.1;
%Q2.2 := NOT %I1.1;
IF %I1.1 THEN
    SET %Q2.4;
END_IF;
IF %I1.2 THEN
    RESET %Q2.4;
END_IF;
```

## AND Logic Instruction

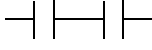
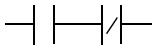

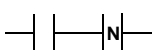
### Role

The following table describes the role of each of the instructions

Language data	Instruction list	Structured text	Description	Timing diagram
	AND	AND	AND logic between the operand and the previous instruction's Boolean result	 <p>AND</p> <p>%I1.1</p> <p>%M1</p> <p>%Q2.3</p>
	ANDN	AND (NOT...)	AND logic between the operand inverse and the previous instruction's Boolean result	 <p>ANDN</p> <p>%M2</p> <p>%I1.2</p> <p>%Q2.2</p>
	ANDR	AND (RE...)	AND logic between the operand's rising edge and the previous instruction's Boolean result (2) Setting during 1 cycle	 <p>ANDR</p> <p>%I1.3</p> <p>%I1.4</p> <p>%Q2.4 (2)</p>
	ANDF	AND (FE...)	AND logic between the operand's falling edge and the previous instruction's Boolean result (2) Setting during 1 cycle	 <p>ANDF</p> <p>%M3</p> <p>%I1.5</p> <p>%Q2.5 (2)</p>

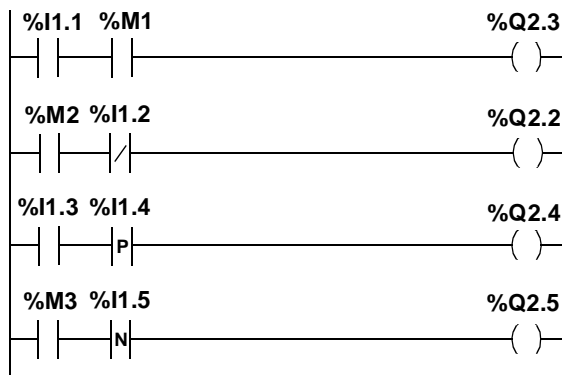
**Permitted operands**

The following table gives a list of the operands used for these instructions

Language data	Instruction list	Structured text	Operands
	AND	AND	%I, %Q, %M, %S, %BLK, %*:Xk, %Xi True (1)/False (0) in instruction list language or structured text
	ANDN	AND (NOT...)	%I, %Q, %M, %S, %BLK, %*:Xk, %Xi True (1)/False (0) in instruction list language or structured text
	ANDR	AND (RE...)	%I, %Q, %M
	ANDF	AND (FE...)	%I, %Q, %M

**Example in language data**

The following example shows how to program the AND Logic instructions in language data.





**Example in instruction list**

The following example shows how to program the AND Logic instructions in the Instruction List.

```
LD    %I1.1
AND  %M1
ST    %Q2.3
LD    %M2
ANDN %I1.2
ST    %Q2.2
LD    %I1.3
ANDR %I1.4
ST    %Q2.4
LD    %M3
ANDF %I1.5
ST    %Q2.5
```

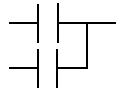
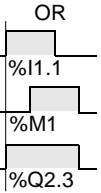
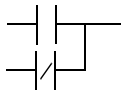
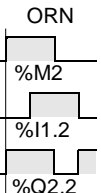
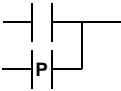
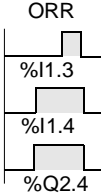
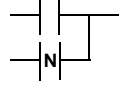
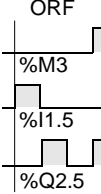
**Example in structured text language**

The following example shows how to program the AND Logic instructions in structured text language.

```
%Q2.3 := %I1.1 AND %M1 ;
%Q2.2 := %M2 AND (NOT %I1.2) ;
%Q2.4 := %I1.3 AND (RE %I1.4) ;
%Q2.5 := %M3 AND (FE %I1.5) ;
```

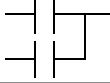
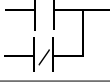
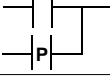
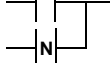
## OR Logic Instruction

**Role** The following table describes the role of each of the instructions

Language data	Instruction list	Structured text	Description	Timing diagram
	OR	OR	OR logic between the operand and the previous instruction's Boolean result	
	ORN	OR (NOT...)	OR logic between the operand inverse and the previous instruction's Boolean result	
	ORR	OR (RE...)	OR logic between the operand's rising edge and the previous instruction's Boolean result	
	ORF	OR (FE...)	OR logic between the operand's falling edge and the previous instruction's Boolean result	

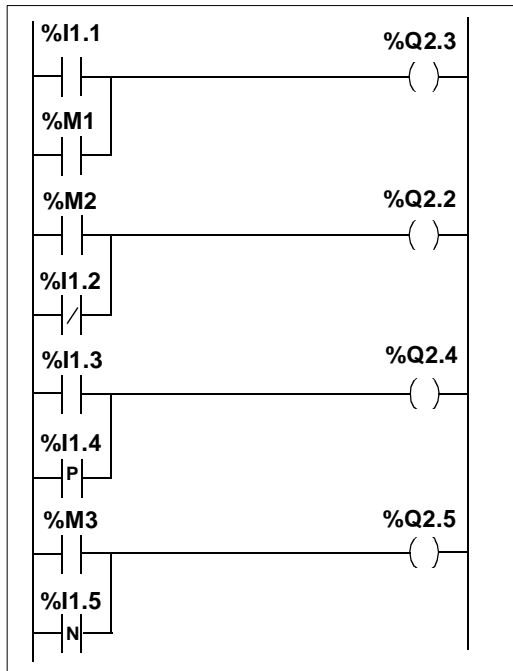
**Permitted operands**

The following table gives a list of the operands used for these instructions

Language data	Instruction list	Structured text	Operands
	OR	OR	%I, %Q, %M, %S, %BLK, %•Xk, %Xi True (1)/False (0) in instruction list language or structured text
	ORN	OR (NOT...)	%I, %Q, %M, %S, %BLK, %•Xk, %Xi True (1)/False (0) in instruction list language or structured text
	ORR	OR (RE...)	%I, %Q, %M
	ORF	OR (FE...)	%I, %Q, %M

**Example in language data**

The following example shows how to program the OR Logic instructions in language data.



**Example in instruction list**

The following example shows how to program the OR Logic instructions in the Instruction List.

```
LD %I1.1
OR %M1
ST %Q2.3

LD %M2
ORN %I1.2
ST %Q2.2

LD %I1.3
ORR %I1.4
ST %Q2.4

LD %M3
ORF %I1.5
ST %Q2.5
```

**Example in structured text language**

The following example shows how to program the OR Logic instructions in structured text language.

```
%Q2.3:=%I1.1 OR %M1;
%Q2.2:=%M2 OR (NOT%I1.2);
%Q2.4:=%I1.3 OR (RE%I1.4);
%Q2.5:=%M3 OR (FE%I1.5);
```

---

## Exclusive OR Instructions

### Role

The following table describes the role of each of the instructions

Instruction list	Structured text	Description	Timing diagram
XOR	XOR	OR Exclusive between the operand and the previous instruction's Boolean result	<p>XOR</p> <p>%I1.1</p> <p>%M1</p> <p>%Q2.3</p>
XORN	XOR (NOT...)	OR Exclusive between the operand inverse and the previous instruction's Boolean result	<p>XORN</p> <p>%M2</p> <p>%I1.2</p> <p>%Q2.2</p>
XORR	XOR (RE...)	OR Exclusive between the operand's rising edge and the previous instruction's Boolean result	<p>XORR</p> <p>%I1.3</p> <p>%I1.4</p> <p>%Q2.4</p>
XORF	XOR (FE...)	OR Exclusive between the operand's falling edge and the previous instruction's Boolean result.	<p>XORF</p> <p>%M3</p> <p>%I1.5</p> <p>%Q2.5</p>

**Note:** There are no specific graphic elements for the OR exclusive in language data. However the OR exclusive can be programmed by using a combination of opening and closing contacts (see example below).

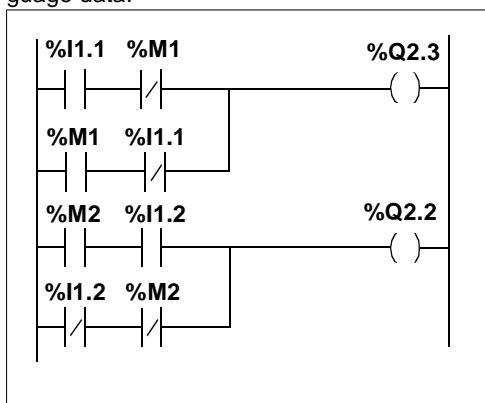
**Permitted operands**

The following table gives a list of the operands used for these instructions

Instruction list	Structured text	Operands
XOR	XOR	%I, %Q, %M, %S, %BLK, %*:Xk, %Xi
XORN	XOR (NOT...)	%I, %Q, %M, %S, %BLK, %*:Xk, %Xi
XORR	XOR (RE...)	%I, %Q, %M
XORF	XOR (FE...)	%I, %Q, %M

**Example in language data**

The following example shows how to program the OR Exclusive instructions in language data.



**Example in instruction list**

The following example shows how to program the OR Exclusive instructions in the Instruction List:

```
LD %I1.1
XOR %M1
ST %Q2.3

LD %M2
XORN %I1.2
ST %Q2.2

LD %I1.3
XORR %I1.4
ST %Q2.4

LD %M3
XORF %I1.5
ST %Q2.5
```

---

**Example in  
structured text  
language**

The following example shows how to program the OR Exclusive instructions in structured text language.

```
%Q2.3:=%I1.1 XOR%M1;  
%Q2.2:=%M2 XOR (NOT%I1.2);  
%Q2.4:=%I1.3 XOR (RE%I1.4)  
%Q2.5:=%M3 XOR (FE%I1.5);
```

**Note:** The brackets are optional but make the program readable

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## 1.3 Predefined function blocks

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### Introduction

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#### Subject of this sub-section

This sub-section describes PL7 language predefined function Blocks

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#### What's in this Section?

This Section contains the following Maps:

Topic	Page
Introduction to timer function block %TMI	33
%TMI timer block operating mode	35
Operation of timer function block %TMI in TON mode	36
Operation of timer function block %TMI in TOF mode	37
Operation of timer function block %TMI in TP mode	38
Programming and configuring timer function blocks	39
Specific cases of operation for the series 7 timer	41
Introduction to the up-down counter function block	42
How the up/down counter function block works	44
Configuration and programming	46

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## Introduction to timer function block %Tmi

### General

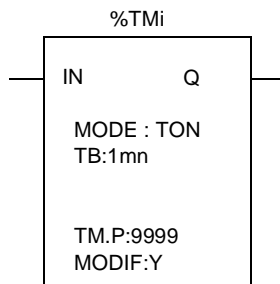
The timer has 3 operating modes:

- **TON**: is used to manage delays on engagement (on delays),
- **TOF**: is used to manage delays on release (off delays),
- **TP**: is used to create a pulse of precise duration.

The delays or pulse periods are programmable and may or may not be modified via the terminal.

### Illustration

The following is the graphic presentation of the timer function block:



### Characteristics

The timer has the following characteristics:

Characteristic	Address	Value
Timer number	%Tmi	0 to 63 for a TSX 37, 0 to 254 for a TSX 57
Mode	TON	• default delay on engagement (on delay)
	TOF	• delay on release (off delay)
	TP	• monostable
Time base	TB	1mn (default), 1s, 100ms, 10ms (16 timers max. at 10ms). The shorter the time base, the more precise the timer.
Current value	%Tmi.V	Word which increases from 0 to %Tmi.P on completion of the timer cycle. May be read, tested, but not written in a program (%Tmi.V may be modified by the terminal).
Preset value	%Tmi.P	0-%Tmi.P-9999. Word which may be read, tested and written in a program. Is set at the value of 9999 by default. The period or delay generated is equal to %Tmi.P x TB.

Characteristic	Address	Value
Terminal adjustment (MODIF)	Y/N	Y: possibility to modify the preset %Tmi.P value in adjust mode. N: cannot be accessed in adjust mode.
Input (instruction "Activation")	IN	Starts the timer on rising edge (TON or TP mode) or falling "Activation" edge (TOF mode).
Output "Timer"	Q	%Tmi.Q associated bit; setting to 1 depends on the TON, TOF or TP function.

---

## %TMI timer block operating mode

### Description

The following table shows the operating modes specific to the timer block.

Impact...	Description
of a cold restart	(%S0=1), causes the current value to set to 0, the output %TMI.Q to set to 0 while the preset value is reset to the value defined on configuration.
of a warm restart	(%S1=1) has no effect on the timer's current value, or on the preset value. The current value does not change during power outage.
of a shift to stop mode, deactivation of a task or execution of a breakpoint	does not freeze the current value.
a program jump	Not polling the instructions in which the timer block is programmed does not freeze the current %TMI.V value; this continues to increase to %TMI.P. Similarly, the %TMI.Q bit associated with the Q output of the timer block maintains its normal operation and can thus be tested by another instruction. However the output, which is directly connected to the block output, is not activated since it is not polled by the PLC
of the alteration to the preset value	The alteration to the preset value by instruction or in adjust mode is only taken into account at the next activation of the timer. The alteration to the preset value in the variables editor is only taken into account after a cold restart (%S0=1).

**Note:** it is advisable to test the %TMI.Q bit once only during the program.

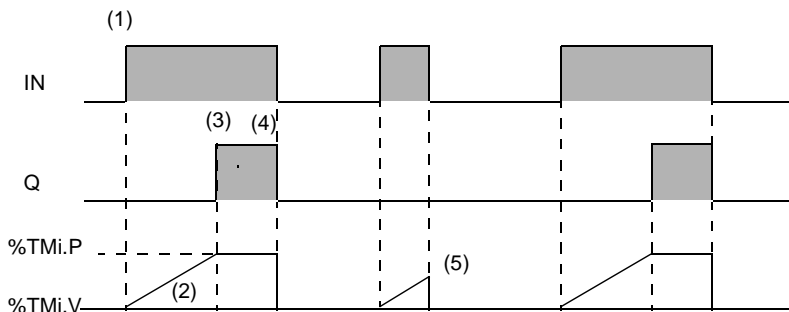
## Operation of timer function block %TMI in TON mode

### General

Operation in TONmode is used to manage the on delays.

### Illustration

The timing diagram illustrates the operation of the timer in TON mode.



### Operation

The following table shows the operation of the timer in TON mode.

Phase	Description
1	The timer is started with a rising edge on the IN input
2	The current value %TMI.V of the timer increases from 0 to %TMI.P by one unit at each pulse of the time base TB
3	The %TMI.Q output bit moves to 1 when the current value has reached %TMI.P
4	The %TMI.Q output bit stays at 1 while the IN input is at 1.
5	When the IN input is at 0, the timer is stopped even if it is still running: %TMI.V takes the value 0.

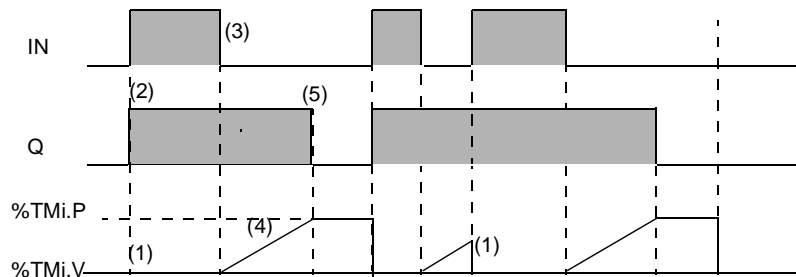
## Operation of timer function block %TMi in TOF mode

### General

Operation in TOF mode is used to manage the off delays.

### Illustration

The timing diagram illustrates the operation of the timer in TOF mode.



### Operation

The following table shows the operation of the timer in TOF mode.

Phase	Description
1	The current value %TMi.V takes 0, on a rising edge of the IN input (even if the timer is running)
2	The %TMi.Q output bit moves to 1.
3	The timer is started with a falling edge on the IN input.
4	The current value %TMi.P increases to %TMi.P by one unit at each pulse of the time base TB.
5	The %TMi.Q output bit returns to 0 when the current value has reached %TMi.P

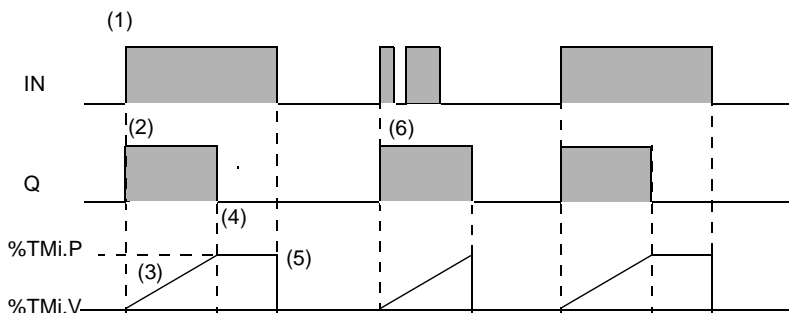
## Operation of timer function block %TMI in TP mode

### General

Timer operation in TP mode is used to manage the creation of a pulse of precise duration (monostable function).

### Illustration

The timing diagram illustrates the operation of the timer in TP mode.



### Operation

The following table shows the operation of the timer in TP mode.

Phase	Description
1	The timer is started with a rising edge on the IN input
2	The %TMI.Q output bit moves to 1.
3	The current value %TMI.V of the timer increases from 0 to %TMI.P by one unit at each pulse of the time base TB
4	The %TMI.Q output bit returns to 0 when the current value has reached %TMI.P.
5	When the IN input and the %TMI.Q output are at 0, %TMI.V takes the value 0.
6	This monostable cannot be reactivated.

## Programming and configuring timer function blocks

### General

Programming timer function blocks is always the same regardless of the selected user mode.

The choice between TON, TOF or TP operation is made in the variables editor.

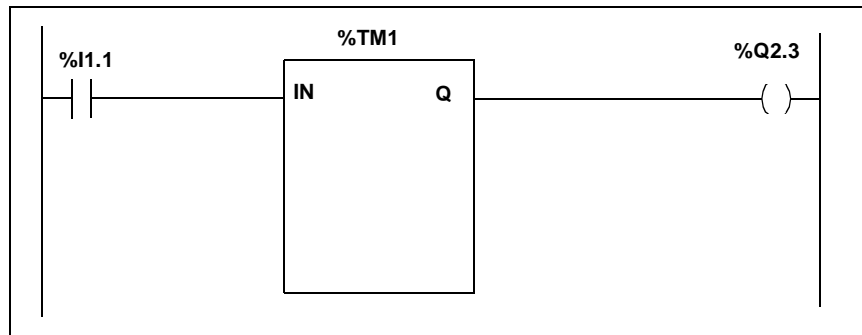
### Configuration

This involves setting the following parameters :

Parameter	Values
Mode	TON, TOF or TP.
TB	1min, 1s, 100ms or 10ms
%TMi.P	0 to 9999
MODIF	Y or N

### Programming in ladder language

The following program illustrates the use of a timer function block in ladder language.



### Example in instruction list

The following program illustrates the use of a timer function block in instruction list .

```
LD      %I1.1
IN      %TM1
LD      %TM1.Q
ST      %Q2.3
```

**Example in structured text**

The following program illustrates the use of a timer function block in structured text language.

```
IF RE %I1.1 THEN
  START %TM1;
ELSIF FE %I1.1 THEN
  DOWN %TM1;
END_IF;
%Q2.3 := %TM1.Q;
```

The instruction `START %TMi`, generates a rising edge on the IN input of the timer block.

The instruction `DOWN %TMi`, generates a falling edge on the IN input of the timer block.

---



---

## Specific cases of operation for the series 7 timer

---

### Specific cases

- **Incidence of a "cold restart":** (%S0 = 1) loads the preset value (defined by the variables editor) in the current value and sets the output %Ti.D at 0, as the preset value, which may have been altered by the terminal, has been lost.
  - **Incidence of a "warm restart":** there is no incidence of (%S1=1) on the current value of the timer.
  - **Incidence of a switch to stop mode:** the switch of the PLC into stop mode does not freeze the current value. The same applies when the current task is deactivated or on execution of a breakpoint.
  - **Incidence of a program jump:** not polling the network in which the timer block is programmed does not freeze the current value %Ti.V which continues to decrease to 0. Similarly, the %Ti.D and %Ti.R bits associated with the D and R outputs maintain their normal operation and can thus be tested on another network. However the spools which are directly connected to the block outputs are not activated since they are not polled by the PLC.
  - **Test of %Ti.D and %Ti.R bits:** these bits can change state during the cycle.
-

## Introduction to the up-down counter function block

### General

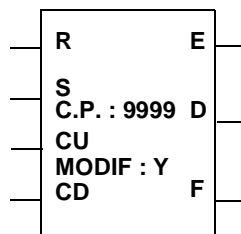
This function block is used for:

- Counting an event
- Down counting events

These operations can happen simultaneously

### Illustration

Graphic representation of the up-down counter function block



### Characteristics

The up-down counter has the following characteristics:

Characteristics	Address	Value
Number Counter	%Ci	0 to 31 for a TSX 37, 0 to 254 for a TSX 57
Current value	%Ci.V	Increased or decreased word according to the CU and CD inputs. May be read, and tested but not written by the program. Can be set by the terminal
Preset value	%Ci.P	$0 \leq \%Ci.P \leq 9999$ . Word which can be read, tested and written (with a default value of 9999)
Terminal adjustment (MODIF)	Y/N	<ul style="list-style-type: none"> <li>● Y: possibility to modify the preset value in adjust mode</li> <li>● N: cannot be accessed in adjust mode</li> </ul>
Input (instruction) "Resetting to zero"	R	On state 1: %Ci.V = 0
Input (instruction) "Preset"	S	On state 1: %Ci.V = %Ci.P
Input (instruction) "Counting"	CU	%Ci.V increment on rising edge
Input (instruction) "Down counting"	CD	%Ci.V decreased on rising edge

---

Characteristics	Address	Value
Output Overrun	E (Empty)	When %Ci.V switches from 0 to 9999 (set when %Ci.V is equal to 9999), the associated bit %Ci.E=1 is cleared if the counter continues counting down. When there is an overrun, bit %S18 switches to 1
Preset Output reached	D (Done)	Associated bit %Ci.D=1, when %Ci.V=%Ci.P.
Output Overrun	F (Full)	When %Ci.V switches from 9999 to 0 (set when %Ci.V is equal to 0), the associated bit %Ci.F is cleared if the counter continues counting up. When there is an overrun, bit %S18 switches to 1

---

## How the up/down counter function block works

### Operation

#### Counting Function

Action	Result
A rising edge appears on the CU counting input	The %Ci.V current value is increased by one unit
The %Ci.V current value is equal to the %Ci.P preset value	the %Ci.D output bit "preset reached" associated to output D switches to set
The %Ci.V current value switches from 9999 to 0	The %Ci.F output bit (counting overrun) switches to set
The counter continues counting	The %Ci.F output bit (counting overrun) is reset to clear

#### Down counting Function

Action	Result
A rising edge appears on the CU down counting input	The %Ci.V current value is decreased by one unit
The %Ci.V current value switches from 0 to 9999	The %Ci.E output bit (counting overrun) switches to set
The counter continues down counting	The %Ci.E output bit (counting overrun) is reset to clear

#### Up/Down Counting Function

Action	Result
A rising edge appears on the CU counting input	The %Ci.V current value is increased by one unit
A rising edge appears on the CU down counting input	The %Ci.V current value is decreased by one unit
The two inputs set simultaneously	The current value remains unchanged

#### Reset to zero

When	Result
Input R is set (this input has priority over the other inputs)	The %Ci.V current value is forced to 0. Outputs %Ci.V, %Ci.D and %Ci.F are at 0

## Preset

Action	Result
Input S "Preset" is in state 1 and input R "Reset to zero"	The %Ci.V current value takes the %Ci.P value and the %Ci.D output switches to 1

**Note**

On reset to 0 (input R or instruction R):

- In language data, the CU and CD input archives are updated with the connected values
- In instruction list language and in structured text language, the archives of the CU and CD inputs are not updated; each input keeps the value it had before the call

**Specific cases**

## Different specific cases

Action	Result
<ul style="list-style-type: none"> <li>● Cold reset (%S0=1)</li> </ul>	<ul style="list-style-type: none"> <li>● The %Ci.V current value is set to zero</li> <li>● The %Ci.E, %Ci.D and %Ci.F output bits are set to zero</li> <li>● The preset value is initialized to the value defined during configuration</li> </ul>
<ul style="list-style-type: none"> <li>● Warm restart (%S1=1)</li> <li>● Switch to stop</li> <li>● Task deactivation</li> <li>● Breakpoint execution</li> </ul>	<ul style="list-style-type: none"> <li>● No incidence on the current counter value (%Ci.V)</li> </ul>
<ul style="list-style-type: none"> <li>● Modification of the %Ci.P preset</li> </ul>	<ul style="list-style-type: none"> <li>● Modifying the preset value by instruction or during recalibration is taken into account during the application's block management (activating one of the inputs)</li> </ul>

## Configuration and programming

### Example

Counting of number of parts = 5000. Each pulse on the input %I1.2 (when the internal %M0 bit is at 1) causes the incrementation of the counter %C8 up to the final preset counter value %C8 (bit %C8.D=1). The input %I1.1 resets the counter to zero.

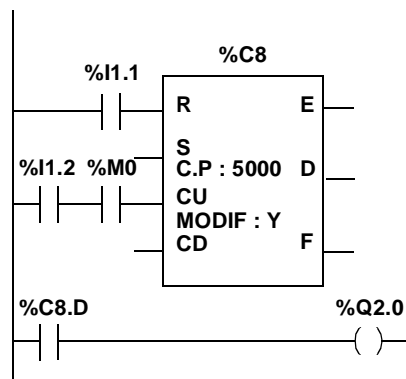
### Configuration

The following are the parameters to be entered using the variables editor:

- %Ci.P, fixed at 5000 in this example
- MODIF: Y

### Programming

#### Ladder language



#### Instruction list language

```

LD %I1.1
R %C8
LD %I1.2
AND %M0
CU %C8
LD %C8.D
ST %Q2.0
  
```

**Structured text language**

```
IF %I1.1 THEN
    RESET %C8
END_IF;
%M1:=%I1.2 THEN
    UP %C8;
END_IF;
%Q2.0: =%C8.D;
```

In structured text language, 4 instructions are used to program the up/down counter function blocks:

- **RESET** %Ci: Resets the current value to zero.
- **PRESET** %Ci: Loads the preset value in the current value
- **UP** %Ci: Increments the current value
- **DOWN** %Ci: Lowers the current value

In the case of structured text language, the CU and CD inputs archive is reset to zero when the instructions UP and DOWN are used. It is therefore the user who must manage the rising edges for these two instructions.

---

## 1.4 Numerical processing on integers

---

### Introduction

---

#### Subject of this sub-section

This sub-section describes PL7 language numeric processing on integers

---

#### What's in this Section?

This Section contains the following Maps:

Topic	Page
Introduction to numerical processing using integers	49
Comparison instructions	52
Assign instructions	54
Word assignment	56
Arithmetic instructions on integers	58
Logic instructions	62
Numerical expressions	64

---



## Introduction to numerical processing using integers

### General

The numerical instructions described in this chapter are for the following objects:

- bit tables
- words
- double words

Instructions for other object types are described in the "Advanced instructions (See *Advanced instructions, p. 79*)" section.

### Programming in ladder language

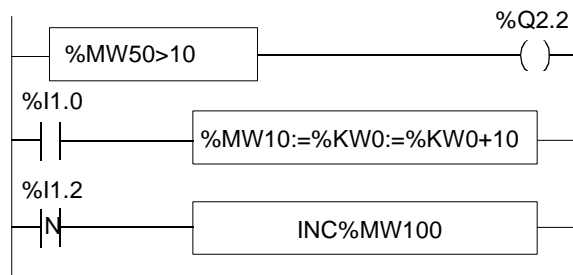
Numerical instructions are entered in the blocks:

- placed in the test zone for the comparison blocks
- placed in the action zone for the operation blocks

These blocks can contain:

- a simple expression; e.g.:  $OP3 := OP1 + OP2$
- a complex expression; e.g.:  $OP5 := (OP1 + OP2) * OP3 - OP4$ .

Programming example:



### Programming in Instruction List language

The instructions are placed between square brackets.

They are executed if the Boolean result from the test instruction preceding the numerical instruction is set to 1.

**Programming example:**

```
LD      [ %MW50 > 10 ]
ST      %Q2.2
LD      %I1.0
[ %MW10 := %KW0 + 10 ]
LDF     %I1.2
[ INC %MW100 ]
```

**Programming in structured text language**

Numerical instructions are entered directly.  
The conditional IF instruction enables these numeric instructions to be conditioned by a Boolean expression.

**Programming example:**

```
%Q2.2:=%MW50 > 10;
IF %I1.0 THEN
    %MW10:=%KW0 + 10;
END_IF;
IF FE %I1.2 THEN
    INC %MW100;
END_IF;
```

**Operand list**

Bit table list

Abbreviations	Complete addressing	Word type	Access
%M:L	%Mi:L	internal bit table	R/W
%I:L	%Ixy.i:L	input bit table	R/W
%Q:L	%Qxy.i:L	output bit table	R/W
	%Xi:L or %Xj.i:L	step bit table	R

List of simple format words

Abbreviations	Complete addressing	Word type	Access	Indexed form
Imm. val.	-	immediate values	R	-
%MW	%MWi	internal word	R/W	%MWi[index]
%KW	%KW <sub>i</sub>	internal constant	R	%KW <sub>i</sub> [index]
%SW	%SW <sub>i</sub>	system word	R/W (1)	-
%IW	%IWxy.i(.r)	input bit	R	-
%QW	%QWxy.i(.r)	output word	R/W	-
%NW	%NW{j}k	common word	R/W	-
%BLK	e.g.: %T <sub>Mi</sub> .P	word extracted from a standard function block or function block	R/W (2)	-
%Xi.T	%Xi.T or %Xj.i.T	step activity time	R	%Xi.T[index]

(1) writing according to i.

(2) writing according to word type, for example: preset values (%Ci.P can be written whilst the current %Ci.V values can only be read).

## List of double words

Abbreviations	Complete addressing	Word type	Access	Indexed form
Imm. val.	-	immediate values	R	-
%MD	%MDi	double internal word	R/W	%MDi[index]
%KD	%KDi	internal double constant	R	%KDi[index]
%SD	%SDi	double system word	R/W (1)	-
%ID	%IDxy.i(.r)	double input word	R	-
%QD	%QDxy.i(.r)	double output word	R/W	-

(1) only double word %SD18

**Note:** There are other types of words and double words, such as %MWxy.i %KWxy.i and %MDxy.i %KDxy.i associated with specific applications, these double words behave like the double words %MWi %KWi and %MDi %KDi respectively.

**Note: Implicit word <--> double word conversions**

The PL7 software authorizes operations to be mixed using words and double words. Conversions into one or other format, are done in an implicit manner, one operation making a double word intervene or several immediate values are internally executed automatically in double format.

## Comparison instructions

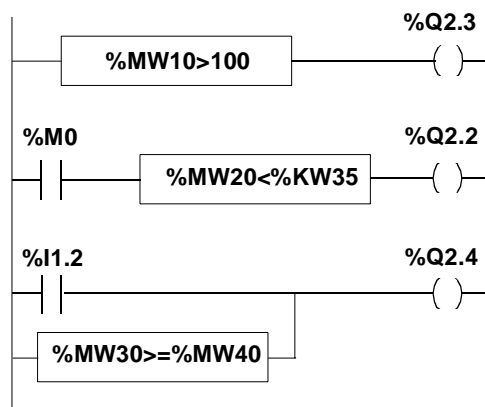
### General

Comparison instructions are used to compare two operands.

- >: tests whether operand 1 is greater than operand 2,
- >=: tests whether operand 1 is greater than or equal to operand 2,
- <: tests whether operand 1 is less than operand 2,
- <=: tests whether operand 1 is less than or equal to operand 2,
- =: tests whether operand 1 is different from operand 2.

### Structure

#### Ladder language



**Note:** The comparison blocks program themselves in the test zone.

#### Instruction list language

```
LD    [%MW10>100]
ST    %Q2.3
LD    %M0
AND   [%MW20<%KW35]
ST    %Q2.2
LD    %I1.2
OR    [%MW30>=%MW40]
ST    %Q2.4
```

**Note:** The comparison is made between the square brackets following the LD, AND and OR instructions.

### Structured text language

```
%Q2.3:=%MW10>100;
%Q2.2:=%M0 AND (%MW20<%KW35);
%Q2.4:=%I1.2 OR (%MW30>=%MW40);
```

**Note:** The brackets are optional but improve the readability of the program

## Syntax

### Comparison instruction operators

Operators	Syntax
>,>=,<,<=,=,<>	Op1 Operator Op2

### Operands

Type	Operands 1 and 2 (Op1 and Op2)
Indexable words	%MW,%KW,%Xi.T
Non-indexable words	Imm.val.,%IW,%QW,%SW,%NW,%BLK, Numeric Expr.
Indexable double words	%MD,%KD
Non-indexable double words	Imm.val.,%ID,%QD,%SD, Numeric expr.

### Note:

- in ladder language, the comparison operation can also be performed with the Vertical comparison block (See *Introduction to the vertical comparison operation block*, p. 109)
- in instruction list language, the comparison instructions can be used within brackets.

## Assign instructions

### General

They change an operand Op2 into an operand Op1

Assignment operations can be performed:

- on bit tables,
- on words or double words.

Several assign instructions can be linked up in the same block:

Op1:=Op2:=Op3:=Op4:=...

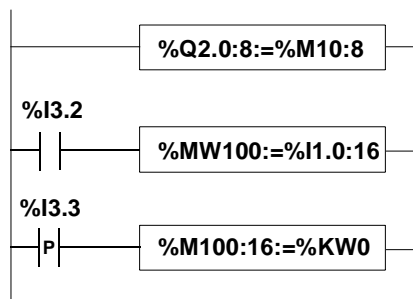
### Bit table assignment

The following bit table operations can be performed:

- bit table -> bit table (E.g.: 1)
- bit table -> word or double word (indexed) (E.g.: 2)
- word or double word (indexed) -> bit table (E.g.: 3)

### Structure

#### Ladder language



#### Instruction list language

##### Example 1:

```
LD TRUE
[ %Q2.0:8 ]
```

##### Example 2:

```
LD %I3.2
[ %MW100 := %I1.0:16 ]
```

##### Example 3:

```
LDR %I3.3
[ %MW100:16 := %KW0 ]
```

**Structured text language****Examples 1 and 2:**

```
%Q2.0:8:=%M10:8;
IF %I3.2 THEN
    %MW100:=%I1.0:16;
END_IF;
```

**Example 3:**

```
IF RE %I3.3 THEN
    %M100:16:=%KW0;
END_IF;
```

**Syntax**

## Operator and syntax

Operator	Syntax
:=	Op1:=Op2

## Operands

Type	Operand 1 (Op1)	Operand 2 (Op2)
Bit table	%M:L,%Q:L,%I:L	%M:L,%Q:L,%I:L,%Xi:L
Indexable words	%MW	%MW,%KW,%Xi.T
Non-indexable words	%QW,%SW,%NW,%BLK	Imm.val., %IW,%QW,%SW,%NW,%BLK,Num.expr.
Indexable double words	%MD	%MD,%KD
Non-indexable double words	%QD,%SD	Imm.val., %ID,%QD,%SD,Numeric expr.

**Rules of use**

- the home and destination bit tables are not necessarily the same length. If the home table is longer than the destination table, only the least significant bits are transferred. If the destination table is the longer, it is completed with some 0s
- For a bit table -> word (or double word) assignment: the table bits are transferred into the word (the least significant word for a double word) by commencing on the right (first table bit in the 0 bit of the word). The word bits not concerned by the transfer (length < 16 or 32) are set to 0
- For a word -> bit table assignment: the word bits are transferred from the right (bit 0 of the word into the first table bit)

## Word assignment

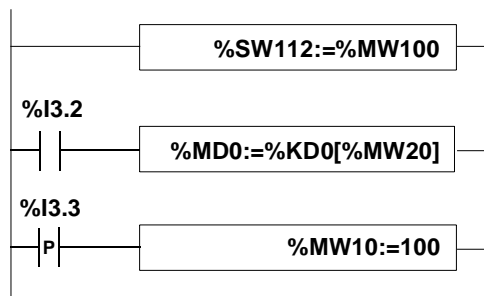
### General

Assignment operations can be performed on the following words:

- word (indexed) -> word (indexed) or double word (indexed) (E.g.: 1)
- double word (indexed) -> double word (indexed) or word (indexed) (E.g.: 2)
- immediate value -> word (indexed) or double word (indexed) (E.g.: 3)

### Structure

#### Ladder language



#### Instruction list language

##### Example 1:

```
LD TRUE
[ %SW112 := %MW100 ]
```

##### Example 2:

```
LD %I3.2
[ %MD10 := %KD0 [%MW20] ]
```

#### Structured text language

##### Example 3:

```
IF %I3.3 THEN
  %MW10 := 100;
END_IF;
```

### Syntax

#### Operator and syntax

Operator	Syntax
:=	Op1:=Op2



## Operands

Type	Operand 1 (Op1)	Operand 2 (Op2)
Indexable words	%MW	%MW,%KW,%Xi.T
Non-indexable words	%QW,%SW,%NW,%BLK	Imm.Val.,%IW,%QW,%SW,%NW,%BLK, Num.expr.
Indexable double words	%MD	%MD,%KD
Non-indexable double words	%QD,%SD	Imm.Val.,%ID,%QD,%SD, Numeric expr.

**Note:** Word <--> double word conversions are made implicitly, during double word --> word assignment, if the double word value cannot be contained in the word, the %S18 bit is set to 1.

It is possible to perform multiple assignments. Example: %MW0 := %MW2 := %MW4

Caution, in the example %MD14 := %MW10 := %MD12, it is not necessarily the case that %MD14 := %MD12, as during the assignment to %MW10, the double word loses its significance due to the double word-single word conversion.

## Arithmetic instructions on integers

### General

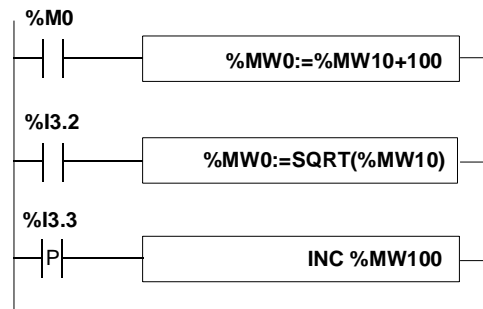
These instructions are used to perform an arithmetic operation between two operands or on one operand.

List of instructions:

<b>+</b>	addition of two operands	<b>SQRT</b>	square root of an operand
<b>-</b>	subtraction of two operands	<b>INC</b>	incrementation of an operand
<b>*</b>	multiplication of two operands	<b>DEC</b>	decrementation of an operand
<b>/</b>	division of two operands	<b>ABS</b>	absolute value of an operand
<b>REM</b>	remainder from the division of 2 operands		

### Structure

#### Ladder language



#### Instruction list language

```
LD %M0
[ %MW0 := %MW10 + 100 ]
```

```
LD %I3.2
[ %MW0 := SQRT (%MW10) ]
```

```
LD %I3.3
[ INC %MW100 ]
```

**Structured text language**

```

IF %M0 THEN
  %MW0 := %MW10 + 100;
END_IF;
IF %I3.2 THEN
  %MW0 := SQRT (%MW10);
END_IF;
IF RE %I1.3 THEN
  INC %MW100;
END_IF

```

**Syntax**

## Operator and syntax

Operator	Syntax
+, -, *, /, REM	Op1 := Op2 Operator Op3
SQRT, ABS	Op1 := Operator(Op2)
INC, DEC	Operator Op1

## Operands

Type	Operand 1 (Op1)	Operand 2 (Op2)
Indexable words	%MW	%MW, %KW, %Xi.T
Non-indexable words	%QW, %SW, %NW, %BLK	Imm.Val., %IW, %QW, %SW, %NW, %BLK, Num.expr.
Indexable double words	%MD	%MD, %KD
Non-indexable double words	%QD, %SD	Imm.Val., %ID, %QD, %SD, Numeric expr.

**Note:** The INC and DEC operations cannot be used in numerical expressions.

**Rules of use**

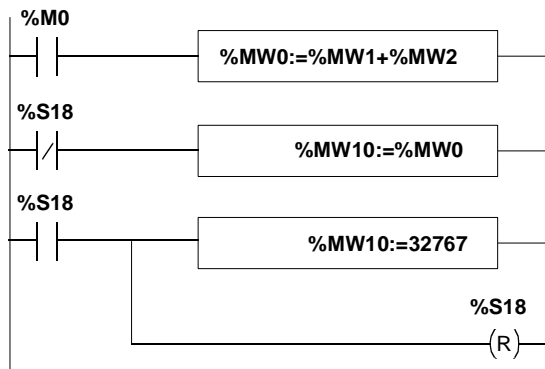
- **Addition: Capacity overflow during operation**

If the result exceeds the limits:

- -32768 or +32767 for a single length operand,
- -2.147.483.648 or +2.147.483.647 for a double length operand.

The %S18 bit (overflow) is set to 1. The result is then not significant.

Bit %S18 is managed by a user program:

**Example in ladder language:****Example in instruction list language:**

```
LD    %M0
[ %MW0 := %MW1 + %MW2 ]
LDN   %S18
[ %MW10 := %MW0 ]
LD    %S18
[ %MW10 := 32767 ]
R     %S18 ]
```

**Example in structured text language:**

```
IF %M0 THEN
    %M0 := %MW1 + %MW2 ;
END_IF ;
IF %S18 THEN
    %MW10 := 32767 ; RESET %S18 ;
ELSE
    %MW10 := %MW0 ;
END_IF ;
```

If %MW1 = 23241 and %MW2 = 21853, the integer result (45094) cannot be expressed in a 16 bit word, bit %S18 is set to 1 and the result obtained (-20442) is incorrect. In this example, when the result is greater than 32767, its value is fixed at 32767.

- **Multiplication:**  
Capacity overflow during operation.  
If the result exceeds the storage word capacity, the %S18 bit (overflow) is set to 1 and the result is not significant.
- **Division/remainder of the division:**  
Dividing by 0.

If the divisor is equal to 0, division is impossible and the %S18 system bit is set to 1. The result is then incorrect.

Capacity overflow during operation.

- **Extracting the square root:**

The square root can only be extracted on positive values. The result is then always positive. If the operand of the square root is negative, the %S18 system bit is set to 1 and the result is incorrect.

**Note:**

- When an operation does not result in an integer (i.e. with a division or square root), the result is truncated (rounded down to the nearest whole number).
  - The sign of the remainder of the division (REM) is that of the numerator.
  - The %S18 system bit is managed by the user program. It is set to 1 by the PLC. It must be reset to 0 by the program in order to be reused (see example below).
-

## Logic instructions

### General

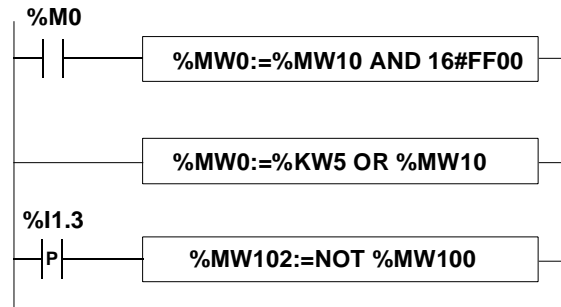
The associated instructions are used to perform a logic operation between two operands or on one operand.

List of instructions:

<b>AND</b>	AND (bit by bit) between two operands
<b>OR</b>	logical OR (bit by bit) between two operands
<b>XOR</b>	exclusive OR (bit by bit) between two operands
<b>NOT</b>	logical complement (bit by bit) of an operand

### Structure

#### Ladder language



#### Instruction list language:

```
LD %M0
[%MW0 := %MW10 AND 16#FF00]
```

```
LD TRUE
[%MW0 := %KW5 OR %MW10]
```

```
LD %I1.3
[%MW102 := NOT %MW100]
```

**Structured text language:**

```

IF %M0 THEN
    %MW0 := %MW10 AND 16#FF00;
END_IF;
%MW0 := %KW5 OR %MW10;
IF %I1.3 THEN
    %MW102 := NOT %MW100;
END_IF;

```

**Syntax**

## Operator and syntax

Operator	Syntax
<b>AND,OR,XOR</b>	Op1:=Op2 Operator Op3
<b>NOT</b>	Op1:=NOT Op2

## Operands

Type	Operand 1 (Op1)	Operand 2 and 3 (Op2, Op3)
Indexable words	%MW	%MW,%KW,%Xi.T
Non-indexable words	%QW,%SW,%NW	Imm.Val.,%IW,%QW,%SW,%NW, %BLK, Num.expr.
Indexable double words	%MD	%MD,%KD
Non-indexable double words	%QD,%SD	Imm.Val.,%ID,%QD,%SD, Numeric expr.

## Numerical expressions

### General

The numerical expression is composed of several numerical operands and the arithmetic and logic operators described above.

There can be an unlimited number of operators and operands in an arithmetic expression.

Example:

```
%MW25*3-SQRT(%MW10)+%KW8*(%MW15 + %MW18)AND16#FF
```

### Application rules

- The operands of a numerical expression can be either of single or double length:

Example:

```
%MW6*%MW15+SQRT(%DW6)/(%MW149[%MW8])+%KD29)AND16#FF
```

- An operand or an operation with only one operand can be preceded by a + or – sign (+ sign by default)

Example:

```
SQRT(%MW5)*-%MW9
```

- All word objects can be used in an arithmetic expression. It is possible to index certain words.

### Instruction execution priority

The priority of the different instructions is respected in the numerical expression. Instructions are executed in the following order:

Execution order:

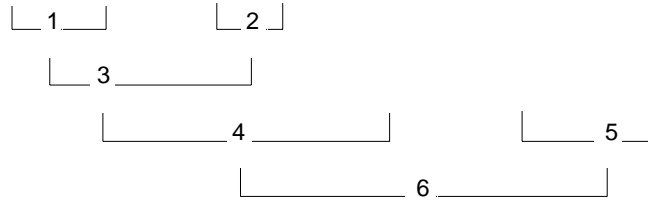
Rank	Instruction
1	Instruction to an operand
2	*,/,REM
3	+,-
4	<,>,<=,>=
5	=,<>
6	AND
7	XOR
8	OR

Example:



The instructions below are carried out in numerical order:

SQRT (%MW3) + %MW5 \* 7 AND %MW8 OR %MW5 XOR %MW10

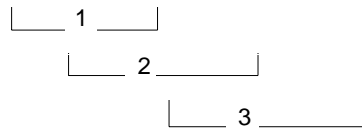


## Brackets

Brackets are used to change the order of priority. It is recommended that they be used to structure numerical expressions.

The example below shows the order of execution of instructions between brackets

((%MW5 AND %MW6) + %MW7) \* %MW8



# 1.5 Program instructions

---

## Introduction

---

**Subject of this sub-section** This sub-section describes PL7 language program instructions.

---

**What's in this Section?** This Section contains the following Maps:

Topic	Page
Subroutine call	67
Subroutine return	69
Jump in the program	71
End of program instructions	74
Program stop	76
Event masking/unmasking instructions	77
NOP Instructions	78

---

---

## Subroutine call

---

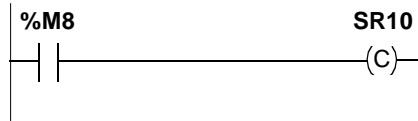
### General

The subroutine call instruction is used to call a subroutine module from the same task.

---

### Structure

**Ladder language:**



**Instruction list language:**

```
LD %M8
SR10
```

**Structured text language:**

```
IF %M8 THEN
  SR10;
END_IF;
```

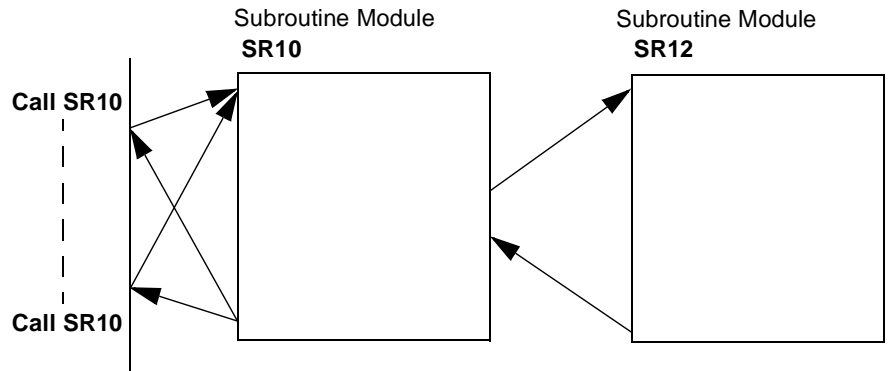
---

### Rules

- The subroutine call can only be performed if the subroutine module has been created beforehand
  - A subroutine is returned on the action immediately following the subroutine call instruction
  - A subroutine can call another subroutine; the number of calls in a cascade is limited to 8
  - The subroutines are assigned to a task, they can only be called from that particular task
-

**Principle**

Subroutine performance principle:



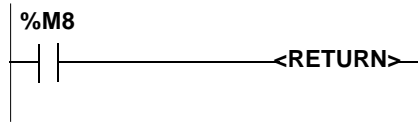
## Subroutine return

### General

The subroutine return instruction is reserved for the subroutine modules and is used for returning to the calling module, if the Boolean result from the previous test instruction is set to 1.

### Structure

#### Ladder language



#### Instruction list language

```
LD %M8
RET
```

#### Structured text language

```
IF %M8 THEN
  RETURN;
END_IF;
```

Instruction list language incorporates the following additional instructions:

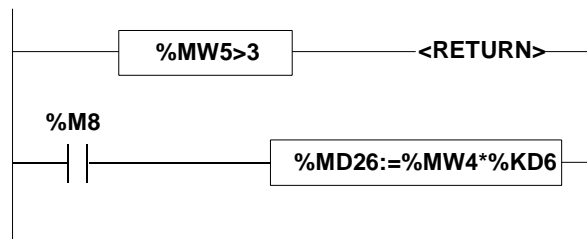
- **RET**: unconditional return of the subroutine.
- **RET**: unconditional return of the subroutine.
- **RET**: return of the subroutine if the Boolean result from the previous test instruction is set to 0.

### Rules of use

The subroutine return instruction is implicit at the end of each subroutine, but can be used for returning to the calling module before the end of the subroutine.

### Examples

#### Ladder language



### Instruction list language

```
LD    [%MW5>3]
RETC
LD    %M8
[%MD26 := %MW4 * %KD6]
```

### Structured text language

```
IF (%M5>3) THEN
    RETURN;
END_IF;
IF %M8 THEN
    %MD26 := %MW4 * %KD6;
END_IF;
```

---

## Jump in the program

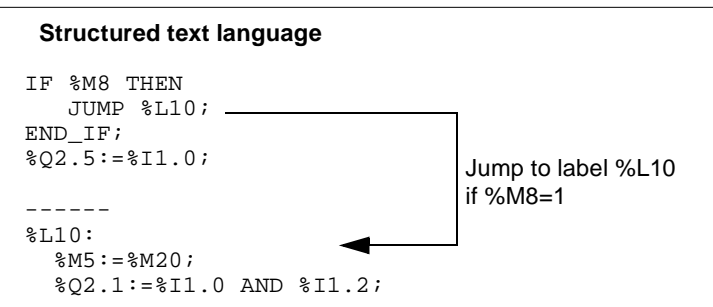
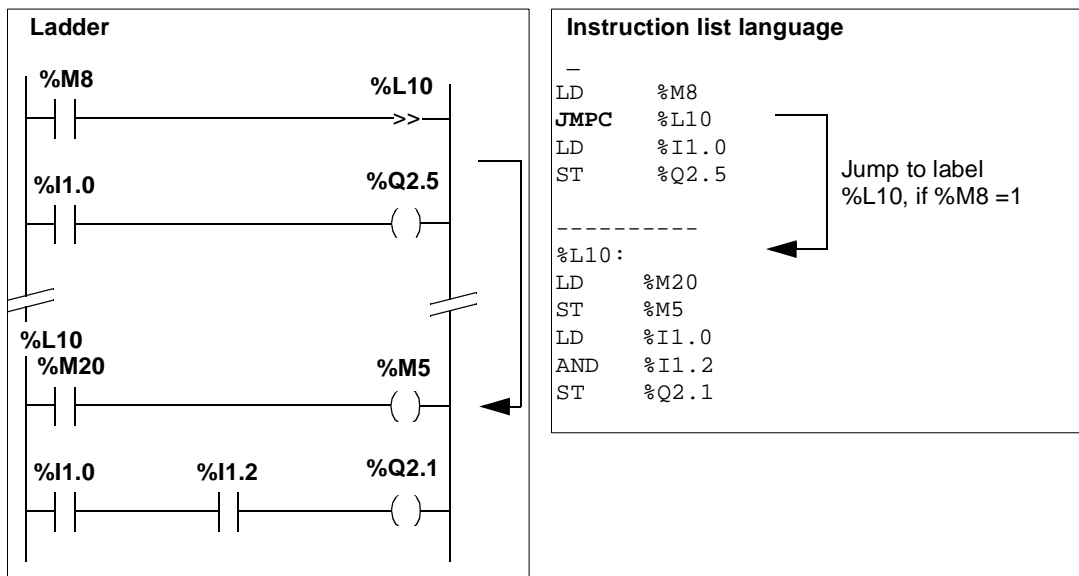
### General

Jump instructions are used to go to a programming line with an %Li label address:

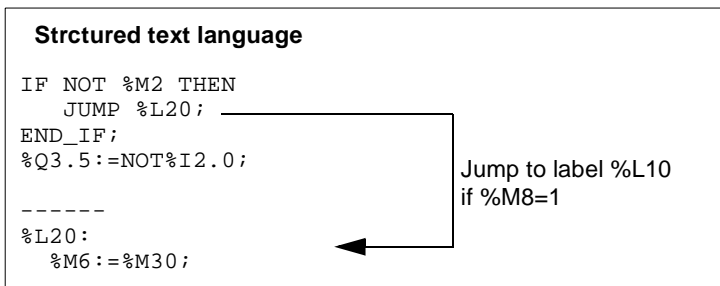
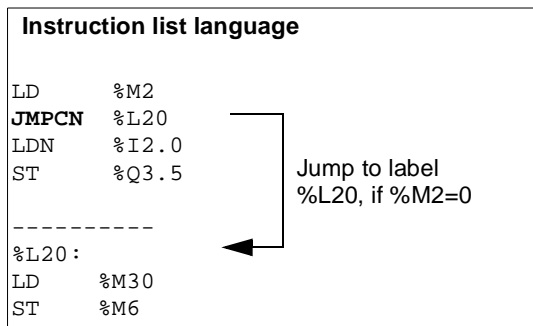
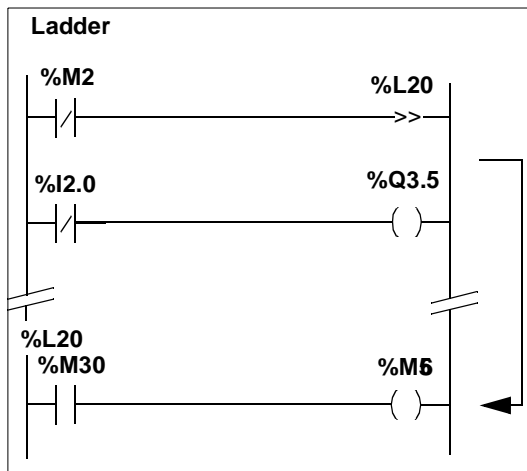
- **JMP**: unconditional program jump
- **JMPC**: program jump if the instruction's Boolean result from the previous test is set at 1
- **JMPCN**: program jump if the instruction's Boolean result from the previous test is set at 0. %Li is the label of the line to which the jump has been made (address i from 1 to 999 with maximum 256 labels)

### Structure

#### JUMPC

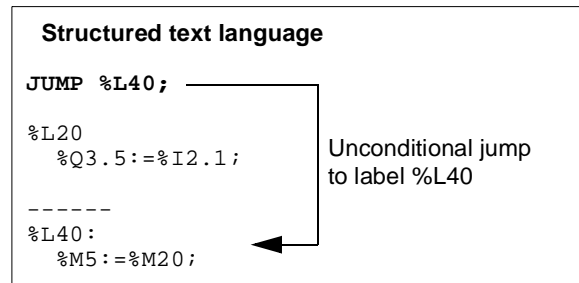
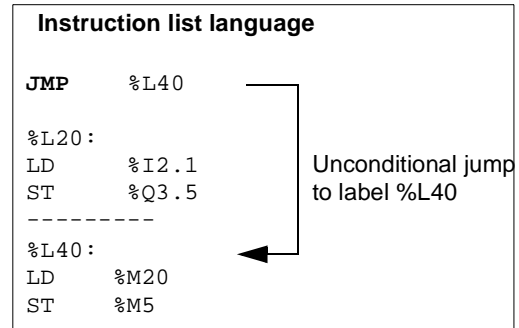
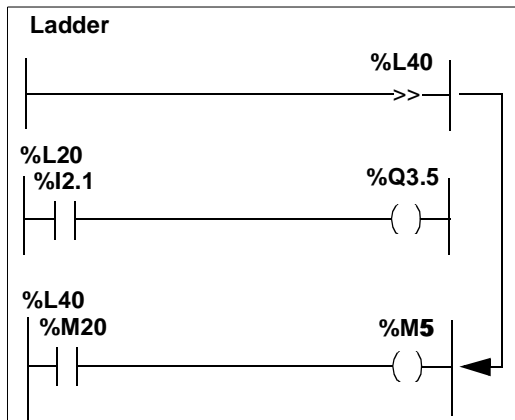


### JUMPCN





## JMP



## Rules

- A program jump takes place inside one particular programming entity (a master task MAIN module, subroutine %SRi, etc.)
- A program jumps to a downstream or upstream programming line  
If it is an upstream jump, close attention should be paid to the program execution time: the program execution time is then extended and can lead to a task period overrun for the task including the upstream jump.

## End of program instructions

### General

The END, ENDC and ENDCN instructions are used to define the end of the program cycle execution:

- **END**: unconditional end of program
- **ENDC**: end of program if the instruction's Boolean result from the previous test is set at 1.
- **ENDCN**: end of program if the instruction's Boolean result from the previous test is set at 0.

### Rules

By default (in normal mode), when the end of program is activated, the outputs are updated and there is a switch to the next cycle.

If the scanning is periodic, the outputs are updated, the end of the period is awaited and then there is a switch to the next cycle.

**Note:** These instructions can only be used in instruction list language in the master task.

### Example

#### Instruction list language

##### Example 1:

```
LD   %M1
ST   %Q2.1
LD   %M2
ST   %Q2.2
-----
```

**END**

##### Example 2:

```
LD   %M1
ST   %Q2.1
LD   %M2
ST   %Q2.2
-----
```

```
LD   %I2.2
```

**ENDC**

```
LD   %M2
ST   %Q2.2
-----
```

**END**

- If %I1.2 = 1, the program scanning ends

- If  $\%I1.2 = 0$ , Scanning continues until the next END instruction
-

## Program stop

---

### General

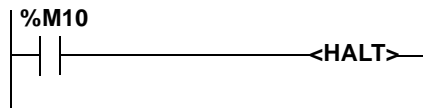
The HALT instruction in an application program is used to stop its execution (stopping all the tasks). This has the effect of freezing the variable objects of this program.

To restart a program stopped in the aforementioned manner, it must be initialized (using the PL7 INIT command). The instructions following the HALT instruction are then not executed.

---

### Structure

#### Ladder language



#### Instruction list language

```
LD    %M10
HALT
```

#### Structured text language

```
IF %M10 THEN
    HALT;
END_IF;
```

---

## Event masking/unmasking instructions

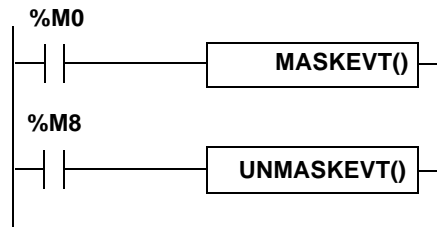
### General

The masking/unmasking instructions are used to mask or unmask all the events which activate event tasks.

- **MASKEVT**: global event masking. The events are stored by the PLC, but the associated event tasks remain inactive whilst the masking operation is enabled (until the next UNMASKEVT instruction).
- **UNMASKEVT**: global event unmasking. The events that were stored during the masking period are processed. The event processing mechanism is operational until the next MASKEVT instruction.

### Structure

#### Ladder language



#### Instruction list language

```
LD %M0
[MASKEVT()]
```

```
LD %M8
[UNMASKEVT()]
```

#### Structured text language

```
IF %M0 THEN
    MASKEVT();
END_IF;
IF %M8 THEN
    UNMASKEVT();
END_IF;
```

## NOP Instructions

---

### General

The **NOP** instruction does not perform any action. It is used to "reserve" lines in a program and thus makes it possible to write instructions without any modification of line numbers.

---

---

# Advanced instructions

# 2

---

## Introduction

### Contents of this section

This section describes the advanced instructions for PL7 language.

### What's in this Chapter?

This Chapter contains the following Sections:

Section	Topic	Page
2.1	Introduction to advanced instructions	81
2.2	Advanced predefined function blocks	82
2.3	Shift instructions	111
2.4	Floating point instructions	113
2.5	Numerical conversion instructions	131
2.6	Word table instructions	143
2.7	Character string instructions	168
2.8	Time management instructions: Dates, Times, Duration	201
2.9	Bit table instructions	235
2.10	"Orpheus" functions: Shift registers, counter	245
2.11	Timing functions	254
2.12	Data storage functions	266
2.13	Grafcet functions	274

---





---

## 2.1 Introduction to advanced instructions

---

### Introduction to the advanced instructions

---

#### General

The instructions described in this chapter are intended for advanced programming needs.

They have the same effects in any language. Only the syntax is different.

These are:

- either standard software instructions,
- or functions considered as extensions of the software.

Instructions for the Function type ranges are used to enhance the basic software using specific programming instructions.

- Operations on character strings, word tables, etc.
  - Task functions: Communication, Regulation, Operator dialog, etc.
- 

#### Instruction families

They consist of the following families:

- Character strings,
- Integer tables,
- Managing dates, times, periods,
- Conversions,
- Bit tables,
- "Orpheus" functions.

The following families are described in the tasks concerned:

- Communication,
- Regulation,
- Operator dialog,
- Movement command.

**Note:** Function type instructions imply additional application memory occupation (only when they are actually used in the program). This memory occupation is to be taken into account by the programmer for each function, whatever their user number, and this is in accordance with the maximum memory size of the reserve PLC.

---

## 2.2 Advanced predefined function blocks

### Introduction

#### Subject of this sub-section

This sub-section describes PL7 language advanced predefined function blocks

#### What's in this Section?

This Section contains the following Maps:

Topic	Page
Introduction to Monostable function block	83
Monostable block function operation	84
Configuring and programming monostable function blocks	85
Introduction to Register function block	87
Register function block operation in FIFO mode	89
Register function block operation in LIFO mode	90
Programming and configuring the Register block function	91
Introduction to the Cyclic Programmer (Drum) function block	93
Cyclic Programmer (Drum) function block operation	95
Programming and configuring the cyclic programmer function block (Drum)	97
Introduction to Timer function block series 7	99
Timer function block series 7 operation	101
Programming the series 7 timer in "Delay on engagement" mode	103
Programming the series 7 timer in "Delay on release" mode	104
Programming the series 7 timer in "Delay accumulated on engagement" mode	105
Programming the series 7 timer in "Delay accumulated on release" mode	107
Introduction to the vertical comparison operation block	109
Operation of vertical comparison operation block	110

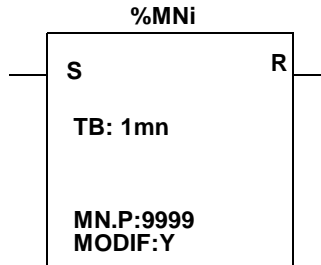
## Introduction to Monostable function block

### General

The monostable function block is used to create a pulse of precise duration. This duration is programmable and may or may not be modifiable using the terminal

### Illustration

Graphic representation of the monostable function block



### Characteristics

Characteristics of the monostable function block

Characteristic	Address	Value
Number	%MNi	0 to 7 for a TSX 37, 0 to 254 for a TSX 57
Time base	TB	1min, 1s, 100ms, 10ms (1mn by default)
Current value	%MNi.V	Word which decreases from %MNi.P to 0 on completion of the timer cycle. May be read, tested but not written.
Preset value	%MNi.P	$0 \leq \%MNi.P \leq 9999$ . Word which can be read, tested and written. The pulse period (PRESET) is equal to: $\%MNi.P \times TB$
MODIF modification	Y/N	<ul style="list-style-type: none"> <li>● Y: possibility to modify the preset value in adjust mode</li> <li>● N: cannot be accessed in adjust mode</li> </ul>
Input "Start" (or instruction)	S (Start)	On the rising edge %MNi.V = %MNi.P then %MNi.V decreases to 0
Output "Monostable"	R (Running)	The associated %MNi.R bit is at 1 if %MNi.V > 0 (monostable "elapsing") %MNi.R = 0 si %MNi.V = 0

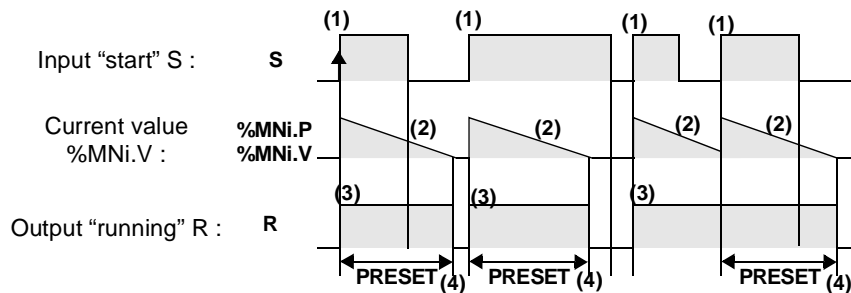
## Monostable block function operation

### General

The monostable function block is used to generate a pulse of precise duration.

### Illustration

Timing diagram illustrating the monostable operation



### Operation

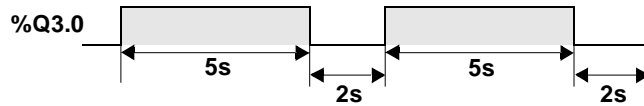
Description of monostable operation

Phase	Description
1	From the appearance of a rising edge on the monostable S input, the current value %MNi.V takes the preset value %MNi.P
2	The current value %MNi.V decreases to 0 by one unit at each pulse of the time base TB.
3	The output bit %MNi.R (Running) associated with the R output moves to state 1 when the current value %MNi.V is different from 0.
4	When the current value %MNi.V = 0, the output bit %MNi.R returns to state 0.

## Configuring and programming monostable function blocks

### Example

Flashing for variable cyclic periods: the preset value of each monostable defines the duration of each pulse.



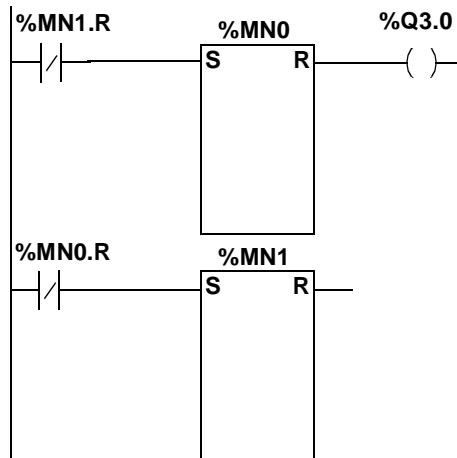
### Configuration

The following parameters are to be entered in the variables editor:

- TB: 1mn, 1s, 100ms, 10ms or 1 ms (100ms in this example)
- %MNi.P: 0 à 9999 (%MN0.P = 50 et %MN1.P = 20 in this example)
- MODIF: Y or N

### Programming

#### Ladder



#### Instruction list language

```
LDN %MN1.R
S %MN0
LD %MN0.R
ST %Q3.0
LDN %MN0.R
S %MN1
```

**Structured text language**

```
%M0 := NOT %MN1.R;  
IF RE %M0 THEN  
  START %MN0;  
END_IF;  
%Q3.0 := %MN0.R;  
%M1 := NOT %MN0.R;  
IF RE %M1 THEN  
  START %MN1;  
END_IF;
```

In the example below, the output %Q3.0 is set at state 1 for 5s (%MN0.P) and reset at state 0 for 2s (%MN1.P).

---

**Observations**

- In structured text language, the instruction `START%MNi` is used to initiate execution of the monostable function block. This instruction forces a rising edge on the S input of the block, which has the effect of resetting the function block. Use of this instruction must therefore be pulse-based.
  - The monostable function may also be carried out by the %TMi function block in TP mode (See *Operation of timer function block %TMi in TP mode, p. 38*).
- 

**Specific cases**

- **Incidence of a "cold restart":** (%S0 = 1) loads the preset value %MNi.P in the current value %MNi.V. Since the preset value, which may have been altered by the terminal, has been lost, the output %MNi.R is reset to 0.
  - **Incidence of a "warm restart":** There is no incidence of (%S1) on the current value of the monostable (%MNi.V).
  - **Incidence of a switch into stop mode, deactivation of the task and breakpoint:** the switch of the PLC into stop mode does not freeze the current value. The same applies when the current task is deactivated or on execution of a breakpoint.
  - **Incidence of a program jump:** Not polling the network in which the monostable block is programmed does not freeze the current value %MNi.V which continues to decrease to 0. Similarly, the %MNi.R bit associated to the monostable block output maintains its normal operation and can thus be tested on another network. However the spools which are directly connected to the block output (ex %Q3.0) are not activated since they are not examined by the PLC.
  - **Test of %MNi.R bit :** this bit can change state during its cycle.
-

## Introduction to Register function block

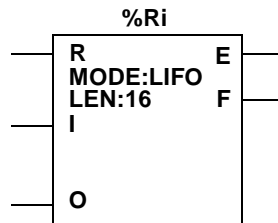
### General

A register is a memory block which is used to store up to 255 words of 16 bits in two different ways:

- queue (first in, first out) called FIFO stack (First In, First Out)
- queue (last in, first out) called the LIFO stack (Last In, First Out)

### Illustration

The following is the graphic presentation of the register function block:



### Characteristics

Characteristics of the Register function block:

Characteristic	Address	Value
Number	%Ri	0 to 3 for a TSX 37, 0 to 254 for a TSX 57
Mode	FIFO LIFO	Stack Queue (choice by default)
Length	LEN	Number of words of 16 bits (1 < LEN < 255) making up the register memory block.
Input word	%Ri.I	Access word for register. May be read, tested and written.
Output word	%Ri.O	On a rising edge, causes an information word to be stored in the word %Ri.O
Input (or instruction) "Store"	I (In)	On a rising edge, causes the contents of the word %Ri.I to be stored
Input (or instruction) "Destore"	O (Out)	On a rising edge, causes an information word to be stored in the word %Ri.O
Input (or instruction) "Resetting to zero"	R (Reset)	At state 1, initiates the register
Output "Empty"	E (Empty)	E associated %Ri.E bit indicates that the register is empty. May be tested.
Output "Full"	F (Full)	The associated %Ri.F bit indicates that the register is full. May be tested.

**Note:** When the two inputs I and O are activated simultaneously, storage is carried out before the destocking.

---



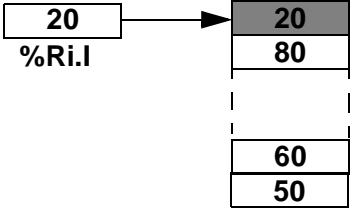
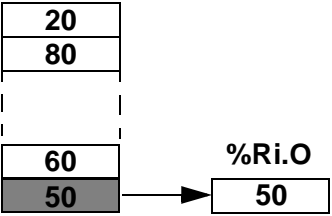
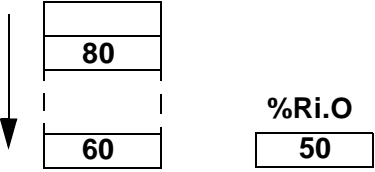
## Register function block operation in FIFO mode

### General

In FIFO mode (First IN – First Out), the first information input in the register stack is the first output.

### Operation

This table describes the operation of the FIFO mode

Step	Description
1	<p>On a rising edge on the input I or on activation of instruction I, the content of the previously loaded input word %Ri.I is stored at the top of the stack. When the stack is full, loading is impossible and the system bit %S18 switches to 1.</p> 
2	<p>On a rising edge on the input O or on activation of instruction O, the information word which is lowest in the queue is stored in the output word %Ri.O.</p> 
3	<p>Once the word has been transferred into Ri.O, the contents of the register are shifted down one step. When the register is empty (output E=1) destocking is impossible. The output word %Ri.O moves no more and maintains its value. The stack can be reset at any time (state 1 on input R or activation of instruction R).</p> 

## Register function block operation in LIFO mode

### General

In LIFO mode (Last In - First Out), the last information input in the register stack is the first output.

### Operation

This table describes the operation of the FIFO mode

Step	Description	
1	On a rising edge on the input I or on activation of instruction I, the contents of the previously loaded input word %Ri.I is stored at the top of the stack. When the stack is full, loading is impossible and the system bit %S18 switches to 1.	
2	On input O rising edge or on instruction O activation, the information word which is highest in the stack (last input information) is stored in the output word %Ri.O.	
3	As soon as the word is transferred into Ri.O, the following register word is available. When the register is empty (output E=1) destocking is impossible. The output word %Ri.O moves no more and maintains its value. The stack can be reset at any time (state 1 on input R or activation of instruction R).	

## Programming and configuring the Register block function

### Example

The following example shows the loading of %R2.I with the word %MW34 on request from input %I1.2, if the register R2 is not full (%R2.F=0). The input request to the register is assured by %M1. The output request is made by input %I1.3 and the storage of %R2.O in %MW20 is carried out if the register is not empty (%R2.E=0).

### Configuration

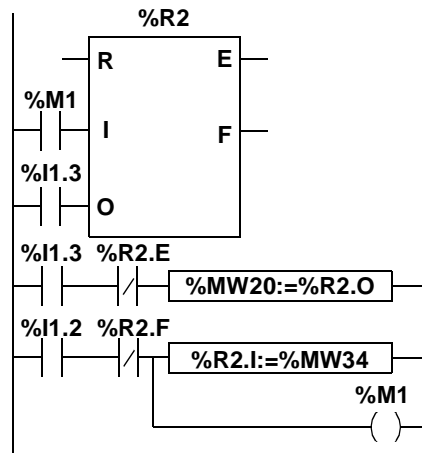
The following parameters are to be entered in the configuration editor:

- Number: 1 to 4 for a TSX 37, 1 to 255 for a TSX 57
- Length: 1 to 255

The operation mode (FIFO or LIFO) is to be entered in the variables editor.

### Programming

#### Ladder



#### Instruction list language

```
LD %M1
I %R2
LD %I1.3
O %R2
LD %I.3
ANDN %R2.E
[%MW20:=%R2.O]
LD %I.2
ANDN %R2.F
[%R2.I:=%MW34]
ST %M1
```

**Structured text language**

```
IF RE %M1 THEN
  PUT %R2;
END_IF;
IF RE %I1.3 THEN
  GET %R2;
END_IF;
IF (%I1.3 AND NOT %R2.E) THEN
  %MW20 := %R2.O;
END_IF;
%M1 := %I1.2 AND NOT %R2.F;
IF %M1 THEN
  %R2.I := %MW34;
END_IF;
```

**Note**

In structured text language, 3 instructions are used to program the register function blocks:

- **RESET** %Ri: Initialize register
- **PUT** %Ri: Causes the content of word %R.I to be stored in the register.
- **GET** %Ri: Causes an information word to be stored in word %Ri.O

The instructions PUT and GET create a rising edge, on the function block inputs I and O respectively. Use of this instruction must therefore be pulse-based

**Specific cases**

- **Incidence of a "cold" restart:** (%S0=1) initializes the contents of the register. The output bit %Ri.E associated with the output E is set to 1.
- **Incidence of a "warm" restart:** There is no incidence of (%S1=1) on the contents of the register, or on the status of the output bits.
- **On reset to 0** (input R or instruction R)
  - In ladder, the input I and O logs are updated with the wired values.
  - In instruction list language, the input I and O logs are not updated: each retains the value which it had before the call.
  - In structured text language, the input I and O logs are updated with 0.

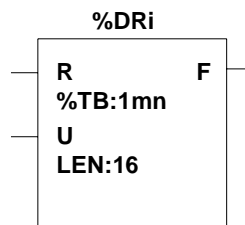
## Introduction to the Cyclic Programmer (Drum) function block

### General

With a similar operating principle to the cam programmer, the cyclic programmer changes step according to external events. At each step, the upper point of a cam gives a command processed by the automatic operation. In the case of a cyclic programmer, these upper points are symbolized by a state 1 at the level of each step and are assigned to the output bits %Qi.j or internal bits %Mi called the command bits.

### Illustration

Graphic representation of the Cyclic Programmer function block (Drum)



### Characteristics

Characteristics of the cyclic programmer function block

Characteristic	Address	Value
Number	%DRi	0 to 7 for a TSX 37, 0 to 254 for a TSX 57
Number of steps	LEN	1 to 16 (16 by default).
Time base	TB	1mn, 1s, 100ms, 10ms (1mn by default).
Time out or duration of current step	%DRi.V	$0 \leq \%DRi.V \leq 9999$ . Word which can be reset to zero at each change of step. May be read, tested but not written. The pulse period is equal to $\%DRi.V \times TB$
Number of step in progress	%DRi.S	$0 \leq \%Di.S \leq 15$ . Word which can be read and tested. Can only be written from an immediate value.
Input "return to step 0"	R (RESET)	At state 1, initialize the programmer at step 0
Input "advance"	U (UP)	On rising edge, causes the programmer to advance one step and the command bits to be updated.

Characteristic	Address	Value
Output	F (FULL)	Indicates that the last defined step is in progress. The associated %DRi.F bit can be tested (%DRi.F=1 if %DRi.S=number of configured steps -1).
Status of a step	%DRi.Wj	16 bit word defining the status of step j of the programmer i. May be read, tested but not written.
Command bits	%DRi.Wj	Outputs or internal bits associated with the step (16 command bits)

**Note:** The %S18 bit switches to 1, if an unconfigured step is written.

---

## Cyclic Programmer (Drum) function block operation

### General

The cyclic programmer comprises:

- a matrix of constant data (cams) organized in columns: in steps from 0 to N-1 (N being the number of configured steps), each column gives the status of the step in the form of 16 pieces of binary information listed from 0 to F,
- a list of command bits (1 per line) corresponding to the outputs %Qxy.i or to the internal bits %Mi. When a step is in progress, the command bits take the binary status defined for this step.

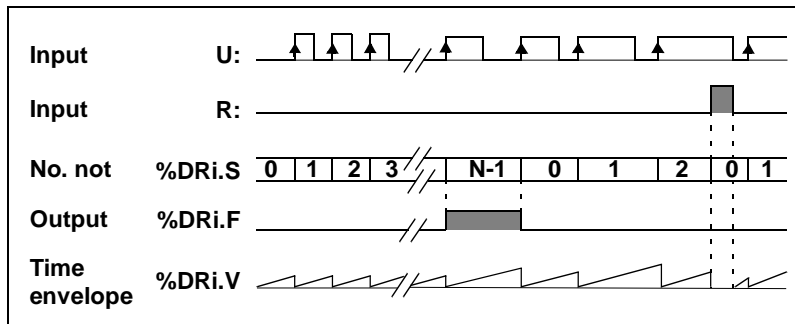
### Illustration

The table below summarizes the main characteristics of the cyclic programmer (programmer configured with 16 steps)

		Step																Address
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
BIT	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	%Q2.1
	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	%Q2.3
	2	1	1	0	0	0	0	0	0	1	0	1	0	0	1	0	0	%Q3.5
	3	2	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	%M0
	4	0	0	1	0	1	0	0	0	0	0	0	0	0	1	1	1	%M10
	5	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	%Q2.6
	6	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	%Q2.7
	7	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	%Q2.8
	8	0	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	%M20
	9	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	%M30
	A	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	%Q2.9
	B	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	1	%Q3.6
	C	1	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	%M5
	D	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	%M6
	E	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	%M7

In the example below, for step 1, the command bits %Q2.1;%Q3.5 ;%Q2.8;%Q3.6;%M5 and %M6 are set at state 1; the other command bits are set at 0.

**Diagram of operation**



The number of the step in progress is incremented at each rising edge on the input U (or activation of instruction U). This number may be modified by program.



## Programming and configuring the cyclic programmer function block (Drum)

### Example

In this example, the first 5 outputs from %Q2.0 to %Q2.4 are activated one after the other, each time the input %I1.1 is set to 1. The input I1.0 resets the outputs at step 0.

### Configuration

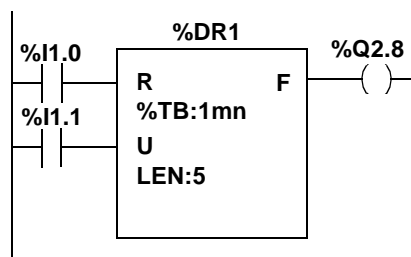
The following information is defined in the variables editor:

- number of steps: (LEN:5),
- time base (TB: 1mn),
- state of outputs (command bits) for each step of the programmer.

Step:	
	0 1 2 3 4
0:	1 0 0 0 0 %Q2.0
1:	0 1 0 0 0 %Q2.1
<b>Bits:</b> 2:	0 0 1 0 0 %Q2.2
3:	0 0 0 1 0 %Q2.3
4:	0 0 0 0 1 %Q2.4

### Programming

#### Ladder language



#### Instruction list language

```
LD %I1.0
R %DR1
LD %I1.1
U %DR1
LD %DR1.F
ST %Q2.8
```

**Structured text language**

```
IF %I1.0 THEN
  RESET %DR1;
END_IF;
IF RE %I1.1 THEN
  UP %DR1;
END_IF;
%Q2.8 := %DR1.F;
```

---

**Observations**

In structured text language, 2 instructions are used to program the cyclic programmer function blocks:

- RESET %DRi: Initialize the programmer to step 0,
- UP %DRi: Causes the programmer to advance one step and the command bits to be updated. This instruction creates a rising edge on the function block input U; its use must therefore be pulse-based.

**Note:** On reset to 0 (input R, instruction R or instruction RESET):

- In ladder language, the input U archive is updated with the connected values.
  - In instruction list language, the input U archive is not updated; it retains the values it had before the call.
  - In structured text language, the U archive is updated with 0.
- 

**Specific cases**

- **Incidence of a "cold restart":** (%S0=1) resets the programmer to step 0 (and updates the command bits).
  - **Incidence of a "warm restart":** (%S1=1) resets the command bits, according to the step which is in progress.
  - **Incidence of a program jump, deactivation of the task and breakpoint:** not polling the cyclic programmer does not cause the command bits to reset to 0.
  - **The command bits** :are only updated when the step changes or on a warm or cold restart.
-

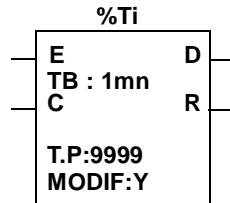
## Introduction to Timer function block series 7

### General

This timer function block which is compatible with blocks of series 7 PL7-2/3 is used to give timed commands for specific actions. This value of this time delay is programmable and can be modified if necessary by the terminal.

### Illustration

Graphic representation of the timer function block series 7



### Characteristics

Characteristics of the timer function block series 7

Characteristic	Address	Value
Number	%Ti	0 to 63 for a TSX 37, 0 to 254 for a TSX 57
Time base	TB	1min, 1s, 100ms, 10ms (1mn by default)
Current value	%Ti.V	Word which decreases from %Ti.P to 0 on completion of the timer cycle. May be read, tested but not written.
Preset value	%Ti.P	$0 \leq \%Ti.P \leq 9999$ . Word which can be read, tested and written. Is set at the value of 9999 by default. The pulse period is equal to %Ti.P x TB.
MODIF modification	Y/N	<ul style="list-style-type: none"> <li>● Y: possibility to modify the preset value in adjust mode.</li> <li>● N: cannot be accessed in adjust mode.</li> </ul>
Input "Activation"	E(Enable)	At state 0, reset the timer %Ti.V = %Ti.P.
Input "Control"	C(Control)	At state 0, freeze the current value %Ti.V.
Output "Timer cycle complete"	D(Done)	The associated bit %Ti.D = 1, if the timer cycle is complete %Ti.V = 0.
Output "Timer cycle complete"	R(Running)	The associated bit %Ti.R = 1, if the timer %Ti.P > %Ti.V > 0 and if input C is at state 1.

**Note:** The function blocks %Ti are not programmable in an instruction list; however the block items %Ti (%Ti.V, %Ti.P, %Ti.D and %Ti.R) can be accessed. The total number of %Tmi + %Ti must be less than 64 on the TSX 37 and 255 on the TSX 57.

---

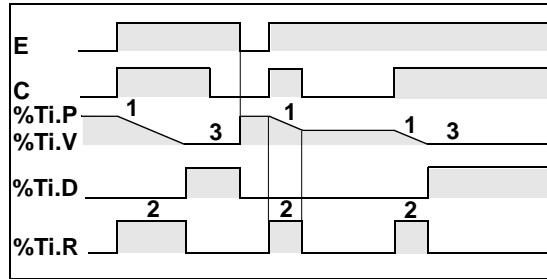
## Timer function block series 7 operation

### General

The timer runs when its 2 inputs (E and C) are at state 1. It works as a down counter

### Illustration

Diagram of operation of the series 7 timer



E	0	0	1	1
C	0	1	0	1
%Ti.V	%Ti.V = %Ti.P	%Ti.V = %Ti.P	%Ti.V frozen	%Ti.V fall in %Ti.P -> 0
%Ti.D	0	1	0	1 if Time elapsed
%Ti.R	0	1	0	1 if Time in progress

### Operation

Description of operation

Phase	Description
1	The current value %Ti.V decreases by one unit from the preset value %Ti.P to 0 at each pulse of the time base TB.
2	The output bit %Ti.R (Timer in progress) associated with the R output is then at state 1, the output bit %Ti.D (Timer cycle complete) associated with the D output is at state 0,
3	When the current value %Ti.V=0, %Ti.D changes to state 1 and %Ti.R returns to state 0.

**Instructions**

In structured text language, 3 instructions are used to program the timer function blocks %Ti

- PRESET %Ti: Resets the timer
  - START %Ti: Starts the timer cycle
  - STOP %Ti: Freezes the current value of the timer
-

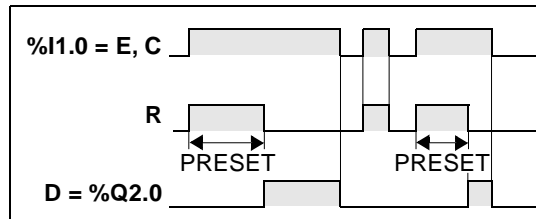
## Programming the series 7 timer in "Delay on engagement" mode

### General

The "Timer" function block can carry out different functions, according to how it has been programmed. The "delay on engagement" function is described here

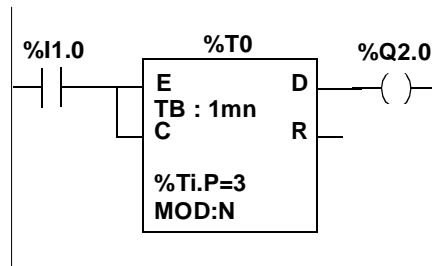
### Illustration

Diagram of operation of the "delay on engagement" function



### Programming

#### Programming in ladder language



#### Programming in structured text language

```
IF %I1.0 THEN
  START %T0;
ELSE
  PRESET %T0;
END_IF;
%Q2.0 := %T0.D;
```

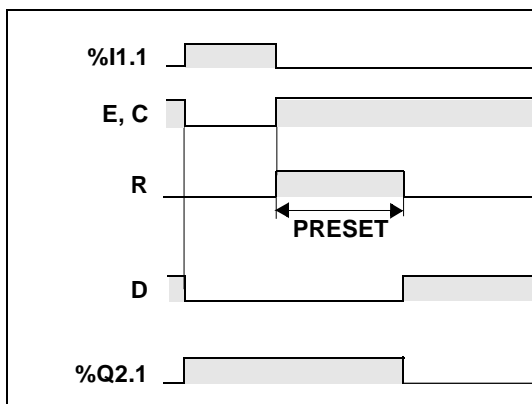
## Programming the series 7 timer in "Delay on release" mode

### General

The "Timer" function block can carry out different functions, according to how it has been programmed. The "delay on release" function is described here.

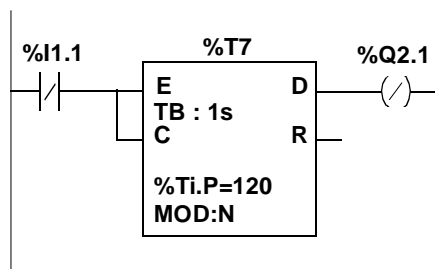
### Illustration

Diagram of operation of the "delay on release" function



### Programming

#### Programming in ladder language



#### Programming in structured text language

```

IF %I1.1 THEN
  PRESET %T7;
ELSE
  START %T7;
END_IF;
%Q2.1 := NOT%T7.D;
    
```



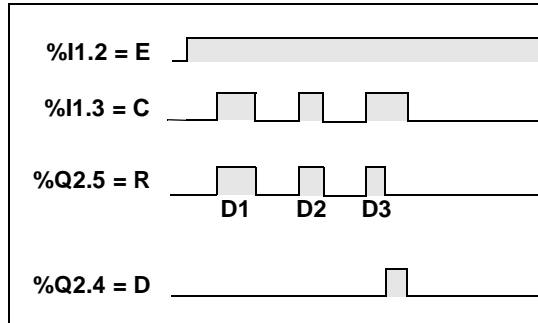
## Programming the series 7 timer in "Delay accumulated on engagement" mode

### General

The "Timer" function block can carry out different functions, according to how it has been programmed. The "delay accumulated on engagement" function is described here.

### Illustration

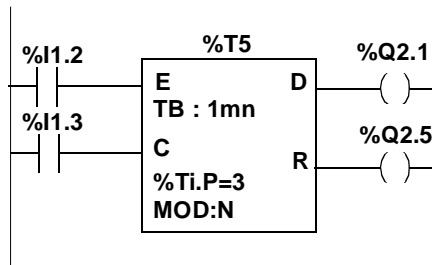
Diagram of operation of the "delay accumulated on engagement" function



$$\text{PRESET} = D1 + D2 + D3$$

### Programming

#### Programming in language data



### Programming in structured text language

```
IF %I1.2 THEN
IF %I1.3 THEN
    START %T5;
ELSE
    STOP %T5;
END_IF;
ELSE
    PRESET %T5;
END_IF;
%Q2.4 := %T5.D;
%Q2.5 := %T5.R;
```

---

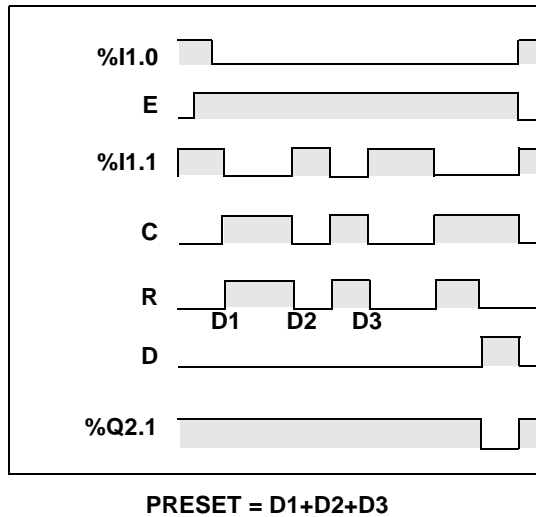
## Programming the series 7 timer in "Delay accumulated on release" mode

### General

The "Timer" function block can carry out different functions, according to how it has been programmed. The "delay accumulated on release" function is described here.

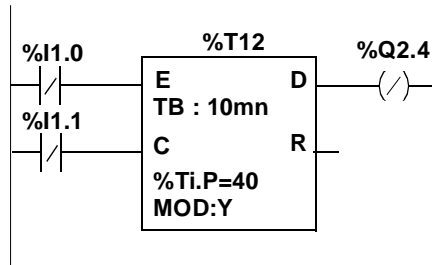
### Illustration

Diagram of operation of the "delay accumulated on release" function



### Programming

#### Programming in language data



### Programming in structured text language

```
IF %I1.0 THEN
  PRESET %T12;
ELSE
  IF %I1.1 THEN
    STOP %T12;
  ELSE
    START %T12;
  END_IF;
END_IF;
%Q2.4 := NOT %T12.D;
```

---

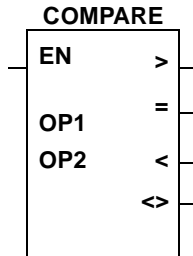
## Introduction to the vertical comparison operation block

### General

The vertical comparison block is used to compare 2 operands (OP). These 2 operands are words of 16 possibly indexed bits, or words of immediate value. The number of vertical comparison blocks is not limited and is not enumerated.

### Illustration

Graphic representation of the vertical comparison operation block



### Characteristics

Characteristics of the vertical comparison operation block

Characteristic	Ad- dress	Value
Command input	EN	At state 1, compares the two operands.
Output "Greater"	>	Is at state 1 if the content of the OP1 is greater than that of OP2.
Output "Equal"	=	Is at state 1 if the content of the OP1 is equal to that of OP2.
Output "Less"	<	Is at state 1 if the content of the OP1 is less than that of OP2.
Output "Different"	<>	Is at state 1 if the content of the OP1 is different from that of OP2.
Operand number 1	OP1	This operand is a single length word object (it may be indexed).
Operand number 2	OP2	This operand is a single length word object (it may be indexed).

## Operation of vertical comparison operation block

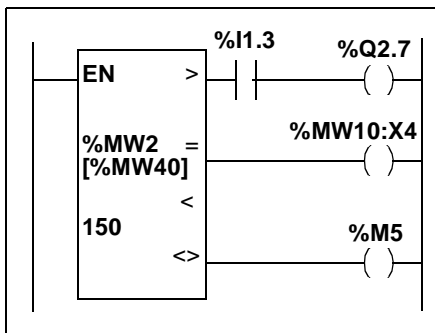
### Operation

Setting the command input to 1 compares the two operands; the four outputs are activated according to the result of the comparison. Setting the command input to 0 sets the activated outputs to zero.

### Example

The program below shows the comparison of the word %MW2 indexed by the word %MW40 and of the immediate value of 150. In this case where the content of %MW2[%MW40] is greater than 150 and if %I1.3 = 1, spool %Q2.7 is commanded. If the content is equal to 150, spool %MW10:X4 is commanded. Spool %M5 is only controlled if the content is different from 150 (< or >).

### Ladder language



**Note:** This function block does not exist in instruction list language or in structured text language. Use the comparison operations >, <, =, <>.

### Specific cases

- **Incidence of a "cold" restart:** (%S0) resets the operand OP1 and possibly OP2 (if OP2 is an internal word) to zero, the outputs are activated according to the comparison with the new values.
- **Incidence of a "warm" restart:** There is no incidence of (%S1) on the comparison block.

## 2.3 Shift instructions

### Shift instructions

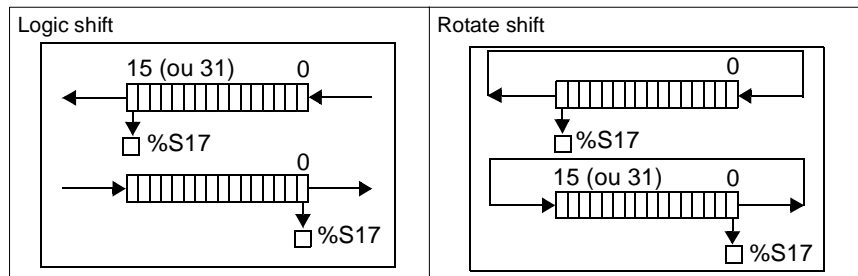
#### General

The shift instructions involve moving the bits of a word or double word operand by a number of positions to the right or left. There are two types of shift:

- **the logic shift:**
  - SHL(op2,i) logic shift of i positions towards the left.
  - SHR(op2,i) logic shift of i positions towards the right.
- **the rotate shift:**
  - ROL(op2,i) rotate shift of i positions towards the left.
  - ROR(op2,i) rotate shift of i positions towards the right.

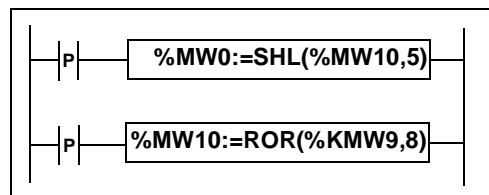
If the operand which is to be shifted is a simple length operand, the variable i will be between 1 and 16. If the operand which is to be shifted is a double length operand, the variable i will be between 1 and 32. The state of the last output bit is memorized in the %S17 bit.

Illustration of the two types of shift:



#### Structure

Ladder language:



Instruction list language:

```
LDR %I1.1
[ %MW0 := SHL( %MW10 , 5 ) ]
```

**Structured text language:**

```
IF RE%I1.2 THEN
  %MW10 := ROR( %KW9 , 8 ) ;
END_IF;
```

---

**Syntax**

Operators: SHL, SHR, ROL, ROR

Operands:

Type	Operand 1 (Op1)	Operand 2 (Op2)
Words which can be indexed	%MW	%MW, %KW, %Xi.T
Words which can not be indexed	%QW, %SW, %NW, %BLK	Imm.val., %IW, %QW, %SW, %NW, %BLK, Expr. num.
Double words which can be indexed	%MD	%MD, %KD
Double words which can not be indexed	%QD, %SD	Imm.val., %ID, %QD, %SD, Expr. num.

Syntax: Op1:=Operator(Op2,i)

---



---

## 2.4 Floating point instructions

---

### Introduction

---

#### Subject of this sub-section

This sub-section describes PL7 language floating point instructions.

---

#### What's in this Section?

This Section contains the following Maps:

Topic	Page
Floating point instructions	114
Floating point comparison instructions	117
Assign instructions on the floating point	119
Arithmetic instructions on a floating point	121
Logarithmic et exponential instructions	123
Trigonometric instructions	125
Conversion instructions	127
Rounding off a floating point value in ASCII format	129

---

## Floating point instructions

### General

Operations on floating objects can be carried out with PL7 software.

The floating format used is the standard IEEE STD 734-1985 (equivalent IEC 559). The length of the words is 32 bits, which corresponds to the single decimal point floating numbers.

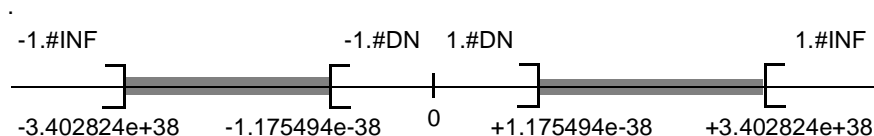
The floating values can be represented with or without exponent; they must always have a decimal point (floating point).

Examples of floating values:

without exponent: 1285.28

with exponent: 1.28528e3

Floating values range from  $-3.402824e+38$  and  $-1.175494e-38$  to  $1.175494e-38$  and  $3.402824e+38$  (grayed out values on the diagram). They also have the value 0, written 0.0



When a calculation result is between  $-1.175494e-38$  and  $1.175494e-38$ , it is rounded off to 0. A value within this range cannot be entered as a floating point value if it is entered in another format; the symbol  $1.\#DN$  or  $-1.\#DN$  will be displayed.

When a calculation result is:

- less than  $-3.402824e+38$ , the symbol  $-1.\#INF$  (for -infinite) is displayed
- greater than  $+3.402824e+38$ , the symbol  $1.\#INF$  (for +infinite) is displayed

When the result of an operation is undefined (for example square root of a negative number), the symbol  $1.\#NAN$  or  $-1.\#NAN$  is displayed.

When the result is not within the valid range, the system bit  $\%S18$  is set to 1.

The status word  $\%SW17$  bits indicate the cause of an error in a floating operation:

Different bits of the word SW17:

%SW17:X0	Invalid operation, result is not a number (1.#NAN or -1.#NAN)
%SW17:X1	Non-standardized operand (between -1.175494e-38 and 1.175494e-38), result is rounded off to 0.
%SW17:X2	Divided by 0, result is infinite (-1.#INF or 1.#INF)
%SW17:X3	Result greater in absolute value than +3.402824e+38, result is infinite (-1.#INF or 1.#INF)
%SW17:X4	Result less than 1.175494e-38, result is 0.
%SW17:X5	Imprecise result

This word is reset to 0 by the system on cold start, and also by the program for re-usage purposes.

Representation precision is 2-24. To display floating point numbers, it is unnecessary to display more than 6 digits after the decimal point.

**Note:**

- the value "1285" is interpreted as a whole value; in order for it to be recognized as a floating point value, it must be written thus: "1285.0"
- instructions for Integer <--> Floating conversion are used to move from one format to another.

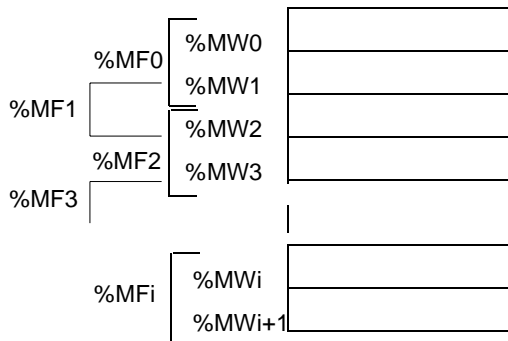
**Addressing floating objects**

Abbreviations	Complete addressing	Type of floating point	Access	Indexed form
Imm.val.	-	Immediate values	R	-
%MF	%MFi	Internal floating point	R/W	%MFi[index]
%KF	%KFi	Floating constant value	R	%KFi[index]

**Possibility of overlap between objects:**

Single, double length and floating words are stored inside the data space in one memory zone. Thus, the floating word %MFi corresponds to the single length words %MWi and %MWi+1 (the word %MWi containing the least significant bits and the word %MWi+1 the most significant bits of the word %Mfi).

Illustration:



**Example:**

%MF0 corresponds to %MW0 and %MW. %KF543 corresponds to %KW543 and %KW544.

---

## Floating point comparison instructions

### General

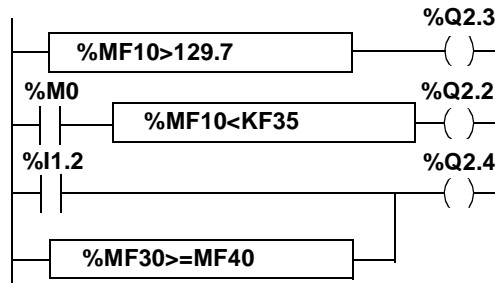
The comparison instructions are used to compare two operands.

>	test if operand 1 is above operand 2,
>=	test if operand 1 is above or equal to operand 2,
<	test if operand 1 is below operand 2,
<=	test if operand 1 is below or equal to operand 2,
=	test if operand 1 is equal to operand 2,
<>	test if operand 1 is different from operand 2

The result is at 1 when the requested comparison is true.

### Structure

#### Language data



The comparison blocks program themselves in the test zone

#### Instruction list language

```
LD [%MF10>129.7]
ST %Q2.3
LD %M0
AND [%MF10<KF35]
ST %Q2.2
LD %I1.2
OR [%MF30>=MF40]
ST %Q2.4
```

The comparison is made inside the fasteners behind the LD, AND and OR instructions.

**Structured text language**

%Q2.3 := %MF10 > 129.7 ;

%Q2.2 := ( %MF20 < %KF35 ) AND %M0 ;

%Q2.4 := ( %MF30 >= %MF40 ) OR %I1.2 ;

**Syntax**

Operators: > , >= , < , <= , = , <>

Operands:

Type	Operands 1 and 2 (Op1 and Op2)
Floating points which can be indexed	%MF,%KF
Floating point which can not be indexed	Immediate floating point value, Digital floating point expression

**Note:** In instruction list language, the comparison instructions can be used within the brackets.

## Assign instructions on the floating point

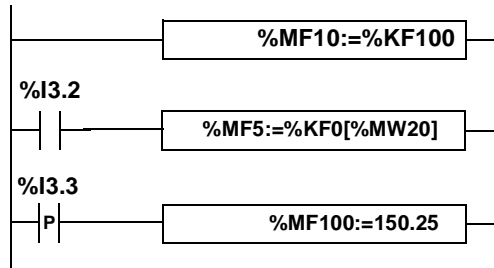
### General

The assignment operations can be performed on the following floating points:

- floating point (indexed) -> floating point (indexed). See e.g. 1
- immediate floating point value -> floating point (indexed). See e.g. 2

### Structure

Language data:



Instruction list language:

#### E.g. 1

```
LD TRUE
[%MF10 := %KF10]
```

```
LD %I3.2
[%MF5 := %KF0 [%MW20]]
```

#### E.g. 2

```
LDR %I3.3
[%MF100 := 150.25]
```

Structured text language:

#### E.g. 1

```
%MF10 := %KF10;
IF %I3.2 THEN
    %MF5 := %KF0 [%MW20];
END_IF;
```

#### E.g. 2

```
IF RE %I1.3 THEN
    %MF100 := 150.25;
END_IF;
```

**Syntax**

Operators: :=

Operands:

Type	Operands 1 (Op1)	Operands 2 (Op2)
Floating points which can be indexed	%MF	%MF, %KF
Floating point which can not be indexed		Immediate floating point value, Digital floating point expression

Syntax: Op1:=Op2

**Note:** It is possible to perform multiple assignments. Example:%MF0 := %MF2 := %MF4

---



## Arithmetic instructions on a floating point

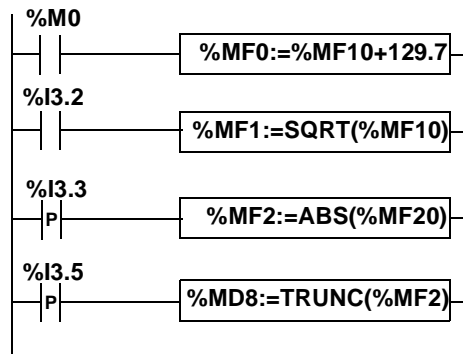
### General

These instructions are used to perform an arithmetic operation between two operands or on one operand.

+	addition of two operands	SQRT	square root of an operand
-	subtraction of two operands	ABS	absolute value of an operand
*	multiplication of two operands	TRUNC	whole part of a floating point value
/	division of two operands		

### Structure

#### Ladder language



#### Instruction list language

```

LD %M0
[ %MF0 := %MF10 + 129.7 ]

LD %I3.2
[ %MF1 := SQRT ( %MF10 ) ]

LDR %I3.3
[ %MF2 := ABS ( %MF20 ) ]

LDR %I3.5
[ %MD8 := TRUNC ( %MF2 ) ]
  
```

**Structured text language**

```

IF %M0 THEN
  %MF0 := %MF10 + 129.7 ;
END_IF ;
IF %I3.2 THEN
  %MF1 := Sqrt (%MF10) ;
END_IF ;
IF %I3.3 THEN
  %MF2 := ABS (%MF20) ;
END_IF ;
IF %I3.2 THEN
  %MD8 := TRUNC (%MF2) ;
END_IF

```

**Syntax**

Operators and syntax of arithmetic instructions on floating point

Operators	Syntax
+, -, *, /	Op1:=Op2 Operator Op3
SQRT, ABS, TRUNC	Op1:=Operator(Op2)

Operands of arithmetic instructions on floating point

Type	Operand 1 (Op1)	Operand 2 (Op2)
Words which can be indexed	%MF (1)	%MF, %KF
Words which can not be indexed	-	Immediate floating point value, Numeric floating point expr.

(1) %MD in the case of instruction TRUNC

**Rules of use**

- operations on floating point and integer values can not be directly mixed. Conversion operations (See *Numerical conversion instructions, p. 131*) convert into one or other of these formats.
- System bit %S18 is managed in exactly the same way as the operations on integers (See *Arithmetic instructions on integers, p. 58*), the word %SW17 (See *Floating point instructions, p. 114*) indicates the cause of the error.

## Logarithmic et exponential instructions

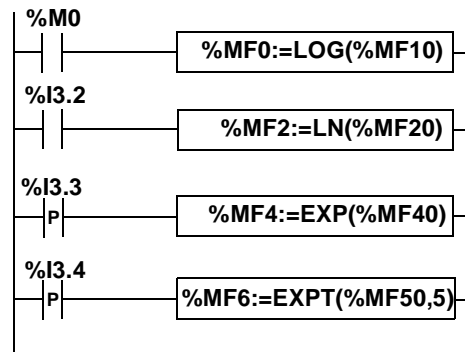
### General

These instructions are used to carry out logarithmic and exponential operations.

<b>LOG</b>	base 10 logarithm
<b>LN</b>	natural logarithm
<b>EXP</b>	natural exponential
<b>EXPT</b>	exponentiation of a real number by a whole number

### Structure

#### Language data



#### Instruction list language

```

LD %M0
[ %MF0 := LOG ( %MF10 ) ]

LD %I3.2
[ %MF2 := LN ( %MF20 ) ]

LDR %I3.3
[ %MF4 := EXP ( %MF40 ) ]

LDR %I3.4
[ %MF6 := EXPT ( %MF50 , 5 ) ]
  
```

**Structured text language**

```

IF %M0 THEN
  %MF0 := LOG ( %MF10 ) ;
END_IF ;
IF %I3.2 THEN
  %MF2 := LN ( %MF20 ) ;
END_IF ;
IF %I3.3 THEN
  %MF4 := EXP ( %MF40 ) ;
END_IF ;
IF %I3.4 THEN
  %MF6 := EXPT ( %MF50 , 5 ) ;
END_IF

```

**Syntax**

Operators and syntax of the logarithmic and exponential instructions

Operators	Syntax
LOG, EXP, LN	Op1:=Operator(Op2)
EXPT	Op1:=Operator (Op2,Op3)

Operands of the logarithmic and exponential instructions

Type	Operand 1 (Op1)	Operand 2 (Op2)	Operand 3 (Op3)
Words which can be indexed	%MF	%MF, %KF	%MW, %KW
Words which can not be indexed	-	Imm. floating point value Numeric floating point Ex- pr.	Imm. whole value Whole numeric Expr.

**Rules of use**

- when the operand of a function is an invalid value (example: logarithm of a negative number), it produces an undetermined or infinite result and causes the %S18 bit to switch to 1, and the %SW17 word indicates the cause of the error (General (See *Floating point instructions*, p. 114)).
- with logarithm functions, for values close to 1.0 (between 0.99 and 1.0 or 1.0 and 1.01), the result will be equal to 0, the %S18 and %SW17:X5 bits are in position 1.

## Trigonometric instructions

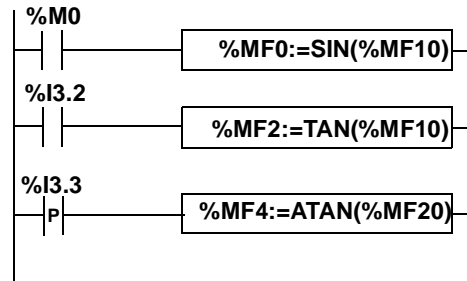
### General

These instructions are used to carry out trigonometric operations.

<b>SIN</b>	sine of an angle expressed in radian,	<b>ASIN</b>	arc sine (result between $-\frac{\pi}{2}$ and $\frac{\pi}{2}$ )
<b>COS</b>	cosine of an angle expressed in radian,	<b>ACOS</b>	arc cosine (result between 0 and $\pi$ )
<b>TAN</b>	tangent of an angle expressed in radian,	<b>ATAN</b>	arc tangent (result between $-\frac{\pi}{2}$ and $\frac{\pi}{2}$ )

### Structure

#### Ladder language



#### Instruction list language

```

LD %M0
[ %MF0 := SIN ( %MF10 ) ]

LD %I3.2
[ %MF2 := TAN ( %MF10 ) ]

LDR %I3.3
[ %MF4 := ATAN ( %MF20 ) ]
  
```

**Structured text language**

```

IF %M0 THEN
  %MF0 := SIN( %MF10 );
END_IF;
IF %I3.2 THEN
  %MF2 := TAN( %MF10 );
END_IF;
IF %I3.3 THEN
  %MF4 := ATAN( %MF20 );
END_IF;

```

**Syntax**

Operators and syntax of trigonometric operation instructions:

Operators	Syntax
<b>SIN, COS, TAN, ASIN, ACOS, ATAN</b>	Op1:=Operator(Op2)

Operands of trigonometric operation instructions:

Type	Operand 1 (Op1)	Operand 2 (Op2)
Words which can be indexed	%MF	%MF, %KF
Words which can not be indexed	-	Imm. floating point value Numeric floating point expr.

**Rules of use**

- when the operand of a function is an invalid value (example: arc cosine of a number greater than 1), it produces an indeterminate or infinite result and causes the %S18 bit move to 1, the word %SW17 (See *Floating point instructions, p. 114*) indicates the cause of the error.
- the SIN/COS/TAN functions allow an angle between  $-4096\pi$  and  $4096\pi$  as a parameter, but their accuracy progressively decreases for angles outside the range  $-2\pi$  to  $+2\pi$  because of the imprecision introduced by the rollover  $2\pi$  performed on the parameter before each operation.

## Conversion instructions

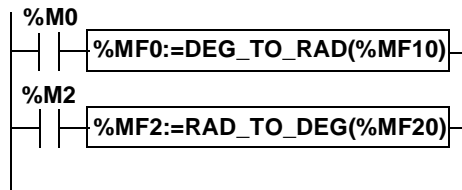
### General

These instructions are used to carry out conversion operations.

<b>DEG_TO_RAD</b>	conversion of degrees into radian, the result is the value of the angle between 0 and $2\pi$
<b>RAD_TO_DEG</b>	cosine of an angle expressed in radian, the result is the value of the angle between 0 and 360 degrees

### Structure

#### Ladder language



#### Instruction list language

```

LD %M0
[ %MF0 := DEG_TO_RAD( %MF10 ) ]

LD %M2
[ %MF2 := RAD_TO_DEG( %MF20 ) ]
  
```

#### Structured text language

```

IF %M0 THEN
  %MF0 := DEG_TO_RAD( %MF10 ) ;
END_IF ;
IF %M2 THEN
  %MF2 := RAD_TO_DEG( %MF20 ) ;
END_IF ;
  
```

### Syntax

Operators and syntax of conversion instructions:

Operators	Syntax
<b>DEG_TO_RAD</b> <b>RAD_TO_DEG</b>	Op1 := Operator(Op2)

Operands of conversion instructions:

Type	Operand 1 (Op1)	Operand 2 (Op2)
Words which can be indexed	%MF	%MF, %KF
Words which can not be indexed	-	Imm. floating point value Numeric floating point Expr.

---

**Rules of use**

The angle to be converted must be between  $-737280.0$  et  $+737280.0$  (for DEG\_TO\_RAD conversions) or between  $-4096\pi$  and  $4096\pi$  (for RAD\_TO\_DEG conversions).

For values outside these ranges, the displayed result will be  $+1.\#NAN$ , the %S18 and %SW17:X0 bits being set at 1.

---



## Rounding off a floating point value in ASCII format

---

### General

The ROUND function supplies the approximate value of a floating point number represented by a string of characters.

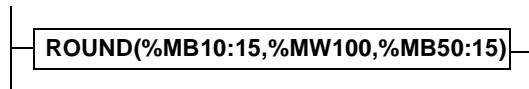
This function uses 3 parameters:

#### ROUND(string 1, Long, String 2)

- **String 1:** Table of bytes constituting the string of source characters
  - **Long:** Word giving the position in the string of characters from which the rounding off will be made (the position is calculated by counting the number of characters from the decimal point, including the decimal point)
  - **String 2:** Byte tables constituting the resulting character string
- 

### Structure

#### Ladder language



#### Instruction list language

```
LD TRUE
[ROUND(%MB10:15,%MW100,%MB50:15)]
```

#### Structured text language

```
ROUND(%MB10:15,%MW100,%MB50:15);
```

---

**Examples**

Examples of ASCII floating point values roundoffs

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
%MB10:15	"."	"1"	"."	"2"	"3"	"4"	"5"	"6"	"7"	"0"	"e"	"+"	"2"	"6"	"\$00"

%MW100 = 4

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
%MB50:15	"."	"1"	"."	"2"	"3"	"4"	"5"	"0"	"0"	"0"	"e"	"+"	"2"	"6"	"\$00"

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
%MB10:15	"."	"1"	"."	"1"	"3"	"5"	"4"	"9"	"4"	"2"	"e"	"-"	"3"	"0"	"\$00"

%MW100 = 2

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
%MB50:15	"+"	"1"	"."	"1"	"0"	"0"	"0"	"0"	"0"	"0"	"e"	"-"	"3"	"0"	"\$00"

**Syntax**

Operators and syntax of conversion instructions:

Operators	Syntax
<b>ROUND</b>	Op(string 1,Long, string 2)

Operands of conversion instructions:

Type	Operand 1 (Op1)	Operand 2 (Op2)
Byte table	%MB:15	-
Words which can not be indexed	-	%MW

**Rules of use**

- The length of the source and result character strings must be between 15 and 255 bytes. If this is not the case, the %S15 bit is set at 1.
- The Long length parameters must be between 0 and 8. If this is not the case, the %S20 bit (index overflow) is set at 1. Special case: for L=0 or L=8, the roundoff is not made (source string = result string).
- When the last character different from 0 is > 5, the previous character is incremented.

---

## 2.5 Numerical conversion instructions

---

### Introduction

---

#### Subject of this sub-section

This sub-section describes PL7 language floating point instructions.

---

#### What's in this Section?

This Section contains the following Maps:

Topic	Page
BCD conversion instructions <-> Binary	132
Integer <-> Floating point value conversion instructions	136
Instructions for Gray <-> Integer conversion	139
Word conversion Instructions <-> double word	141

---

## BCD conversion instructions <-> Binary

### General

There are six conversion instructions.

Instruction list:

<b>BCD_TO_INT</b>	conversion of a 16 bit BCD number into a 16 bit integer
<b>INT_TO_BCD</b>	conversion of a 16 bit integer into a 16 bit BCD number
<b>DBCD_TO_DINT</b>	conversion of a 32 bit BCD number into a 32 bit integer
<b>DINT_TO_DBCD</b>	conversion of a 32 bit integer into a 32 bit BCD number
<b>DBCD_TO_INT</b>	conversion of a 32 bit BCD number into a 16 bit integer
<b>INT_TO_DBCD</b>	conversion of a 16 bit integer into a 32 bit BCD number

### Reminder concerning BCD code

The BCD code (Binary Coded Decimal) is used to represent a decimal number from 0 to 9 by a set of 4 bits. A bit object of 16 bits can thus contain a number expressed in 4 digits ( $0 < N < 9999$ ).

Equivalence between decimal and BCD:

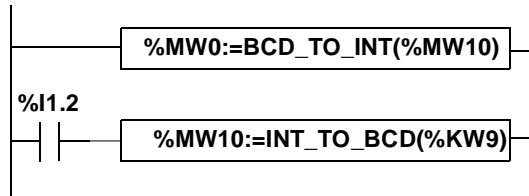
Decimal	0	1	2	3	4	5	6	7	8	9
BCD	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001

Examples of BCD coding:

- Word %MW5 expressing the BCD value "2450" which corresponds to the binary value: 0010 0100 0101 0000
- Word %MW12 expressing the BCD value "2450" which corresponds to the binary value : 0000 1001 1001 0010

The instruction BCD\_TO\_INT changes the word %MW5 to the word %MW12.

The instruction INT\_TO\_BCD changes the word %MW12 to the word %MW5.

**Structure****Ladder language****Instruction list language**

```

LD TRUE
[ %MW0 :=BCD_TO_INT( %MW10 ) ]

LD I1.2
[ %MW10 :=INT_TO_BCD( %KW9 ) ]

```

**Structured text language**

```

%MW0 :=BCD_TO_INT( %MW10 ) ;
IF %I1.2 THEN
  %MW10 :=INT_TO_BCD( %KW9 ) ;
END_IF ;

```

**Syntax**

Operators and syntax (conversion of a 16 bit number):

Operators	Syntax
BCD_TO_INT	Op1=operator(Op2)
INT_TO_BCD	
INT_TO_DBCD	

Operands (conversion of a 16 bit number):

Type	Operand 1 (Op1)	Operand 2 (Op2)
Words which can be indexed	%MW	%MW,%KW,%Xi.T
Words which can not be indexed	%QW,%SW,%NW, %BLK	Imm.val.,%IW,%SW%NW,%BLK, Numeric Expr.
Double words which can be indexed	%MD	-
Double words which can not be indexed	%QD,%SD	-

Operators and syntax (conversion of a 32 bit number):

Operators	Syntax
DBCD_TO_DINT	Op1=operator(Op2)
DINT_TO_DBCD	
DBCD_TO_INT	

Operands (conversion of a 32 bit number):

Type	Operand 1 (Op1)	Operand 2 (Op2)
Words which can be indexed	%MW	%MW,%KW,%Xi.T
Words which can not be indexed	%QW,%SW,%NW, %BLK	-
Double words which can be indexed	%MD	%MD,%KD
Double words which can not be indexed	%QD,%SD	Imm. val.,%ID,%QD%SD, Numeric Expr.

### Example of applications

The BCD\_TO\_INT instruction is used to process a setpoint value present in PLC input on BCD encoded encoder wheels.

The INT\_TO\_BCD instruction is used to display digital values (eg: calculation result, current value of function block) on BCD coded displays.

### Rules of use

- **BCD->Binary conversion**  
The BCD->Binary conversion instructions ensure that the conversion operator is working on a BCD coded value. If the value is not a BCD value, the %S18 system bit is set at 1 and the result returns the value of the first nibble which is at fault.  
E.g.: BCD\_TO\_INT ( %MW2 ) with %MW2=4660 gives 1234 as the result. However, %MW2=242 (16#00F2) causes %S18 to set at 1 and the result is 15.  
For the DBCD\_TO\_INT instruction, if the BCD number is greater than 32767, the system bit %S18 is set at 1 and the value -1 is stored in the result.
- **Binary->BCD conversion**  
When the last character different from 0 is > at 5, the previous character is incremented.  
The instruction INT\_TO\_BCD (or DINT\_TO\_BCD) ensures that the conversion operator is working on a value between 0 and 9999 (or 0 and 9999 9999). If this is not the case, the system bit %S18 is set at 1 and the result returns the input parameter value.  
E.g.: INT\_TO\_BCD ( %MW2 ) with %MW2=2478 gives 9336 as the result. However, %MW2=10004 causes %S18 to set at 1 and the result is 10004.

For the INT\_TO\_DBCD instruction, if the input parameter is negative, the system bit %S18 is set at 1 and the result returns the input parameter value.

---

## Integer <-> Floating point value conversion instructions

### General

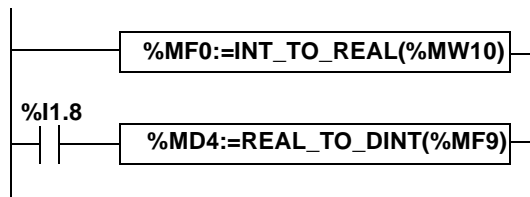
There are four conversion instructions.

Instruction list for integer <-> floating point value conversion:

<b>INT_TO_REAL</b>	conversion of an integer word --> floating point value
<b>DINT_TO_REAL</b>	conversion of an integer double word --> floating point value
<b>REAL_TO_INT</b>	floating point value --> integer word conversion (the result is the nearest algebraic value)
<b>REAL_TO_DINT</b>	floating point value --> integer double word conversion (the result is the nearest algebraic value)

### Structure

#### Ladder language



#### Instruction list language

```
LD TRUE
[ %MF0 := INT_TO_REAL ( %MW10 ) ]
```

```
LD I1.8
[ %MD4 := REAL_TO_DINT ( %MF9 ) ]
```

#### Structured text language

```
%MF0 := INT_TO_REAL ( %MW10 ) ;
IF %I1.8 THEN
  %MD4 := REAL_TO_DINT ( %MF9 ) ;
END_IF ;
```

### Syntax

Operators and syntax (conversion of an integer word --> floating point value):

Operators	Syntax
<b>INT_TO_REAL</b>	Op1=INT_TO_REAL(Op2)



Operands (conversion of an integer word --> floating point value):

Type	Operand 1 (Op1)	Operand 2 (Op2)
Words which can be indexed	-	%MW,%KW,%Xi.T
Words which can not be indexed	-	Imm. val.,%IW,%QW,%SW%NW,%BLK, Numeric Expr.
Floating point words which can be indexed	%MF	-

**Example:** conversion of an integer double word --> floating point value: 147 --> 1.47e+02

Operators and syntax (conversion of an integer double word --> floating point value):

Operators	Syntax
DINT_TO_REAL	Op1=DINT_TO_REAL(Op2)

Operands (conversion of an integer double word --> floating point value):

Type	Operand 1 (Op1)	Operand 2 (Op2)
Words which can be indexed	-	%MD,%KD
Words which can not be indexed	-	Imm. val.,%ID,%QD%SD, Numeric Expr.
Floating point words which can be indexed	%MF	-

**Example:** conversion of an integer double word --> floating point value: 68905000 -> 6.8905e+07

Operators and syntax (conversion floating point value --> integer word or integer double word):

Operators	Syntax
REAL_TO_INT	Op1=Operator(Op2)
REAL_TO_DINT	

Operands (conversion floating point value --> integer word or integer double word):

Type	Operand 1 (Op1)	Operand 2 (Op2)
Words which can be indexed	%MW	-
Words which can not be indexed	%QW,%NW,%BLK	-
Double words which can be indexed	%MD	-
Double words which can not be indexed	%QD	-
Floating point words which can be indexed	-	%MF,%KF
Floating point words which can not be indexed	-	Imm. floating point value

**Example:**

conversion floating point value --> integer word: 5978.6 --> 5979

conversion floating point value --> integer double word: -1235978.6 --> -1235979

**Note:** If during a conversion real to integer (or real to integer double word) the floating point value is outside the range of a word (or double word), the %S18 bit is set at 1.

## Instructions for Gray <-> Integer conversion

### General

The GRAY\_TO\_INT instruction converts a Gray code word into integer (pure binary code).

### Reminder concerning Gray code

The Gray code or "considered binary" is used to code a changing digital value in a series of binary configurations which differ from each other by the change in status of one and only one bit.

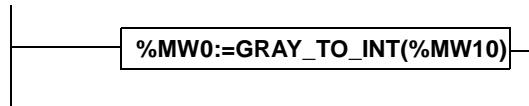
For example, this code is used to avoid the following hazard: in pure binary, the change of a value from 0111 to 1000 can create random values between 0 and 1000, the bits do not change value in a perfectly simultaneous way.

Equivalence between decimal, BCD and Gray:

Décimal	0	1	2	3	4	5	6	7	8	9
BCD	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001
Gray	0000	0001	0011	0010	0110	0111	0101	0100	1100	1101

### Structure

#### Ladder language



#### Instruction list language

```
LD TRUE
[ %MW0 :=GRAY_TO_INT ( %MW10 ) ]
```

#### Structured text language

```
%MW0 :=GRAY_TO_INT ( %MW10 ) ;
```

### Syntax

Operators and syntax:

Operators	Syntax
GRAY_TO_INT	Op1=GRAY_TO_INT(Op2)

Operands:

<b>Type</b>	<b>Operand 1 (Op1)</b>	<b>Operand 2 (Op2)</b>
Words which can be indexed	%MW	%MW,%KW,%Xi.T
Words which can not be indexed	%QW,%SW,%NW, %BLK	Imm.val.,%IW,%QW,%SW,%NW,%BLK, Numeric Expr.

---

## Word conversion Instructions <--> double word

### General

The instructions described below are useful for purely symbolic objects (such as DFB function blocks).

For objects which can be addressed, the overlap mechanisms (example: %MD0 double word is made from the words %MW0 and %MW1) make these instructions unnecessary.

Instruction list for word conversion <--> double word:

<b>LW</b>	Extract instructions from the least significant word from a double word
<b>HW</b>	Extract instructions from the most significant word from a double word
<b>CONCATW</b>	2 word concatenation instructions

### Syntax

Extract instruction operators and syntax from the least significant word from a double word:

Operators	Syntax
<b>LW</b>	Op1=LW(Op2)

Extract instructions operands from the least significant word from a double word

<b>Op1</b>	Single length word (type Word)
<b>Op2</b>	Double length word (type DWord)

#### Example:

```
Pressure_cuve:=LW(Parameter_1)
if Parameter_1=16#FFFF1234, Pressure_cuve=16#1234
```

Extract instruction operators and syntax from the most significant word from a double word:

Operators	Syntax
<b>HW</b>	Op1=HW(Op2)

Extract instructions operands from the most significant word from a double word

<b>Op1</b>	Single length word (type Word)
<b>Op2</b>	Double length word (type DWord)

#### Example:

```
Pressure_cuve:=LW(Parameter_1)
if Parameter_1=16#FFFF1234, Pressure_cuve=16#FFFF
```

Operators and syntax of the 2 single word concatenation instructions and transfer into a double word:

Operators	Syntax
<b>HW</b>	Op1=HW(Op2)

Operands of the 2 single word concatenation instructions and transfer into a double word:

<b>Op1</b>	Double length word (type DWord)
<b>Op2</b>	Single length word (type Word)
<b>Op3</b>	Single length word (type Word)

**Example:**

```
Pressure_cuve:=LW(Parameter_1,Parameter_2)
if Parameter_1=16#1234, Parameter_1=16#FFFF,
Pressure_cuve=16#FFFF
```

---

---

## 2.6 Word table instructions

---

### Introduction

---

#### Subject of this sub-section

This sub-section describes PL7 language word table instructions

---

#### What's in this Section?

This Section contains the following Maps:

Topic	Page
Word table instructions	144
Arithmetic instructions on tables	146
Logic table instructions	148
Table summing functions	150
Table comparison functions	152
Table search functions	154
Table search functions for maxi and mini values	157
Number of occurrences of a value in a table	159
Table rotate shift function	161
Table sort function	164
Table length calculation function	166

---

## Word table instructions

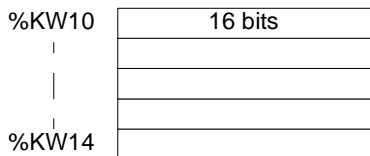
### General

Operations on tables can be carried out with PL7 software:

- common words
- double words
- floating words

Word tables are collections of adjacent words of the same type and defined length: L

Example of a word table: %KW10:5



### Word table characteristics

Type	Format	Maximum address	Size	Write access
Internal words	Simple length	%MWi:L	i+L<=Nmax (1)	Yes
	Double length	%MWDi:L	i+L<=Nmax-1 (1)	Yes
	Floating point	%MFi:L	i+L<=Nmax-1 (1)	Yes
Constant words	Single length	%KWi:L	i+L<=Nmax (1)	No
	Double length	%KWDi:L	i+L<=Nmax-1 (1)	No
	Floating point	%KFi:L	i+L<=Nmax-1 (1)	No
System word	Single length	%SW50:4 (2)	-	Yes

(1) Nmax = maximum number of words defined in software configuration

(2) Only the words %SW50 to %SW53 may be addressed in the form of tables.

### General rules on table operations

- table operations can only be carried out on tables containing objects of the same type
- table operations can only be carried out on a maximum of 2 tables
- if the tables in an operation are of different sizes, the result table will correspond to the smaller of the 2 operand tables
- the user must avoid carrying out operations on tables with overlap (for example: %MW100[20] := %MW90[20] + %KW100[20])
- an operation on 2 tables is carried out on each element of the same rank in both tables and the result is transferred into the element of the same rank in the result table



- if during an operation between 2 elements, the system bit %S18 is set at 1, the result for this operation is invalid, but the operation for the following elements is carried out correctly
  - when one of the operands is a numeric expression, this must be put between brackets
  - the rank of a word in a table corresponds to the position of the word in the table; the first position corresponds to rank 0
-

## Arithmetic instructions on tables

### General

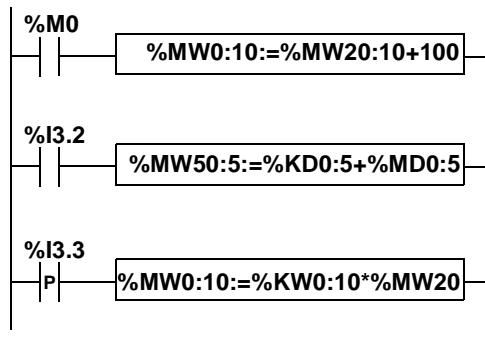
These instructions are used to perform an arithmetic operation between two word table operands (or a word and a word table).

Instruction list

<b>+</b> : addition	<b>*</b> : multiplication
<b>-</b> : subtraction	<b>/</b> : division
<b>REM</b> : remainder of the division:	<b>-</b>

### Structure

#### Language data



#### Instruction list language

```
LD %M0
[ %MW0:10 := %MW20:10 + 100 ]
```

```
LD %I3.2
[ %MD50:5 := %KD0:5 + %MD0:5 ]
```

#### Structured text language

```
IF RE %I3.3 THEN
  %MW0:10 := %KW0:10 * %MW20 ;
END_IF ;
```

### Syntax

Operators and syntax of arithmetic table instructions:

Operators	Syntax
<b>+, -, *, /, REM</b>	Op1:=Op2 Operator Op3

Operands of arithmetic word table instructions:

Type	Operand 1 (Op1)	Operand 2 and 3 (Op2 and 3)
Word tables which can be indexed	%MW:L	%MW:L,%KW:L,%Xi.T:L
Words which can be indexed	-	%MW,%KW,%Xi.T
Words which can not be indexed	-	Imm.val.,%IW,%QW,%SW,%NW, %BLK,Num. expr.

Operands of arithmetic double word table instructions:

Type	Operand 1 (Op1)	Operand 2 and 3 (Op2 and 3)
Word tables which can be indexed	%MD:L	%MD:L,%KD:L
Double words which can be indexed	-	%MD,%KD
Double words which can not be indexed	-	Imm. val., %ID,%QD, Numeric expr.

## Logic table instructions

### General

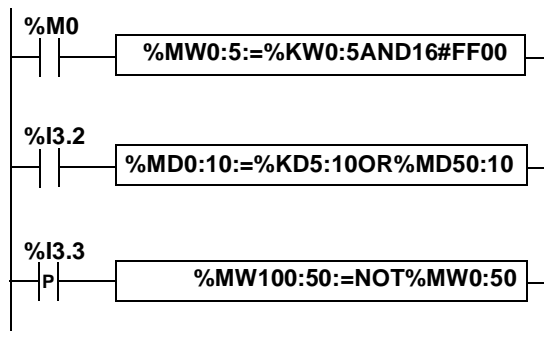
These instructions are used to perform an arithmetic operation between two word table operands (or a word and a word table).

#### Instruction list

<b>AND:</b> AND (bit by bit)	<b>XOR:</b> exclusive OR (bit by bit)
<b>OR:</b> logic OR (bit by bit)	<b>NOT:</b> logic complement (bit by bit) of a table (1 single operand)

### Structure

#### Ladder language



#### Instruction list language

```
LD %M0
[ %MW0:5:=%KW0:5 AND 16#FF00 ]
```

#### Structured text language

```
IF %I3.2 THEN
  %MD0:10:=%KD5:10 OR %MD50:10;
END_IF;
IF RE %I3.3 THEN
  %MW100:50:= NOT %MW0:50;
END_IF;
```

### Syntax

Operators and syntax of arithmetic table instructions:

Operators	Syntax
<b>AND,OR,XOR</b>	Op1:=Op2 Operator Op3
<b>NOT</b>	Op1:=NOT Op2

Operands of logic word table instructions:

Type	Operand 1 (Op1)	Operand 2 and 3 (Op2 and Op3)
Word tables which can be indexed	%MW:L	%MW:L,%KW:L,%Xi.T:L
Words which can be indexed	-	%MW,%KW,%Xi.T
Words which can not be indexed	-	Imm.val.,%IW,%QW,%SW,%NW,%BLK, Numeric Expr.

Operands of logic double word table instructions:

Type	Operand 1 (Op1)	Operand 2 and 3 (Op2 and 3)
Word tables which can be indexed	%MD:L	%MD:L,%KD:L
Double words which can be indexed	-	%MD,%KD,%SD
Double words which can not be indexed	-	Imm. val., %ID,%QD, Numeric expr.

## Table summing functions

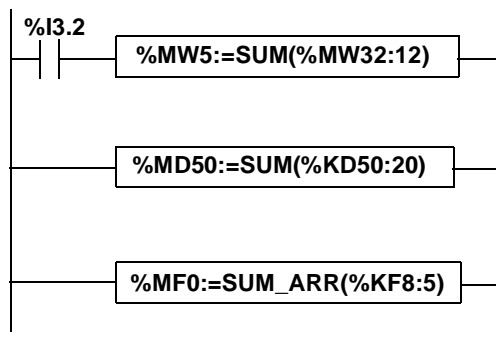
### General

Functions SUM and SUM\_ARR add all the elements of a word table:

- if the table is made up of simple format words, the result is given in the form of a single format word (SUM function)
- if the table is made up of double words, the result is given in the form of a double word (SUM function)
- if the table is made up of floating words, the result is given in the form of a floating word (SUM\_ARR function)

### Structure

#### Ladder language



#### Instruction list language

```
LD %I3.2
[ %MW5 :=SUM( %MW32 : 12 )
```

#### Structured text language

```
%MD50 :=SUM( %KD50 : 20 )
```

```
%MF0 :=SUM_ARR( %KF8 : 5 )
```

### Syntax

Syntax of table summing instructions:

Res:=SUM(Tab)
Res:=SUM_ARR(Tab)

Parameters of table summing instructions:

Type	Result (res)	Table (Tab)
Word tables which can be indexed	-	%MW:L,%KW:L,%Xi.T:L
Words which can be indexed	%MW	-
Words which can not be indexed	%QW,%SW,%NW	-
Double word tables which can be indexed	-	%MD:L,%KD:L
Double words which can be indexed	%MD	-
Double words which can not be indexed	%QD,%SD	-
Floating word tables which can be indexed	-	%MF:L,%KF:L
Floating words which can be indexed	%MF	-

**Note:** When the result is not within the valid word or double word format range according to the table operand, the system bit %S18 is set to 1.

### Example

```
%MW5 := SUM ( %MW30 : 4 )
```

with %MW30=10, %MW31=20, %MW32=30, %MW33=40

```
%MW5=10+20+30+40=100
```

## Table comparison functions

### General

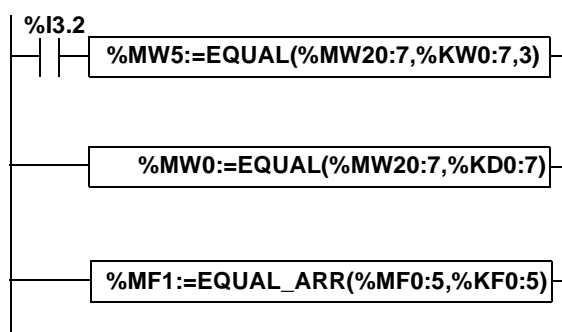
The EQUAL (on integer) and EQUAL-ARR (on floating point) functions carry out a comparison of two tables, element by element.

If a difference is shown, the rank of the first dissimilar elements is returned in the form of a word, otherwise the returned value is equal to -1.

The third parameter supplies the rank from which the comparison begins (example: 0 to start at the beginning). This third parameter is optional (it is not authorized with the EQUAL\_ARR function); when it is omitted, the comparison is carried out on the whole table.

### Structure

#### Ladder language



#### Instruction list language

```
LD %I3.2
[ %MW5 := EQUAL ( %MD20 : 7 , KD0 : 7 , 3 ) ]
```

#### Structured text language

```
%MW0 := EQUAL ( %MD20 : 7 , %KD0 : 7 )

%MW1 := EQUAL_ARR ( %MF0 : 5 , %KF0 : 5 )
```

### Syntax

Syntax of table comparison instructions:

Res:=EQUAL(Tab1,Tab2,rang)
Res:=EQUAL_ARR(Tab1,Tab2)



Parameters of table comparison instructions:

Type	Result (Res)	Table (Tab)	Rank
Word tables	-	%MW:L,%KW:L,%Xi.T:L	-
Words which can be indexed	%MW	-	%MW,%KW,%Xi.T
Words which can not be indexed	%QW,%SW,%NW	-	Imm.val.,%QW,%IW,%SW,%NW, Numeric Expr.
Double word tables	-	%MD:L,%KD:L	-
Double words which can be indexed	%MD	-	%MD,%KD
Double words which can not be indexed	%QD,%SD	-	Imm.val.,%QD,%ID,%SD, Num. expr.
Floating word tables	-	%MF:L,%KF:L	-
Floating words	%MF	-	-

**Note:**

- it is mandatory that the tables are of the same length
- if the parameter rank is greater than the size of the tables, the result is equal to this rank.

**Example**

%MW5 := EQUAL ( %MW30 : 4 , %KW0 : 4 , 1 )

Comparison of 2 tables:

Rank	Word tables	Constant word tables	Difference
0	%MW30=10	%KW0=20	Ignored (rank<1)
1	%MW31=20	%KW1=20	=
2	%MW32=30	%KW2=30	=
3	%MW33=40	%KW3=60	Different

The value of the word %MW5 is 3 (different first rank)

## Table search functions

### General

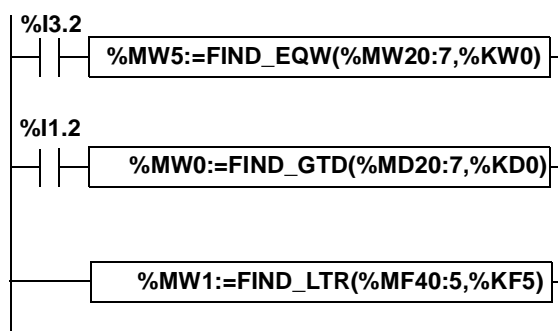
There are 11 search functions:

- **FIND\_EQW**: searches for the position in a word table of the first element which is equal to a given value
- **FIND\_GTW**: searches for the position in a word table of the first element which is greater than a given value
- **FIND\_LTW**: searches for the position in a word table of the first element which is less than a given value
- **FIND\_EQD**: searches for the position in a double word table of the first element which is equal to a given value
- **FIND\_GTD**: searches for the position in a double word table of the first element which is greater than a given value
- **FIND\_LTD**: searches for the position in a double word table of the first element which is less than a given value.
- **FIND\_EQR**: searches for the position in a floating word table of the first element which is equal to a given value
- **FIND\_GTR**: searches for the position in a floating word table of the first element which is greater than a given value
- **FIND\_LTR**: searches for the position in a floating word table of the first element which is less than a given value
- **FIND\_EQWP**: searches for the position in a word table of the first element which is equal to a value given from a rank
- **FIND\_EQDP**: searches for the position in a double word table of the first element which is equal to a value given from a rank

The result of these instructions is equal to the rank of the first element which is found or at -1 if the search is unsuccessful.

### Structure

#### Ladder language



**Instruction list language**

```
LD %I3.2
[ %MW5 := FIND_EQW( %MW20 : 7 , Kw0 ) ]
```

**Structured text language**

```
IF %I1.2 THEN
  %MW0 := FIND_GTD( %MD20 : 7 , %KD0 ) ;
END_IF ;

%MW1 := FIND_LTR( %MF40 : 5 , %KF5 ) ;

%MW9 := FIND_EQWP( %MW30 : 8 , %KF5 , %MW4 ) ;
```

**Syntax**

Syntax of table search instructions:

Function	Syntax
FIND_EQW	Res:=Function(Tab,Val)
FIND_GTW	
FIND_LTW	
FIND_EQD	
FIND_GTD	
FIND_LTD	
FIND_EQR	
FIND_GTR	
FIND_LTR	
FIND_EQWP	
FIND_EQDP	

Parameters of word table search instructions  
(FIND\_EQW,FIND\_GTW,FIND\_LTW,FIND\_EQWP )

Type	Result (Res)	Table (Tab)	Value (val), rank
Word tables which can be indexed	-	%MW:L,%KW:L, %Xi.T:L	-
Words which can be indexed	%MW	-	%MW,%KW,%Xi.T
Words which can not be indexed	%QW,%SW,%NW	-	Imm.val.,%QW,%IW, %SW,%NW, Numeric Expr.

Parameters of double word table search instructions  
(FIND\_EQD,FIND\_GTD,FIND\_LTD,FIND\_EQDP)

Type	Result (Res)	Table (Tab)	Value (val)
Word tables which can be indexed	-	%MD:L,%KD:L, %Xi.T:L	-
Double words which can be indexed	%MW	-	%MD,%KD
Double words which can not be indexed	%QW,%SW,%NW	-	Imm.val.,%QD,%ID, %SD, Num. expr.

**Note:** For the rank, see the word table (idem FIND\_EQWP)

Parameters of floating word table search instructions  
(FIND\_EQR,FIND\_GTR,FIND\_LTR)

Type	Result (Res)	Table (Tab)	Value (val)
Floating word tables	-	%MF:L,%KF:L	-
Floating words which can be indexed	%MW	-	%MF,%KF
Floating words which can not be indexed	%QW,%SW,%NW	-	Imm.val., Num. Expr.

**Example**

%MW5:=FIND\_EQW(%MW30:4,%KW0)

Search for the position of the first word =%KW0=30 in the table:

Rank	Word Table	Result
0	%MW30=10	-
1	%MW31=20	-
2	%MW32=30	%MW5=2 Value (val), rank
3	%MW33=40	-

## Table search functions for maxi and mini values

### General

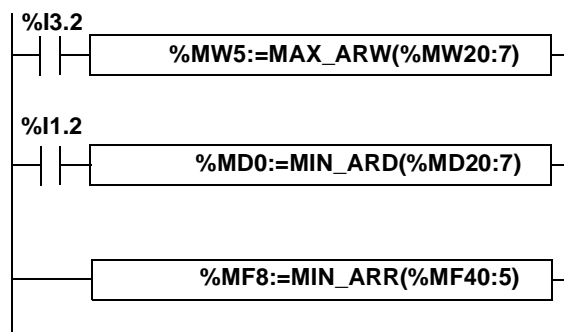
There are 6 search functions:

- **MAX\_ARW**: search for the maximum value in a word table
- **MIN\_ARW**: search for the minimum value in a word table
- **MAX\_ARD**: search for the maximum value in a double word table
- **MIN\_ARD**: search for the minimum value in a double word table
- **MAX\_ARR**: search for the maximum value in a floating word table
- **MIN\_ARR**: search for the minimum value in a floating word table

The result of these instructions is equal to the maximum value (or minimum) found in the table.

### Structure

#### Ladder language



#### Instruction list language

```
LD %I3.2
[ %MW5 := MAX_ARW ( %MW20 : 7 ) ]
```

#### Structured text language

```
IF %I1.2 THEN
  %MD0 := MIN_ARD ( %MD20 : 7 ) ;
END_IF ;
%MF8 := MIN_ARR ( %MF40 : 5 ) ;
```

**Syntax**

Syntax of table search instructions for max and min values:

Function	Syntax
<b>MAX_ARW</b>	Res:=Function(Tab)
<b>MIN_ARW</b>	
<b>MAX_ARD</b>	
<b>MIN_ARD</b>	
<b>MAX_ARR</b>	
<b>MIN_ARR</b>	

Parameters of table search instructions for max and min values:

Type	Result (Res)	Table (Tab)
Word tables which can be indexed	-	%MW:L,%KW:L,%Xi.T:L
Words which can be indexed	%MW	-
Words which can not be indexed	%QW,%SW,%NW	-
Double word tables which can be indexed	-	%MD:L,%KD:L
Double words which can be indexed	%MD	-
Double words which can not be indexed	%QD,%SD	-
Floating word tables	-	%MF:L,%KF:L
Floating words which can be indexed	%MF	-

## Number of occurrences of a value in a table

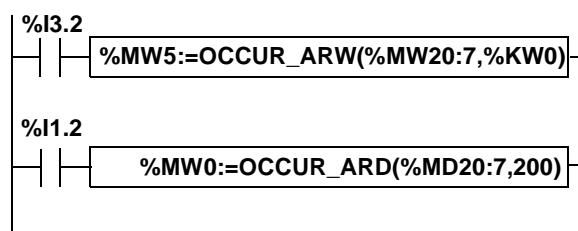
### General

There are 3 search functions:

- **OCCUR\_ARW**: searches in a word table for the number of elements which are equal to a given value
- **OCCUR\_ARD**: searches in a double word table for the number of elements which are equal to a given value
- **OCCUR\_ARR**: searches in a floating word table for the number of elements which are equal to a given value

### Structure

#### Ladder language



#### Instruction list language

```
LD %I3.2
[ %MW5 := OCCUR_ARW ( %MW20 : 7 , %KW0 ) ]
```

#### Structured text language

```
IF %I1.2 THEN
  %MW0 := OCCUR_ARD ( %MD20 : 7 , 200 ) ;
END_IF ;
```

### Syntax

Syntax of table search instructions for max and min values:

Function	Syntax
<b>OCCUR_ARW</b>	Res:=Function(Tab,Val)
<b>OCCUR_ARD</b>	
<b>OCCUR_ARR</b>	

Parameters of table search instructions for max and min values:

<b>Type</b>	<b>Result (Res)</b>	<b>Table (Tab)</b>	<b>Value (Val)</b>
Word tables which can be indexed	-	%MW:L,%KW:L, %Xi.T:L	-
Words which can be indexed	%MW	-	%MW,%KW,%Xi.T
Words which can not be indexed	%QW,%SW,%NW	-	Imm.val.,%QW,%IW, %SW,%NW, Numeric Expr.
Double word tables which can be indexed	-	%MD:L,%KD:L	-
Double words which can be indexed	%MW	-	%MD,%KD
Double words which can not be indexed	%QW,%SW,%NW	-	Imm.val., %QD,%ID,%SD, Num. Expr.
Floating word tables	-	%MF:L,%KF:L	-
Floating words which can be indexed	%MF	-	%MF,%KF
Floating words which can not be indexed	%QW,%SW,%NW	-	Imm. val., Num. Expr.



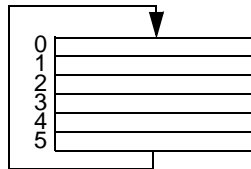
## Table rotate shift function

### General

There are 6 shift functions:

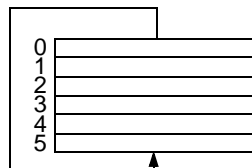
- **ROL\_ARW**: performs a rotate shift of n positions from top to bottom of the elements in a word table
- **ROL\_ARD**: performs a rotate shift of n positions from top to bottom of the elements in a double word table
- **ROL\_ARR**: performs a rotate shift of n positions from top to bottom of the elements in a floating word table

Illustration of the ROL\_ functions



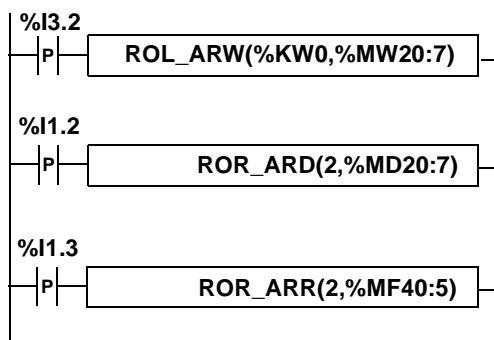
- **ROL\_ARW**: performs a rotate shift of n positions from bottom to top of the elements in a word table
- **ROR\_ARD**: performs a rotate shift of n positions from bottom to top of the elements in a double word table
- **ROR\_ARR**: performs a rotate shift of n positions from bottom to top of the elements in a floating word table

Illustration of the ROR\_ functions



**Structure**

**Ladder language**



**Instruction list language**

```
LDR %I3.2
[ ROL_ARW( %KW0 , %MW0 ) ]
```

**Structured text language**

```
IF RE %I1.2 THEN
  ROR_AR( 2 , %MD20 : 7 ) ;
END_IF ;
IF RE %I1.3 THEN
  ROR_ARR( 2 , %MF40 : 5 ) ;
END_IF ;
```

**Syntax**

Syntax of rotate shift instructions in word tables **ROL\_ARW** and **ROR\_ARW**

Function	Syntax
<b>ROL_ARW</b>	Function(n,Tab)
<b>ROR_ARW</b>	

Parameters of rotate shift instructions in word tables **ROL\_ARW** and **ROR\_ARW**:

Type	Number of positions (n)	Table (Tab)
Word tables which can be indexed	-	%MW:L
Words which can be indexed	%MW,%KW,%Xi.T	-
Words which can not be indexed	Imm.val.,%QW,%IW,%SW, %NW, Num.expr.	-

Syntax of rotate shift instructions in double word tables **ROL\_ARD** and **ROR\_ARD**

Function	Syntax
<b>ROL_ARD</b>	Function(n,Tab)
<b>ROR_ARD</b>	

Parameters of rotate shift instructions in double word tables **ROL\_ARD** and **ROR\_ARD**:

Type	Number of positions (n)	Table (Tab)
Word tables which can be indexed	-	%MD:L
Words which can be indexed	%MW,%KW,%Xi.T	-
Words which can not be indexed	Imm.val.,%QW,%IW,%SW, %NW, Num.expr.	-

Syntax of rotate shift instructions in floating word tables **ROL\_ARR** and **ROR\_ARR**

Function	Syntax
<b>ROL_ARR</b>	Function(n,Tab)
<b>ROR_ARR</b>	

Parameters of rotate shift instructions for floating word tables: **ROL\_ARR** and **ROR\_ARR**:

Type	Number of positions (n)	Table (Tab)
Word tables which can be indexed	-	%MF:L
Words which can be indexed	%MW,%KW,%Xi.T	-
Words which can not be indexed	Imm.val.,%QW,%IW,%SW, %NW, Num.expr.	-

**Note:** if the value of n is negative or null, no shift is performed.

## Table sort function

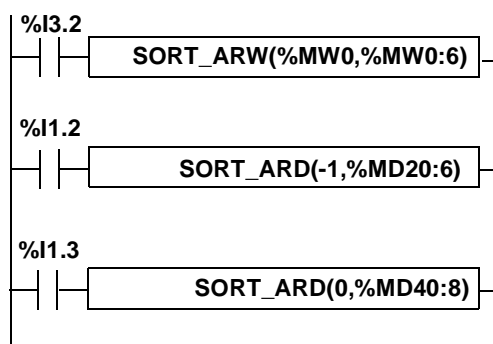
### General

There are 3 sort functions:

- **SORT\_ARW**: performs sorts in ascending or descending order of the elements of the word table and stores the result in the same table.
- **SORT\_ARD**: performs sorts in ascending or descending order of the elements of the double word table and stores the result in the same table.
- **SORT\_ARR**: performs sorts in ascending or descending order of the elements of the floating word table and stores the result in the same table

### Structure

#### Ladder language



#### Instruction list language

```
LD %I3.2
[ SORT_ARW( %MW20 , %MW0 : 6 ) ]
```

#### Structured text language

```
IF %I1.2 THEN
  SORT_ARD( -1 , %MD20 : 6 ) ;
END_IF ;
IF %I1.3 THEN
  SORT_ARR( 0 , %MF40 : 8 ) ;
END_IF ;
```

**Syntax**

Syntax of table sort functions:

Function	Syntax
<b>SORT_ARW</b>	Function(direction,Tab)
<b>SORT_ARD</b>	
<b>SORT_ARR</b>	

- the "direction" parameter gives the order of the sort: direction > 0 the sort is done in ascending order; direction < 0, the sort is done in descending order
- the result (sorted table) is returned in the Tab parameter (table to sort).

Parameters of table sort functions:

Type	Sort direction	Table (Tab)
Word tables (SORT_ARW)	-	%MW:L
Double word tables (SORT_ARD)	-	%MD:L
Floating word tables (SORT_ARR)	-	%MF:L
Words which can be indexed	%MW,%KW	-
Words which can not be indexed	Imm.val.,%QW,%IW,%SW, %NW, Num.expr.	-

## Table length calculation function

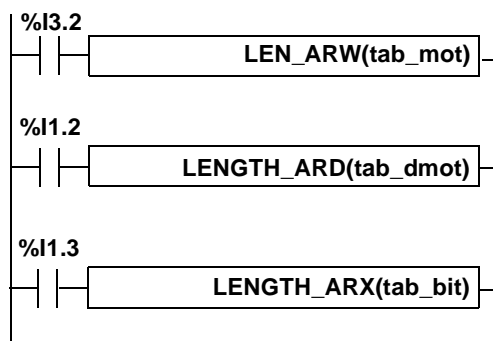
### General

There are 4 table length calculation functions. These functions are especially useful for programming the DFB function blocks when the table lengths have not been explicitly defined:

- **LENGTH\_ARW**: calculation of the length of a word table by the number of elements
- **LENGTH\_ARD**: calculation of the length of a double word table by the number of elements
- **LENGTH\_ARR**: calculation of the length of a floating word table by the number of elements
- **LENGTH\_ARX**: calculation of the length of a bit table by the number of elements

### Structure

#### Ladder language



#### Instruction list language

```
LD %I3.2
[LENGTH_ARW(tab_mot)]
```

#### Structured text language

```
IF %I1.2 THEN
  LENGTH_ARD(tab_dmot);
END_IF;
IF %I1.3 THEN
  LENGTH_ARX(tab_bit);
END_IF;
```

**Syntax**

Syntax of table length calculation functions:

Function	Syntax
LENGTH_ARW	Result=Fonction(Tab)
LENGTH_ARD	
LENGTH_ARR	
LENGTH_ARX	

Parameters of table length calculation functions:

Type	Table (Tab)	Result (Res)
Tables (SORT_ARW)	word	-
Tables (SORT_ARD)	double word	-
Tables of (SORT_ARR)	floating word	-
Tables of (LENGTH_ARX)	bit	-
Words which can be indexed	-	%MW
Words which can not be indexed	-	%QW,%SW,NW

**Note:** the table parameters will be purely symbolic objects.

## 2.7 Character string instructions

### Introduction

#### Subject of this sub-section

This section describes PL7 language character string instructions

#### What's in this Section?

This Section contains the following Maps:

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Extracting characters	193
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## Format of a string of characters or table of characters

### General

- A table of characters is made up of a collection of bytes in which a string of characters can be stored. The size of the table specifies the maximum permissible length of the string of characters (maximum 255).  
Example: **%MB4:6** represents a table of 6 bytes containing a string of maximum 6 characters.
- The first byte at the beginning of a table must be even (it is not possible to enter a table of bytes beginning with an odd byte, e.g.: %MB5:6).
- Tables of bytes use the same memory zone as the words %MW, %MD; there is therefore a risk of overlap ("Overlay Rules" - Reference Manual Volume 1).
- The term string of characters represents all the characters included between the beginning of the table and the first string end found.
- The character NUL (code hexa 00) is called String End. It is symbolized by  $\emptyset$  in the rest of the chapter.
- The length of a string of characters is therefore given either by the number of characters before the string end, or by the size of the table if no string end is detected.

Examples:

The following table (of 12 elements) contains the "ABCDE" character string (length: 5):

"A"	"B"	"C"	"D"	"E"	$\emptyset$	"J"	"K"	"L"	"M"	"N"	"O"
-----	-----	-----	-----	-----	-------------	-----	-----	-----	-----	-----	-----

The following table (of 10 elements) contains the "ABCDEJKLMN" character string (length: 10):

"A"	"B"	"C"	"D"	"E"	"J"	"K"	"L"	"M"	"N"
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

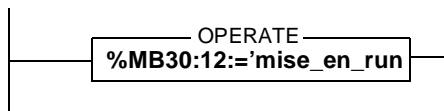
**Note:** The system bit %S15 is set in the following cases:

- When writing a string in a table, if this string is longer than the size of the table (impossible to write the string end  $\emptyset$ )
- When an attempt is made to access a character which is not in the string in question
- Incoherence of parameters: Length to delete null (DELETE function), length to extract null (MID function), length to replace null (REPLACE function), search of a substring longer than the string (FIND function).

## Assignment on string of characters

**General** Used to transfer a string of characters into a table of bytes of length L.

**Structure** **Ladder language**



### Instruction list language

```
LD TRUE
[%MB30:12:='set_to_run']
```

### Structured text language

```
%MB30:12:='set_to_run';
```

**Example** Transfer of the string of characters 'set\_to\_run' into the byte table of length 12

```
%MB 30 31 32 33 34 35 36 37 38 39 40 41
```

'm'	'i'	's'	'e'	'_'	'e'	'n'	'_'	'r'	'u'	'n'	Ø
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	---

**Syntax** Assignment operators on string of characters

```
Op1:=Op2
```

Assignment operands on string of characters

Type	Operand 1 (Op1)	Operand 2 (Op2)
Byte table	%MB:L	%MB:L,KB:L, Immediate value

## Alphanumeric comparisons

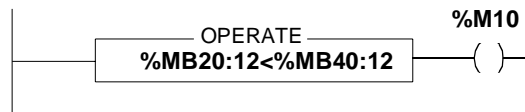
### General

These operators are used to compare two strings of characters contained in the byte tables in parameters. The comparison is made character by character.

The result is a bit with a value of 1 if the two strings satisfy the condition supplied by the operator, character by character; if this is not the case, the bit has a value of 0. The order of the characters is given by the table of codes ASCII (ISO 646). For example, the string 'Z' is larger than the string 'AZ' which is larger than the string 'ABC'.

### Structure

#### Ladder language



**Note:** The comparison blocks program themselves in the test zone.

#### Instruction list language

```
LD [%MB20:12<%MB40:12]
ST %M10
```

**Note:** The comparison is made inside the square brackets behind the LD, AND and OR instructions.

#### Structured text language

```
%MB10<%MB40:12;
```

### Example

Example: `%MB20:12<%MB40:12 ==>` YES The result has a value of 1

illustration

%MB 20 21 22 23 24 25 26 27 28 29 30 31

'a'	'b'	'c'	'd'	'e'	'f'	'g'	'i'	∅	'k'	'w'	'z'
-----	-----	-----	-----	-----	-----	-----	-----	---	-----	-----	-----

%MB 40 41 42 43 44 45 46 47 48 49 50 51

'a'	'b'	'c'	'd'	'e'	'f'	'h'	'i'	∅	'k'	'w'	'z'
-----	-----	-----	-----	-----	-----	-----	-----	---	-----	-----	-----

The elements after the string end are not taken into account.

---

## Syntax

Operators of alphanumeric comparisons

Operators	Syntax
<, >, <=, >=, =, <>	Op1 Operator Op2

Operands of alphanumeric comparisons

Type	Operand 1 (Op1) and Operand 2 (Op2)
Byte table	%MB:L, %KB:L, immediate value

---

## Numeric conversion functions <---> ASCII

---

### General

These functions are used to convert a numeric value (or floating point value) into a string of ASCII coded characters, or vice versa.

The result of the conversion must be transferred into a PL7 object via an assignment operation: byte table, single or double length word, floating point.

List of the possible numeric <---> ASCII conversion functions

Operators	Description
INT_TO_STRING	Binary-->ASCII (words) conversion
DINT_TO_STRING	Binary-->ASCII (double words) conversion
STRING_TO_INT	ASCII-->Binary (single words) conversion
STRING_TO_DINT	Binary-->ASCII (double words) conversion
REAL_TO_STRING	Floating point-->ASCII conversion
STRING_TO_REAL	ASCII-->Floating point conversion

**Reminder on the floating point format** (See *Floating point instructions*, p. 114)

### Reminder concerning ASCII code:

All of the 256 alphanumeric and control characters can be coded on 8 bits. This code called ASCII (American Standard Code for Information Interchange) is compatible with the notion of bytes. Any table of n bytes can therefore be formed by n ASCII codes defining n characters.

---

## binary-->ASCII conversion

### General

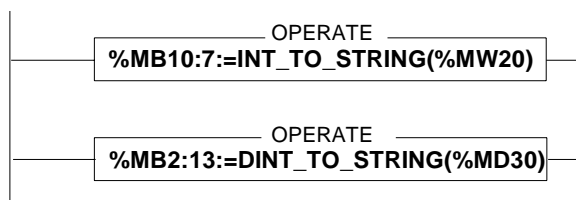
These functions are used to convert a numeric value (single or double length word) into a string of ASCII coded characters.

Each digit and the value sign in the parameter is coded in ASCII in an element of the result byte table.

- Function **INT\_TO\_STRING**: The content of a single length word can be between -32768 and +32767, that is 5 digits plus the sign; the result will be a table of 6 characters plus the string end. The sign '+' or '-' is stored in the first character and the units in the sixth character, the tens in the fifth, and so on.
- Function **DINT\_TO\_STRING**: The content of a double length word can be between -2147483648 and +2147483647, that is 10 digits plus the sign; the result will be a table of 12 characters plus the string end. The sign '+' or '-' is stored in the first character, the units in the twelfth character, the tens in the eleventh, and so on. The second character is always 0.

### Structure

#### Ladder language



#### Instruction list language

```
LD TRUE
[ %MB10:7 :=INT_TO_STRING(%MW20) ]
```

#### Structured text language

```
%MB2:13 :=DINT_TO_STRING(%MD30);
```

### Examples

Binary-->ASCII conversion

`%MB10:7 :=INT_TO_STRING(%MW20)` with `%MW20 = - 3782` in decimal  
 ==> The result is stored in the table of 7 bytes according to `%MB10`:

## Illustration

*%MB* 10 11 12 13 14 15 16

'_'	'0'	'3'	'7'	'8'	'2'	Ø
-----	-----	-----	-----	-----	-----	---

Example: *%MB*2:13:=DINT\_TO\_STRING(*%MD*30)  
with *%MD*30 = - 234701084

## Illustration

*%MB* 2 3 4 5 6 7 8 9 10 11 12 13 14

'-'	'0'	'0'	'2'	'3'	'4'	'7'	'0'	'1'	'0'	'8'	'4'	Ø
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	---

## Syntax

## Binary--&gt;ASCII conversion operators

<b>Syntax</b>
Result:= <b>INT_TO_STRING</b> (value)

## Binary--&gt;ASCII conversion operands

Type	Result (res)	value
Table of 6 bytes + string end	<i>%MB</i> :7	-
Words which can be indexed	-	<i>%MW</i> , <i>%KW</i> , <i>%Xi</i> .T
Words which can not be indexed	-	<i>%IW</i> , <i>%QW</i> , <i>%SW</i> , <i>%NW</i> ,Imm.val., Num. Expr.

## Binary--&gt;ASCII (double words) conversion operators

<b>Syntax</b>
Result:= <b>DINT_TO_STRING</b> (value)

## Binary--&gt;ASCII (double words) conversion operands

Type	Result (res)	value
Table of 12 bytes + string end	%MB:13	-
Words which can be indexed	-	%MD,%KD
Words which can not be indexed	-	%ID,%QD,%SD,Imm.val.,Num. expr.

---



## ASCII-->binary conversion

### General

These functions are used to convert a string of characters representing a numeric value into binary (result transferred into a single or double length word). Each element of the table in the parameter represents the ASCII code of a character. Authorized characters are the digits and the characters '+' and '-'.

- Function **STRING\_TO\_INT**: converts a string of 6 characters representing a numeric value between -32768 et +32767. The first character must represent the sign and the following characters the value: the second, the tens of thousands;... ; the sixth character, the units. The value must be set to the right of the string.
- Function **STRING\_TO\_DINT**: converts a chain of 12 characters representing a numeric value between -2147483648 and +2147483647. The first character must represent the sign and the following characters the value: The second character is 0; the third, the billions;... ; the twelfth, the units. The value must be set to the right of the string.

### Structure

#### Ladder language



#### Instruction list language

```
LD TRUE
[%MW13:=STRING_TO_INT(%MB20:7)]
```

#### Structured text language

```
%MD2:=STRING_TO_DINT(%MB30:13);
```

### Examples

Example: `%MW13:=STRING_TO_INT(%MB20:7)` , with

`%MB 20 21 22 23 24 25 26`

'-'	'0'	'2'	'3'	'4'	'7'	Ø
-----	-----	-----	-----	-----	-----	---

The result in `%MW13` = -2347 in decimal

**Syntax**

ASCII--&gt;Binary conversion operators

<b>Syntax</b>
Result:= <b>STRING_TO_INT</b> (string)

ASCII--&gt;Binary conversion operands

Type	Result (res)	value
Words which can be indexed	%MW	-
Words which can not be indexed	%QW,%SW,%NW	-
Table of 6 bytes + string end	-	%MB:7,%KB:7,Imm.val.

**Note:** The %S18 bit is set if the value described by the string is not between -32768 et +32767 or if one of the 6 characters is invalid.

ASCII--&gt;Binary (double words) conversion operators

<b>Syntax</b>
Result:= <b>DINT_TO_STRING</b> (string)

ASCII--&gt;Binary (double words) conversion operands

Type	Result (res)	value
Words which can be indexed	%MD	-
Words which can not be indexed	%QD,%SD	-
Table of 12 bytes + string end	-	%MB:13,%KB:13,Imm.val.

**Note:** The %S18 bit is set if the value described by the string is not between -2147483648 et +2147483647 or if one of the 12 characters is invalid.

## Floating point-->ASCII conversion

### General

This function is used to convert a real numeric value contained in a floating word into a string of ASCII coded characters. The result is transferred to a table of 13 bytes + the string end.

Each digit of the value as well as the characters '+', '-', '.', 'e' and 'E' are coded in ASCII in an element of the result table.

The value sign is in the first character, the decimal point (.) in the third, the exponent 'e' in the tenth, the exponent sign in the eleventh.

- Function **STRING\_TO\_INT**: converts a chain of 6 characters representing a numeric value between -32768 and +32767. The first character must represent the sign and the following characters the value: the second, the tens of thousands;... ; the sixth character, the units. The value must be set to the right of the string.
- Function **STRING\_TO\_DINT**: converts a chain of 12 characters representing a numeric value between -2147483648 and +2147483647. The first character must represent the sign and the following characters the value: The second is the character 0; the third, the billions;... ; the twelfth, the units. The value must be set to the right of the string.

### Structure

#### Ladder language



#### Instruction list language

```
LD TRUE
[ %MB20:14:=REAL_TO_STRING(%MF30) ]
```

#### Structured text language

```
%MB20:14:=REAL_TO_STRING(%MF30);
```

### Examples

Example: %MB20:14:=REAL\_TO\_STRING(%MF30) with %MF30=-3.234718e+26

====> Result:

%MB	20	21	22	23	24	25	26	27	28	29	30	31	32	33
	'-	'3'	'.'	'2'	'3'	'4'	'7'	'1'	'8'	'e'	'+'	'2'	'6'	Ø

## Syntax

Floating point-->ASCII conversion operators

<b>Syntax</b>
Result:= <b>REAL_TO_STRING</b> (value)

Floating point-->ASCII conversion operands

Type	Result (res)	value
Table of 13 bytes + string end	%MB14	-
Words which can be indexed	-	%MF,%KF
Words which can not be indexed	-	Imm.val.,Num. expr.

<p><b>Note:</b> The %S18 bit is set to 1 if the floating value in the parameter is not between 3.402824e+38 and -1.175494e-38 or +1.175494e-38 and +3.402824e+38. In this case, the result value is invalid.</p>
--

## ASCII-->Floating point conversion

### General

This function is used to convert a string of characters representing a real numeric value into a floating point value (result transferred into a floating word).

Each element of the table in the parameter represents the ASCII code of a character. Authorized characters are the digits and the characters '+', '-', '.', 'e' and 'E'. The string end is not used to determine the end of the string which means that the 13 characters of the table must all be correct.

The value sign must be in the first character, the decimal point (.) in the third, the 'e' in the tenth, the exponent sign in the eleventh. For example, the value 3.12 must be given in the form '+3.120000e+00'.

### Structure

#### Ladder language



#### Instruction list language

```
LD TRUE
[%MF18:=STRING_TO_REAL(%MF20:13)]
```

#### Structured text language

```
%MB18:=STRING_TO_REAL(%MB20:13);
```

### Examples

Example: %MF18:=STRING\_TO\_REAL(%MB20:13) with

```
%MB 20 21 22 23 24 25 26 27 28 29 30 31 32
      '-' '3' '.' '2' '3' '4' '7' '1' '8' 'e' '+' '2' '6'
```

====> result: %MF18 = -3.234718e+26

### Syntax

ASCII-->Floating point conversion operators

<b>Syntax</b>
Result:=STRING_TO_REAL (string)

## ASCII--&gt;Floating point conversion operands

Type	Result (res)	value
Words which can be indexed	%MF	-
Table of 13 bytes	-	%MB:13,%KB:13,Immediate value

**Note:** The %S18 bit is set to 1:

- if the value described by the string is not between  $-3.402824e+38$  and  $-1.175494e-38$
  - if the value described by the string is not between  $+1.175494e-38$  et  $+3.402824e+38$
  - if one of the 13 characters is invalid.
-

## Concatenation of two strings

### General

These instructions perform the concatenation of two strings of characters defined in parameters. The result is a byte table containing a string of characters.

### Structure

#### Ladder language



#### Instruction list language

```
LD TRUE
[ %MB30:14:=CONCAT(%MB4:6,%MB14:9) ]
```

#### Structured text language

```
%MB30:14:=CONCAT(%MB4:6,%MB14:9);
```

### Examples

Example: %MB30:14:=CONCAT(%MB4:6,%MB19:9)

%MB 4 5 6 7 8 9

'i'	'n'	'c'	'o'	'n'	Ø
-----	-----	-----	-----	-----	---

%MB 14 15 16 17 18 19 20 21 22

't'	'e'	's'	't'	'a'	'b'	'l'	'e'	Ø
-----	-----	-----	-----	-----	-----	-----	-----	---

%MB 30 31 32 33 34 35 36 37 38 39 40 41 42 43

'i'	'n'	'c'	'o'	'n'	't'	'e'	's'	't'	'a'	'b'	'l'	'e'	Ø
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	---

### Syntax

String concatenation operators

<b>Syntax</b>
Result:=CONCAT(string 1, string 2)

String concatenation operands

Type	Result (res)	String 1 and 2
Byte tables	%MB:L	%MB:L,%KB;L,Immediate value

**Note:**

- If the result table is too short, it is truncated and the system bit %S15 is set to 1.  
`%MB30:10:=CONCAT(%MB4:6, %MB14:9)`

`%MB 30 31 32 33 34 35 36 37 38 38`  

'i'	'n'	'c'	'o'	'n'	't'	'e'	's'	't'	'Ø'
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

 ==>%S15=1

- If the result table is too long, the string is completed with end characters 'Ø'.  
`%MB30:15:=CONCAT(%MB4:6, %MB14:9)`

`%MB 30 31 32 33 34 35 36 37 38 39 40 41 42 43`  

'i'	'n'	'c'	'o'	'n'	't'	'e'	's'	't'	'a'	'b'	'l'	'e'	'Ø'	'Ø'
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----





## Operands for deletion of a substring of characters

Type	Result (res)	String	Long (length), Pos (position)
Byte tables	%MB:L	%MB:L,%KB:L, Immediate value	-
Indexable words	-	-	%MW,%KW,%Xi.T
Non-indexable word	-	-	%IW,%QW,%SW,%NW, Imm.val., Num. Expr.

**Note:** Possibility of overlap between the parameters following the indexes of the PL7 objects:

- Table containing the source string.
- Table containing the result string.
- Word containing the length to be deleted.
- Word containing the position of the first character to be deleted.

A negative length or position is interpreted as being equal to 0. The parameter position starts at the value 1, which corresponds to the first position in the string of characters.

## Inserting a substring of characters

### General

Insertion of the substring of characters defined by the second parameter (string2) in the string of characters defined by the first parameter (string1). The insertion is carried out in the first string, after the character situated at the position given by the parameter position (Pos). The result of the insertion is a new string of characters transferred into a byte table.

### Structure

#### Ladder language



#### Instruction list language

```
LD TRUE
[ %MB2:14:=INSERT(%MB20:9,%MB30:6,%MW40) ]
```

#### Structured text language

```
%MB2:14:=INSERT(%MB20:9,%MB30:6,%MW40);
```

### Examples

Example: %MB2:14:=INSERT(%MB20:9,%MB30:6,%MW40)  
with %MW40=position 2

```
%MB 20 21 22 23 24 25 26 27 28
```

'i'	'n'	's'	't'	'a'	'b'	'l'	'e'	Ø
-----	-----	-----	-----	-----	-----	-----	-----	---

```
%MB 30 31 32 33 34 35
```

'c'	'o'	'n'	't'	'e'	Ø
-----	-----	-----	-----	-----	---

```
%MB 2 3 4 5 6 7 8 9 10 11 12 13 14 15
```

'i'	'n'	'c'	'o'	'n'	't'	'e'	's'	't'	'a'	'b'	'l'	'e'	Ø
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	---

### Syntax

Operators for insertion of a substring of characters

#### Syntax

```
Result:=INSERT(string1, string2, pos)
```

## Operands for insertion of a substring of characters

Type	Result (res)	String 1 and 2	Pos (position)
Byte tables	%MB:L	%MB:L,%KB:L	-
Indexable words	-	-	%MW,%KW,%Xi.T
Non-indexable words	-	-	%IW,%QW,%SW,%NW, Imm.val., Num. Expr.

**Note:**

- The parameter position starts at the value 1 which corresponds to the first position in the string of characters.
- It is impossible to carry out an insertion at the beginning of a string. For this, use the CONCAT function.
- If the table is too long, it is completed with end characters.
- Word containing the position of the first character to be deleted.
- The system bit %S15 is set to 1 in the following cases:
  - The value of the parameter position is negative or equal to 0. In this case, it is interpreted as being equal to 0 and the result table contains an empty string (made up of string end characters).
  - result table contains an empty string (made up of string end characters). The result table is too short; it is then truncated.

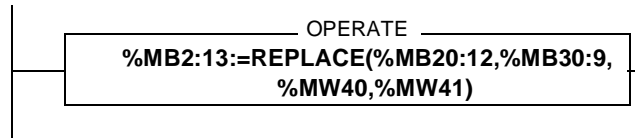
## Replacing a substring of characters

### General

Replaces a section of a string of characters defined in the source table (string1) with a substring of characters defined in the replacement table (string2). The replacement which is to be made is defined by the position (pos.) and length (long.) parameters. This length corresponds to the length of the string which disappears and not to the length of the substring which replaces it.

### Structure

#### Ladder language



#### Instruction list language

```
LD TRUE
[ %MB2:13:=REPLACE( %MB20:12, %MB30:9, %MW40, %MW41 ) ]
```

#### Structured text language

```
%MB2:13:=REPLACE( %MB20:12, %MB30:12, %MW40, %MW41 );
```

### Examples

Example: %MB2:13:=REPLACE( %MB20:12, %MB30:12, %MW40, %MW41 )  
with %MW40=3 (length=3) and %MW41=9 (position 9)

%MB	20	21	22	23	24	25	26	27	28	29	30	31
Chaîne 1	'm'	'i'	's'	'e'	'_'	'e'	'n'	'_'	'r'	'u'	'n'	Ø

%MB	30	31	32	33	34	35	36	37	38
Chaîne 2	's'	't'	'o'	'p'	Ø	'r'	'u'	'n'	Ø

%MB	2	3	4	5	6	7	8	9	10	11	12	13	14
	'm'	'i'	's'	'e'	'_'	'e'	'n'	'_'	's'	't'	'o'	'p'	Ø

**Syntax**

Operators for replacement of a substring of characters

<b>Syntax</b>
Result:=REPLACE (string1, string2, long., pos.)

Operands for replacement of a substring of characters

Type	Result (res)	String 1 and 2	Long (length), Pos (position)
Byte tables	%MB:L	%MB:L,%KB;L	-
Indexable words	-	-	%MW,%KW,%Xi.T
Non-indexable words	-	-	%IW,%QW,%SW,%NW, Imm.val., Num. Expr.

**Note:**

- The parameter position starts at the value 1 which corresponds to the first position in the string of characters.
  - If the output table is too long, the string is completed with end characters.
- The system bit %S15 is set to 1 in the following cases:
- If the value of the position parameter is negative or equal to 0. In this case, it is interpreted as being equal to 0 and the result table contains an empty string (made up of string end characters).
  - If the position parameter is greater or equal to the length of the source string, the result table will contain an empty string (made up of end characters).
  - If the result table is too short; it is truncated.
  - Word containing the position of the first character to be deleted.
  - If the position of the first string end is less than or equal to the position of the first character which is to be replaced, the output table will be a copy of the source table up until the string end, completed by end characters.

## Extracting a substring of characters

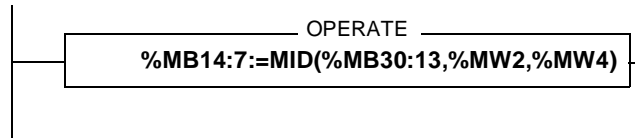
### General

Extraction of a number of characters from a source string entered as a parameter (string).

The rank of the first character to be extracted is determined by the position parameter (pos.), and the number of characters to be extracted is determined by the length parameter (length). The extracted string is stored in a byte table (result).

### Structure

#### Ladder language



#### Instruction list language

```
LD TRUE
[ %MB14:7:=MID(%MB30:13,%MW2,%MW4) ]
```

#### Structured text language

```
%MB14:7:=MID(%MB30:13,%MW2,%MW4);
```

### Examples

Example: `%MB14:7:=MID(%MB30:13,%MW2,%MW4)`  
with `%MW2=4` (length) and `%MW4=9` (position)

`%MB 30 31 32 33 34 35 36 37 38 39 40 41 42`

'm'	'i'	's'	'e'	'_'	'e'	'n'	'_'	's'	't'	'o'	'p'	Ø
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	---

#### Résultat :

`%MB 14 15 16 17 18 19 20`

's'	't'	'o'	'p'	Ø	Ø	Ø
-----	-----	-----	-----	---	---	---

### Syntax

Operators for extraction of a substring of characters

#### Syntax

Result:=MID (string, length, position)

## Operands for extraction of a substring of characters

Type	Result	String	Length, Pos (position)
Byte tables	%MB:L,Imm.val..	%MB:L,%KB;L	-
Indexable words	-	-	%MW,%KW,%Xi.T
Non-indexable words	-	-	%IW,%QW,%SW,%NW, Imm.val., Num. Expr.

**Note:**

- The position parameter starts at the value 1 which corresponds to the first position in the string of characters.
- If the output table is too long, the string is completed with end characters.
- If the length set as a parameter is greater than the size of the source string, the result table will contain the source string.
- If the last element of the table or the string end is reached before the number of characters defined by the parameter length has been extracted, the extraction stops there.

The system bit %S15 is set in the following cases:

- If the value of the parameter length to be extracted is negative or zero. In this case, it is interpreted as being equal to 0 and the result table contains an empty string (made up of string end characters).
- If the value of the position parameter at the start of the extraction is zero or greater than or equal to the length of the table or greater than or equal to the position of the first string end. In this case, the result table contains an empty string (made up of string end characters).
- If the result table is too short; it is truncated.



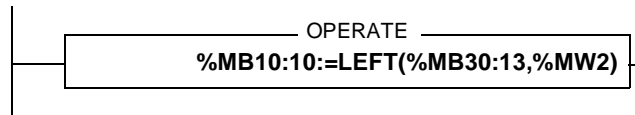
## Extracting characters

### General

Extraction of a number of characters the furthest to the left (LEFT) or the furthest to the right (RIGHT) in a source string entered as a parameter (string). The number of characters which is to be extracted is defined by the length parameter. The extracted string is stored in a byte table (result).

### Structure

#### Ladder language



#### Instruction list language

```
LD TRUE
[ %MB10:10:=LEFT( %MB30:13, %MW2 ) ]
```

#### Structured text language

```
%MB10:10:=LEFT( %MB30:13, %MW2 );
```

### Examples

Example: `%MB10:10:=LEFT( %MB30:13, %MW2 )`  
with `%MW2=8` (length)

*%MB* 30 31 32 33 34 35 36 37 38 39 40 41 42

'm'	'i'	's'	'e'	'_'	'e'	'n'	'_'	's'	't'	'o'	'p'	Ø
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	---

Résultat :

*%MB* 10 11 12 13 14 15 16 17 18 19

'm'	'i'	's'	'e'	'_'	'e'	'n'	'_'	Ø	Ø
-----	-----	-----	-----	-----	-----	-----	-----	---	---

### Syntax

Operators for extraction of characters

<b>Syntax</b>
Result:=LEFT (string, length)
Result:=RIGHT (string, length)

## Operands for extraction of characters

Type	Result	String	Length, Pos (position)
Byte tables	%MB:L	%MB:L,%KB;L, Imm. val.	-
Indexable words	-	-	%MW,%KW,%Xi.T
Non-indexable words	-	-	%IW,%QW,%SW,%NW, Imm.val., Num. Expr.

**Note:**

- If the output table is too long, the result string is completed with end characters.
- If the length in the parameter is greater than the size of the source string, the result table will contain the source string.

The system bit %S15 is set to 1 in the following cases:

- If the value of the length parameter to be extracted is negative or zero. In this case, the result table contains an empty string (made up of string end characters).
- If the value of the position parameter at the start of the extraction is zero or greater than or equal to the length of the table or greater than or equal to the position of the first string end. In this case, the result table contains an empty string (made up of string end characters).
- If the result table is too short; it is truncated.

## Comparing two character strings

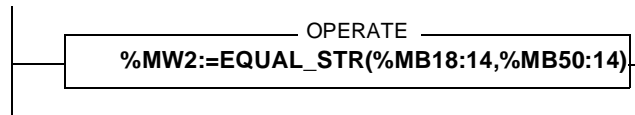
### General

Comparison of two character strings. The result is a word containing the position of the first different character.

In the case of perfect equality between the two character strings, the result value is -1.

### Structure

#### Ladder language



#### Instruction list language

```
LD TRUE
[ %MW2:=EQUAL_STR( %MB18:14 , %MB50:14 ) ]
```

#### Structured text language

```
%MW2:=EQUAL_STR( %MB18:14 , %MB50:14 );
```

### Examples

Example: %MW2:=EQUAL\_STR( %MB18:14 , %MB50:14 )  
with

%MB 18 19 20 21 22 23 24 25 26 27 28 29 30 31

'a'	'b'	'c'	'd'	'e'	'f'	'g'	'h'	'i'	'p'	'w'	'x'	'y'	'z'
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Résultat :

%MB 50 51 52 53 54 55 56 57 58 59 60 61 62 63

'a'	'b'	'c'	'd'	'?'	'f'	'g'	'h'	'Ø'	'v'	'w'	'x'	'y'	'z'
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

==> MW2:= 5

### Syntax

Operators for comparison of two character strings

#### Syntax

```
Result:=EQUAL_STR( string1, string2)
```

## Operands for comparison of two character strings

Type	Result	String 1 and 2
Byte tables	-	%MB:L,%KB;L,Imm. val.
Indexable words	%MW	-
Non-indexable words	%QW,%SW,%NW	-

**Note:**

- A negative length or position is interpreted as being equal to 0.
  - Upper case letters are different from lower case letters.
-

## Searching for a character substring

### General

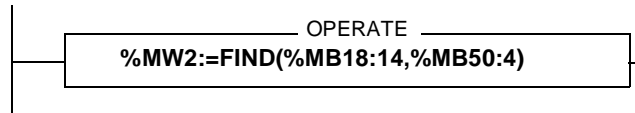
Search for the substring of characters defined by the second parameter in the character string defined by the first parameter.

The result is a word containing the position, in the first string, of the beginning of the searched substring.

In case of failure in the search, the result value is -1.

### Structure

#### Ladder language



#### Instruction list language

```
LD TRUE
[ %MW2:=FIND(%MB18:14,%MB50:4) ]
```

#### Structured text language

```
%MW2:=FIND(%MB18:14,%MB50:4);
```

### Examples

Example: %MW2:=FIND(%MB18:14,%MB50:4) with:

%MB 18 19 20 21 22 23 24 25 26 27 28 29 30 31

'a'	'b'	'c'	'd'	'e'	'f'	'g'	'h'	'i'	Ø	'w'	'x'	'y'	'z'
-----	-----	-----	-----	-----	-----	-----	-----	-----	---	-----	-----	-----	-----

%MB 50 51 52 53

'f'	'g'	'h'	Ø
-----	-----	-----	---

==> MW2:= 6 Indicates that the beginning of the searched string starts at the sixth character.

### Syntax

Search operators for character substrings

<b>Syntax</b>
Result:=FIND (string1, string2)

## Search operands for characters substrings

Type	Result	String 1 and 2
Indexable words	%MW	-
Non-indexable words	%QW,%SW,%NW	-
Byte tables	-	%MB:L,%KB;L,Imm. val.

**Note:** A negative length or position is interpreted as being equal to 0.

---

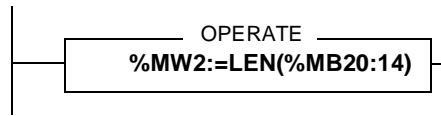
## Length of a character string

### General

This function returns the length of the character string in the parameters, i.e. the number of characters before the string end.

### Structure

#### Ladder language



#### Instruction list language

```
LD TRUE
[ %MW2 :=LEN( %MB20 : 14 ) ]
```

#### Structured text language

```
%MW2 :=LEN( %MB20 : 14 );
```

### Examples

Example: %MW2 :=LEN( %MB20 : 14 with: ))

%MB	20	21	22	23	24	25	26	27	28	29	30	31
	'a'	'b'	'c'	'd'	'e'	'f'	'g'	'Ø'	'n'	'o'	'p'	'r'

==> MW2 := 7

### Syntax

Operator for length of a character string

Syntax
Result:=LEN( string)

Operands for length of a characters string

Type	Result	String 1 and 2
Indexable words	%MW	-
Non-indexable words	%QW,%SW,%NW	-
Byte tables	-	%MB:L,%KB;L,Imm. val.

**Note:** If no string end is found, this function returns the size of the table as indicated in: "Formats of a character string or character table" (See *Format of a string of characters or table of characters, p. 169*).

---



## 2.8 Time management instructions: Dates, Times, Duration

### Introduction

#### Subject of this sub-section

This sub-section describes the time management instructions: Dates, Times, Duration, of PL7 language

#### What's in this Section?

This Section contains the following Maps:

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## Format of parameters in the time management instructions

---

### General

The Date, Time, Duration parameters used by these instructions correspond to the typical formats defined by the standard IEC1131-3.

---

### Duration Format (TIME Type)

This format is used to encode durations periods expressed in tenths of a second and corresponds to the TIME format in the standard.

Such values are displayed in the form: **sssssssss.d**

This gives for example: 3674.3 , for 1 hour, 1 minute, 14 seconds et 3 tenths  
 The value is coded in 32 bits (a double word) with the range fixed at [0, 4294967295] tenths of a second, which represents approximately 13 years and 7 months.

**Note:** Only values within the interval [00:00:00, 23:59:59] are allowed.

---

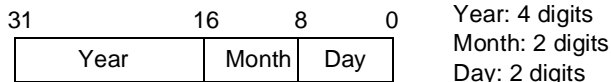
### Date Format (DATE Type)

This format is used to code the year, the month and the day. It corresponds to the DATE format in the standard.

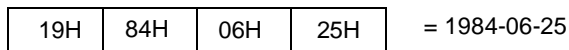
The value is displayed in the form: **yyyy-mm-dd**

This gives for example: 1984-06-25

The value is coded in BCD in 32 bits (a double word) with 3 fields:



Example, expressed in hexadecimal:



**Note:** Only values within the interval [1990-01-01, 2099-12-31] are allowed.

---

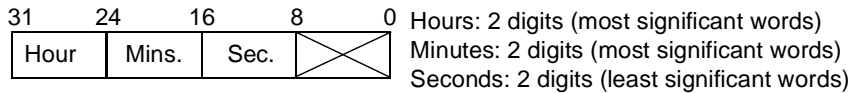
### Time of day Format (TOD Type)

This format is used to code the hour, the minutes and the seconds. It corresponds to the TIME\_OF\_DAY format in the standard.

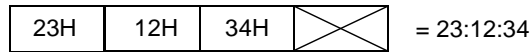
The value is displayed in the form: **hh:mm:ss**

This gives for example: 23:12:34

The value is coded in BCD in 32 bits (a double word) with 3 fields:



Example, expressed in hexadecimal:



**Note:** Only values within the interval [00:00:00, 23:59:59] are allowed.

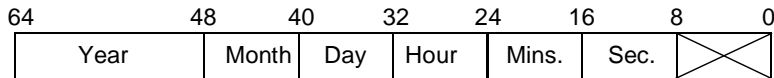
### Date and time Format (DT Type)

This format is used to code the year, the month, the day, the hour, the minutes and the seconds. It corresponds to the DATE\_AND\_TIME format in the standard.

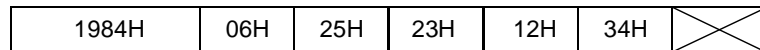
The value is displayed in the form: **yyyy-mm-dd-hh:mm:ss**

This gives for example: 1984-06-25-23:12:34

The value is coded in BCD in 64 bits (a table of words of length 4):



Example, expressed in hexadecimal:



**Note:** Only values within the interval [1990-01-01-00:00:00, 2099-12-31-23:59:59] are allowed.

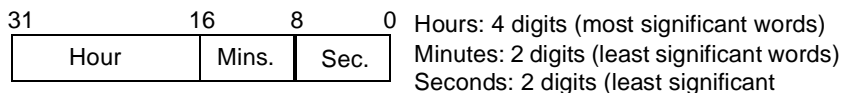
### Hour, Minute, Second Format (HMS Type)

This format used exclusively by the TRANS\_TIME function is used to code the hours, the minutes and the seconds.

The value is displayed in the form: **hh:mm:sss**

This gives for example: 23:12:34

The value is coded in BCD in 32 bits (a double word) with 3 fields:



Example, expressed in hexadecimals:

23H	12H	34H
-----	-----	-----

 = 23:12:34

## Using system bits and words - General

---

- System Bit %S17** The system bit %S17 is set in the following cases:
- Result of an operation outside the range of permitted values
  - An input parameter cannot be interpreted and is not coherent with the desired format (DATE, DT or TOD)
  - Operation on a Time of Day (TOD) format involving a change of day
  - Real time clock access conflict
- 
- System bit %S15** The system bit %S15 is set to 1 when a string is being written in a table, when this string is longer than the size of the table.
- 
- System words** System words:
- **%SD18**: absolute time counter is also used to calculate durations (incremented every 1/10 of a second by the system)
  - **%SW49 à %SW53** (See *Description of system words %SW48 to %SW59, p. 297*) can also be used to display dates
-

## Real time clock function

### General

This function is used to send commands at predefined or calculated times and dates.  
 It sets the output parameter OUT to 1 providing the date provided by the PLC clock at the moment of the function call falls within the period programmed in the input parameters.

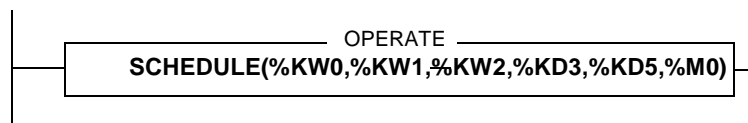
### Syntax

Real time clock function operator

**SCHEDULE** (DBEG, DEND, WEEK, HBEG, HEND, OUT)

### Characteristics of parameters:

Output	<b>OUT</b>	Bit containing the result of the comparisons made by the real time clock function: at 1 during the periods defined by the parameters.
Start date	<b>DBEG</b>	Word encoding the start date of the period (month-date) in BCD (thresholds: 01-01 to 12-31)
End date	<b>DEND</b>	Word encoding the end date of the period (month-date) in BCD (thresholds: 01-01 to 12-31)
Day of the week	<b>WEEK</b>	Word encoding the day or days of the week which are included in the period defined by the parameters DBEG and DEND. The 7 least significant bits represent the 7 days of the week: bit 6 = Monday, bit 5 = Tuesday, ..., bit 0 = Sunday.
Start time	<b>HBEG</b>	Double word encoding the start time of the period in the day (hours-minutes-seconds) in Time of Day BCD format (type: TOD). Thresholds: 00:00:00, 23:59:59
End time	<b>HEND</b>	Double word encoding the end time of the period in the day (hours-minutes-seconds) in Time of Day BCD format (type: TOD). Thresholds: 00:00:00, 23:59:59

**Structure****Ladder language****Instruction list language**

LD TRUE

[ SCHEDULE ( %KW0 , %KW1 , %KW2 , %KD3 , %KD5 , %M0 ) ]

**Structured text language**

SCHEDULE ( %KW0 , %KW1 , %KW2 , %KD3 , %KD5 , %M0 ) ;

**Examples**

Example: Programming 2 non-continuous time ranges

SCHEDULE	(16#0501, 16#1031, 2#0000000001111100, 16"08300000, 16#12000000, %M0 );	(*start date: 1st May*) (*end date: 31st October*) (*Monday to Friday*) (*start time: 8.30a.m.*) (*end time: 6p.m.*) (*result in %M0*)
SCHEDULE	(16#0501, 16#1031, 2#0000000001111100, 16"14000000, 16#18000000, %M1 );	(*start date: 1st May*) (*end date: 31st October*) (*Monday to Friday*) (*start time: 2p.m.*) (*end time: 6p.m.*) (*result in %M1*)
	%Q0.0:=%M0 OR %M1;	

**Operands**

Real time clock function operands

Type	DBEG,DEND,WEEK	HBEG,HEND	OUT
Indexable words	%MW,%KW,%Xi.T	-	-
Non-indexable words	%IW,%QW,%SW,%N W,Imm.val.,Num.expr.	-	-

Type	DBEG,DEND,WEEK	HBEG,HEND	OUT
Indexable double words	-	%MD,%KD	-
Non-indexable double words	-	%ID,%QD,Imm.val., Num.expr.	-
Bits	-	-	%I,%Q,%M,%S, %BLK,%*:Xk,%X

**Note:**

- The 2 parameters DBEG and DEND define a range of days in the year; this range can overlap 2 civil years. Example: from 10th October to 7th April. The 29th February can be included in this period; it will be ignored in non-leap years.
- The 2 parameters HBEG and HEND define a range of time in the day; this range can overlap 2 civil days. Example: from 10p.m. to 6:10:20a.m.
- If one of the DBEG and DEND dates or one of the HBEG and HEND times is invalid, i.e. it does not correspond to a real date or time, the OUT output will be at 0 and the %S17 bit will be set to 1.
- If the target PLC does not have an internal clock (as in TSX37-10), the output will be at 0 and the system bit %S17 will be set to 1.
- It is possible to lighten the load on a PLC processor where precision is not important by cadencing the call to the SCHEDULE function using the system bit %S6 or %S7.



## Reading system date

### General

Reading the system date (Real Time Clock) and transferring into the object set in the parameters in Date and Time format (DT).

### Structure

#### Ladder language



#### Instruction list language

```
LD %M6
[RRTC(%MW2:4)]
```

#### Structured text language

```
IF %M6 THEN
  RRTC(%MW2:4);
END_IF;
```

### Examples

Example: RRTC(%MW2:4)

The result is transferred to the table of internal words of length 4: %MW2 to %MW5.

### Syntax

System date read operator

<b>Syntax</b>
RRTC(date)

System date read operands

Type	Date
Table of 4 Words in Date and Time format	%MW:4

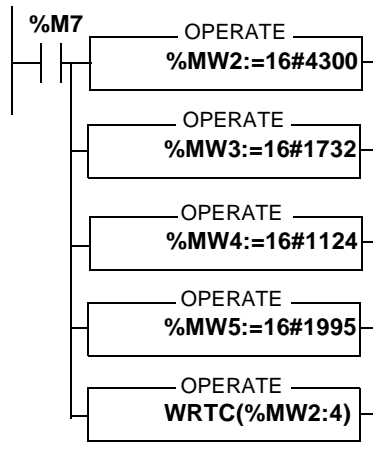
## Updating the system date

### General

Updating the system date (Real Time Clock) and transferring into the object given in parameter in Date and Time format (DT).

### Structure

#### Language data



#### Instruction list language

```

LD %M7
[ %MW2 :=16#4300 ]
[ %MW3 :=16#1732 ]
[ %MW4 :=16#1124 ]
[ %MW5 :=16#1995 ]
[ WRTC ( %MW2 : 4 ) ]
  
```

#### Structured text language

```

IF %M7 THEN
  %MW2 :=16#4300 ;
  %MW3 :=16#1732 ;
  %MW4 :=16#1124 ;
  %MW5 :=16#1995 ;
  WRTC ( %MW2 : 4 ) ;
END_IF ;
  
```

**Examples**

Example: The new date is loaded into an internal word table with a length of 4 %MW2:4, then sent to the system by the WRTC functions

---

**Syntax**

System date updating operator

<b>Syntax</b>
WRTC(date)

System date updating operands

Type	Date
4 Word Table	%MW:4,%KW:4 in date and time format

---

## Reading stop date and code

---

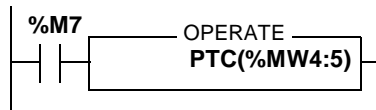
### General

Reading of the date of the last PLC stop and of the code specifying the cause of this stop (in the 5th word, equivalent to %SW58 (See *Description of system words %SW48 to %SW59, p. 297*))

---

### Structure

#### Ladder language



#### Instruction list language

```
LD %M7
[ PTC ( %MW4 : 5 ) ]
```

#### Structured text language

```
IF %M7 THEN
    PTC ( %MW4 : 5 ) ;
END_IF ;
```

---

### Examples

Example: PTC ( %MW4 : 5 )  
 The result is transferred to the table of internal words of length 5: %MW4 to %MW8

---

### Syntax

Read stop date and code operator

<b>Syntax</b>
PTC (date)

Read stop date and code operands

Type	Date
5 Word table in Date and Time format	%MW:5

---

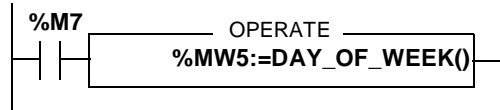
## Reading day of the week

### General

This result of this function is to supply current day of the week information in the form of a digit between 1 and 7 transferred in a word (1 = Monday, 2 = Tuesday, 3 = Wednesday, 4 = Thursday, 5 = Friday, 6 = Saturday, 7 = Sunday).

### Structure

#### Ladder language



#### Instruction list language

```
LD %M7
[ %MW5 := DAY_OF_WEEK ( ) ]
```

#### Structured text language

```
IF %M7 THEN
  %MW5 := DAY_OF_WEEK ( ) ;
END_IF ;
```

### Examples

Example: %MW5 := DAY\_OF\_WEEK ( )  
%MW5:=4 corresponds to Thursday

### Syntax

Read day of the week operator

<b>Syntax</b>
Result:=DAY_OF_WEEK()

Read day of the week operands

Type	Result (res)
Indexable words	%MW
Non-indexable words	%QW,%SW,%NW

**Note:** If the function has not been able to update the result following a real-time clock access error, the result returned is 0 and the system bit %S17 is set at 1.

---

## Addition / Subtraction of a duration from a date

### General

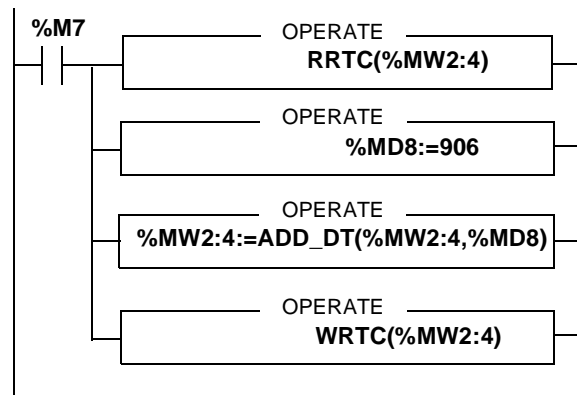
Addition or subtraction of a duration (in tenths of a second) (In2) from a source date (In1). The result is a new date transferred in a 4 word table.

**ADD\_DT ()** = Addition of a duration

**SUB\_DT ()** = Subtraction of a duration

### Structure

#### Ladder language



#### Instruction list language

```

LD %M7
[ RRTC( %MW2 : 4 ) ]
[ %MD8 := 906 ]
[ %MW2 : 4 := ADD_DT( %MW2 : 4 , %MD8 ) ]
[ WRTC( %MW2 : 4 ) ]
  
```

#### Structured text language

```

IF %M7 THEN
  RRTC( %MW2 : 4 ) ;
  %MD8 := 906 ;
  %MW2 : 4 := ADD_DT( %MW2 : 4 , %MD8 ) ;
  WRTC( %MW2 : 4 ) ;
END_IF ;
  
```

### Examples

Example: %MW2 : 4 := ADD\_DT( %MW2 : 4 , %MD8 )

%MW2:4:= Source date

%MD8:=906 (906 tenths of a second rounded off to 1 min. 31s)

%MW2:4:= New date

**Syntax**

Operators for addition/subtraction of a time duration from a date

<b>Syntax</b>
Result:= <b>ADD_DT</b> (In1, In2)
Result:= <b>SUB_DT</b> (In1, In2)

Operands for addition/subtraction of a time duration from a date

Type	Result (res)	In1 (source date)	In2 (duration)
Tables of 4 Words in Date and Time format	%MW4	%MW4:4,%KW:4	-
Indexable double words	-	-	%MD,%KD
Non-indexable double words	-	-	%ID,%QD,Imm.val., Num.expr.

**Note:**

- The rounding off principle will be applied to the 'duration' parameter (expressed in tenths of a second) to enable the addition or subtraction from the date (precise to the second).
  - ssssssss.0 à ssssssss.4 rounded off to ssssssss.0
  - ssssssss.5 à ssssssss.9 rounded off to ssssssss.0 +1.0
- The application is to provide for the management of leap years.
- If the result of the operation is outside the interval for permitted values, the system bit %S17 is set at 1 and the result value is equal to the minimum limit (for SUB\_DT) or remains blocked at the maximum (for ADD\_DT).
- If the input parameter 'source date' cannot be interpreted and is not coherent in DT format (DATE\_AND\_TIME), the system bit %S17 is set at 1 and the result value is equal to 0001-01-01-00:00:00.



## Addition / Subtraction of a duration from a time of day

### General

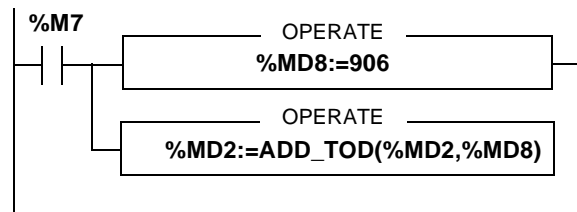
Addition or subtraction of a duration to a time of day. The result is a new time of day transferred in a double word.

**ADD\_TOD ()** = Addition of a duration

**SUB\_TOD ()** = Subtraction of a duration

### Structure

#### Ladder language



#### Instruction list language

```
LD %M7
[ %MD8 := 906 ]
[ %MD2 := ADD_TOD ( %MD2 , %MD8 ) ]
```

#### Structured text language

```
IF %M7 THEN
  %MD8 := 906 ;
  %MD2 := ADD_TOD ( %MD2 , %MD8 ) ;
END_IF ;
```

### Examples

Example: %MD2 := ADD\_TOD ( %MD2 , %MD8 )  
 %MD2 := Source time (e.g.: 12:30:00)  
 %MD8 := 906 (906 tenths of a second rounded off to 1 min. 31s)  
 %MD2 := New time (e.g.: 13:31:31)

### Syntax

Operators for addition/subtraction of a time duration from a time of day

<b>Syntax</b>
Result:= <b>ADD_TOD</b> (In1, In2)
Result:= <b>SUB_TOD</b> (In1, In2)

Operands for addition/subtraction of a time duration from a time of day

Type	Result (res)	In1 (source time) and In2 (duration)
Indexable double words	%MD	%MD,%KD
Non-indexable double words	%QD	%ID,%QD,Imm.val.,Num.expr.

**result** and **In1** are in TOD format, **In2** is in duration format.

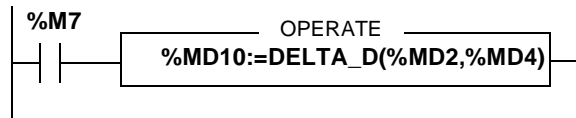
**Note:**

- The rounding off principle will be applied to the 'duration' parameter (expressed in tenths of a second) to enable the addition or subtraction from the date (precise to the second).
  - ssssssss.0 à ssssssss.4 rounded off to ssssssss.0
  - ssssssss.5 à ssssssss.9 rounded off to ssssssss.0 +1.0
- The day is changed if the result of the operation is outside the interval for permitted values. In this case, the system bit %S17 is set at 1 and the value of the result can be interpreted with a 24:00:00 rollover.
- If the input parameter 'time of day' cannot be interpreted in TOD format, the system bit %S17 is set at 1 and the result value is equal to 00:00:00.

## Interval between two dates (without time)

**General** Calculates the time interval between two dates. The result, given as an absolute value, is transferred in a double word.

**Structure** **Ladder language**



### Instruction list language

```
LD %M7
[ %MD10:=DELTA_D( %MD2, %MD4 ) ]
```

### Structured text language

```
IF %M7 THEN
  %MD10:=DELTA_D( %MD2, %MD4 );
END_IF;
```

### Examples

```
%MD10:=DELTA_D( %MD2, %MD4 )
%MD2:= Date number1 (e.g.: 1994-05-01)
%MD4:= Date number2 (e.g.: 1994-04-05)
==> %MD10:= 22464000 (==> interval = 26 days)
```

### Syntax

Operator for an interval between two dates (without time)

<b>Syntax</b>
Result:=DELTA_D(Date1, Date2)

Operands for an interval between two dates (without time)

Type	Result (res)	Date 1 and 2
Indexable double words	%MD	%MD,%KD
Non-indexable double words	%QD	%ID,%QD,Imm.val.,Num.expr.

**result** is in TIME format, **Date 1** and **2** are in DATE format.

The TIME format is defined with precision to a tenth of a second. The DATE format is defined with precision to a day. The calculated time interval will be a multiple of 864000 (= 1day = 24 h x 60 mn x 60 s x 10 tenths).

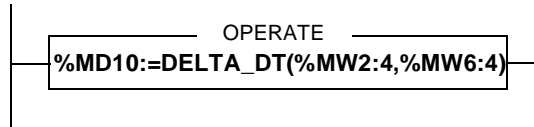
**Note:**

- There is overflow if the result exceeds the maximum value permitted for a duration (TIME). In this case, the result is equal to 0 and the system bit %S18 is set at 1.
- If one of the input parameters cannot be interpreted and is not coherent in DATE format, the system bit %S17 is set at 1 and the result is equal to 0.

## Interval between two dates (with time)

**General** Calculates the time interval between two dates. The result, given as an absolute value, is transferred in a double word.

**Structure** **Ladder language**



**Instruction list language**

```
LD TRUE
[ %MD10:=DELTA_DT( %MW2:4 , %MW6:4 ) ]
```

**Structured text language**

```
%MD10:=DELTA_DT( %MW2:4 , %MW6:4 );
```

**Examples**

```
%MD10:=DELTA_DT( %MW2:4 , %MW6:4 )
%MW2:4:= Date number1 (e.g.: 1994-05-01-12:00:00)
%MW6:4:= Date number2 (e.g.: 1994-05-01-12-01-30)
==> %MD10:= 900 (==> interval = 1 minute and 30 seconds)
```

**Syntax**

Operator for an interval between two dates (with time)

<b>Syntax</b>
Result:=DELTA_DT(Date1, Date2)

Operands for an interval between two dates (with time)

Type	Result (res)	Date 1 and 2
Indexable double words	%MD	-
Non-indexable double words	%QD	-
4 word table in DT format	-	%MW:4,%KW:4

**result** is in TIME format, **Date 1** and **2** are in DT format.

The TIME format is defined with precision to a tenth of a second. The DT format is defined with precision to a second. The calculated time interval is a multiple of 10.

**Note:**

- There is overflow if the result exceeds the maximum value permitted for a duration (TIME). In this case, the result is equal to 0 and the system bit %S18 is set at 1.
- If one of the input parameters cannot be interpreted and is not coherent in DT format, the system bit %S17 is set at 1 and the result is equal to 0.

## Interval between two times

**General** Calculates the time interval between two times of day. The result is transferred in a double word as an absolute value giving a duration.

**Structure** **Ladder language**



**Instruction list language**

```
LD TRUE
[ %MD10 := DELTA_TOD ( %MD2 , %MD4 ) ]
```

**Structured text language**

```
%MD10 := DELTA_TOD ( %MD2 , %MD4 ) ;
```

**Examples**

```
%MD10 := DELTA_TOD ( %MD2 , %MD4 )
%MD2 := Time1 (e.g.: 02:30:00)
%MD4 := Time2 (e.g.: 02 41 00)
==> %MD10 := 6600 (==> interval = 11 minutes)
```

**Syntax**

Operator for an interval between two times

<b>Syntax</b>
Result:=DELTA_TOD(Date1, Date2)

Operands for an interval between two times

Type	Result (res)	Time 1 and 2
Indexable double words	%MD	%MD,%KD
Non-indexable double words	%QD	%ID,%QD, Immediate value, Numeric expr.

**result** is in TIME format, **Time 1** and **2** are in TOD format.

The TIME format is defined with precision to a tenth of a second. The TOD format is defined with precision to a second. The calculated time interval is a multiple of 10.

**Note:** If one of the input parameters cannot be interpreted and is not coherent in TOD format, the system bit %S17 is set at 1 and the result is equal to 0.

---



## Conversion of a date into a string of characters

### General

This instruction converts a date into a string of characters (without time) in the following format: YYYY-MM-DD (10 characters). This string ends with an end character Ø. Each character Y,M,D symbolizes a digit.

### Structure

#### Ladder language



#### Instruction list language

```
LD TRUE
[ %MB2:11=DATE_TO_STRING(%MD40) ]
```

#### Structured text language

```
%MB2:11=DATE_TO_STRING(%MD40);
```

### Examples

```
%MB2:11=DATE_TO_STRING(%MD40)
%MD40:= Date (e.g.: 1998-12-27)
```

%MB	2	3	4	5	6	7	8	9	10	11	12
	'1'	'9'	'9'	'8'	'.'	'1'	'2'	'.'	'2'	'7'	Ø

### Syntax

Date to string conversion operator

#### Syntax

```
Result:=DATE_TO_STRING(Date)
```

Date to string conversion operands

Type	Result (res)	Date
Tables of 11 bytes	%MB:11	-
Indexable double words	-	%MD,%KD
Non-indexable double words	-	%ID,%QD, Immediate value, Numeric expr.

**Note:**

- If the input (date) parameter cannot be interpreted and is not coherent in DATE format, the system bit %S17 is set at 1 and the function returns the string `**** - ** - **`.
- If the output string is too short, it is truncated and the system bit %S15 is set to 1.  
`%MB2:8 := DATE_TO_STRING(%MD40)`

==> %MB    2   3   4   5   6   7   8   9

'1'	'9'	'9'	'8'	'-'	'1'	'2'	'-'
-----	-----	-----	-----	-----	-----	-----	-----

==> %S15 = 1

- If the output string is too long, it is completed with end characters `Ø`.  
`%MB2:12 := DATE_TO_STRING(%MD40)`

==> %MB    2   3   4   5   6   7   8   9   10   11   12   13

'1'	'9'	'9'	'8'	'-'	'1'	'2'	'-'	'2'	'7'	Ø	Ø
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	---	---

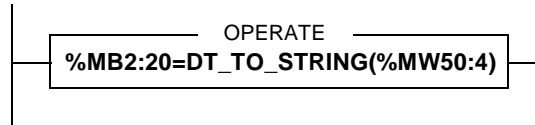
## Conversion of a complete date into a string of characters

### General

This instruction converts a complete date (with time) into a string of characters in the following format: YYYY-MM-DD-HH:MM:SS (19 characters). This string ends with an end character Ø. Each character Y,M,D,H,M,S symbolizes a digit.

### Structure

#### Ladder language



#### Instruction list language

```
LD TRUE
[ %MB2:20=DT_TO_STRING(%MW50:4) ]
```

#### Structured text language

```
%MB2:20=DT_TO_STRING(%MW50:4);
```

### Examples

```
%MB2:20=DT_TO_STRING(%MW50:4)
%M50:4:= Date and time (type DT) (e.g.: 1998-12-27-23:14:37)
```

```
==>
%MB 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
  '1' '9' '9' '8' '-' '1' '2' '-' '2' '7' '-' '2' '3' ':' '1' '4' ':' '3' '7' 'Ø' 'Ø'
```

### Syntax

#### Complete date to string conversion operator

##### Syntax

```
Result:=DT_TO_STRING(Date)
```

#### Complete date to string conversion operands

Type	Result (res)	Date
Tables of 20 bytes	%MB:20	-
4 word table in DT format	-	%MW:4,%KW:4

**Note:**

- If the (date) input parameter cannot be interpreted and is not coherent in DT (DATE\_AND\_TIME) format, the system bit %S17 is set at 1 and the function returns the string \*\*\*\*-\*\*-\*\*-\*\*:\*:\*:\*. .
- If the output string is too short, it is truncated and the system bit %S15 is set to 1.  
`%MB2:8:=DT_TO_STRING(%MW50:4)`

==> %MB

2	3	4	5	6	7	8	9
'1'	'9'	'9'	'8'	'.'	'1'	'2'	'.'

==> %S15 = 1

- If the output string is too long, it is completed with end characters Ø.  
`%MB2:21:=DT_TO_STRING(%MD50:4)`

==>

%MB	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	'1'	'9'	'9'	'8'	'.'	'1'	'2'	'.'	'2'	'7'	'.'	'2'	'3'	':'	'1'	'4'	':'	'3'	'7'	Ø	Ø

## Conversion of a duration into a string of characters

### General

This instruction converts a duration (in TIME format) into a string of characters. The format of the result is in hours, minutes, seconds and tenths of a second expressed in 15 characters: HHHHHH:MM:SS.D. This string ends with the end character Ø. Each character H,M,S,D symbolizes a digit. The maximum duration corresponds to 119304 hours, 38 minutes, 49 seconds and 5 tenths.

### Structure

#### Ladder language



#### Instruction list language

```
LD TRUE
[ %MB2:15=TIME_TO_STRING(%MD40) ]
```

#### Structured text language

```
%MB2:15=TIME_TO_STRING(%MD40);
```

### Examples

```
%MB2:15=TIME_TO_STRING(%MD40)
%MD40:= 27556330.3 (TIME format)
```

%MB	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	'0'	'0'	'7'	'6'	'5'	'4'	':'	'3'	'2'	':'	'1'	'0'	':'	'3'	Ø

### Syntax

Duration to string conversion operator

<b>Syntax</b>
Result:= <b>TIME_TO_STRING</b> (Duration)

Duration to string conversion operands

Type	Result (res)	Duration
Tables of 15 bytes	%MB:15	-
Indexable double words	-	%MD,%KD
Non-indexable double words	-	%ID,%QD, Immediate value, Numeric expr.

**Duration** is in TIME format

**Note:**

- If the output string is too short, it is truncated and the system bit %S15 is set to 1.

`%MB2:8:=TIME_TO_STRING(%MD40)`

==> %MB    2   3   4   5   6   7   8   9

'0'	'0'	'7'	'6'	'5'	'4'	':'	'3'
-----	-----	-----	-----	-----	-----	-----	-----

==> %S15 = 1

- If the output string is too long, it is completed with end characters Ø.

`%MB2:16:=TIME_TO_STRING(%MD40)`

==>

%MB    2   3   4   5   6   7   8   9   10   11   12   13   14   15   16   17

'0'	'0'	'7'	'6'	'5'	'4'	':'	'3'	'2'	':'	'1'	'0'	':'	'3'	Ø	Ø
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	---	---

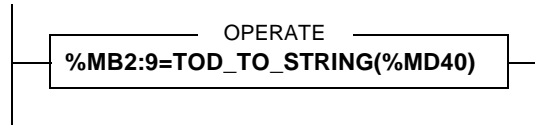
## Conversion of a time of day to a character string

### General

This instruction converts a time of day (in TOD – TIME\_OF\_DAY format) into a character string with 8 characters in HH:MM:SS format plus an end character Ø. Each character H,M,S symbolizes a digit.

### Structure

#### Ladder language



#### Instruction list language

```
LD TRUE
[ %MB2:9=TOD_TO_STRING(%MD40) ]
```

#### Structured text language

```
%MB2:9=TOD_TO_STRING(%MD40);
```

### Examples

```
%MB2:9=TOD_TO_STRING(%MD40)
%MD40:= 23:12:27 (TOD format)
```

%MB	2	3	4	5	6	7	8	9	10
	'2'	'3'	':'	'1'	'2'	':'	'2'	'7'	Ø

### Syntax

Time of day to string conversion operator

Syntax
Result:=TOD_TO_STRING(Duration)

Time of day to string conversion operands

Type	Result (res)	Time
9 byte tables	%MB:9	-
Indexable double words	-	%MD,%KD
Non-indexable double words	-	%ID,%QD, Immediate value, Numeric expr.

**Time** is in TOD format

**Note:**

- If the output string is too short, it is truncated and the system bit %S15 is set to 1.  
**%MB2:8 := TOD\_TO\_STRING (%MD40)** (where %MD40 := 23:12:27)

==> %MB    2   3   4   5   6   7   8   9

'2'	'3'	':'	'1'	'2'	':'	'2'	'7'
-----	-----	-----	-----	-----	-----	-----	-----

==> %S15 = 1

- If the output string is too long, it is completed with end characters Ø.  
**%MB2:10 := TOD\_TO\_STRING (%MD40)** (where %MD40 := 23:12:27)

==>

%MB    2   3   4   5   6   7   8   9   10 11

'2'	'3'	':'	'1'	'2'	':'	'2'	'7'	Ø	Ø
-----	-----	-----	-----	-----	-----	-----	-----	---	---



## Conversion of a duration into HHHH:MM:SS

### General

This instruction converts a duration (in TIME format) into hours-minutes-seconds: HHHH:MM:SS. Threshold [0000:00:00 , 9999:59:59].

### Structure

#### Ladder language



#### Instruction list language

```
LD TRUE
[%MD100=TRANS_TIME(%MD2)]
```

#### Structured text language

```
%MD100=TRANS_TIME(%MD2);
```

### Examples

```
%MD100=TRANS_TIME(%MD2)
where %MD2:= 36324873 tenths of a second
```

```
==> %MD2
```

31	16	8	0
2 3 9 7	5 4	4 7	

values are expressed in hexadecimal

### Syntax

Duration to HHHH:MM:SS conversion operator

<b>Syntax</b>
Result:=TRANS_TIME(Duration)

Duration to HHHH:MM:SS conversion operator

Type	Result (res)	Duration
Indexable double words	%MD	%MD,%KD
Non-indexable double words	%QD	%ID,%QD, Immediate value, Numeric expr.

**Result** is in HMS format

**Duration** is in TIME format

**Note:**

- The rounding off principle will be applied to the "duration" parameter (expressed in tenths of a second) to enable conversion (precise to the second).
  - ssssssss.0 à ssssssss.4 rounded off to ssssssss.0
  - ssssssss.5 à ssssssss.9 rounded off to ssssssss.0 +1.0
- The maximum converted duration may be up to 10000 hours. This means that if the duration value (TIME) in the parameter is equal or greater than 360000000, it cannot be converted. %S15 system bit is set to 1 and the result is equal to 0000:00:00.

---

## 2.9 Bit table instructions

---

### Introduction

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#### Subject of this sub-section

This sub-section describes PL7 language bit table instructions

---

#### What's in this Section?

This Section contains the following Maps:

Topic	Page
Copying a bit table into a bit table	236
Logic instructions on bit tables	237
Copying a bit table into a word table	239
Copy of a word table in a bits table	242

---

## Copying a bit table into a bit table

**General** This function copies a bit table bit by bit into another bit table.

**Structure** **Ladder language**



### Instruction list language

```
LD TRUE
[ %MD10:5=COPY_BIT(%M20:5) ]
```

### Structured text language

```
%MD10:5=COPY_BIT(%M20:5);
```

**Syntax**

Bit table copy operator

<b>Syntax</b>
Result:=COPY_BIT(Tab)

Bit table copy operands

Type	Result (res)	Tab (table)
Bit table	%M:L,%Q:L,%I:L	%M:L,%Q:L,%I:L,%Xi:L

#### Note:

- Tables can be of different sizes. In this case, the result table contains the result of the function executed for a length equivalent to the smallest of the tables, and the rest of the table has not been modified.
- Be careful of possible overlap between the input table and the result table.

## Logic instructions on bit tables

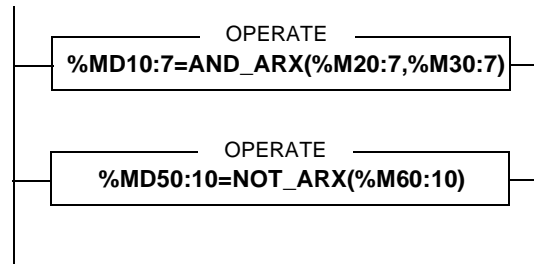
### General

Associated functions are used to carry out a bit by bit logic operation between two bit tables, and arrange the result in another bit table.

- **AND\_ARX**: logic AND (bit by bit)
- **OR\_ARX**: logic OR (bit by bit)
- **XOR\_ARX**: Exclusive OR (bit by bit)
- **NOT\_ARX**: logic (bit by bit) complement of a table

### Structure

#### Ladder language



#### Instruction list language

```
LD TRUE
[ %MD10:7=AND_ARX(%M20:7,%M30:7) ]
```

```
LD TRUE
[ %MD50:10=NOT_ARX(%M60:10) ]
```

#### Structured text language

```
%MD10:7=AND_ARX(%M20:7,%M30:7);
%MD50:10=NOT_ARX(%M60:10);
```

### Syntax

Logic instruction on bit table operators

Syntax
Result:= <b>AND_ARX</b> (Tab 1, Tab 2)
Result:= <b>OR_ARX</b> (Tab 1, Tab 2)
Result:= <b>XOR_ARX</b> (Tab 1, Tab 2)
Result:= <b>NOT_ARX</b> (Tab 1)

## Logic instruction on bit tables operands

Type	Result (res)	Tab 1 and Tab 2 (table)
Bit table	%M:L,%Q:L,%I:L	%M:L,%Q:L,%I:L,%Xi:L

**Note:**

- Tables can be of different sizes. In this case, the result table contains the result of the function executed for a length equivalent to the smallest of the tables, and the rest of the table has not been modified.
  - Possibility of overlap between the input table and the result table.
-

## Copying a bit table into a word table

### General

This function copies the bits of a bit table or part of a bit table and copies them into a word (or double word) table.

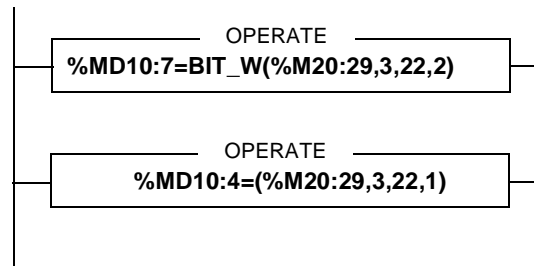
In the bit table, the bits are taken starting from a certain position (brow) for a set number of bits (nbit).

In the word (or double word) table, the copy is made from the position (wrow or drow) starting with the least significant bit of each word.

- **BIT\_W**: Copies a bit table into a word table.
- **BIT\_D**: Copies a bit table into a double word table.

### Structure

#### Ladder language



#### Instruction list language

```
LD TRUE
[ %MD10:7=BIT_W( %M20:29,3,22,2) ]
```

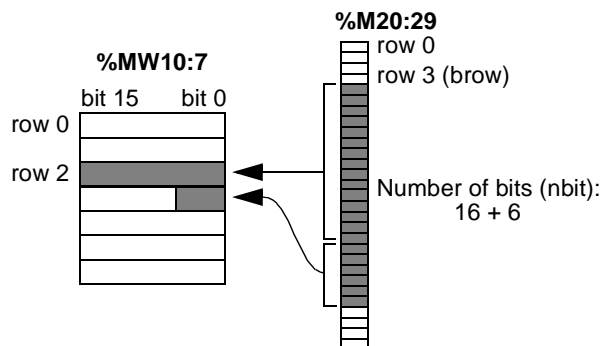
```
LD TRUE
[ %MD10:4=( %M20:29,3,22,1) ]
```

#### Structured text language

```
%MD10:7=BIT_W(%M20:29,3,22,2);
%MD10:4=(%M20:29,3,22,1);
```

**Example**

```
%MD10:7=BIT_W(%M20:29,3,22,2);
```



**Syntax**

Bit table to word table copy operators

<b>Syntax</b>
Result:= <b>BIT_W</b> (Tab, brow, nbit, wrow)
Result:= <b>D_BIT</b> (Tab, brow, nbit, drow)

Bit table to word table copy operands

Type	Result (res)	Tab (table)	brow - nbit wrow or drow
Word tables	%MW:L	-	-
Double word tables	%MD:L	-	-
Bit table	-	%M:L,%Q:L,%I:L, %Xi:L	-
Indexable words	-	-	%MW,%KW,%Xi.T
Non-indexable words	-	-	%IW,%QW,%SW, %NW, Imm. value., Num. expr.



**Note:**

- If the number of bits to be processed is greater than the number of bits remaining in the tables from position (brow), the function copies up to the last table element.
  - If the number of bits to be copied is greater than the number of bits that make up the remaining words in the result table, the function stops copying at the last element of the word (or double word) table.
  - A negative value in the brow, nbit, wrow or drow parameters will be interpreted as zero.
-

## Copy of a word table in a bits table

### General

The function takes the bits that make up a word table or part of a word (or double word) table and copies them into a bit table.

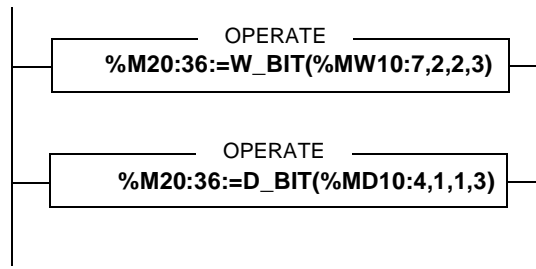
In the word (or double word) table, the deduction is made from position word (wrow or draw) for a number of words (nwd).

In the bit table, the copy is made from the position (brow) starting with the least significant bit of each word.

- **W\_BIT**: Recopying a word table into a bit table.
- **D\_BIT**: Recopying a double word table into a bit table.

### Structure

#### Language data



#### Instruction list language

```
LD TRUE
[ %M20:36:=W_BIT(%MW10:7,2,2,3) ]
```

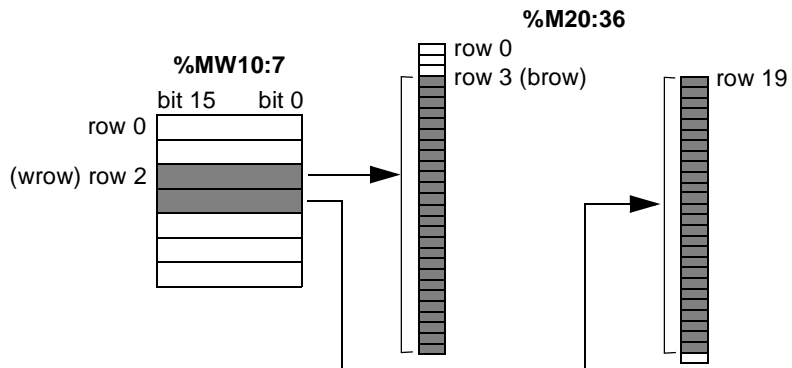
```
LD TRUE
[ %M20:36:=D_BIT(%MD10:4,1,1,3) ]
```

#### Structured text language

```
%M20:36:=W_BIT(%MW10:7,2,2,3);
%M20:36:=D_BIT(%MD10:4,1,1,3);
```

**Example**

```
%M20:36:=W_BIT(%MW10:7,2,2,3);
```

**Syntax**

Operators for copying a word table into a bit table

Syntax
Result:= <b>W_BIT</b> (Tab, wrow, nwd, brow)
Result:= <b>D_BIT</b> (Tab, drow, nwd, brow)

Operands for copying a word table into a bit table

Type	Result (res)	Tab (table)	wrow or drow nwd - brow
Bit tables	%M:L,%Q:L,%I:L	-	-
Word tables	-	%MW:L,%KW:L	-
Double word tables	-	%MD:L,%KD:L	-
Words which can be indexed	-	-	%MW,%KW,%Xi.T
Words which can not be indexed	-	-	%IW,%QW,%SW,%NW, Imm value., Num. expr.

**Note:**

- If the number of bits to be processed is greater than the number of bits remaining in the tables from position (wrow), the function recopies up to the last table element.
- If the number of bits to be recopied is greater than the number of bits that make up the remaining words in the result table, the function stops copying at the last word (or double word) table element.
- If the number of bits to be recopied is greater than the number of bits remaining in the result table, the function stops recopying at the last table element.
- A negative value in the brow, nbit, wrow or drow parameters will be interpreted as zero.

---

## 2.10 "Orpheus" functions: Shift registers, counter

---

### Introduction

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#### Subject of this sub-section

This sub-section describes the following "Orpheus" functions of PL7 language: shift register and counter

---

#### What's in this Section?

This Section contains the following Maps:

Topic	Page
Shift register on words with shifted bit retrieval	246
Up/down counting with overshoot signaling	249
Rotate shifts	252

---

## Shift register on words with shifted bit retrieval

### General

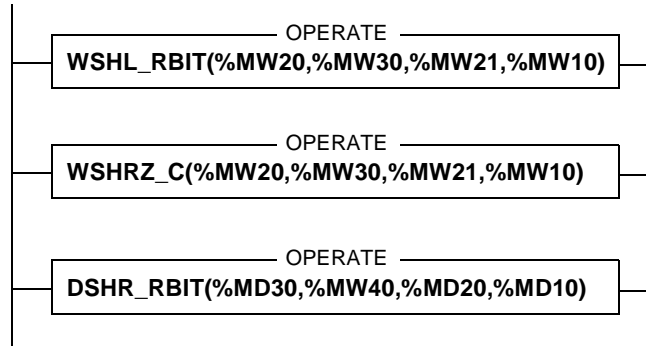
The functions cause right or left arithmetic shifts on a number of shift registers (nbit) on a word or on a double word (a).

After shifting, the value is placed in (résu) and the shifted bits are placed in (rest).

- **WSHL\_RBIT**: Left shift on word with shifted bit retrieval.
- **DSHL\_RBIT**: Left shift on double word with shifted bit retrieval.
- **WSHRZ\_C**: Right shift on word, filling with 0s and shifted bit retrieval.
- **DSHRZ\_C**: Right shift on double word, filling with 0s and shifted bit retrieval.
- **WSHR\_RBIT**: Right shift on word with sign extension and shifted bit retrieval.
- **DSHR\_RBIT**: Right shift on double word with sign extension and shifted bit retrieval.

### Structure

#### Ladder language



#### Instruction list language

```
LD TRUE
[WSHL_RBIT(%MW20,%MW30,%MW21,%MW10)]
```

```
LD TRUE
[WSHRZ_C(%MW20,%MW30,%MW21,%MW10)]
```

```
LD TRUE
[DSHR_RBIT(%MD30,%MW40,%MD20,%MD10)]
```

**Structured text language**

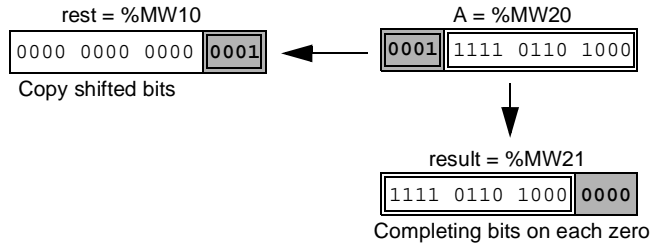
`WSHL_RBIT(%MW20,%MW30,%MW21,%MW10);`

`WSHRZ_C(%MW20,%MW30,%MW21,%MW10);`

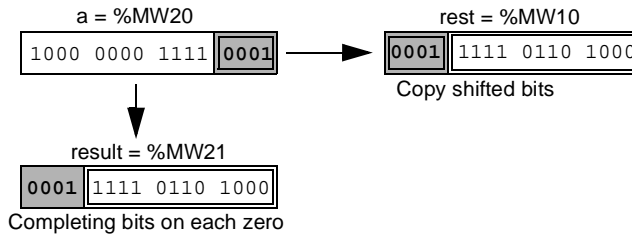
`DSHR_RBIT(%MD30,%MW40,%MD20,%MD10);`

**Examples**

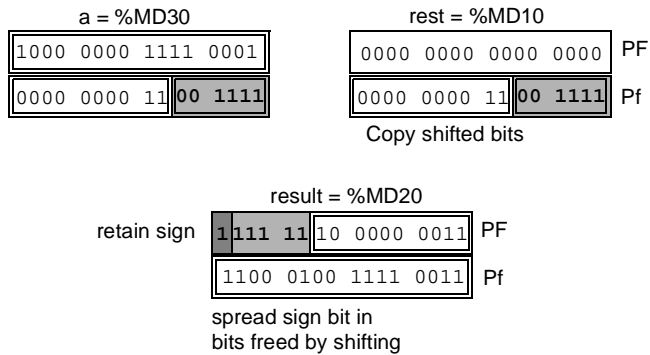
`WSHL_RBIT(%MW20,%MW30,%MW21,%MW10)` with `%MW30 = 4`



`WSHRZ_C(%MW20,%MW30,%MW21,%MW10)` with `%MW30 = 4`



`DSHR_RBIT(%MD30,%MW40,%MD20,%MD10)` with `%MW40 = 6`



**Syntax**

Shift register operators on words with shifted bit retrieval

<b>Syntax</b>
<b>WSHL_BIT</b> (a, nbit, résu, rest)
<b>WSHRZ_C</b> (a, nbit, résu, rest)
<b>WSHR_RBIT</b> (a, nbit, résu, rest)

Shift register operands on words with shifted bit retrieval

Type	a	nbit	résu, rest
Words which can be indexed	%MW,%KW	%MW,%KW,%Xi.T	%MW
Words which can not be indexed	%IW,%QW,%SW, %NW, Imm.value, Num.expression	%IW,%QW,%SW, %NW, Imm.value, Num.expression	%QW,%SW,%NW

Shift register operators on double words with shifted bit retrieval

<b>Syntax</b>
<b>DSHL_BIT</b> (a, nbit, résu, rest)
<b>DSHRZ_C</b> (a, nbit, résu, rest)
<b>DSHR_RBIT</b> (a, nbit, résu, rest)

Shift register operands on double words with shifted bit retrieval

Type	a	nbit	résu, rest
Double words which can be indexed	%MD,%KD	-	%MD
Double words which can not be indexed	%ID,%QD,%SD, Immediate value, Num.expression	-	%QD,%SD
Words which can be indexed	-	%MW,%KW,%Xi.T	-
Words which can not be indexed	-	%IW,%QW,%SW, %NW, Imm.value, Num.expression	-

**Note:** If the parameter (nbit) is not between 1 and 16 for word shifts, or between 1 and 32 for double word shifts, the outputs (résu) and (rest) are not significant and the %S18 system bit is set to 1.



## Up/down counting with overshoot signaling

### General

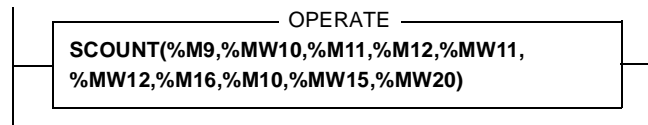
The function is used to up/down count with overshoot signaling. This function is only executed if the confirmation input (en) is set.

Two separate inputs (cu and cd) are used to up and down count the events. The output (Qmin) is set to 1 as soon as the minimum threshold (min) has been reached, the output (Qmax) is set to 1 as soon as the maximum threshold (max) is reached. The initial count value is set by the parameter (pv) and the current count value is given by the parameter (cv).

A 16 bit word (mwd) is used to store the state of the cu and cd inputs (bit 0 for storing cu and bit 1 for storing cd).

### Structure

#### Ladder language



#### Instruction list language

```
LD TRUE
[ SCOUNT ( %M9 , %MW10 , %M11 , %M12 , %MW11 , %MW12 , %M16 , %M10 , %MW15 , %MW20 ) ]
```

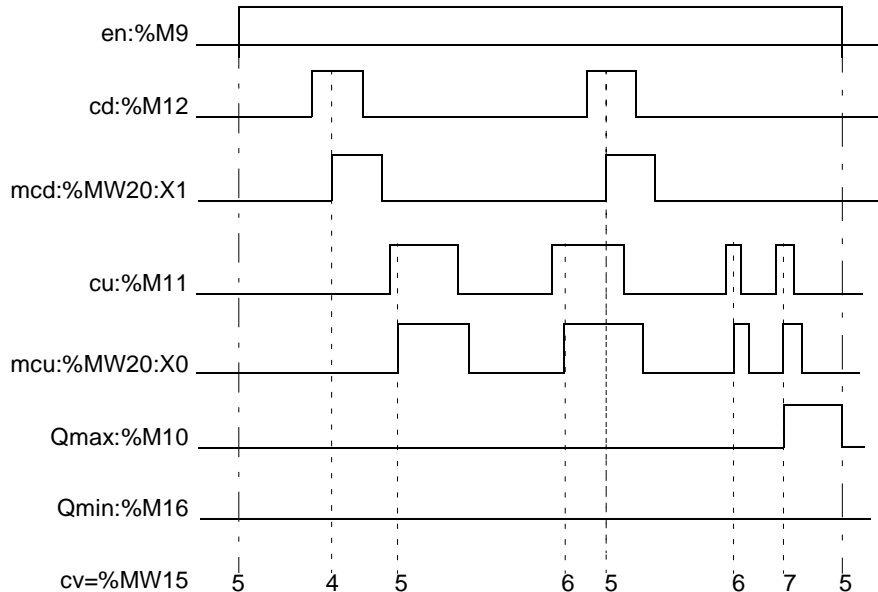
#### Structured text language

```
SCOUNT ( %M9 , %MW10 , %M11 , %M12 , %MW11 , %MW12 , %M16 , %M10 , %MW15 , %MW20 ) ;
```

### Examples

```
SCOUNT ( %M9 , %MW10 , %M11 , %M12 , %MW11 , %MW12 , %M16 , %M10 , %MW15 , %MW20 )
```

with %MW10 (pv) = 5, %MW11 (min) = 0, %MW12 (max) = 7



**Syntax**

Up/down counting operators with overshoot signaling

<b>Syntax</b>
<b>SCOUNT</b> (en, pv, cu, cd, min, max, Qmin, Qmax, cv, mwd)

Up/down counting operands with overshoot signaling

Type	en, cu, cd	Qmin, Qmax	pv, min, max	cv,mwd
Bits	%I,%Q,%M,%S, %BLK,%.:Xk	%I,%Q,%M	-	-
Words which can be indexed	-	-	%MW,%KW,%Xi.T	%MW
Words which can not be indexed	-	-	%IW,%QW,%SW, %NW, Imm.value, Num.expression	%QW,%SW, %NW

**Note:**

- If  $(en) = 0$  then the function is no longer enabled and on each call, there is:  
 $Qmin = Qmax = 0$   
 $mcu = mcd = 0$   $cv = pv$
- If  $max > min$  then:  
 $cv \geq max \rightarrow Qmax = 1$  and  $Qmin = 0$   
 $min < cv < max \rightarrow Qmax = Qmin = 0$   
 $cv \leq min \rightarrow Qmax = 0$  and  $Qmin = 1$
- If  $max < min$  then:  
 $max \leq cv \leq min \rightarrow Qmax = 1$  and  $Qmin = 0$   
 $cv < max \rightarrow Qmax = 0$  and  $Qmin = 1$   
 $cv > min \rightarrow Qmax = 1$  and  $Qmin = 0$
- If  $max = min$  then:  
 $cv < min$  and  $max \rightarrow Qmax = 0$  and  $Qmin = 1$   
 $cv \geq min$  and  $max \rightarrow Qmax = 1$  and  $Qmin = 0$
- There is no incidence of a modification of parameter  $(pv)$  with  $(en)$  in state 1
- A negative value for parameters  $(pv)$  and  $(min)$  is interpreted as a zero value.
- A value lower than 1 for the parameter  $(max)$  is interpreted as being equal to 1.

## Rotate shifts

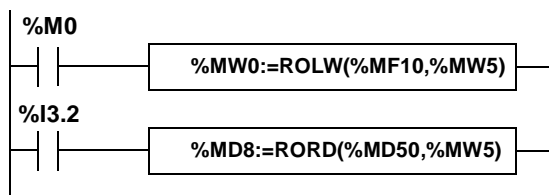
### General

The functions rotate the shifts left or right on a word or double word.

- **ROLW**: rotate shift left on a word with a number of calculated shift registers
- **RORW**: rotate shift right on a word with a number of calculated shift registers
- **ROLD**: rotate shift left on a double word with a number of calculated shift registers
- **RORD**: rotate shift right on a double word with a number of calculated shift registers

### Structure

#### Ladder language



#### Instruction list language

```
LD %M0
[ %MW0 :=ROLW( %MW10 , %MW5 ) ]

LD %I3.2
[ %MD10 :=RORD( %MD100 , %MW5 ) ]
```

#### Structured text language

```
IF %M0 THEN
  %MW0 :=ROLW( %MW10 , %MW5 ) ;
END_IF ;
IF %I3.2 THEN
  %MD8 :=RORD( %MD100 , %MW5 ) ;
END_IF
```

### Syntax

Rotate shift operators

Operators	Syntax
<b>ROLW, RORW, ROLD, RORD</b>	Op1:=Operator(Op2,n)

Rotate shift operands on a word **ROLW, RORW**

Type	Operand 1 (Op1)	Operand 2 (Op2)	Position number (n)
Words which can be indexed	%MW	%MW,%KW,%Xi.T	%MW,%KW,%Xi.T
Words which can not be indexed	-	Imm.val.,%IW,%QW,%SW,%NW,%BLK,Num.expr.	Imm.val. %IW,%QW,%SW,%NW,%BLK,Num.expr.

Rotate shift operands on a double word **ROLD, RORD**

Type	Operand 1 (Op1)	Operand 2 (Op2)	Position number (n)
Words which can be indexed	%MD	%MD,%KD	%MW,%KW,%Xi.T
Words which can not be indexed	%QD,%SD	Imm.val.,%ID,%QD,%SD,Num.expr.	Imm.val. %IW,%QW,%SW,%NW,%BLK,Num.expr.

**Note:** The preferred basic instructions are ROL and ROR (when the shift register number is static, because these instructions have a higher performance.

## 2.11 Timing functions

---

### Introduction

---

#### Subject of this sub-section

This sub-section describes PL7 language timing functions

---

#### What's in this Section?

This Section contains the following Maps:

Topic	Page
Timing functions	255
Engagement timing (on delay) function	256
Release timing (off delay) function	259
Pulse timer function	261
Rectangular signal generator function	263

---

## Timing functions

---

### General

As opposed to the predefined function blocks, these timing functions are not limited in number and can be used in the DFB function block code.

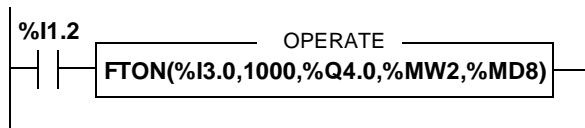
4 timing functions are available.

- **FTON**: Engagement timing (on delay).
  - **FTOF**: Release timing (off delay).
  - **FTP**: Pulse timing: Timing
  - **FPULSOR**: rectangular signal: Timing
-

## Engagement timing (on delay) function

**General** This function is used to manage the delays on engagement. This delay is programmable

**Structure** **Ladder language**



**Instruction list language**

```
LD I1.2
[FTON(%I3.0,1000,%Q4.0,%MW2,%MD8)]
```

**Structured text language**

```
IF %I1.2 THEN
  FTON(%I3.0,1000,%Q4.0,%MW2,%MD8);
END_IF;
```

**Syntax**

FTON engagement timing function operators

<b>Syntax</b>
<b>FTON(EN,PT,Q,ET,PRIV)</b>

FTON engagement timing function operands

Type	EN	PT	Q	ET	PRIV
Words which can be indexed	-	%MW,%KW, %Xi.T	-	%MW	-



Type	EN	PT	Q	ET	PRIV
Words which can not be indexed	-	%IW,%QW, %SW,%NW, Immediate value, Numeric expression	-	%IW,%QW	-
Double words which can be indexed	-	-	-	-	%MD
Bits	%I,%Q,%M, %S,%BLK, %*:Xk,%X		%I,%Q,%M %S,%*:Xk, %X	-	-

## Characteristics

### FTON engagement timing function characteristics

Characteristic	Address	Value
Input "Activation"	EN	The timing starts on rising edge
Preset value	PT	Input word which determines the timing length (in one hundredths of a second). It is used to define a maximum duration of 5 min and 27 s to the nearest 10 ms. (1)
Output "Timer"	Q	Output set to 1 on time-out.
Current value	ET	Output word which increases from 0 to PT on completion of the timer cycle.
Calculation variable	PRIV	Double word for internal latching. An application variable exclusively reserved for this is associated with this double word.

**Note:** (1) a modification of this word is taken into account during the timing.

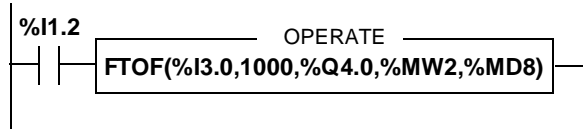
**Operation** FTON engagement timing function operation description

Step	Action	Description	Illustration
1	Rising edge on the EN input	The timer is started: its current value ET increases from 0 to PT (hundredths of a second).	
2	The current value has reached PT	The output bit Q switches to 1, then stays at 1 whilst the input EN is at 1.	
3	the EN input is clear	The timer is stopped even if it was still running: ET takes a 0 value.	

## Release timing (off delay) function

**General** This function is used to manage the release delays. This delay is programmable

**Structure** **Ladder language**



**Instruction list language**

```
LD I1.2
[ FTOF( %I3.0 , 1000 , %Q4.0 , %MW2 , %MD8 ) ]
```

**Structured text language**

```
IF %I1.2 THEN
  FTOF( %I3.0 , 1000 , %Q4.0 , %MW2 , %MD8 ) ;
END_IF ;
```

**Syntax** FTOF Release timing function operators

<b>Syntax</b>
<b>FTOF</b> (EN,PT,Q,ET,PRIV)

FTOF Release timing function operands: identical to FTON (See *Engagement timing (on delay) function*, p. 256)

**Characteristics** FTOF Release timing function characteristics

Characteristic	Address	Value
Input "Activation"	EN	The timing starts on falling edge
Preset value	PT	Input word which determines the timing length (in one hundredths of a second). It is used to define a maximum duration of 5 min and 27 s with a 10 ms precision. (1)

Characteristic	Address	Value
Output "Timer"	Q	Output set to 1 on rising edge of EN and set to 0 on time-out.
Current value	ET	Output word which increases from 0 to PT on completion of the timer cycle.
Calculation variable	PRIV	Double word for internal latching. An application variable exclusively reserved for this is associated with this double word.

**Note:** (1) a modification of this word is taken into account during the timing.

**Operation**

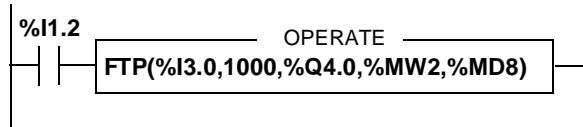
FTOF release timing function operation description

Step	Action	Description	Illustration
1	Rising edge on the EN input	The current ET value takes a 0 value (even if the timer is still running) and the output bit Q switches to 1 (or remains at 1)	
2	On falling edge of EN input	the timer is started, then the current value increases from 0 to PT (hundredths of a second).	
3	When the current value has reached PT.	Output bit Q falls back to 0.	

## Pulse timer function

**General** This function is used to generate a pulse of precise duration. This duration can be programmed.

**Structure** **Ladder language**



### Instruction list language

```
LD I1.2
[ FTP (%I3.0,1000,%Q4.0,%MW2,%MD8) ]
```

### Structured text language

```
IF %I1.2 THEN
  FTP (%I3.0,1000,%Q4.0,%MW2,%MD8) ;
END_IF ;
```

**Syntax** FTP pulse timer function operators

Syntax
FTP(EN,PT,Q,ET,PRIV)

FTP pulse timer function operands: identical to FTON (See *Engagement timing (on delay) function*, p. 256)

**Characteristics** FTP pulse timer function characteristics

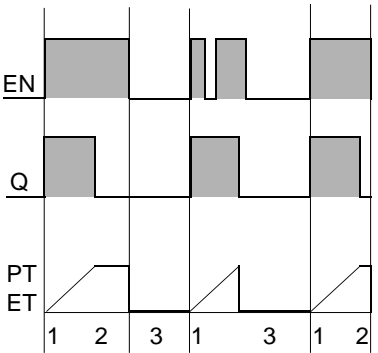
Characteristic	Address	Value
Input "Activation"	EN	The timing starts on falling edge
Preset value	PT	Input word which determines the timing length (in one hundredths of a second). It is used to define a maximum duration of 5 min and 27 s with a 10 ms precision. (1)

Characteristic	Address	Value
Output "Timer"	Q	Output set to 1 on time-out.
Current value	ET	Output word which increases from 0 to PT on completion of the timer cycle.
Calculation variable	PRIV	Double word for internal latching. An application variable exclusively reserved for this is associated with this double word.

**Note:** (1) a modification of this word is taken into account during the timing.

**Operation**

FTP pulse timer function operating description

Step	Action	Description	Illustration
1	Rising edge on the EN input	The timer is started (if it is not already on) and the current ET value advances from 0 to PT (hundredths of a second). Output bit Q switches to 1	 <p>This monostable cannot be reactivated.</p>
2	When the current value has reached PT.	Output bit Q falls back to 0.	
3	The EN input and output Q are at 0	PT takes a 0 value.	

## Rectangular signal generator function

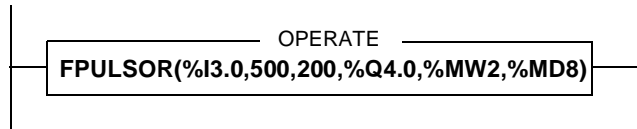
### General

This function is for generating a periodic rectangular signal, the set slot size and clear slot size of which can be varied by the program using 2 timers:

- **TON**: rise timing (for the set slot).
- **TOFF**: fall back timing (for the clear slot).

### Structure

#### Ladder language



#### Instruction list language

```
LD TRUE
[FPULSOR(%I3.0,500,200,%Q4.0,%MW2,%MD8)]
```

#### Structured text language

```
IF %I1.2 THEN
  FPULSOR(%I3.0,500,200,%Q4.0,%MW2,%MD8);
END_IF;
```

### Syntax

FPULSOR rectangular signal generator function operators

<b>Syntax</b>
FPULSOR(EN,TON,TOFF,Q,ET,PRIV)

## FPULSOR rectangular signal generator function operands

Type	EN	TON,TOFF	Q	ET	PRIV
Words which can be indexed	-	%MW,%KW, %Xi.T	-	%MW	-
Words which can not be indexed	-	-	-	%IW,%QW	-
Double words which can be indexed	-	-	-	-	%MD
Bits	%BLK,%*:Xk, %X	%I,%Q,%M, %S	%S,%*:Xk,%X	%I,%Q,%M	-

## Characteristics

## FPULSOR rectangular signal generator function characteristics

Characteristic	Address	Value
Input "Activation"	EN	The rectangular signal generation starts on rising edge
Preset value (slot set)	TON	The input word determining the period (in hundredths of a second) of the set slot period. It is used to set a maximum duration of 5 min and 27 s to the nearest 10 ms. (1)
Preset value (slot clear)	TOFF	The input word determining the period (in hundredths of a second) of the clear slot period. It is used to set a maximum duration of 5 min and 27 s to the nearest 10 ms. (1)
Rectangular signal output	Q	Output slot clear on the TOFF period, set on the TON period.
Current value	ET	Output word which increases from 0 to TON+TOFF on completion of the timer cycle.
Calculation variable	PRIV	Double word for internal latching. An application variable exclusively reserved for this is associated with this double word.



**Note:** (1) a modification of these words is taken into account during timing. The TOFF+TON sum has a maximum duration of 5 min and 27 s.

**Operation**

FPULSOR rectangular signal generator function operating description:

Step	Action	Description	Illustration
1	Rising edge on the EN input	The rectangular signal is generated: (if the signal is not already on) its current ET value increases from 0 to TON+TOFF (hundredths of a second).	<p>The illustration shows a timing diagram with four signals: EN, Q, TON+TOFF, and ET. EN is a high-level pulse. Q is a square wave that is low during TOFF intervals and high during TON intervals. TON+TOFF is a sawtooth wave that ramps up during TON and resets to zero at the start of each TOFF interval. ET is a sawtooth wave that ramps up linearly from zero to the TON+TOFF value during each TON interval.</p>
2	As long as the TOFF timing has not elapsed	Output bit Q remains at 0.	
3	TOFF is complete, TON is engaged	Output bit Q switches to 1 until the end of TON and the generator loops back on (2) and (3)	
4	EN switches to 0	TON and TOFF are reset to 0, output bit Q switches to 0	

## 2.12 Data storage functions

---

### Introduction

---

#### Subject of this sub-section

This sub-section describes PL7 language data storage functions

---

#### What's in this Section?

This Section contains the following Maps:

Topic	Page
Data storage functions	267
Initalization of the storage zone	268
Writing data in the storage zone	270
Reading the data in the storage zone	272

---

## Data storage functions

---

### Introduction

These functions enable the program to store data in a dedicated zone on the user memory card.

---

### Example of application

- automatic storage of data (status consignments, logs, etc.) from the application in the PLC user memory card and transmission of data to the central site by remote transmission (via a modem).
  - saving production formulae in the PLC user memory card.
- 

### Different functions

3 functions are used to store and restore data:

- **SET\_PCMCIA**: to initialize all or part of the memory card's storage zone to a value
- **WRITE\_PCMCIA**: to write data in the memory card's storage zone
- **READ\_PCMCIA**: to read data in the memory card's storage zone

**Note:** data stored in the memory card storage zone is only accessible via these 3 standard functions from the resident PLC application. A remote station is unable to access such data directly via a network or communication bus.

---

## Initialization of the storage zone

### Introduction

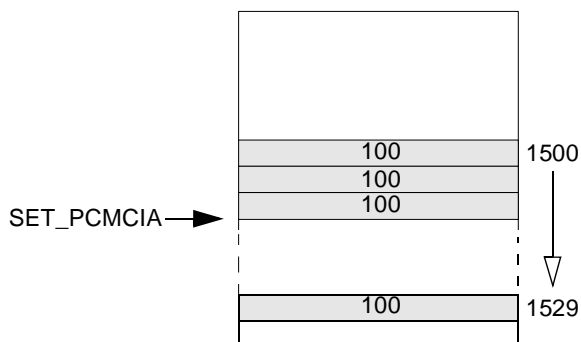
The **SET\_PCMCIA** function is used to initialize all or part of the user memory card storage zone to a desired value.

This function uses 4 parameters:

- **address**: address of storage zone from which initialisation is to be performed
- **nb\_words**: number of words to be initialized
- **value**: Initialization value
- **status**: code giving the result of execution of the Initialization command

### Example

The user memory card:

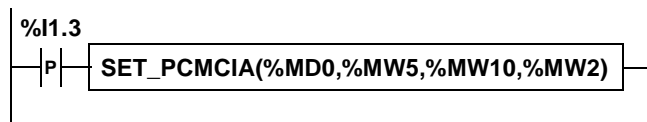


In this example:

- **address** = %MD0, %MD0 containing the value 1500
- **nb\_words** = %MW5, %MW5 containing the value 30
- **value** = %MW10, %MW10 containing the value 100

### Structure

Ladder language:



Instruction list language

```
LDR    %I1.3
[ SET_PCMCIA ( %MD0 , %MW5 , %MW10 , %MW2 ) ]
```

**Structured text language:**

```

IF RE %I1.3 THEN
    SET_PCMCIA ( %MD0 , %MW5 , %MW10 , %MW2 ) ;
END_IF ;

```

**Syntax**

Function syntax:

<b>SET_PCMCIA</b> (address, nb_words, value, status)
--

Parameters:

Type	address	nb_words	value	status
Indexable words	-	%MW,Imm.val.	%MW,Imm.val.	%MW
Non-indexable words	-	-	-	%QW,%SW, %NW
Indexable double words	%MD,Imm.val.	-	-	-
Non-indexable double words	%QD,%SD	-	-	-

Coding of the **status** parameter returned after the initialization command:

Value (hexadecimal)	Meaning
0000	initialization successful
0201	no file zone in the memory card
0202	memory card error
0204	write-protected memory card
0241	negative address
0242	address + Nb_words-1 > the highest address in the memory card
0401	Nb_words= 0 or negative

## Writing data in the storage zone

### Introduction

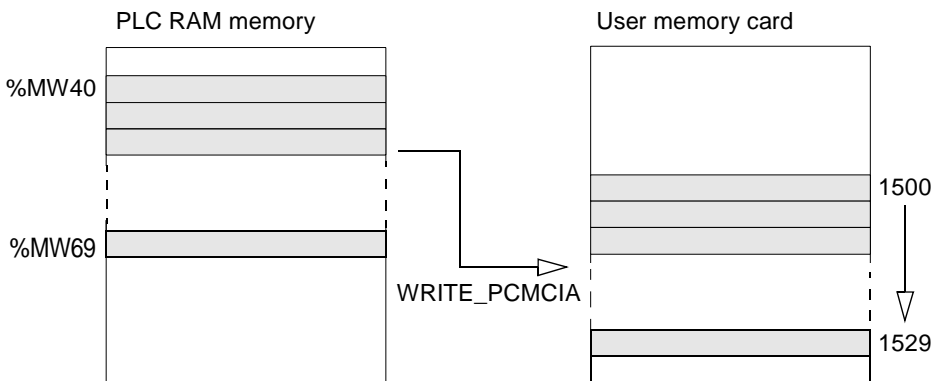
The **WRITE\_PCMCIA** function is used to transfer data from the PLC RAM memory (%MW words) to the user memory card storage zone.

This function uses 4 parameters:

- **ad\_des**: address of the storage zone from where data storage is to begin
- **nb\_words**: number of words to be stored
- **source**: word containing the start address of the zone to be transferred into the memory card
- **status**: code giving the result of the write command.

### Example

Illustration:

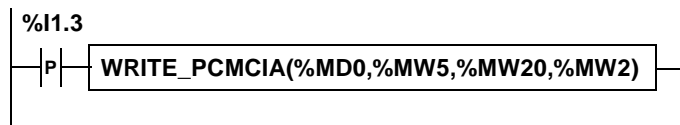


In this example:

- **ad\_des** = %MD0, %MD0 containing the value 1500
- **nb\_words** = %MW5, %MW5 containing the value 30
- **source** = %MW20, %MW20 containing the value 40

### Structure

Ladder language:



Instruction list language:

```
LDR    %I1.3
[WRITE_PCMCIA(%MD0,%MW5,%MW20,%MW2)]
```

**Structured text language:**

```

IF RE %I1.3 THEN
  WRITE_PCMCIA ( %MD0 , %MW5 , %MW20 , %MW2 ) ;
END_IF ;

```

**Syntax**

Function syntax:

<b>WRITE_PCMCIA</b> (ad_des, nb_words, source, status)
--

Parameters:

Type	ad_des	nb_words	source	status
Indexable words	-	%MW,Imm.val.	%MW,Imm.val.	%MW
Non-indexable words	-	-	-	%QW,%SW, %NW
Indexable double words	%MD,Imm.val.	-	-	-
Non-indexable double words	%QD,%SD	-	-	-

Coding of the **status** parameter returned after the write command:

Value (hexadecimal)	Meaning
0000	write successful
0102	source + Nb_words-1 > maximum number of %MW declared in the PLC
0104	no enabled application or no %MW in the PLC
0201	no file zone in the memory card
0202	memory card error
0204	write-protected memory card
0241	ad_des < 0
0242	ad_des + Nb_words-1 > the highest address in the memory card
0401	Nb_words = 0

## Reading the data in the storage zone

### Introduction

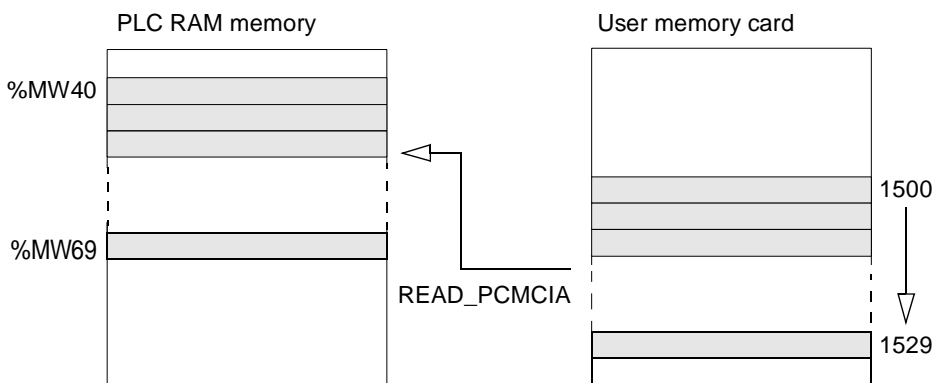
The READ\_PCMCIA function is used to transfer data from the user memory card storage zone into the PLC RAM memory (%MW words).

This function uses 4 parameters:

- **ad\_source**: storage zone address where the data to be read is stored
- **nb\_words**: number of words to be read
- **dest**: word containing the start address of the zone transferred by the memory card
- **status**: code giving the result of execution of the read command

### Example

Illustration:

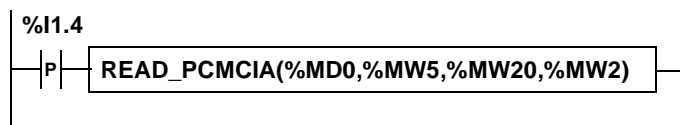


In this example:

- **ad\_source** = %MD0, %MD0 containing the value 1500
- **nb\_words** = %MW5, %MW5 containing the value 30
- **dest** = %MW20, %MW20 containing the value 40

### Structure

Ladder language:



Instruction list language:

```
LDR    %I1.4
[READ_PCMCIA(%MD0,%MW5,%MW20,%MW2)]
```



**Structured text language:**

```

IF RE %I1.4 THEN
  READ_PCMCIA( %MD0 , %MW5 , %MW20 , %MW2 ) ;
END_IF ;

```

**Syntax**

Function syntax:

<b>READ_PCMCIA</b> (ad_source, nb_words, dest, status)
--

Parameters:

Type	ad_des	nb_words	source	status
Indexable words	-	%MW,Imm.val.	%MW,Imm.val.	%MW
Non-indexable words	-	-	-	%QW,%SW, %NW
Indexable double words	%MD,Imm.val.	-	-	-
Non-indexable double words	%QD,%SD	-	-	-

Coding of the **status** parameter returned after the write command:

Value (hexadecimal)	Meaning
0000	read successful
0102	dest + Nb_words-1 > maximum number of %MW declared in the PLC
0104	no enabled application or no %MW in the PLC
0201	no file zone in the memory card
0202	memory card error
0204	write-protected memory card
0241	ad_source < 0
0242	ad_des + Nb_words-1 > the highest address in the memory card
0401	Nb_words = 0

## 2.13 Grafcet functions

### Step activity time reset to zero function

#### General

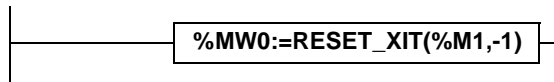
This function resets all sequential "Chart" processing or macro step activity times. This function is enabled on the Premium/Atrium PLC (software version 3.0V or above).

It has the following input and output parameters:

Type	Parameters	Role
Input	In	Function enabling condition
	Num	Grafcet module number to be reset. This is equal to: <ul style="list-style-type: none"> <li>● -1 if the module is "Chart" sequential processing,</li> <li>● or the macro step number concerned.</li> </ul>
Output	Result	Report on the execution of the function.

#### Structure

##### Ladder language



##### Instruction list language

```
LD True
[ %MW0 :=RESET_XIT( %M1 , -1 ) ]
```

##### Structured text language

```
%MW0 :=RESET_XIT( %M1 , -1 ) ;
```

#### Syntax

Operator:

<b>Syntax</b>
<b>Result:=RESET_XIT(In,Num)</b>

Operands:

Type	Result	Confirmation condition (In)	Grafcet module number (Num)
Bits	-	%M	-
Words	%MW	-	%MW, %KW, Immediate value

## Result

Encoding of the returned result parameter after execution of the instruction:

Value (in hexadecimal)	Meaning
0000	Correct operation
FFFF	Input parameter outside limits: the macro step does not exist in the application.
FFFA	The PLC-type is a MICRO



---

# System objects

# 3

---

## Introduction

### Contents of this section

This section describes all the PL7 language system bits and system words

### What's in this Chapter?

This Chapter contains the following Sections:

Section	Topic	Page
3.1	System Bits	279
3.2	System words	291



---

## 3.1 System Bits

---

### Introduction

#### Subject of this sub-section

This chapter describes the PL7 language system bits.

---

#### What's in this Section?

This Section contains the following Maps:

Topic	Page
System bit introduction	280
Description of system bits %S0 to %S7	280
Description of system bits %S8 to %S16	282
Description of system bits %S17 to %S20	283
Description of system bits %S21 to %S26	285
Description of system bits %S30 to %S59	286
Description of system bits %S60 to %S69	287
Description of system bits %S70 to %S92	288
Description of system bits %S94 to %S99	289
Description of system bits %S100 to %S119	290

---

## System bit introduction

### General

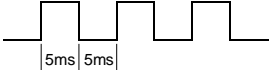
The TSX 37 and TSX 57 PLCs use %Si system bits which indicate the state of the PLC, or they can be used to operate its functioning.

This bits can be tested in the user program to detect any function event before starting a set processing procedure. Some bits must be reset to their initial or usual state by program. However, the system bits, which are reset to their initial or usual state by the system, must not be done so by program or by the terminal.

## Description of system bits %S0 to %S7

### In-depth description

Description of system bits %S0 to %S7

Bit	Function	Description	Initial state	TSX37	TSX57
%S0	Cold start	<p>Normally on 0, this bit is set on 1 by:</p> <ul style="list-style-type: none"> <li>● loss of data on power restart (battery fault),</li> <li>● the user program,</li> <li>● the terminal,</li> <li>● cartridge uploading,</li> <li>● pressing on the RESET button.</li> </ul> <p>This bit goes to 1 during the first complete cycle. It is reset to 0 before the following cycle. (Operation)</p>	0	YES	YES
%S1	Warm restart	<p>Normally on 0, this bit is set on 1 by:</p> <ul style="list-style-type: none"> <li>● power restart with data save,</li> <li>● the user program,</li> <li>● the terminal.</li> </ul> <p>It is reset to 0 by the system at the end of the first complete cycle and before output is updated. (Operation)</p>	0	YES	YES
%S4	Time base 10ms	<p>An internal timer regulates the change in status of this bit. It is asynchronous in relation to the PLC cycle. Graph :</p> 	-	YES	YES



---

Bit	Function	Description	Initial state	TSX37	TSX57
%S5	Time base 100 ms	Idem %S4	-	YES	YES
%S6	Time base 1 s	Idem %S4	-	YES	YES
%S7	Time base 1 mn	Idem %S4	-	YES	YES

---

## Description of system bits %S8 to %S16

### In-depth description

### Description of system bits %S8 to %S16

Bit	Function	Description	Initial state	TSX37	TSX57
%S8	Wiring system test	Normally on 1, this bit is used to test the wiring system while the TSX 37 PLC is in "non-configured" state <ul style="list-style-type: none"> <li>state 1: outputs are forced to 0,</li> <li>state 0: outputs can be modified by an adjustment terminal.</li> </ul>	1	YES	NO
%S9	Outputs set into fallback position on all buses	Normally on 0, this bit is set on 1 by the program or the terminal: <ul style="list-style-type: none"> <li>state 1: forces PLC (bus X, FIPIO, AS-I etc.) outputs into fallback position,</li> <li>state 0: outputs are usually updated,</li> </ul>	0	YES	YES
%S10	I/O fault	Normally on 1, it is cleared when a module on rack or a remote module (FIPIO) I/O fault (eg. non-conforming configuration, exchange fault, hardware fault) is detected. The %S10 bit is reset on 1 as soon as the fault disappears.	1	YES	YES
%S11	Watchdog overrun	Normally on 0, it is set on 1 by the system as soon as the task execution time becomes greater than the maximum execution time (ie the watchdog) declared in the configuration. Watchdog overrun changes the PLC to STOP and the application is stopped through error (evident by flashing ERR LED).	0	YES	YES
%S13	First cycle after starting RUN	Normally on 0, it is set on 1 by the system during the first cycle after the PLC is set on RUN.	-	YES	YES
%S15	Character string fault	Normally on 0, it is set on 1 when the destination zone for a character string is not big enough to receive the string. This bit must be reset to 0 by the user. Each task generates its own %S15 bit.	0	YES	YES
%S16	I/O task fault	Normally on 1, it is set on 0 by the system when a fault occurs on an I/O module on rack or a remote module on FIPIO configured in the task. The user must reset this bit to 1. Each task generates its own %S16 bit.	1	YES	YES

## Description of system bits %S17 to %S20

### In-depth description

### Description of system bits %S17 to %S20

Bit	Function	Description	Initial state	TSX37	TSX57
%S17	Bit outputted on shifting or a arithmetic report.	Normally on 0, this bit is set on 1 by the system: <ul style="list-style-type: none"> <li>during a shift operation containing the state of the last bit,</li> <li>overshooting in unsigned arithmetic (dates).</li> </ul> This bit must be reset on 0 by the user.	0	YES	YES
%S18	Overrun or arithmetic error	Normally on 0, it is set on 1 should a capacity overload occur during an operation on 16 bits, either through: <ul style="list-style-type: none"> <li>a result above +32767 or less than -32768 in single length,</li> <li>a result above +2,147,483,647 or less than -2.147.483.648 in double length,</li> <li>a result above +3.402824E+38 or less than -3.402824E+38, in floating point (software version &gt; 1.0),</li> <li>capacity overload in DCB,</li> <li>dividing by 0,</li> <li>the root of a negative number,</li> <li>forcing a non-existent step onto a drum.</li> <li>stacking up an already full register, emptying an already empty register.</li> </ul> It must be tested by the user program after each operation where there could be an overload risk, then reset to 0 by the user if there is indeed an overload. Each task generates its own %S18 bit.	0	YES	YES
%S19	Task period overrun (periodical scanning)	Normally on 0, this bit is set on 1 by the system in the event of a time period overrun (ie. task execution time is greater than the period defined by the user in the configuration or programmed into the %SW word associated with the task). The user must reset this bit to 0. Each task manages its own %S19 bit.	0	YES	YES

Bit	Function	Description	Initial state	TSX37	TSX57
<b>%S20</b>	Index overflow	Normally on 0, it is set on 1 when the address of the indexed object becomes less than 0 or exceeds the number of objects declared in the configuration. It must be tested by the user program after each operation where there could be an overload risk, then reset to 0 if there is indeed an overload. Each task generates its own %S20 bit.	0	YES	YES

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## Description of system bits %S21 to %S26

**In-depth description** %21 to %S26 system bits associated with Grafcet

Bit	Function	Description	Initial state	TSX37	TSX57
<b>%S21</b>	Initialization	This bit is managed by the user to initialize Grafcet (preferably set on 1 for preliminary processing). It is repositioned to 0 by the system after Grafcet has been initialized (ie. after preliminary processing during evaluation of the new Grafcet state). Initializing Grafcet involves disabling all active steps and enabling the initial steps. On a cold start, this bit is set on 1 by the system during preliminary processing.	0	YES	YES
<b>%S22</b>	Setting Grafcet to 0	Normally on 0, this bit can be set on 1 by the program only during preliminary processing. On 1, it disables all Grafcet steps. It is reset to 0 by the system after all has been taken into account at the end of the preliminary processing.	0	YES	YES
<b>%S23</b>	Freezing Grafcet	Normally on 0, setting %S23 onto 1 preserves Grafcet in the state is it at the time. Whatever the value of downstream transition conditions, Grafet does not change. The freeze is maintained as long as the %S23 bit is on 1. The bit is managed by the user program, and is positioned on 1 or 0 only during preliminary processing.	0	YES	YES
<b>%S24</b>	Setting macro-steps to 0	Normally on 0, setting %S24 to 1 will zero the macro-steps chosen in a 4 word table %SW22 to %SW25 system. It is reset to 0 by the system after all has been taken into account at the end of the preliminary processing.	0	NO	YES
<b>%S26</b>	Table overrun (steps/transitions)	Normally on 0, this bit is set on 1 by the table system when the enabling possibilities (steps or transitions) have been overrun or when an invalid chart has been executed (eg sending a destination to a step which does not belong to a chart). An overrun causes the PLC to go to STOP. The user must reset this bit to 0 on initializing the terminal.	0	YES	YES

## Description of system bits %S30 to %S59

### In-depth description

### Description of system bits %S30 to %S59

Bit	Function	Description	Initial state	TSX37	TSX57
%S30	Activating/de-activating the master task	Normally on 1, the user setting the bit to 0 disables the master task.	1	YES	YES
%S31	Fast task activation	Normally on 1, the user setting the bit to 0 disables the fast task.	1	YES	YES
%S38	Enabling/inhibiting events	Normally on 1, the user setting the bit to 0 causes events to be inhibited.	1	YES	YES
%S39	Saturation of event processing	This bit is set on 1 by the system to indicate that one or several events cannot be processed following saturation of the queues. The user must reset this bit to 0.	0	YES	YES
%S40 to %S47	I/O tripped static (racks) fault	Bits %S40 to %S47 are assigned to rack 0 to 7 respectively. Normally on 1, each bit is set on 0 following a corresponding rack input/output fault. The bit is reset on 1 when the fault disappears.	1	NO	YES
%S49	Reactivating outputs	Normally on 0, this bit can be set on 1 by the user for a request to reactivate all IOs, after the appearance of a static outputs fault triggered by an overcurrent or a short-circuit.	0	YES	NO
%S50	Updating time and date via words %SW50 to 53	Normally on 0, this bit can be set on 1 or 0 by the program or the terminal. <ul style="list-style-type: none"> <li>on 0: accesses date and time by reading words via system words %SW50 to 53,</li> <li>on 1: updates date and time by writing system words %SW50 to 53.</li> </ul>	0	YES	YES
%S51	Time loss in real time clock	This system-managed bit on 1 indicates that the real-time clock is absent or that its system words are meaningless. In this case the clock must be reset to the correct time.	0	YES	YES
%S59	Updating time and date via word %SW59	Normally on 0, this bit can be set on 1 or 0 by the program date or the terminal. <ul style="list-style-type: none"> <li>on 0: the system does not manage the system word %SW59,</li> <li>on 1: the system manages edges on the words %SW59 to adjust the date and current time (by increment).</li> </ul>	0	YES	YES

## Description of system bits %S60 to %S69

### In-depth description

Description of system bits %S60 to %S69

Bit	Function	Description	Initial state	TSX37	TSX57
%S60	Voluntary switching command	system bit which controls voluntary switching on implementation of a back-up architecture (see usage in the "Warm Standby Premium"). This bit can be reset on 0 either by the user or by the application.	0	NO	YES
%S66	Managing LED battery	Normally on 0, this bit can be set on 1 or 0 by the program or the terminal. It is used to activate/deactivate the LED battery , in the event of the absence of or an error in the backup stack. <ul style="list-style-type: none"> <li>● state 0: the LED battery is lit when the backup stack is absent or contains a fault,</li> <li>● state 1: the LED battery is always off.</li> </ul> On a cold start, %S66 is reset to 0 by the system.	0	YES	NO
%S67	State of cartridge stack	This bit is used to control the functioning of the RAM cartridge memory backup stack: <ul style="list-style-type: none"> <li>● state 0: stack present and operational</li> <li>● state 1: pile absent or non-operational</li> </ul>	-	YES	YES
%S68	State of processor stack	This bit is used to control the functioning of the backup stack for data and programming in RAM memory. <ul style="list-style-type: none"> <li>● state 0: stack present and operational</li> <li>● state 1: pile absent or non-operational</li> </ul>	-	YES	YES
%S69	Display of user data on PLC display panels	Normally on 0, this bit can be set on 1 or 0 by the program or the terminal. <ul style="list-style-type: none"> <li>● state 0: stack present and operational</li> <li>● state 1: pile absent or non-operational</li> </ul>	0	YES	NO

## Description of system bits %S70 to %S92

### In-depth description

### Description of system bits %S70 to %S92

Bit	Function	Description	Initial state	TSX37	TSX57
<b>%S70</b>	Refreshing data on AS-I bus or TSX Nano link	This bit is set on 1 by the system at the end of each TSX Nano link cycle, or the end of AS-I bus scanning cycle. On power up, it indicates that all data has been refreshed at least once and it is thus significant. This bit is to be reset on 0 by the user.	0	YES	YES
<b>%S73</b>	Switch to protected mode on AS-i bus	Normally on 0, this bit is set on 1 by the user to switch to protected mode on the AS-i bus. Before this, the bit must have already been on 1. This bit will only be used in a wiring system test, and has no application within the PLC.	0	YES	NO
<b>%S74</b>	Saving configuration in AS-i bus	Normally on 0, this bit is set on 1 by the user to save the current configuration in the AS-i bus. This bit will only be used in a wiring system test, and has no application within the PLC.	0	YES	NO
<b>%S80</b>	Message reset counter	Normally on 0, this bit can be set to 1 by the user to clear the message counters %SW80 to %SW86.	0	YES	YES
<b>%S90</b>	Refreshing common words	Normally on 0, this bit is set to 1 on receiving common words arriving from another network station. This bit can be set to 0 by the program or the terminal to check the common words exchange cycle.	0	YES	NO
<b>%S92</b>	Switch to communication function measurement mode	Normally on 0, this bit can be set to 1 by the user to set communication functions to performance measurement mode. The communication functions Time-Out parameter then displays the total exchange time in tens of ms (if this time is < 10s, unless not significant).	0	YES	YES



## Description of system bits %S94 to %S99

### In-depth description

Description of system bits %S94 to %S99

Bit	Function	Description	Initial state	TSX37	TSX57
%S94	Saving DFB adjustments	Normally on 0, this bit can be set on 1 by the user to save the adjustment values of user function blocks.	0	NO	YES
%S95	Restoring DFB adjustments	Normally on 0, this bit can be set on 1 by the user to restore the adjustment values of user function blocks.	0	NO	YES
%S96	Validity of application program saves	<ul style="list-style-type: none"> <li>● on 0: application program saves are invalid,</li> <li>● on 1: application program saves are valid,</li> </ul> This bit can be read at any time ( either by the program or while adjusting), in particular after a cold start or a warm restart. It is significant with regard to a PL7-effected Backup application within the internal Flash EPROM.	-	YES	NO
%S97	Validity of %MW saves	<ul style="list-style-type: none"> <li>● on 0: %MW saves are invalid,</li> <li>● on 1: %MW saves are valid,</li> </ul> This bit can be read at any time ( either by the program or while adjusting), in particular after a cold start or a warm restart.	-	YES	NO
%S98	Deport of TSX SAZ 10 module button	Normally on 0, this bit is managed by the user: <ul style="list-style-type: none"> <li>● on 0: TSX SAZ 10 module button is enabled,</li> <li>● on 1: TSX SAZ 10 button is replaced by a Discrete input (Word %SW98 (See <i>Description of system words %SW98 to %SW109, p. 306</i>)).</li> </ul>	0	YES	NO
%S99	Deport of display block button	Normally on 0, this bit is managed by the user: <ul style="list-style-type: none"> <li>● on 0: centralized display block button is enabled,</li> <li>● on 1: centralized display block button is replaced by a Discrete input (Word %SW99 (See <i>Description of system words %SW98 to %SW109, p. 306</i>)).</li> </ul>	0	YES	NO

## Description of system bits %S100 to %S119

### In-depth description

### Description of system bits %S100 to %S119

Bit	Function	Description	Initial state	TSX37	TSX57
<b>%S100</b>	Protocol on terminal port	This bit is set on 0 or 1 by the system according to the state of the INL/DPT shunt on the console. <ul style="list-style-type: none"> <li>if the shunt is absent (%S100=0), then the master UNITELWAY protocol is used,</li> <li>if the shunt is present (%S100=1) then the protocol used is the one indicated by the application configuration.</li> </ul>	-	YES	YES
<b>%S101</b>	Configured diagnostics buffer	This bit is set on 1 by the system when the diagnostics option has been configured – a diagnostics buffer aimed at storing errors found by DFB diagnostics is then reserved.	-	YES	YES
<b>%S102</b>	Full diagnostics buffer	This bit is set on 1 by the system when the buffer that receives DFB errors is full.	-	YES	YES
<b>%S118</b>	General FIPIO I/O fault	Normally on 1, this bit is set to 0 by the system when a fault appears on a device connected to the FIPIO bus. This bit is reset to 1 by the system when the fault disappears.	1	YES	YES
<b>%S119</b>	General I/O on rack fault	Normally on 1, this bit is set to 0 by the system when a fault appears on an I/O module placed in one of the racks. This bit is reset to 1 by the system when the fault disappears.	1	YES	YES

## 3.2 System words

### Introduction

#### Subject of this sub-section

This sub-section describes the PL7 language system words.

#### What's in this Section?

This Section contains the following Maps:

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## Description of system words %SW0 to %SW11

### In-depth description

### Description of system words %SW0 to %SW11

Words	Function	Description	Management
<b>%SW0</b>	Master task scanning period	The user program or the terminal modify the duration of the master task defined in configuration. The duration is expressed in ms (1.255 ms) %SW0=0 in cyclic operation. On a cold restart: it takes on the value defined by the configuration.	User
<b>%SW1</b>	Fast task scanning period	The user program or the terminal modify the duration of the fast task as defined in configuration. The duration is expressed in ms (1.255 ms) On a cold restart: it takes on the value defined by the configuration.	User
<b>%SW8</b>	Acquisition of task input monitoring	Normally on 0, this bit can be set on 1 or 0 by the program or the terminal. It inhibits the input acquisition phase of each task. <ul style="list-style-type: none"> <li>● %SW8:X0 =1 assigned to MAST task: outputs linked to this task are no longer guided.</li> <li>● %SW8:X1 =1 assigned to FAST task: outputs linked to this task are no longer guided.</li> </ul>	User
<b>%SW9</b>	Monitoring of task output update	Normally on 0, this bit can be set on 1 or 0 by the program or the terminal. Inhibits the output updating phase of each task. <ul style="list-style-type: none"> <li>● %SW9:X0 =1 assigned to MAST task: outputs linked to this task are no longer guided.</li> <li>● %SW9:X1 =1 assigned to FAST task: outputs linked to this task are no longer guided.</li> </ul>	User
<b>%SW10</b>	First cycle after cold start	If the bit for the current task is on 0, this indicates that the first cycle is being carried out after a cold start. <ul style="list-style-type: none"> <li>● %SW10:X0: is assigned to the MAST Master task</li> <li>● %SW10:X1: is assigned to the FAST fast task</li> </ul>	System
<b>%SW11</b>	Watchdog duration	Reads the duration of the watchdog as set in configuration. It is expressed in ms (10...500 ms).	System

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	<b>CAUTION</b>
	<b>Matters relating to system words %SW8 and %SW9:</b> Caution: outputs for modules connected to the X bus switch automatically to fallback mode. Outputs for devices connected to the FIPIO bus remain as they were before the bit was set to 1. <b>Failure to observe this precaution can result in injury or equipment damage.</b>

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## Description of system words %SW12 to %SW18

### In-depth description

### Description of system words %SW12 to %SW18

Words	Function	Description	Management
<b>%SW12</b>	Terminal port UNI-TELWAY address	UNI_TELWAY address of terminal port (in slave mode) as defined in configuration and loaded into this word on cold start.	System
<b>%SW13</b>	Main address of the station	Indicates for the main network: <ul style="list-style-type: none"> <li>● the station number (least significant byte) from 0 to 127</li> <li>● the network number (most significant byte) from 0 to 63 (micro-switch value on PCMCIA card)</li> </ul>	System
<b>%SW17</b>	Fault status on floating operation	On detection of a fault in a floating arithmetic operation, bit %SW18 is set to 1 and %SW17 fault status is updated according to the following coding : <ul style="list-style-type: none"> <li>● %SW17:X0 = Invalid operation / result is not a number</li> <li>● %SW17:X1 = Non-standardized operand / result is acceptable</li> <li>● %SW17:X2 = Divided by 0 / result is infinity</li> <li>● %SW17:X3 = Overflow / result is infinity</li> <li>● %SW17:X4 = Underflow / result is 0</li> <li>● %SW17:X5 = Result is not precise</li> </ul> This word is reset to 0 by the system on cold start, and also by the program for re-usage purposes.	System User
<b>%SD18</b>	Absolute time counter	This double word is used to calculate duration. It is incremented every 1/10th of a second by the system (even when PLC is on STOP). It can be read and written by the user program or by the terminal.	System User

## Description of system words %SW20 to %SW25

### In-depth description

Description of system words %SW20 to %SW25 (associated with Grafcet)

Words	Function	Description	Management
<b>%SW20</b>	Grafcet activity level	This word contains the number of active steps to be enabled or disabled for the current cycle. It is updated by the system on each change in the chart.	System
<b>%SW21</b>	Validity table for Grafcet transitions	This word contains the number of valid transitions to be enabled and disabled for the current cycle. It is updated by the system on each change in the chart.	System
<b>%SW22 to %SW25</b>	Macro-step clearing table	Each bit in this table corresponds with a macro-step where %SW22:X0 is for XM0 ... %SW25:X16 is for XM63 Macro-steps, for which the associated bit in this table is on 0, will be zeroed when bit %S24 is set on 1.	User

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## Description of system words %SW30 to %SW35

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### In-depth description

Description of system words %SW30 to %SW35

Words	Function	Description	Management
%SW30	Master task execution time	Indicates the execution time of the last master task cycle (in ms).	System
%SW31	Maximum master task execution time	Indicates the longest master task execution time from the last cold start (in ms).	System
%SW32	Minimum master task execution time	Indicates the shortest master task execution time from the last cold start (in ms).	System
%SW33	Fast task execution time	Indicates the execution time of the last fast task cycle (in ms).	System
%SW34	Maximum fast task execution time	Indicates the longest fast task execution time from the last cold start (in ms).	System
%SW35	Minimum fast task execution time	Indicates the shortest fast task execution time from the last cold start (in ms).	System

**Note: More detail on execution time:** this is the time elapsed between the beginning (input acquisition) and the end (output update) of a scanning period. This time includes the processing of event tasks and fast tasks, as well as processing console requests.

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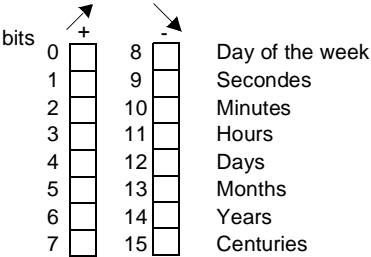


## Description of system words %SW48 to %SW59

### In-depth description

### Description of system words %SW48 to %SW59

Words	Function	Description	Management
%SW48	Number of Events	Indicates the number of events processed since the last cold start (in ms). This word can be written by a program or a terminal.	System User
%SW49 %SW50 %SW51 %SW52 %SW53	Dater function (1)	System words containing date and current time (in BCD): <ul style="list-style-type: none"> <li>● %SW49: day of the week (1 for Monday through to 7 for Sunday).</li> <li>● %SW50: Seconds (SS00)</li> <li>● %SW51: Hours and Minutes (HHMM)</li> <li>● %SW52: Month and Day (MMDD)</li> <li>● %SW53: Year (YYYY)</li> </ul> These words are managed by the system when bit %S50 is on 0. These words can be written by the user program or by the terminal when the bit %S50 is set on 1 (See <i>Description of system bits %S30 to %S59, p. 286</i> ).	System User
%SW54 %SW55 %SW56 %SW57 %SW58	Dater function (1)	System words containing date and time of the last power fault or PLC stop (in BCD): <ul style="list-style-type: none"> <li>● %SW54: Seconds (00SS)</li> <li>● %SW55: Hours and Minutes (HHMM)</li> <li>● %SW56: Month and Day (MMDD)</li> <li>● %SW57: Year (YYYY)</li> <li>● %SW58: most significant byte containing the day of the week (1 for Monday through to 7 for Sunday).</li> </ul>	System
%SW58	Last stop code	The least significant byte contains the code for the last stop: <ul style="list-style-type: none"> <li>● 1 = switch by the terminal from RUN to STOP</li> <li>● 2 = stop caused by software fault (PLC task overrun)</li> <li>● 4 = power outage</li> <li>● 5 = stop caused by hardware fault</li> <li>● 6 = stop on HALT instruction</li> </ul>	System

Words	Function	Description	Management																																																								
<b>%SW59</b>	Adjusting the current date	<p>Contains two 8 bit series to adjust the current date.                      The action is always performed on the rising edge of the bit.                      This word is enabled by bit %S59.                      Illustration:</p>  <p>bits</p> <table border="0" style="display: inline-table; vertical-align: middle;"> <tr> <td style="text-align: center;">0</td> <td style="text-align: center;">+</td> <td style="border: 1px solid black; width: 15px; height: 15px;"></td> <td style="padding: 0 10px;">8</td> <td style="text-align: center;">-</td> <td style="border: 1px solid black; width: 15px; height: 15px;"></td> <td style="padding-left: 10px;">Day of the week</td> </tr> <tr> <td style="text-align: center;">1</td> <td></td> <td style="border: 1px solid black; width: 15px; height: 15px;"></td> <td style="padding: 0 10px;">9</td> <td></td> <td style="border: 1px solid black; width: 15px; height: 15px;"></td> <td style="padding-left: 10px;">Secondes</td> </tr> <tr> <td style="text-align: center;">2</td> <td></td> <td style="border: 1px solid black; width: 15px; height: 15px;"></td> <td style="padding: 0 10px;">10</td> <td></td> <td style="border: 1px solid black; width: 15px; height: 15px;"></td> <td style="padding-left: 10px;">Minutes</td> </tr> <tr> <td style="text-align: center;">3</td> <td></td> <td style="border: 1px solid black; width: 15px; height: 15px;"></td> <td style="padding: 0 10px;">11</td> <td></td> <td style="border: 1px solid black; width: 15px; height: 15px;"></td> <td style="padding-left: 10px;">Hours</td> </tr> <tr> <td style="text-align: center;">4</td> <td></td> <td style="border: 1px solid black; width: 15px; height: 15px;"></td> <td style="padding: 0 10px;">12</td> <td></td> <td style="border: 1px solid black; width: 15px; height: 15px;"></td> <td style="padding-left: 10px;">Days</td> </tr> <tr> <td style="text-align: center;">5</td> <td></td> <td style="border: 1px solid black; width: 15px; height: 15px;"></td> <td style="padding: 0 10px;">13</td> <td></td> <td style="border: 1px solid black; width: 15px; height: 15px;"></td> <td style="padding-left: 10px;">Months</td> </tr> <tr> <td style="text-align: center;">6</td> <td></td> <td style="border: 1px solid black; width: 15px; height: 15px;"></td> <td style="padding: 0 10px;">14</td> <td></td> <td style="border: 1px solid black; width: 15px; height: 15px;"></td> <td style="padding-left: 10px;">Years</td> </tr> <tr> <td style="text-align: center;">7</td> <td></td> <td style="border: 1px solid black; width: 15px; height: 15px;"></td> <td style="padding: 0 10px;">15</td> <td></td> <td style="border: 1px solid black; width: 15px; height: 15px;"></td> <td style="padding-left: 10px;">Centuries</td> </tr> </table>	0	+		8	-		Day of the week	1			9			Secondes	2			10			Minutes	3			11			Hours	4			12			Days	5			13			Months	6			14			Years	7			15			Centuries	User
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**Note:** (1) Only on TSX 37-21/22 and TSX 57 PLC

## Description of system words %SW60 to %SW62

### In-depth description

Description of system words %SW60 to %SW61 specific to Warm Standby Premium diagnostics.

Words	Function	Description	Management
%SW60	Backup PLC diagnostics	<p>Diagnostics specific to the backup for a local PLC (Warm Standby Premium)</p> <p>Significance of the different bits for the word %SW60:</p> <ul style="list-style-type: none"> <li>● %SW60:X0=1 indicates that the PLC is "Normal"</li> <li>● %SW60:X1=1 indicates that the PLC is in "Backup"</li> <li>● %SW60:X3=0 indicates an I/O fault in FIPIO while PLC is "Normal", it is the image of bit %S118</li> <li>● %SW60:X4=0 indicates a rack I/O fault; it is the image of bit %S119</li> <li>● %SW60:X5=1 indicates a fault has been detected by the self-tests in at least one of the TSX ETY 210</li> <li>● %SW60:X7=1 indicates a serious fault in the FIPIO network, such as a short circuit or a disconnected terminal block</li> <li>● %SW60:X8=1 indicates a fault in the TSX ETY 110 module used for inter-PLC links</li> <li>● %SW60:X9=1 indicates an inter-PLC communication fault – it is not possible to recover dual-PLC diagnostics</li> <li>● %SW60:X10 is a reserved bit</li> <li>● %SW60:X11=1 indicates that the Backup PLC is unsuitable to be a "Normal" PLC. This information is generated only in a Normal PLC and has no significance in a Backup PLC.</li> <li>● %SW60:X12=0 indicates that the PLC is station A</li> <li>● %SW60:X12=1 indicates that the PLC is station B</li> <li>● %SW60:X13=1 indicates PLC Run mode</li> <li>● %SW60:X14=1 indicates PLC Stop mode</li> <li>● %SW60:X15=1 indicates PLC Halt mode</li> </ul>	System

Words	Function	Description	Management
<b>%SW61</b>	Backup PLC diagnostics	<p>Significance of the different bits for the word %SW61:</p> <ul style="list-style-type: none"> <li>● %SW61:X0=1 indicates there is a problem on the Data Base exchange via the Ethway inter-PLC link. This information is only generated for a Normal PLC in Run mode.</li> <li>● %SW60:X1=1 indicates that the PLC is in "Backup"</li> <li>● %SW61:X1=1 indicates there is a problem in communication between a TSX ETY 210 client TCP-IP module third party device. This information is generated only for a Normal PLC in Run mode. When this bit changes to 1, a switch is caused if the Backup PLC can become a Normal PLC.</li> <li>● %SW60:X4=0 indicates a rack I/O fault; it is the image of bit %S119</li> <li>● %SW60:X5=1 indicates a fault has been detected by the self-tests in at least one of the TSX ETY 210</li> <li>● %SW61:X2 is a reserved bit</li> <li>● %SW61:X3 is a reserved bit</li> <li>● %SW61:X4=1 indicates the first correct Data Base exchange</li> <li>● %SW61:X5=1 indicates that the processor has been Stopped by the backup function. Diagnostics is given in the word %MWp.14.2</li> <li>● %SW61:X6 is a reserved bit</li> <li>● %SW61:X7=0 indicates a problem in configuration of operation of the backup function. Diagnostics is given in the word %MWp.14.2</li> <li>● %SW61:X7=1 indicates that the backup function has been correctly configured</li> <li>● %SW61:X8 to %SW61:X15 are reserved bits</li> </ul> <p>p: designates the processor slot</p>	System
<b>%SW62</b>	Display of the arbiter function for bus and producer / consumer of FIPIO bus.	<p>The least significant byte indicates the state of the producer / consumer function, The most significant byte indicates the state of the bus arbiter function (BA)</p> <p>Byte value:</p> <ul style="list-style-type: none"> <li>● 16#00: the function does not exist (no FIPIO application),</li> <li>● 16#07: the function currently in STOP BA (STOP BA order is sent and the command has not finished).</li> <li>● 16#0F: the function currently in RUN BA (RUN BA order is sent and the command has not finished).</li> <li>● 16#70: the function has been initialized but is not operational (in STOP BA mode),</li> <li>● 16#F0: the function is currently being executed normally (in RUN BA mode). BA),</li> </ul>	System

## Description of system words %SW63 to %SW65

### Detailed description

Description of system words %SW63 to %SW65 specific to Warm Standby Premium diagnostics.

Words	Function	Description	Management															
%SW63 to %SW65	Exchange of diagnostics words between PLCs	<p>Dual-PLC backup diagnostics is available in the words %SW63 to %SW65.</p> <p>Normal PLC words %SW63, %SW64 and %SW65 are respective to Backup PLC words %SW60, %SW61 and %SW62. Similarly, Backup PLC words %SW63, %SW64 and %SW65 are respective to Normal PLC words %SW60, %SW61 and %SW62.</p> <p>Illustration</p> <div style="text-align: center;"> <table style="margin: auto;"> <tr> <td></td> <td style="text-align: center;">Normal PLC</td> <td style="text-align: center;">Backup PLC</td> </tr> <tr> <td>Standart diagnostic</td> <td style="border: 1px solid gray; padding: 5px;">%SWxx</td> <td style="border: 1px solid gray; padding: 5px;">%SWxx</td> </tr> <tr> <td>PLC backup diagnostic</td> <td style="border: 1px solid gray; padding: 5px;">%SW60, %SW61, %SW62</td> <td style="border: 1px solid gray; padding: 5px;">%SW60, %SW61, %SW62</td> </tr> <tr> <td>Dual PLC backup diagnostic</td> <td style="border: 1px solid gray; padding: 5px;">%SW63, %SW64, %SW65</td> <td style="border: 1px solid gray; padding: 5px;">%SW63, %SW64, %SW65</td> </tr> <tr> <td>Warm Standby Premium global diagnostic</td> <td style="border: 1px solid gray; padding: 5px;">%SW66</td> <td style="border: 1px solid gray; padding: 5px;">%SW66</td> </tr> </table> </div> <p>These words are exchanges via the Ethway inter-PLC link (TSX ETY 110 module)</p>		Normal PLC	Backup PLC	Standart diagnostic	%SWxx	%SWxx	PLC backup diagnostic	%SW60, %SW61, %SW62	%SW60, %SW61, %SW62	Dual PLC backup diagnostic	%SW63, %SW64, %SW65	%SW63, %SW64, %SW65	Warm Standby Premium global diagnostic	%SW66	%SW66	System
	Normal PLC	Backup PLC																
Standart diagnostic	%SWxx	%SWxx																
PLC backup diagnostic	%SW60, %SW61, %SW62	%SW60, %SW61, %SW62																
Dual PLC backup diagnostic	%SW63, %SW64, %SW65	%SW63, %SW64, %SW65																
Warm Standby Premium global diagnostic	%SW66	%SW66																

## Description of system words %SW66 to %SW69

### Detailed description

Description of system word %SW66 for Warm Standby Premium diagnostics

Words	Function	Description	Management
%SW66	Global diagnostics for Warm Standby Premium architecture	In each of the PLCs, global diagnostics of Warm Standby Premium are created from the backup diagnostics of the two PLCs. These global diagnostics are stored in %SW66. Its bits have the following significance :	System
	<ul style="list-style-type: none"> <li>● %SW66:X0=0 indicates Warm Standby Premium downgraded functioning.</li> <li>● %SW66:X0=1 indicates Warm Standby Premium nominal functioning.</li> <li>● %SW66:X1=1 indicates that PLC A is a Normal PLC</li> <li>● %SW66:21=1 indicates that PLC B is a Normal PLC</li> <li>● %SW66:X3=1 indicates a break-down in inter-PLC communication</li> </ul> <p><b>Information on PLC A</b></p> <ul style="list-style-type: none"> <li>● %SW66:X4=1 indicates a serious FIPIO network fault on PLC A</li> <li>● %SW66:X5=1 indicates that PLC A is on STOP</li> <li>● %SW66:X6=1 indicates that PLC A is on Halt</li> <li>● %SW66:X7=1 indicates an Ethernet TCP-IP communication breakdown in PLC A (module TSX ETY 210 or client function)</li> <li>● %SW66:X8=1 indicates a breakdown on at least one of the racked modules in PLC A</li> <li>● %SW66:X9=1 indicates a breakdown on at least one of FIPIO devices in PLC A</li> </ul> <p><b>Information on PLC B</b></p> <ul style="list-style-type: none"> <li>● %SW66:X10=1 indicates a serious FIPIO network fault on PLC B</li> <li>● %SW66:X11=1 indicates that PLC B is on STOP</li> <li>● %SW66:X12=1 indicates that PLC B is on Halt</li> <li>● %SW66:X13=1 indicates an Ethernet TCP-IP communication breakdown in PLC B (module TSX ETY 210 or client function)</li> <li>● %SW66:X14=1 indicates a breakdown on at least one of the racked modules in PLC B</li> <li>● %SW66:X15=1 indicates a breakdown on at least one of FIPIO devices in PLC B</li> </ul>		

**Note:** %SW66 X4 to %SW66 X15 information is not significant if an inter-PLC communication breakdown is present (%SW66 X3 = 1)

Description of system words %SW67 to %SW69 for Warm Standby Premium diagnostics.

Words	Function	Description	Management		
<b>%SW67</b>	Network address and dual-PLC station address	<p>This word contains the network address and the dual-PLC station address, which can be used to set up inter-PLC communication. This word must be displayed in hexadecimal for interpretation in the following manner :</p> <p style="text-align: center;"> <span style="margin-right: 100px;">MSB</span> <span>LSB</span> </p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td style="padding: 2px 10px;">network address</td> <td style="padding: 2px 10px;">station address</td> </tr> </table>	network address	station address	System
network address	station address				
<b>%SW68</b> <b>%SW69</b>	Time base used by EF Tempo.	These words contains a time base used by EF Tempo. It is transferred from the Normal PLC to the Backup PLC for updating and synchronisation.	System		

## Description of system words %SW80 to %SW89

### Detailed description

### Description of system words %SW80 to %SW89

Words	Function	Description	Management
%SW80 %SW81 %SW82 %SW83 %SW84 %SW85 %SW86	Telegram and message management	<ul style="list-style-type: none"> <li>● %SW80: No. of messages sent by the system to the terminal port.</li> <li>● %SW81: No. of messages received by the system from the terminal port.</li> <li>● %SW82: No. of messages sent by the system to the PCMCIA module.</li> <li>● %SW83: No. of messages received by the system from the PCMCIA module.</li> <li>● %SW84: No. of telegrams sent by the system.</li> <li>● %SW85: No. of telegrams received by the system.</li> <li>● %SW86: No. of messages refused by the system.</li> </ul>	System User
%SW87 %SW88 %SW89	Managing communication flows (1)	<ul style="list-style-type: none"> <li>● %SW87: Number of requests processed by synchronous server per master (MAST) task cycle.</li> <li>● %SW88: Number of requests processed by asynchronous server per master (MAST) task cycle.</li> <li>● %SW89: Number of requests processed by server functions (immediately) per master (MAST) task cycle.</li> </ul>	System

**Note:** (1) Only for TSX/PCX/PMX 57 PLC



## Description of system words %SW96 to %SW97

### Detailed description

These words only exist in TSX 37  
Description of system words %SW96 to %SW97

Words	Function	Description	Management
%SW96	Command and/or diagnostics for save/restore function of application program and %MW	<ul style="list-style-type: none"> <li>● bit 0: requests a send to the save zone This bit is enabled on the rising edge. It is reset to 0 by the system as soon as the restoration of the rising edge has been taken into account.</li> <li>● bit 1: when this bit is on 1, this indicates that the save function has finished. This bit is reset to 0 as soon the rising edge on bit 0 has been taken into account.</li> <li>● bit 2: save report: <ul style="list-style-type: none"> <li>● 0 -&gt; save without error,</li> <li>● 1 -&gt; error while saving.</li> </ul> </li> <li>● bits 3 to 5: reserved.</li> <li>● bit 6: validity of application program saves (idem %S96).</li> <li>● bits 8 to 15: this bit is only significant is the report bit is on 1 (bit 2 = 1 means an error while saving): <ul style="list-style-type: none"> <li>● 1 -&gt; number of %MW to be saved is greater than the number of %MW that are configured</li> <li>● 2 -&gt; number of %MW to be saved is greater than 1000 or less than 0,</li> <li>● 3 -&gt; number of %MW to be restored is greater than the number of %MW that are configured</li> <li>● 4 -&gt; size of application in internal RAM greater than 15 Kwords (remember that saving %MW is always associated with saving an application program in the internal Flash EPROM),</li> <li>● 5 -&gt; facilities are not allowed in RUN,</li> <li>● 6 -&gt; presence of a Backup cartridge in the PLC,</li> <li>● 7 -&gt; write fault in the Flash EPROM.</li> </ul> </li> </ul>	System User
%SW97	Number of %MW to be saved	<p>Parameterizes the number of %MW to be saved.</p> <p>When this word is between 1 and 1000, the first 1 to 1000 %MW are sent to the internal Flash EPROM.</p> <p>When this word is 0, only the application program in the internal RAM is sent to the internal Flash EPROM.</p> <p><b>Any %MW save is then wiped.</b></p> <p>On a cold start, this word is initialized on -1 if the internal Flash EPROM contains no saved %MW. If the opposite should happen, it is initialized at the value of the number of saved words.</p>	User

## Description of system words %SW98 to %SW109

### Detailed description

### Description of system words %SW98 to %SW109

Words	Function	Description	Management		
%SW98	Discrete input module/channel geographical address (2)	<p>When the bit %S98 = 1, this word indicates the Discrete input (module /channel) geographical address, in the replacement of the TSX SAZ 10 module button :</p> <p style="text-align: center;">MSB                      LSB</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td style="padding: 5px;">Module number</td> <td style="padding: 5px;">Channel number</td> </tr> </table>	Module number	Channel number	User
Module number	Channel number				
%SW99	Discrete input address (2)	<p>When the bit %S99 = 1, this word indicates the Discrete input (module / channel) geographical address, in the replacement of the centralized display block button :</p> <p style="text-align: center;">MSB                      LSB</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td style="padding: 5px;">Module number</td> <td style="padding: 5px;">Channel number</td> </tr> </table>	Module number	Channel number	User
Module number	Channel number				
%SW108	Forced channel counter	Makes channels forced to 0 or 1 compatible within the application. It is updated by forcing or unforcing channels.	System		
%SW109	Forced analog channel counter	Makes analog channels forced to 0 compatible.	System		

**Note:** (2) Only in TSX 37

## Description of system word %SW116

### Detailed description

Description of system word %SW116 - FIPIO

Words	Function	Description	Management
%SW116	FIPIO I/O task fault	<p>Normally on 0, each bit for this word signifies FIPIO exchange status <b>within the task</b> in which it is being tested. This word is to be reset on 0 by the user.</p> <p>More details on words bits %SW116:</p> <ul style="list-style-type: none"> <li>● x0 = 1 explicit exchange error (variable has not been exchanged on the bus),</li> <li>● x1 = 1 time-out on an explicit exchange (no reply at the end of time-out),</li> <li>● x2 = 1 maximum number of explicit exchanges achieved at the same time,</li> <li>● x3 = 1 a frame is invalid,</li> <li>● x4 = 1 the length of frame received is greater than the length that was declared,</li> <li>● x5 = reserved on 0,</li> <li>● x6 = 1 a frame is invalid, or an agent is initializing,</li> <li>● x7 = 1 absence of a configured device,</li> <li>● x8 = 1 channel fault (at least one device channel is indicating a fault),</li> <li>● x9 to x14 = reserved on 0,</li> <li>● x15 = Global fault (OR bits 3, 4, 6, 7, 8).</li> </ul>	System User

## Description of system words %SW124 to %SW127

### Detailed description

### Description of system words %SW124 to %SW127

Words	Function	Description	Management
%SW124	Type of CPU fault	The last type of CPU fault encountered is written into this word by the system (these codes are unchanged on a cold restart): <ul style="list-style-type: none"> <li>● 16#30: system code fault</li> <li>● 16#60 to 64: stack overrun</li> <li>● 16#90: System switch fault: Unforeseen IT</li> <li>● 16#53: time-out fault during I/O exchanges</li> </ul>	System
%SW125	Type of blocking fault	The last type of blocking fault encountered is written into this word: <ul style="list-style-type: none"> <li>● 16#DEB0: watchdog overrun</li> <li>● 16#2258: execution of HALT instruction</li> <li>● 16#DEF8: execution of JMP instruction to an undefined label</li> <li>● 16#2XXX: execution of CALL instruction to an undefined sub-program</li> <li>● 16#0XXX: execution of an unknown function</li> <li>● 16#DEFE: the grafcet program consists of sendings to undefined steps.</li> <li>● 16#DEFF: floating point has not been not implemented</li> <li>● 16#DEF0: division by 0 (1--&gt;%S18)</li> <li>● 16#DEF1: character string transfer error (1--&gt;%S15)</li> <li>● 16#DEF2: capacity overflow (1--&gt;%S18)</li> <li>● 16#DEF3: index overflow (1--&gt;%S20)</li> </ul>	System
%SW126 %SW127	Blocking fault instruction address	Instruction address that generated the application blocking fault. <ul style="list-style-type: none"> <li>● %SW126 contains the offset for this address</li> <li>● %SW127 contains the base for this address</li> </ul>	System

## Description of system words %SW128 to %SW143

### Detailed description

Description of system words %SW128 to %SW143 - FIPIO

Words	Function	Description	Management
%SW128 to %SW143	Faulty FIPIO connection point	Each bit in this group of words indicates the state of a device connected to the FIPIO bus. Normally on 1, the presence of a 0 in one of these bits indicates the appearance of a fault in this connection point. For a non-configured connection point, the corresponding bit is always 1.	System

Table showing correspondence between word bits and connection point address.

	x0	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	x11	x12	x13	x14	x15
%SW128 :	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
%SW129 :	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
%SW130 :	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
%SW131 :	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
%SW132 :	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
%SW133 :	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
%SW134 :	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111
%SW135 :	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127
%SW136 :	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143
%SW137 :	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159
%SW138 :	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175
%SW139 :	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191
%SW140 :	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207
%SW141 :	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223
%SW142 :	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239
%SW143 :	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255


## Description of system words %SW144 to %SW146

### Detailed description

### Description of system words %SW144 to %SW146 - FIPIO

Words	Function	Description	Management
%SW144	FIPIO bus arbiter function operating mode	<p>This system word is used to start and stop the bus arbiter function and the producer / consumer function. It can modify the starting, automatic and manual modes of the bus in the event of a stop.</p> <ul style="list-style-type: none"> <li>● x0 = 1 producer / consumer function in RUN mode</li> <li>● x0 = 0 producer / consumer function in STOP mode (no variables are exchanged in the bus),</li> <li>● x1 = 1 bus arbiter is in RUN 0 mode</li> <li>● x1 = 0 bus arbiter is in STOP mode (no variables or message scanning is carried out in the bus),</li> <li>● x2 = 1 automatic start in the event of an automatic bus stop</li> <li>● x2 = 0 manual start in the event of an automatic bus stop</li> <li>● x3 = reserved on 1</li> <li>● x4 to x15 reserved on 0.</li> </ul>	User
%SW145	Modification of FIPIO bus arbiter parameters	<p>The bits are set on 1 by the user, and reset to 0 by the system when initialization has been carried out.</p> <ul style="list-style-type: none"> <li>● x0 = 1 modification of bus arbiter priority: the most significant system word byte contains the priority value of the bus arbiter which will be applied to the bus.</li> <li>● x1 = 1 modification of the return time value (Rt): the most significant system word byte contains the Rt value (in ms) which will be applied to the bus. The system word is zeroed when initialization is complete.</li> <li>● x2 = 1 modification of the pause time value (T0): the most significant system word byte contains the T0 value (in ms) which will be applied to the bus. The system word is zeroed when initialization is complete.</li> <li>● x3 to x7 are reserved on 0.</li> <li>● x8 = 1 value of bus arbiter priority,</li> <li>● x9 = 1 Rt value,</li> <li>● x10 = 1 T0 value.</li> </ul> <p>These parameters can be modified when the bus arbiter is in RUN mode, but for them to be taken into account by the application, the BA must be stopped then restarted.</p>	User System

Words	Function	Description	Management
%SW146	FIPIO bus arbiter function display	<p>The least significant byte indicates the state of the producer / consumer function</p> <p>The most significant byte indicates the state of the bus arbiter function.</p> <p>Byte value</p> <ul style="list-style-type: none"> <li>● 16#00: the function does not exist (no FIPIO application),</li> <li>● 16#07: the function currently in STOP (ie STOP order has been sent and the command has not finished).</li> <li>● 16#0F: the function currently in RUN (ie RUN order has been sent and the command has not finished).</li> <li>● 16#70: the function has been initialized but is not operational (in STOP mode),</li> <li>● 16#F0: the function is currently being executed normally (in RUN mode).</li> </ul>	System

	<b>CAUTION</b>
	<p><b>Matters affecting the words %SW144 and %SW145</b></p> <p>modifying these system words can lead the PLC station to stop.</p> <p><b>Failure to observe this precaution can result in injury or equipment damage.</b></p>

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## Description of system words %SW147 to %SW152

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### Detailed description

Description of system words %SW147 to %SW152

Words	Function	Description	Management
%SW147	MAST network cycle time	A value which is not zero indicates, in ms, the MAST task network cycle (TCR-MAST) time value.	System
%SW148	FAST task network cycle time value	A value which is not zero indicates, in ms, the MAST task network cycle (TCR-FAST) time value.	System
%SW149		Reserved on 0.	System
%SW150	Number of frames sent	This word indicates the number of frames sent by the FIPIO channel manager	System
%SW151	Number of frames received	This word indicates the number of frames received by the FIP-IO channel manager.	System
%SW152	Number of messages resumed	This word indicates the number of messages resumed by the FIPIO channel manager.	System

---



## Description of system word %SW153

### Detailed description

Description of system word %SW153 - FIPIO

Words	Function	Description	Management
%SW153	list of FIPIO channel manager faults.	Each bit is set on 1 by the system, and reset to 0 by the user. See the list below.	User System

### Bits description

- X0 = overrun station fault: corresponds to losing an MAC symbol while receiving – this is linked to the receiver reacting too slowly.
- X1 = message refusal fault: indicates an acknowledged message was refused, or it was not acknowledged in the first place. receiving MAC.
- X3 = underrun station fault: corresponds to the station being unable to respect transfer speed on the network.
- X4 = physical layer fault: corresponds to a prolonged transmission absence in the physical layer.
- X5 = non-echo fault: corresponds to a fault for which the transmitter is currently sending out, with an emission current in the operating format, and at the same time detection that a signal is absent on the same channel.
- X6 = excessive communication fault: corresponds to a fault whereby the transmitter is controlling the line for longer than the maximum set operating limit. This fault is caused, for example, by deterioration of the modulator, or by a faulty layer data link.
- X7 = undercurrent fault: corresponds to a fault whereby the transmitter generates, when solicited, a current weaker than the minimum set operating limit. This fault is caused by, for example, by increased line impedance (eg. open line etc.).
- X8 = breached frame fault indicates that a pause has been received in the frame body, after identifying a delimiter at the start of the frame, and before identifying a delimiter at the end of the frame. The appearance of a pause in normal operating conditions takes place after a delimiter has been identified at the end of a frame.
- X9 = CRC frame receiving fault: indicates that the CRC calculated on a frame usually received and the CRC contained within this frame have different values.
- X10 = receiving frame code fault: indicates that certain symbols, exclusive to delimitation sequences at the beginning and end of frames, have been received within the body of the frame.
- X11 = length fault within the frame received: more than 256 bytes have been received for the frame body.
- X12 = unknown frame type received: within the frame body, the first byte identifies the type of frame link. A set number of frame types are defined in the WORLDIFIP norm link protocol. Any other code found within a frame is therefore an unknown frame type.

- X13 = a truncated frame has been received: a frame section is recognized by sequence of symbols delimiting the end of the frame, while the destination station awaits the arrival of a delimiter sequence for the beginning of the frame.
  - X14 = unused, non-significant value.
  - X15 = unused, non-significant value.
-

## Description of system word %SW154

### Detailed description

Description of system word %SW154 - FIPIO

Words	Function	Description	Management
%SW154	list of FIPIO channel manager faults.	Each bit is set on 1 by the system, and reset to 0 by the user. See the list below.	User System

### Bits description

- X0 = aperiodic time-out sequence: indicates that the messages or aperiodic variables window has overflowed its limit within an elementary cycle of the macro-cycle.
- X1 = refusal of messaging request: indicates that the message queue is saturated - for the time being the bus arbiter is in no position to latch onto nor comply with a request.
- X2 = urgent update command refused: indicates that the queue for urgent aperiodic variables exchange requests is saturated - for the time being the bus arbiter is in no position to latch onto nor comply with a request.
- X2 = non-urgent update command refused: indicates that the queue for non-urgent aperiodic variables exchange requests is saturated - for the time being the bus arbiter is in no position to latch onto nor comply with a request.
- X4 = pause fault: the bus arbiter has not detected any bus activity during a time period larger than the standardized WorldFip time period.
- X5 = a network collision has occurred on identifier transmission: indicates activity on the network during theoretical pause periods. Between a transmission and awaiting a reply from the bus arbiter, there should be nothing circulating on the bus. If the bus arbiter detects activity, it will generate a collision fault (for example, when several arbiters are active at the same time on the bus).
- X6 = bus arbiter overrun fault: indicates a conflict on accessing the bus arbiter station memory.
- X7 = unused, non-significant value.
- X8 to X15 = reserved on 0.

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## Description of system words %SW155 to %SW162

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### Detailed description

Description of system words %SW155 to %SW162

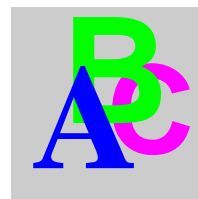
Words	Function	Description	Management
%SW155	Number of explicit exchanges	Number of explicit exchanges currently being processed	System
%SW160		Result of the last recording (diagnostics function).	System
%SW161		Result of the last non-recording (diagnostics function).	System
%SW162		Number of errors currently in the diagnostics buffer.	System

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