# Standard function blocks

## What this chapter contains

This chapter describes the standard function blocks. The blocks are grouped according to the grouping in the DriveSPC tool. It depends about drive type which amount of blocks and what kind of blocks are available.

The number in brackets in the standard block heading is the block number.

**Note:** The given execution times can vary depending on the used drive application.

## Terms

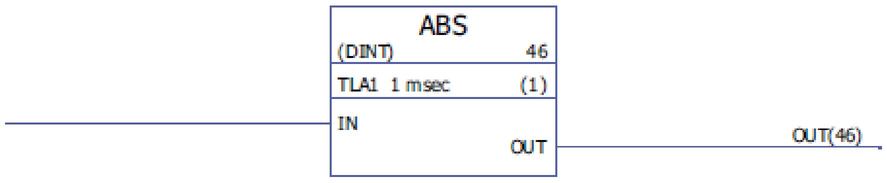
| **Data type** | **Description** | **Range** |
|---|---|---|
| Boolean | Boolean | 0 or 1 |
| DINT | 32-bit integer value (31 bits + sign) | -2147483648…2147483647 |
| INT | 16-bit integer value (15 bits + sign) | -32768…32767 |
| PB | Packed Boolean | 0 or 1 for each individual bit |
| REAL | $\underbrace{\text{16-bit value}}_{\text{= integer value}}\ \underbrace{\text{16-bit value}}_{\text{= fractional value}}$ (31 bits + sign) | -32768,99998…32767,9998 |
| REAL24 | $\underbrace{\text{8-bit value}}_{\text{= integer value}}\ \underbrace{\text{24-bit value}}_{\text{= fractional value}}$ (31 bits + sign) | -128,0…127,999 |

# Arithmetic

## ABS

### (10001)

**Illustration**

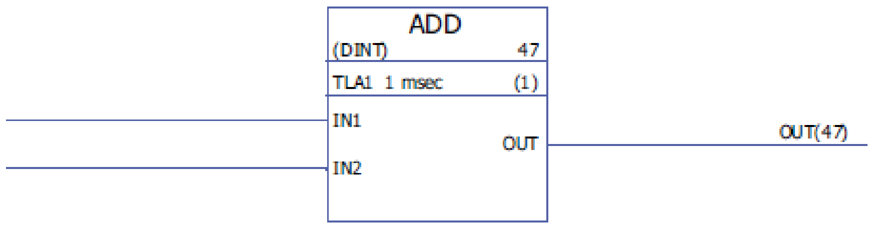


| | |
|---|---|
| **Execution time** | 0.53 µs |
| **Operation** | The output (OUT) is the absolute value of the input (IN).<br>OUT = \| IN \| |
| **Inputs** | The input data type is selected by the user.<br>Input (IN): DINT, INT, REAL or REAL24 |
| **Outputs** | Output (OUT): DINT, INT, REAL or REAL24 |

## ADD

### (10000)

**Illustration**



| | |
|---|---|
| **Execution time** | 3.36 µs (when two inputs are used) + 0.52 µs (for every additional input). When all inputs are used, the execution time is 18.87 µs. |

**Operation**

The output (OUT) is the sum of the inputs (IN1…IN32).

OUT = IN1 + IN2 + … + IN32

The output value is limited to the maximum and minimum values defined by the selected data type range.

**Inputs**

The input data type and the number of the inputs (2…32) are selected by the user.

Input (IN1…IN32): DINT, INT, REAL or REAL24

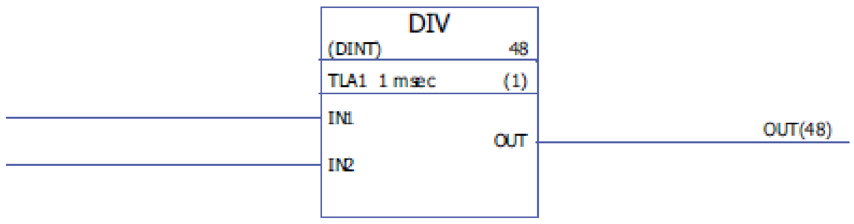
**Outputs**

Output (OUT): DINT, INT, REAL or REAL24

## DIV

## (10002)

**Illustration**



**Execution time**

2.55 µs

**Operation**

The output (OUT) is input IN1 divided by input IN2.

OUT = IN1/IN2

The output value is limited to the maximum and minimum values defined by the selected data type range.

If the divider (IN2) is 0, the output is 0.

**Inputs**

The input data type is selected by the user.

Input (IN1, IN2): INT, DINT, REAL, REAL24

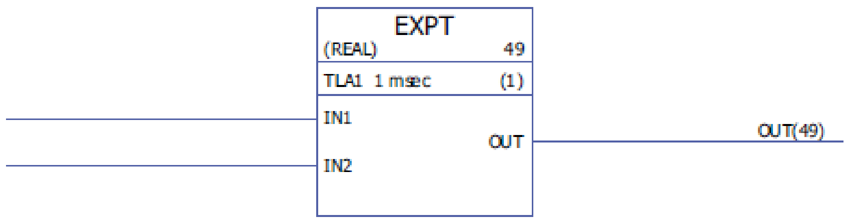
**Outputs**

Output (OUT): INT, DINT, REAL, REAL24

## EXPT

### (10003)

**Illustration**



**Execution time** 81.90 µs

**Operation**

The output (OUT) is input IN1 raised to the power of the input IN2:

OUT = $IN1^{IN2}$

If input IN1 is 0, the output is 0.

The output value is limited to the maximum value defined by the selected data type range.

**Note:** The execution of the EXPT function is slow.

**Inputs**

The input data type is selected by the user.

Input (IN1): REAL, REAL24

Input (IN2): REAL

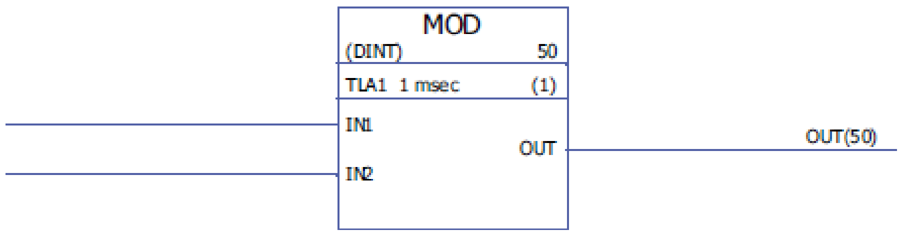
**Outputs**

Output (OUT): REAL, REAL24

## MOD

### (10004)

**Illustration**



**Execution time** 1.67 µs

**Operation** The output (OUT) is the remainder of the division of the inputs IN1 and IN2.

OUT = remainder of IN1/IN2

If input IN2 is zero, the output is zero.

**Inputs** The input data type is selected by the user.

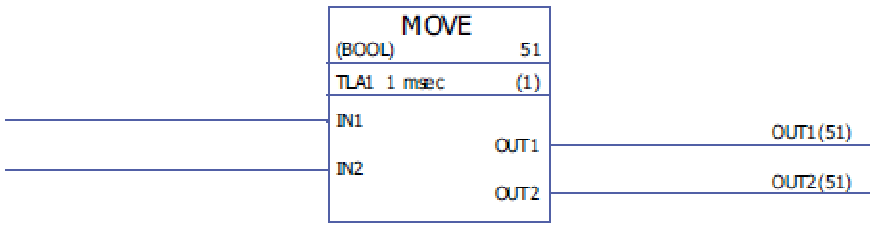
Input (IN1, IN2): INT, DINT

**Outputs** Output (OUT): INT, DINT

## MOVE

### (10005)

**Illustration**



**Execution time** 2.10 µs (when two inputs are used) + 0.42 µs (for every additional input). When all inputs are used, the execution time is 14.55 µs.

**Operation** Copies the input values (IN1…32) to the corresponding outputs (OUT1…32).

**Inputs** The input data type and number of inputs (2…32) are selected by the user.

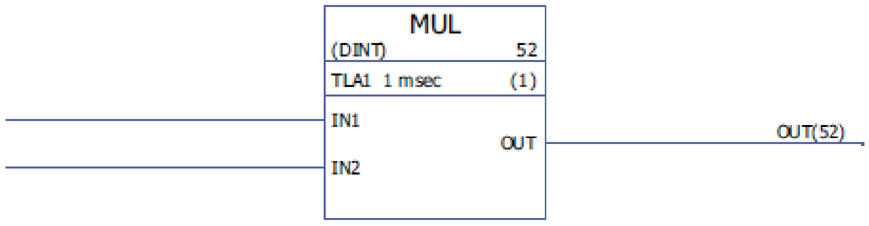
Input (IN1…IN32): INT, DINT, REAL, REAL24, Boolean

**Outputs** Output (OUT1…OUT32): INT, DINT, REAL, REAL24, Boolean

## MUL

## (10006)

**Illustration**



**Execution time** 3.47 µs (when two inputs are used) + 2.28 µs (for every additional input). When all inputs are used, the execution time is 71.73 µs.

**Operation** The output (OUT) is the product of the inputs (IN).

O = IN1 × IN2 × … × IN32

The output value is limited to the maximum and minimum values defined by the selected data type range.

**Inputs** The input data type and the number of inputs (2…32) are selected by the user.

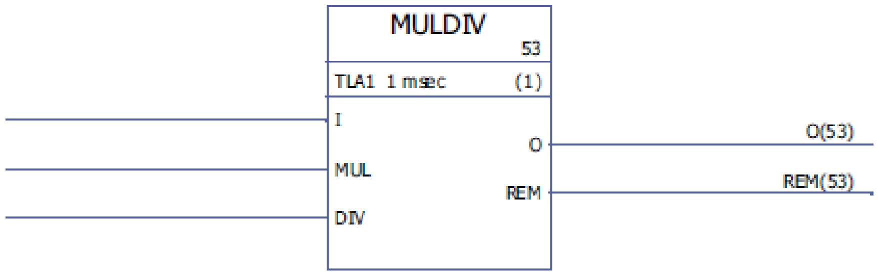
Input (IN1…IN32): INT, DINT, REAL, REAL24

**Outputs** Output (OUT): INT, DINT, REAL, REAL24

## MULDIV

## (10007)

**Illustration**



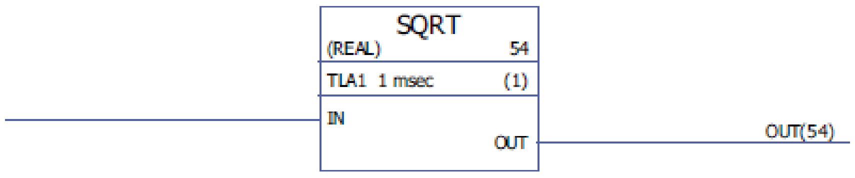
**Execution time** 7.10 µs

| | |
|---|---|
| **Operation** | The output (O) is the product of input IN and input MUL divided by input DIV.<br>Output = (I × MUL) / DIV<br>O = whole value. REM = remainder value.<br>Example: I = 2, MUL = 16 and DIV = 10:<br>(2 × 16) / 10 = 3.2, i.e. O = 3 and REM = 2<br>The output value is limited to the maximum and minimum values defined by the data type range. |
| **Inputs** | Input (I): DINT<br>Multiplier input (MUL): DINT<br>Divider input (DIV): DINT |
| **Outputs** | Output (O): DINT<br>Remainder output (REM): DINT |

## SQRT

### (10008)

**Illustration**



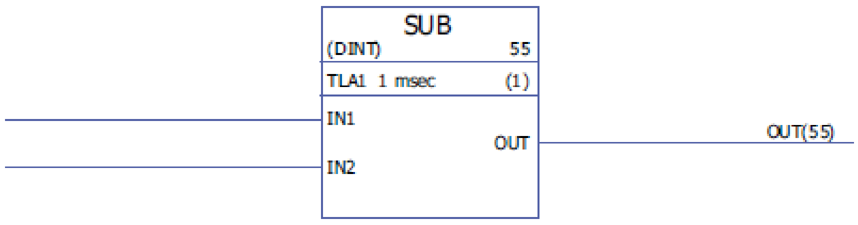
| | |
|---|---|
| **Execution time** | 2.09 µs |
| **Operation** | Output (OUT) is the square root of the input (IN).<br>OUT = sqrt(IN)<br>Output is 0 if the input value is negative. |
| **Inputs** | The input data type is selected by the user.<br>Input (IN): REAL, REAL24 |
| **Outputs** | Output (OUT): REAL, REAL24 |

-

## SUB

## (10009)

**Illustration**



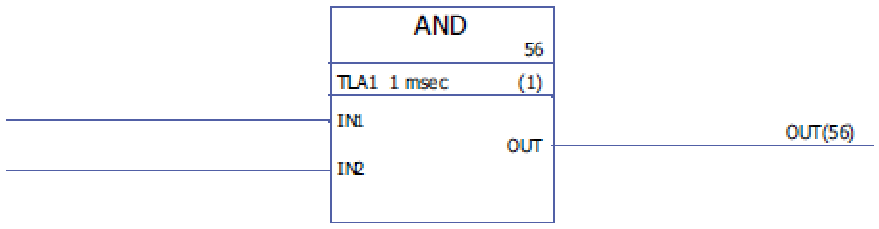
| | |
|---|---|
| **Execution time** | 2.33 µs |
| **Operation** | Output (OUT) is the difference between the input signals (IN):<br>OUT = IN1 - IN2<br>The output value is limited to the maximum and minimum values defined by the selected data type range. |
| **Inputs** | The input data type is selected by the user.<br>Input (IN1, IN2): INT, DINT, REAL, REAL24 |
| **Outputs** | Output (OUT): INT, DINT, REAL, REAL24 |

## Bitstring

### AND

### (10010)

**Illustration**



**Execution time** 1.55 µs (when two inputs are used) + 0.60 µs (for every additional input). When all inputs are used, the execution time is 19.55 µs.

**Operation** The output (OUT) is 1 if all the connected inputs (IN1…IN32) are 1. Otherwise the output is 0.

Truth table:

| IN1 | IN2 | OUT |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

The inputs can be inverted.

**Inputs** The number of inputs is selected by the user.

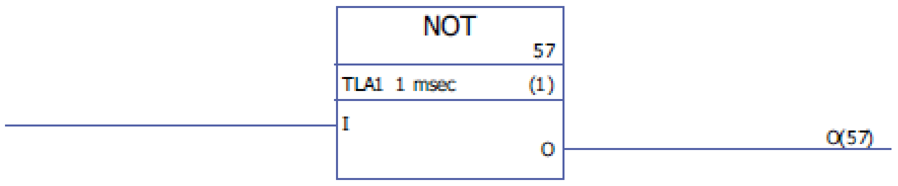
Input (IN1…IN32): Boolean

**Outputs** Output (OUT): Boolean

## NOT

## (10011)

**Illustration**

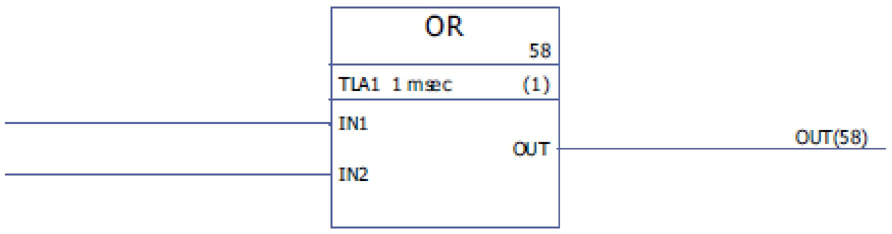


| | |
|---|---|
| **Execution time** | 0.32 µs |
| **Operation** | The output (O) is 1 if the input (I) is 0. The output is 0 if the input is 1. |
| **Inputs** | Input (I): Boolean |
| **Outputs** | Output (O): Boolean |

## OR

## (10012)

**Illustration**



| | |
|---|---|
| **Execution time** | 1.55 µs (when two inputs are used) + 0.60 µs (for every additional input). When all inputs are used, the execution time is 19.55 µs. |

**Operation**

The output (OUT) is 0, if all connected inputs (IN) are 0. Otherwise the output is 1.

Truth table:

| IN1 | IN2 | OUT |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |

The inputs can be inverted.

**Inputs**

The number of inputs (2…32) is selected by the user.

Input (IN1…IN32): Boolean

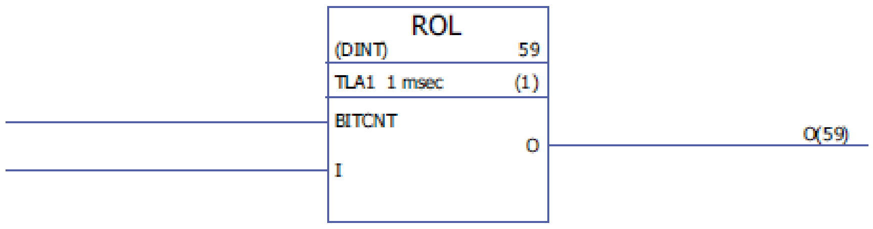
**Outputs**

Output (OUT): Boolean

## ROL

## (10013)

**Illustration**



**Execution time**

1.28 µs

**Operation**

Input bits (I) are rotated to the left by the number (N) of bits defined by BITCNT. The N most significant bits (MSB) of the input are stored as the N least significant bits (LSB) of the output.

Example: If BITCNT = 3

3 MSB

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **I** | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 |
| **O** | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 |

3 LSB

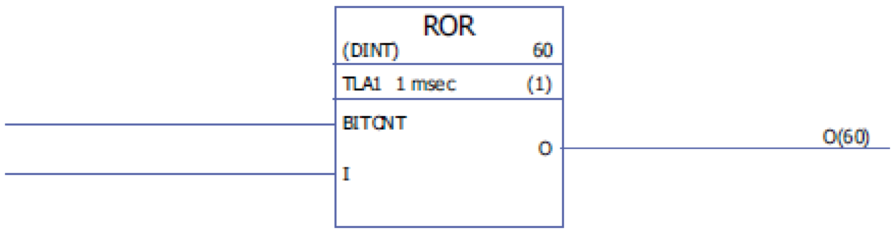
**Inputs** The input data type is selected by the user.
Number of bits input (BITCNT): INT, DINT
Input (I): INT, DINT

**Outputs** Output (O): INT, DINT

## ROR

### (10014)

**Illustration**



**Execution time** 1.28 µs

**Operation** Input bits (I) are rotated to the right by the number (N) of bits defined by BITCNT. The N least significant bits (LSB) of the input are stored as the N most significant bits (MSB) of the output.

Example: If BITCNT = 3

3 LSB

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **I** | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 |
| **O** | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 |

3 MSB

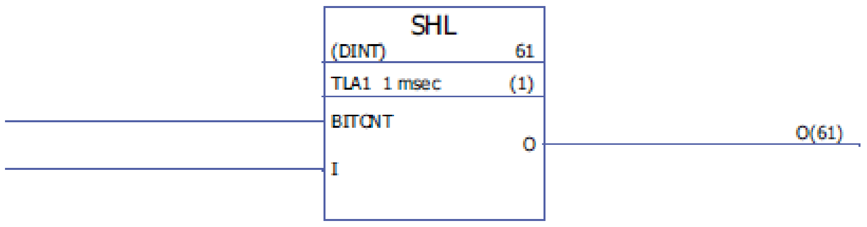
**Inputs** The input data type is selected by the user.
Number of bits input (BITCNT): INT, DINT
Input (I): INT, DINT

**Outputs** Output (O): INT, DINT

## SHL

### (10015)

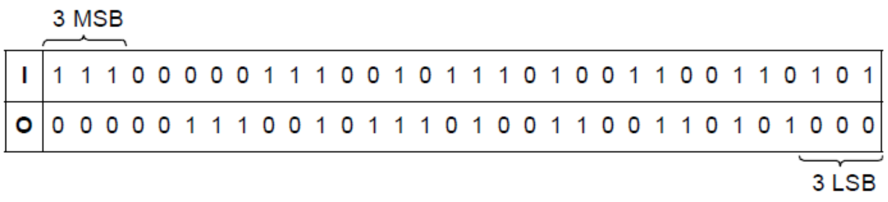
**Illustration**



**Execution time** 0.80 µs

**Operation** Input bits (I) are rotated to the left by the number (N) of bits defined by BITCNT. The N most significant bits (MSB) of the input are lost and the N least significant bits (LSB) of the output are set to 0.

Example: If BITCNT = 3


3 MSB

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 |
| O | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |

3 LSB

**Inputs** The input data type is selected by the user.

Number of bits (BITCNT): INT; DINT

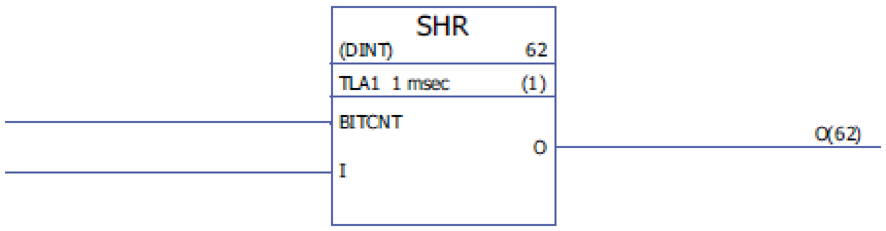
Input (I): INT, DINT

**Outputs** Output (O): INT; DINT

## SHR

## (10016)

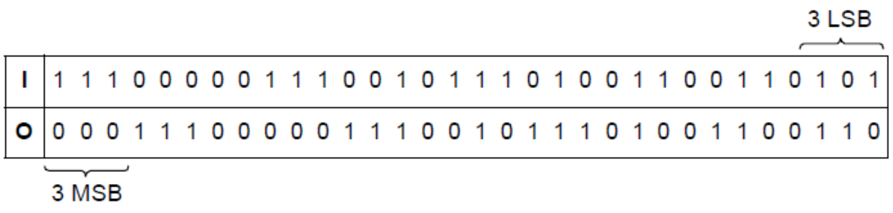
**Illustration**



**Execution time** 0.80 µs

**Operation** Input bits (I) are rotated to the right by the number (N) of bits defined by BITCNT. The N least significant bits (LSB) of the input are lost and the N most significant bits (MSB) of the output are set to 0.

Example: If BITCNT = 3



| | |
|---|---|
| I | 1 1 1 0 0 0 0 0 1 1 1 0 0 1 0 1 1 1 0 1 0 0 1 1 0 0 1 1 0 1 0 1 |
| O | 0 0 0 1 1 1 0 0 0 0 0 1 1 1 0 0 1 0 1 1 1 0 1 0 0 1 1 0 0 1 1 0 |

**Inputs** The input data type is selected by the user.

Number of bits (BITCNT): INT; DINT

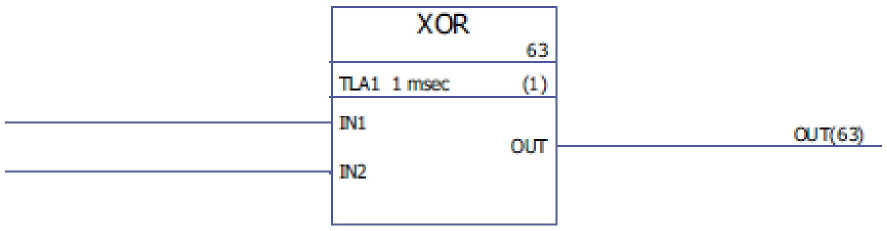
Input (I): INT, DINT

**Outputs** Output (O): INT; DINT

## XOR

### (10017)

**Illustration**



**Execution time**

1.24 µs (when two inputs are used) + 0.72 µs (for every additional input). When all inputs are used, the execution time is 22.85 µs.

**Operation**

The output (OUT) is 1 if one of the connected inputs (IN1…IN32) is 1. Output is zero if all the inputs have the same value.

Example:

| IN1 | IN2 | OUT |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

The inputs can be inverted.

**Inputs**

The number of inputs (2…32) is selected by the user.

Input (IN1…IN32): Boolean

**Outputs**

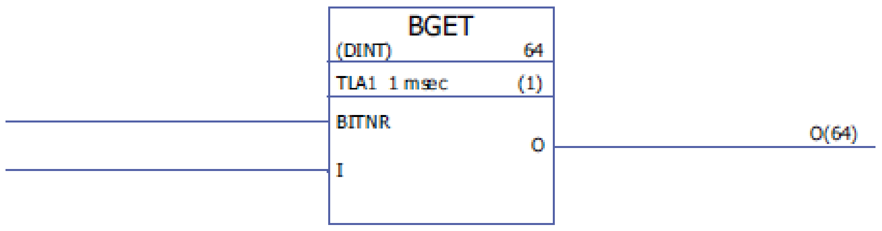
Output (OUT): Boolean

## Bitwise

### BGET

### (10034)

**Illustration**



**Execution time** 0.88 µs

**Operation** The output (O) is the value of the selected bit (BITNR) of the input (I).
BITNR: Bit number (0 = bit number 0, 31 = bit number 31)
If bit number is not in the range of 0…31 (for DINT) or 0…15 (for INT), the output is 0.

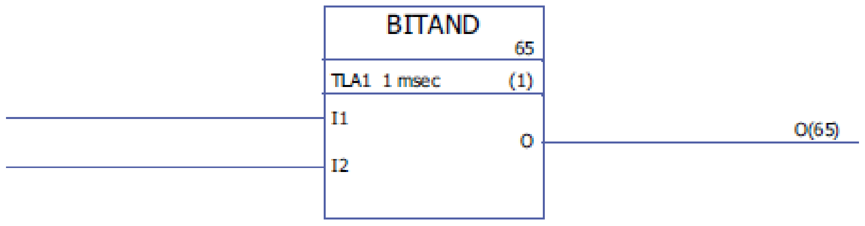
**Inputs** The input data type is selected by the user.
Number of the bit (BITNR): DINT
Input (I): DINT, INT

**Outputs** Output (O): Boolean

### BITAND

### (10035)

**Illustration**



**Execution time** 0.32 µs

**Operation**

The output (O) bit value is 1 if the corresponding bit values of the inputs (I1 and I2) are 1. Otherwise the output bit value is 0.

Example:

| | |
|---|---|
| **I1** | 1 1 1 0 0 0 0 0 1 1 1 0 0 1 0 1 1 1 0 1 0 0 1 1 0 0 1 1 0 1 0 1 |
| **I2** | 0 0 0 0 0 1 1 1 0 0 1 0 1 1 1 0 1 0 0 1 1 0 0 1 1 0 1 0 1 1 1 1 |
| **O** | 0 0 0 0 0 0 0 0 0 0 1 0 0 1 0 0 1 0 0 1 0 0 0 1 0 0 1 0 0 1 0 1 |

**Inputs**

Input (I1, I2): DINT

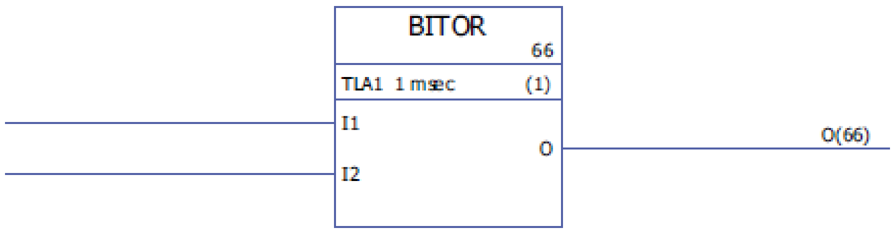
**Outputs**

Output (O): DINT

## BITOR

### (10036)

**Illustration**



**Execution time**

0.32 µs

**Operation**

The output (O) bit value is 1 if the corresponding bit value of any of the inputs (I1 or I2) is 1. Otherwise the output bit value is 0.

Example:

| | |
|---|---|
| **I1** | 1 1 1 0 0 0 0 0 1 1 1 0 0 1 0 1 1 1 0 1 0 0 1 1 0 0 1 1 0 1 0 1 |
| **I2** | 0 0 0 0 0 1 1 1 0 0 1 0 1 1 1 0 1 0 0 1 1 0 0 1 1 0 1 0 1 1 1 1 |
| **O** | 1 1 1 0 0 1 1 1 1 1 1 0 1 1 1 1 1 1 0 1 1 0 1 1 1 0 1 1 1 1 1 1 |

**Input**

Input (I1, I2): DINT

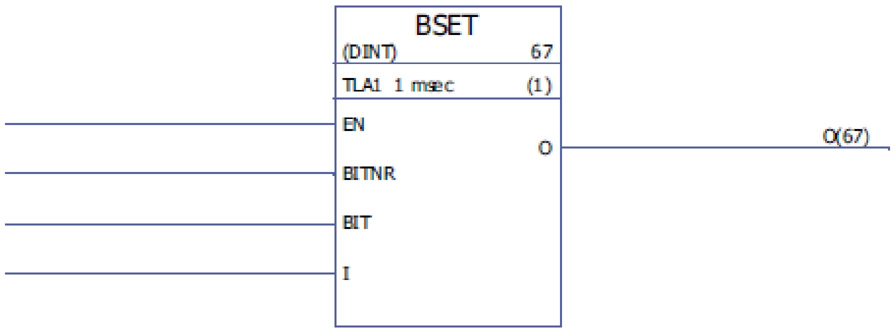
**Output**

Output (O): DINT

## BSET

### (10037)

**Illustration**



**Execution time** 1.36 µs

**Operation** The value of a selected bit (BITNR) of the input (I) is set as defined by the bit value input (BIT). The function must be enabled by the enable input (EN).

BITNR: Bit number (0 = bit number 0, 31 = bit number 31)

If BITNR is not in the range of 0…31 (for DINT) or 0…15 (for INT) or if EN is reset to zero, the input value is stored to the output as it is (i.e. no bit setting occurs).

Example:

EN = 1, BITNR = 3, BIT = 0

IN = 0000 0000 1111 1111

O = 0000 0000 1111 0111

**Inputs** The input data type is selected by the user.

Enable input (EN): Boolean

Number of the bit (BITNR): DINT

Bit value input (BIT): Boolean

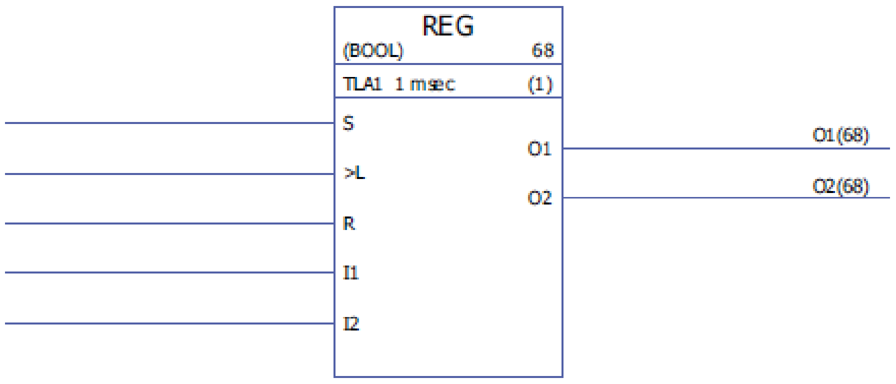
Input (I): INT, DINT

**Outputs** Output (O): INT, DINT

## REG

### (10038)

**Illustration**



**Execution time**

2.27 µs (when two inputs are used) + 1.02 µs (for every additional input). When all inputs are used, the execution time is 32.87 µs.

**Operation**

The input (I1…I32) value is stored to the corresponding output (O1…O32) if the load input (L) is set to 1 or the set input (S) is 1. When the load input is set to 1, the input value is stored to the output only once. When the set input is 1, the input value is stored to the output every time the block is executed. The set input overrides the load input.

If the reset input (R) is 1, all connected outputs are 0.

Example:

| S | R | L | I | $O1_{previous}$ | O1 |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 10 | 15 | 15 |
| 0 | 0 | 0->1 | 20 | 15 | 20 |
| 0 | 1 | 0 | 30 | 20 | 0 |
| 0 | 1 | 0->1 | 40 | 0 | 0 |
| 1 | 0 | 0 | 50 | 0 | 50 |
| 1 | 0 | 0->1 | 60 | 50 | 60 |
| 1 | 1 | 0 | 70 | 60 | 0 |
| 1 | 1 | 0->1 | 80 | 0 | 0 |
| $O1_{previous}$ is the previous cycle output value. | | | | | |

**Inputs**

The input data type and number of inputs (1…32) are selected by the user.

Set input (S): Boolean

Load input (L): Boolean

Reset input (R): Boolean

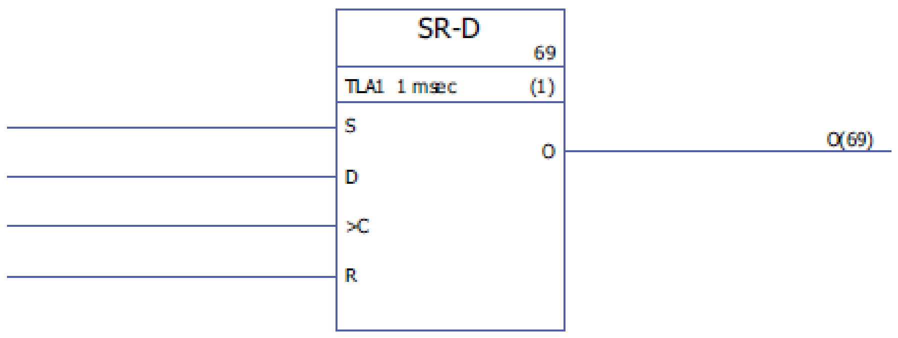
Input (I1…I32): Boolean, INT, DINT, REAL, REAL24

**Outputs** Output (O1…O32): Boolean, INT, DINT, REAL, REAL24

## SR-D

## (10039)

**Illustration**



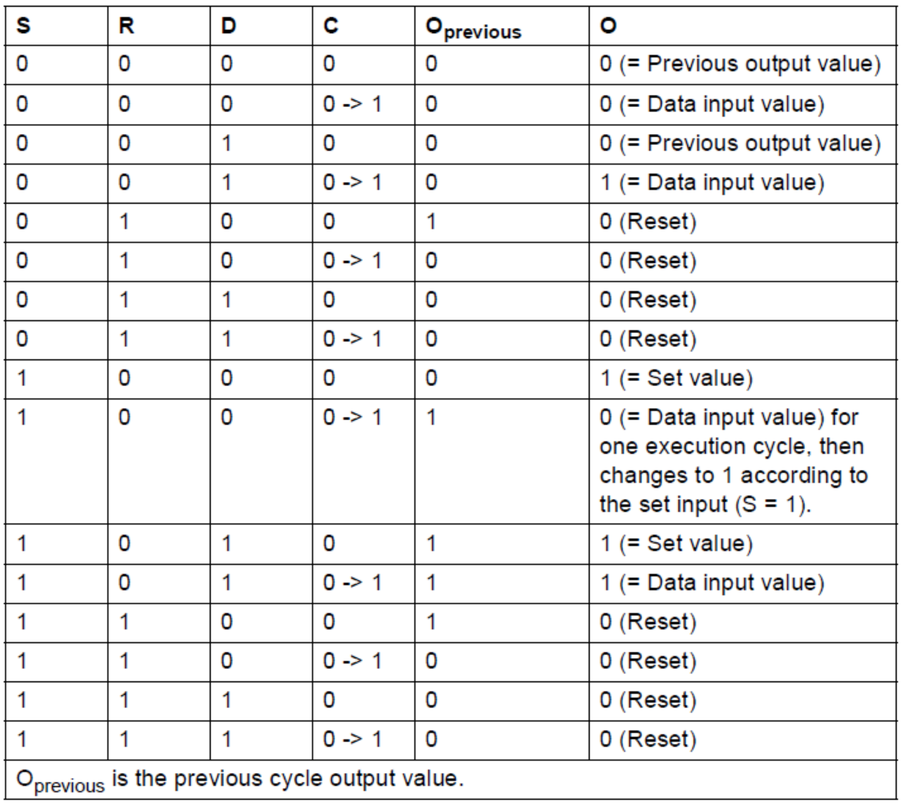
**Execution time** 1.04 µs

**Operation**

When clock input (C) is set to 1, the data input (D) value is stored to the output (O). When reset input (R) is set to 1, the output is set to 0.

If only set (S) and reset (R) inputs are used, SR-D block acts as an SR block:
The output is 1 if the set input (S) is 1. The output will retain the previous output state if the set input (S) and reset input (R) are 0. The output is 0 if the set input is 0 and the reset input is 1.

Truth table:



| S | R | D | C | $O_{previous}$ | O |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 (= Previous output value) |
| 0 | 0 | 0 | 0 -> 1 | 0 | 0 (= Data input value) |
| 0 | 0 | 1 | 0 | 0 | 0 (= Previous output value) |
| 0 | 0 | 1 | 0 -> 1 | 0 | 1 (= Data input value) |
| 0 | 1 | 0 | 0 | 1 | 0 (Reset) |
| 0 | 1 | 0 | 0 -> 1 | 0 | 0 (Reset) |
| 0 | 1 | 1 | 0 | 0 | 0 (Reset) |
| 0 | 1 | 1 | 0 -> 1 | 0 | 0 (Reset) |
| 1 | 0 | 0 | 0 | 0 | 1 (= Set value) |
| 1 | 0 | 0 | 0 -> 1 | 1 | 0 (= Data input value) for one execution cycle, then changes to 1 according to the set input (S = 1). |
| 1 | 0 | 1 | 0 | 1 | 1 (= Set value) |
| 1 | 0 | 1 | 0 -> 1 | 1 | 1 (= Data input value) |
| 1 | 1 | 0 | 0 | 1 | 0 (Reset) |
| 1 | 1 | 0 | 0 -> 1 | 0 | 0 (Reset) |
| 1 | 1 | 1 | 0 | 0 | 0 (Reset) |
| 1 | 1 | 1 | 0 -> 1 | 0 | 0 (Reset) |
| $O_{previous}$ is the previous cycle output value. | | | | | |

**Inputs**

Set input (S): Boolean

Data input (D): Boolean

Clock input (C): Boolean

Reset input (R): Boolean

**Outputs**

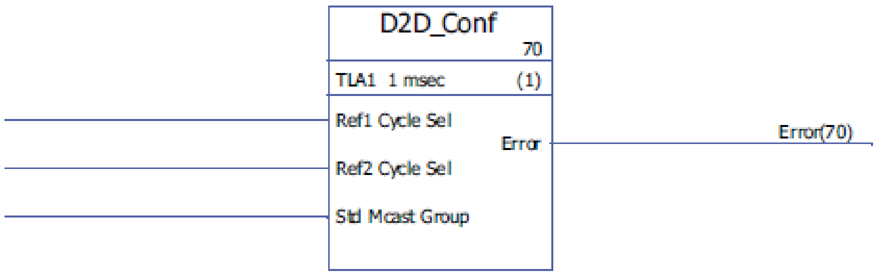
Output (O): Boolean

# Communication

## D2D_Conf

## (10092)

**Illustration**



**Execution time** -

**Operation**

Defines handling interval for drive-to-drive references 1 and 2, and the address (group number) for standard (non-chained) multicast messages.

The values of the Ref1/2 Cycle Sel inputs correspond to the following intervals:

| Value | Handling interval |
|---|---|
| 0 | Default (500 µs for reference 1; 2 ms for reference 2) |
| 1 | 250 µs |
| 2 | 500 µs |
| 3 | 2 ms |

**Note:** Negative value of Ref2 Cycle Sel disables the handling of Ref2 (if disabled in the master, it must be disabled in all follower drives as well).

Allowable values for the Std Mcast Group input are 0 (= multicasting not used) and 1…62 (multicast group).

An unconnected input, or an input in an error state, is interpreted as having the value 0.

The error codes indicated by the Error output are as follows:

| Bit | Description |
|---|---|
| 0 | REF1_CYCLE_ERR: Value of input Ref1 Cycle Sel out of range |
| 1 | REF2_CYCLE_ERR: Value of input Ref2 Cycle Sel out of range |
| 2 | STD_MCAST_ERR: Value of input Std Mcast Group out of range |

.

**Inputs**

Drive-to-drive reference 1 handling interval (Ref1 Cycle Sel): INT
Drive-to-drive reference 2 handling interval (Ref2 Cycle Sel): INT
Standard multicast address (Std Mcast Group): INT

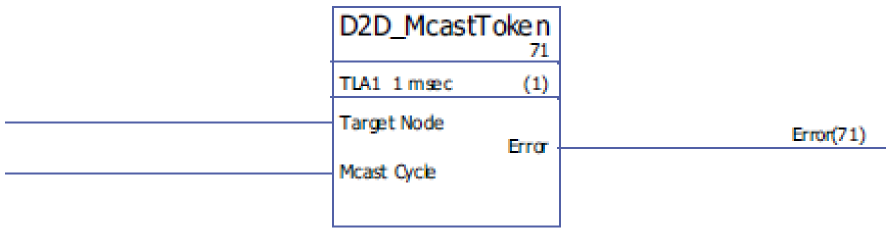
**Outputs**

Error output (Error): PB

## D2D_McastToken

### (10096)

**Illustration**



**Execution time**

-

**Operation**

Configures the transmission of token messages sent to a follower. Each token authorizes the follower to send one message to another follower or group of followers. For the message types, see the block D2D_SendMessage.

**Note:** This block is only supported in the master.

The Target Node input defines the node address the master sends the tokens to; the range is 1…62.

The Mcast Cycle specifies the interval between token messages in the range of 2…1000 milliseconds. Setting this input to 0 disables the sending of tokens.

The error codes indicated by the Error output are as follows:

| Bit | Description |
|---|---|
| 0 | D2D_MODE_ERR: Drive is not master |
| 5 | TOO_SHORT_CYCLE: Token interval is too short, causing overloading |
| 6 | INVALID_INPUT_VAL: An input value is out of range |
| 7 | GENERAL_D2D_ERR: Drive-to-drive communication driver failed to initialize message |

**Inputs**

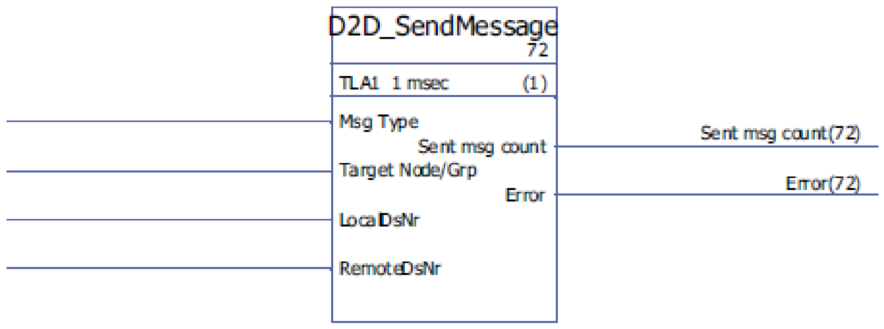
Token recipient (Target Node): INT
Token interval (Mcast Cycle): INT

**Outputs** Error output (Error): DINT

## D2D_SendMessage

### (10095)

**Illustration**



**Execution time** -

**Operation**

Configures the transmission between the dataset tables of drives.

The Msg Type input defines the message type as follows:

| Value | Message type |
|---|---|
| 0 | Disabled |
| 1 | Master P2P:<br>The master sends the contents of a local dataset (specified by LocalDsNr input) to the dataset table (dataset number specified by RemoteDsNr input) of a follower (specified by Target Node/Grp input).<br>The follower replies by sending the next dataset (RemoteDsNr + 1) to the master (LocalDsNr + 1).<br>The node number of a drive is defined by parameter 57.03.<br>**Note:** Only supported in the master drive. |
| 2 | Read Remote:<br>The master reads a dataset (specified by RemoteDsNr input) from a follower (specified by Target Node/Grp input) and stores it into local dataset table (dataset number specified by LocalDsNr input).<br>The node number of a drive is defined by parameter 57.03.<br>**Note:** Only supported in the master drive. |
| 3 | Follower P2P:<br>The follower sends the contents of a local dataset (specified by LocalDsNr input) to the dataset table (dataset number specified by RemoteDsNr input) of another follower (specified by Target Node/Grp input).<br>The node number of a drive is defined by parameter 57.03.<br>**Note:** Only supported in a follower drive. A token from the master drive is required for the follower to be able to send the message. See the block D2D_McastToken. |
| 4 | Standard Multicast:<br>The drive sends the contents of a local dataset (specified by LocalDsNr input) to the dataset table (dataset number specified by RemoteDsNr input) of a group of followers (specified by Target Node/Grp input).<br>Which multicast group a drive belongs to is defined by the Std Mcast Group input of the D2D_Conf block.<br>A token from the master drive is required for a follower to be able to send the message. See the block D2D_McastToken. |
| 5 | Broadcast:<br>The drive sends the contents of a local dataset (specified by LocalDsNr input) to the dataset table (dataset number specified by RemoteDsNr input) of all followers.<br>A token from the master drive is required for a follower to be able to send the message. See the block D2D_McastToken. |

The Target Node/Grp input specifies the target drive or multicast group of drives depending on message type. See the message type explanations above.

**Note:** The input must be connected in DriveSPC even if not used.

The LocalDsNr input specifies the number of the local dataset used as the source or the target of the message.

The RemoteDsNr input specifies the number of the remote dataset used as the target or the source of the message.

The Sent msg count output is a wrap-around counter of successfully sent messages.

The error codes indicated by the Error output are as follows:

| Bit | Description |
|---|---|
| 0 | D2D_MODE_ERR: Drive-to-drive communication not activated, or message type not supported in current drive-to-drive mode (master/follower) |
| 1 | LOCAL_DS_ERR: LocalDsNr input out of range (16…199) |
| 2 | TARGET_NODE_ERR: Target Node/Grp input out of range (1…62) |
| 3 | REMOTE_DS_ERR: Remote dataset number out of range (16…199) |
| 4 | MSG_TYPE_ERR: Msg Type input out of range (0…5) |
| 5…6 | Reserved |
| 7 | GENERAL_D2D_ERR: Unspecified error in D2D driver |
| 8 | RESPONSE_ERR: Syntax error in received response |
| 9 | TRA_PENDING: Message has not yet been sent |
| 10 | REC_PENDING: Response has not yet been received |
| 11 | REC_TIMEOUT: No response received |
| 12 | REC_ERROR: Frame error in received message |
| 13 | REJECTED: Message has been removed from transmit buffer |
| 14 | BUFFER_FULL: Transmit buffer full |

**Inputs**

Message type (Msg Type): INT
Target node or multicast group (Target Node/Grp): INT
Local dataset number (LocalDsNr): INT
Remote dataset number (RemoteDsNr): INT

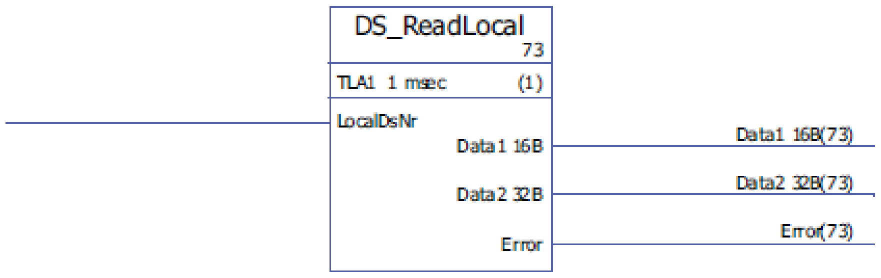
**Outputs**

Successfully sent messages counter (Sent msg count): DINT
Error output (Error): PB

## DS_ReadLocal

### (10094)

**Illustration**



**Execution time** -

**Operation** Reads the dataset defined by the LocalDsNr input from the local dataset table. One dataset contains one 16-bit and one 32-bit word which are directed to the Data1 16B and Data2 32B outputs respectively.

The LocalDsNr input defines the number of the dataset to be read.

The error codes indicated by the Error output are as follows:

| Bit | Description |
|---|---|
| 1 | LOCAL_DS_ERR: LocalDsNr out of range (16…199) |

**Inputs** Local dataset number (LocalDsNr): INT

**Outputs** Contents of dataset (Data1 16B): INT

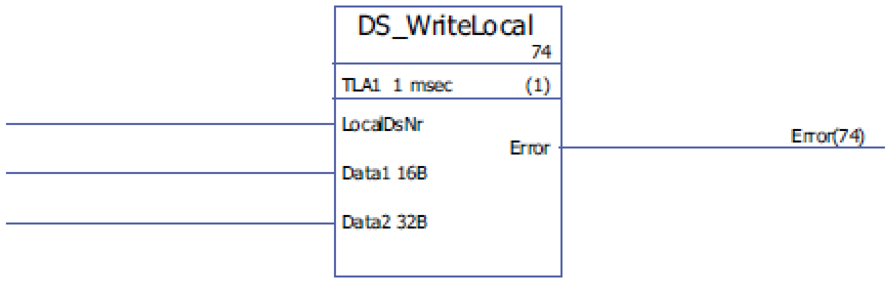
Contents of dataset (Data2 32B): DINT

Error output (Error): DINT

## DS_WriteLocal

### (10093)

**Illustration**



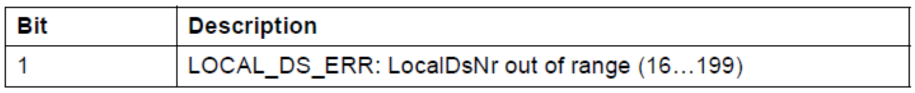
**Execution** -

**time**

**Operation**

Writes data into the local dataset table. Each dataset contains 48 bits; the data is input through the Data1 16B (16 bits) and Data2 32B (32 bits) inputs. The dataset number is defined by the LocalDsNr input.

The error codes indicated by the Error output are as follows:



| Bit | Description |
|---|---|
| 1 | LOCAL_DS_ERR: LocalDsNr out of range (16…199) |

**Inputs**

Local dataset number (LocalDsNr): INT

Contents of dataset (Data1 16B): INT

Contents of dataset (Data2 32B): DINT

**Outputs**

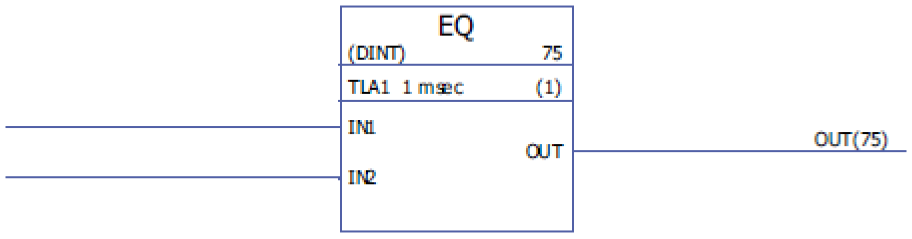
Error output (Error): DINT

## Comparison

### EQ

### (10040)

**Illustration**



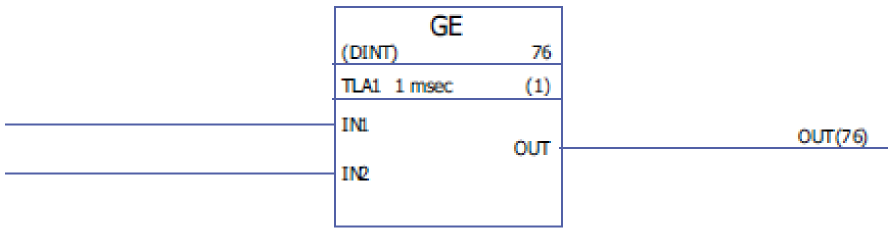
| | |
|---|---|
| **Execution time** | 0.89 µs (when two inputs are used) + 0.43 µs (for every additional input). When all inputs are used, the execution time is 13.87 µs. |
| **Operation** | The output (OUT) is 1 if all the connected input values are equal (IN1 = IN2 = … = IN32). Otherwise the output is 0. |
| **Inputs** | The input data type and the number of inputs (2…32) are selected by the user.<br>Input (IN1…IN32): INT, DINT, REAL, REAL24 |
| **Outputs** | Output (OUT): Boolean |

**>=**

### GE

### (10041)

**Illustration**



| | |
|---|---|
| **Execution time** | 0.89 µs (when two inputs are used) + 0.43 µs (for every additional input). When all inputs are used, the execution time is 13.87 µs. |

**Operation** The output (OUT) is 1 if (IN1 ≥ IN2) & (IN2 ≥ IN3) & … & (IN31 ≥ IN32). Otherwise the output is 0.

**Inputs** The input data type and the number of inputs (2…32) are selected by the user.

Input (IN1…IN32): INT, DINT, REAL, REAL24

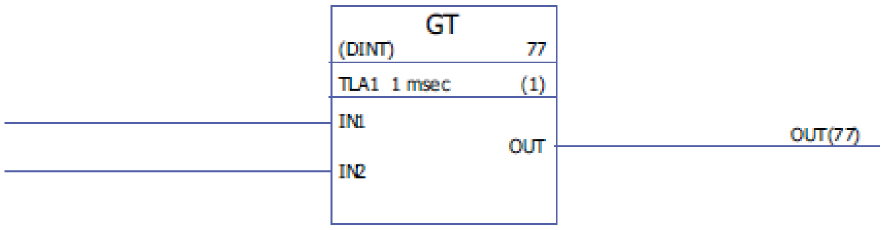
**Outputs** Output (OUT): Boolean

## >

## GT

## (10042)

**Illustration**



**Execution time** 0.89 µs (when two inputs are used) + 0.43 µs (for every additional input). When all inputs are used, the execution time is 13.87 µs.

**Operation** The output (OUT) is 1 if (IN1 > IN2) & (IN2 > IN3) & … & (IN31 > IN32). Otherwise the output is 0.

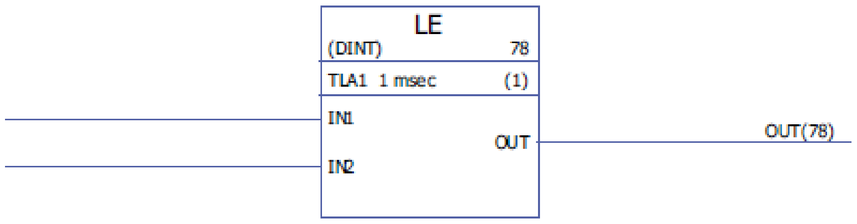
**Inputs** The input data type and the number of inputs (2…32) are selected by the user.

Input (IN1…IN32): INT, DINT, REAL, REAL24

**Outputs** Output (OUT): Boolean

## <=
## LE
## (10043)

**Illustration**



**Execution time** 0.89 µs (when two inputs are used) + 0.43 µs (for every additional input). When all inputs are used, the execution time is 13.87 µs.

**Operation** Output (OUT) is 1 if (IN1 ≤ IN2) & (IN2 ≤ IN3) & … & (IN31 ≤ IN32). Otherwise the output is 0.

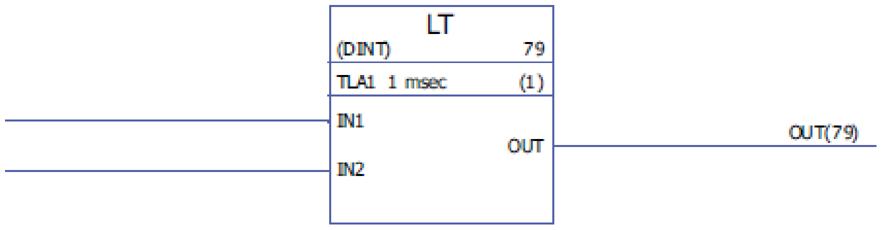
**Inputs** The input data type and the number of inputs (2…32) are selected by the user.

Input (IN1…IN32): INT, DINT, REAL, REAL24

**Outputs** Output (OUT): Boolean

## <
## LT
## (10044)

**Illustration**



**Execution time** 0.89 µs (when two inputs are used) + 0.43 µs (for every additional input). When all inputs are used, the execution time is 13.87 µs.

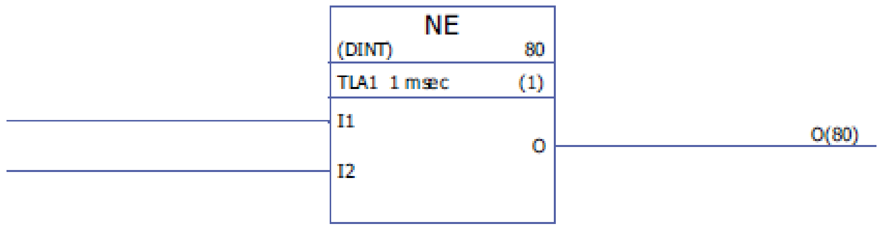
**Operation** Output (OUT) is 1 if (IN1 < IN2) & (IN2 < IN3) & … & (IN31 < IN32). Otherwise the output is 0.

**Inputs** The input data type and the number of inputs (2…32) are selected by the user. Input (IN1…IN32): INT, DINT, REAL, REAL24

**Outputs** Output (OUT): Boolean

## <> NE (10045)

**Illustration**



**Execution time** 0.44 µs

**Operation** The output (O) is 1 if I1 <> I2. Otherwise the output is 0.

**Inputs** The input data type is selected by the user. Input (I1, I2): INT, DINT, REAL, REAL24

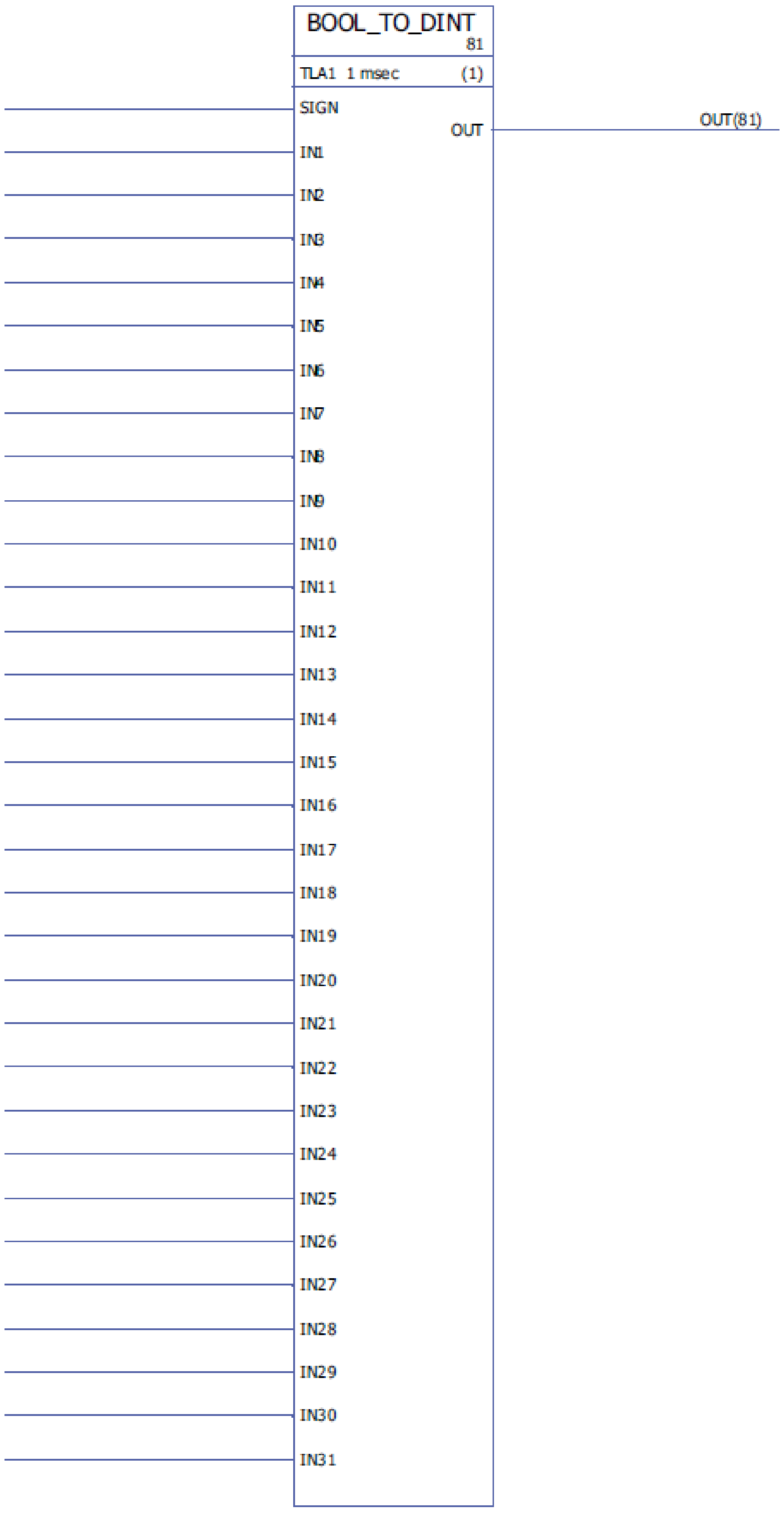
**Outputs** Output (O): Boolean

## Conversion

### BOOL_TO_DINT

**(10018)**

**Illustration**

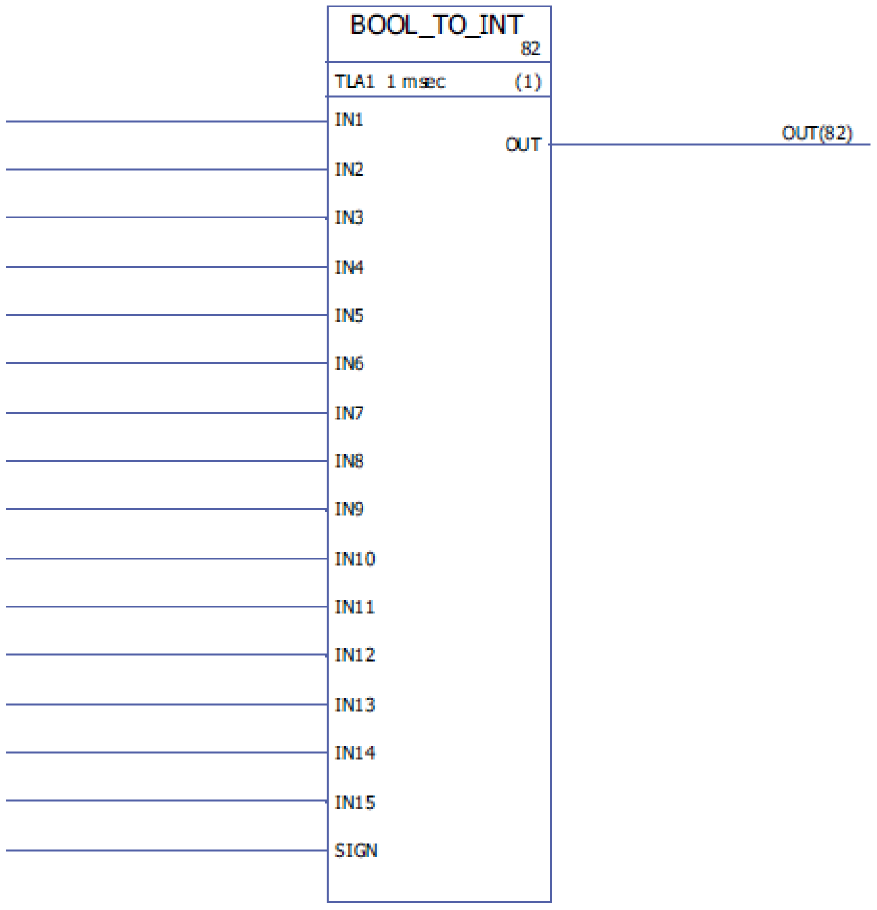


| | |
|---|---|
| **Execution time** | 13.47 µs |
| **Operation** | The output (OUT) value is a 32-bit integer value formed from the boolean input (IN1…IN31 and SIGN) values. IN1 = bit 0 and IN31 = bit 30.<br>Example:<br>$\text{IN1} = 1,\ \text{IN2} = 0,\ \text{IN3…IN31} = 1,\ \text{SIGN} = 1$<br>$\text{OUT} = \underbrace{1}_{\text{SIGN}}\underbrace{111\ 1111\ 1111\ 1111\ 1111\ 1111\ 1111\ 1101}_{\text{IN31…IN1}}$ |
| **Input** | Sign input (SIGN): Boolean<br>Input (IN1…IN31): Boolean |
| **Output** | Output (OUT): DINT (31 bits + sign) |

## BOOL_TO_INT

### (10019)

**Illustration**



**Execution time** 5.00 µs

**Operation** The output (OUT) value is a 16-bit integer value formed from the boolean input (IN1…IN15 and SIGN) values. IN1 = bit 0 and IN15 = bit 14.

Example:

IN1…IN15 = 1, SIGN = 0

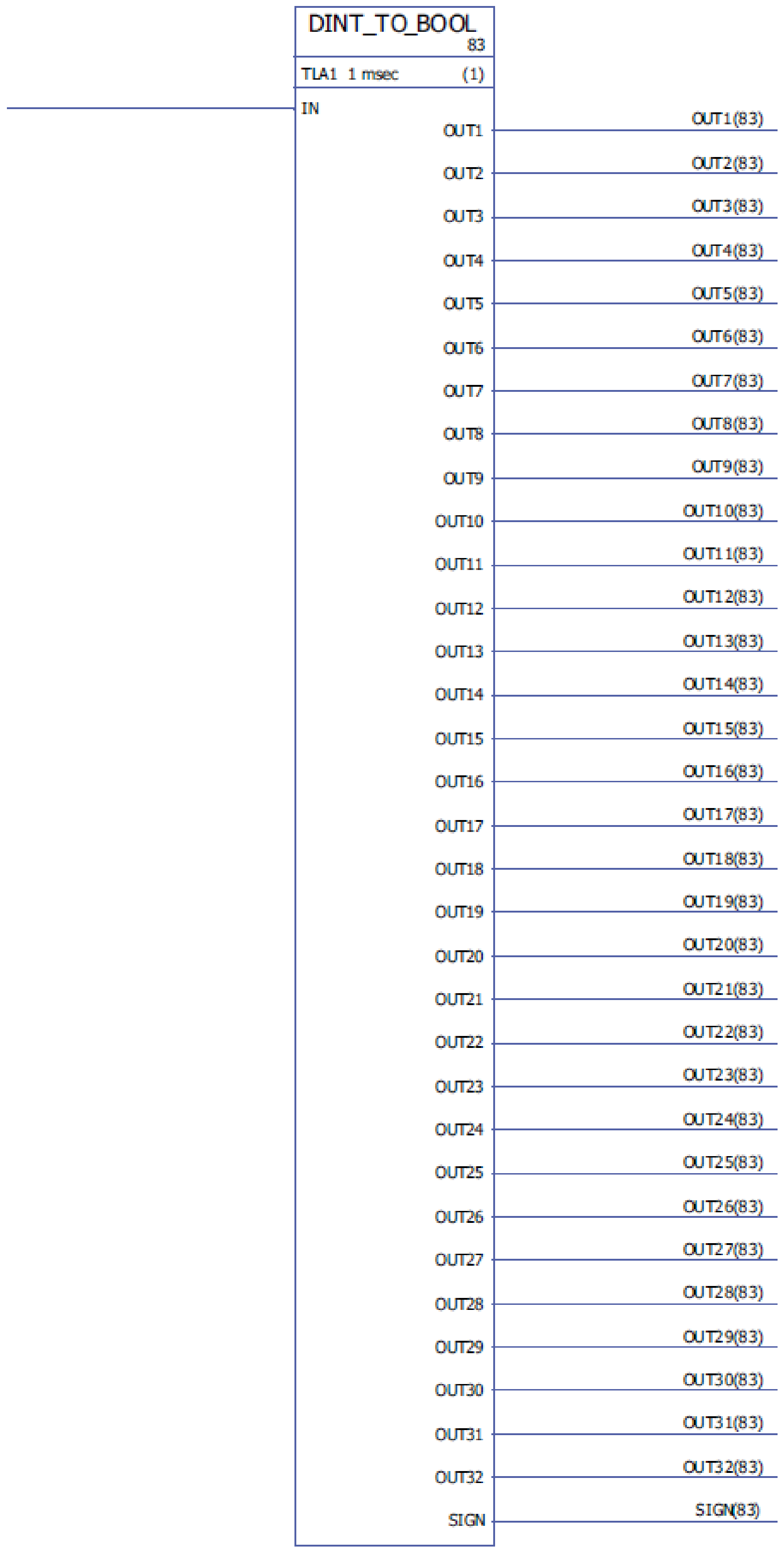
$$\text{OUT} = \underbrace{0}_{\text{SIGN}}\underbrace{111\ 1111\ 1111\ 1111}_{\text{IN15…IN1}}$$

|  |  |
|---|---|
| **Inputs** | Input (IN1…IN15): Boolean<br>Sign input (SIGN): Boolean |
| **Outputs** | Output (OUT): DINT (15 bits + sign) |

## DINT_TO_BOOL

**(10020)**

**Illustration**



**Execution time** 11.98 µs

**Operation** The boolean output (OUT1…OUT32) values are formed from the 32-bit integer input (IN) value.

Example:

$$\mathrm{IN} = \underbrace{\underbrace{0}_{\mathrm{SIGN}}\ 111\ 1111\ 1111\ 1111\ 1111\ 1111\ 1111\ 1100}_{\mathrm{OUT32...OUT1}}$$

**Inputs** Input (IN): DINT

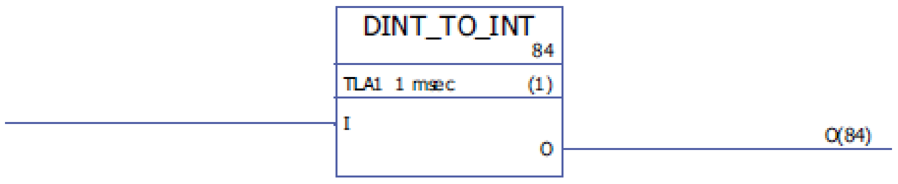
**Outputs** Output (OUT1…OUT32): Boolean

Sign output (SIGN): Boolean

## DINT_TO_INT

## (10021)

**Illustration**



**Execution time** 0.53 µs

**Operation** The output (O) value is a 16-bit integer value of the 32-bit integer input (I) value.

Examples:

| **I** (31 bits + sign) | **O** (15 bits + sign) |
|---|---|
| 2147483647 | 32767 |
| -2147483648 | -32767 |
| 0 | 0 |

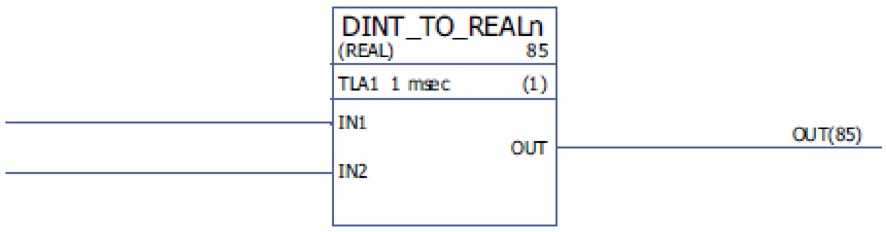
**Inputs** Input (I): DINT

**Outputs** Output (O): INT

## DINT_TO_REALn

### (10023)

**Illustration**

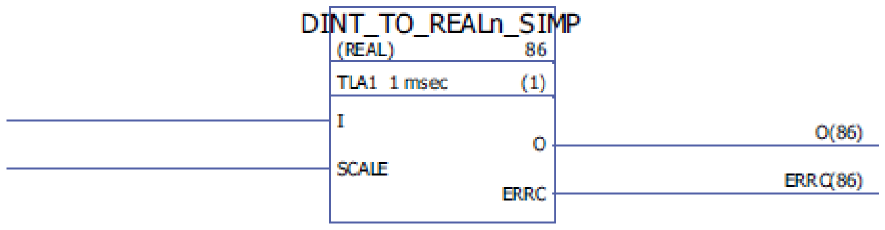


| | |
|---|---|
| **Execution time** | 7.25 µs |
| **Operation** | The output (OUT) is the REAL/REAL24 equivalent of the input (IN). Input IN1 is the integer value and input IN2 is the fractional value.<br>If one (or both) of the input values is negative, the output value is negative.<br>Example (from DINT to REAL):<br>When IN1 = 2 and IN2 = 3276, OUT = 2.04999.<br>The output value is limited to the maximum value of the selected data type range. |
| **Inputs** | Input (IN1, IN2): DINT |
| **Outputs** | The output data type is selected by the user.<br>Output (OUT): REAL, REAL24 |

## DINT_TO_REALn_SIMP

### (10022)

**Illustration**



| | |
|---|---|
| **Execution time** | 6.53 µs |

**Operation**

The output (O) is the REAL/REAL24 equivalent of the input (I) divided by the scale input (SCALE).

Error codes indicated at the error output (ERRC) are as follows:

| Error code | Description |
|---|---|
| 0 | No error |
| 1001 | The calculated REAL/REAL24 value exceeds the minimum value of the selected data type range. The output is set to the minimum value. |
| 1002 | The calculated REAL/REAL24 value exceeds the maximum value of the selected data type range. The output is set to the maximum value. |
| 1003 | The SCALE input is 0. The output is set to 0. |
| 1004 | Incorrect SCALE input, i.e. the scale input is < 0 or is not a factor of 10. |

Example (from DINT to REAL24):

When I = 205 and SCALE = 100, I/SCALE = 205 /100 = 2.05 and O = 2.04999.

**Inputs**

Input (I): DINT

Scale input (SCALE): DINT

**Outputs**

The output data type is selected by the user.

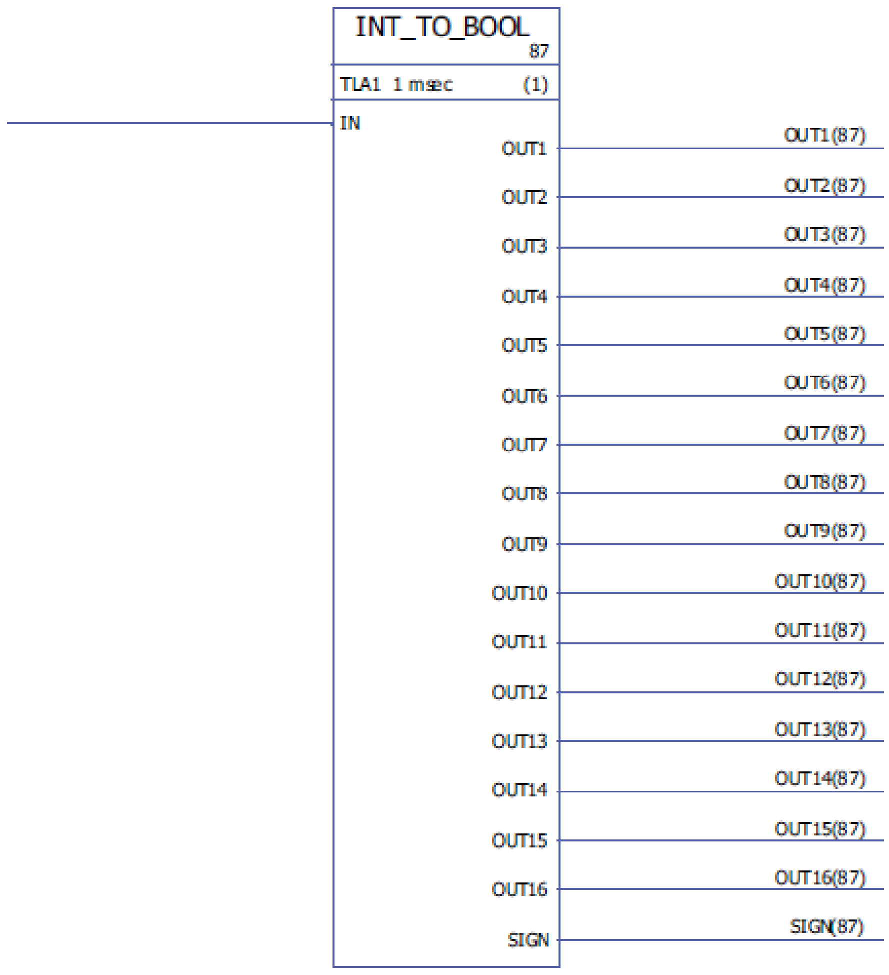
Output (O): REAL, REAL24

Error output (ERRC): DINT

## INT_TO_BOOL

### (10024)

**Illustration**



**Execution time** 4.31 µs

**Operation** The boolean output (OUT1…OUT16) values are formed from the 16-bit integer input (IN) value.

Example:

$$\text{IN} = \underbrace{\underbrace{0}_{\text{SIGN}}111\ 1111\ 1111\ 1111}_{\text{OUT16...OUT1}}$$

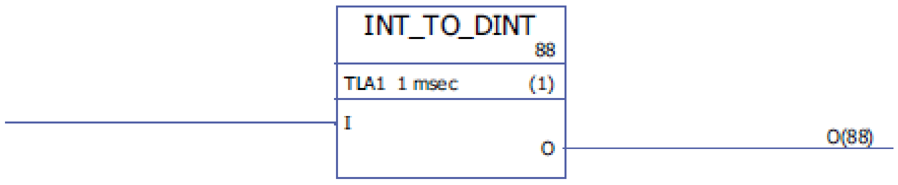
**Inputs** Input (IN): INT

**Outputs** Output (OUT1…OUT16): Boolean
Sign output (SIGN): Boolean

## INT_TO_DINT

### (10025)

**Illustration**



**Execution time** 0.33 µs

**Operation** The output (O) value is a 32-bit integer value of the 16-bit integer input (I) value.

| I | O |
|---|---|
| 32767 | 32767 |
| -32767 | -32767 |
| 0 | 0 |

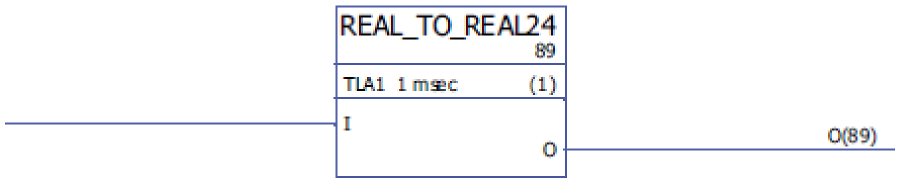
**Inputs** Input (I): INT

**Outputs** Output (O): DINT

## REAL_TO_REAL24

### (10026)

**Illustration**



**Execution time** 1.35 µs

**Operation** Output (O) is the REAL24 equivalent of the REAL input (I).

The output value is limited to the maximum value of the data type.

Example:

$$I = \underbrace{0000\ 0000\ 0010\ 0110}_{\text{Integer value}}\ \underbrace{1111\ 1111\ 1111\ 1111}_{\text{Fractional value}}$$

$$O = \underbrace{0010\ 0110}_{\text{Integer value}}\ \underbrace{1111\ 1111\ 1111\ 1111\ 0000\ 0000}_{\text{Fractional value}}$$

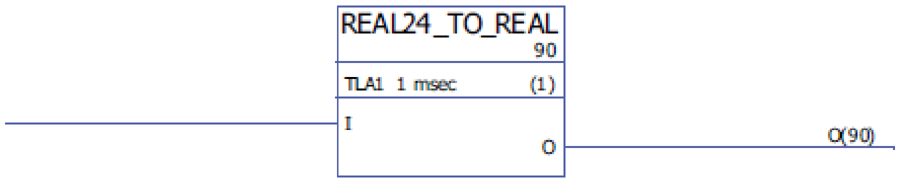
**Inputs** Input (I): REAL

**Outputs** Output (O): REAL24

## REAL24_TO_REAL

### (10027)

**Illustration**



**Execution time** 1.20 µs

**Operation** Output (O) is the REAL equivalent of the REAL24 input (I).

The output value is limited to the maximum value of the data type range.

Example:

$$I = \underbrace{0010\ 0110}_{\text{Integer value}}\ \underbrace{1111\ 1111\ 1111\ 1111\ 0000\ 0000}_{\text{Fractional value}}$$

$$O = \underbrace{0000\ 0000\ 0010\ 0110}_{\text{Integer value}}\ \underbrace{1111\ 1111\ 1111\ 1111}_{\text{Fractional value}}$$

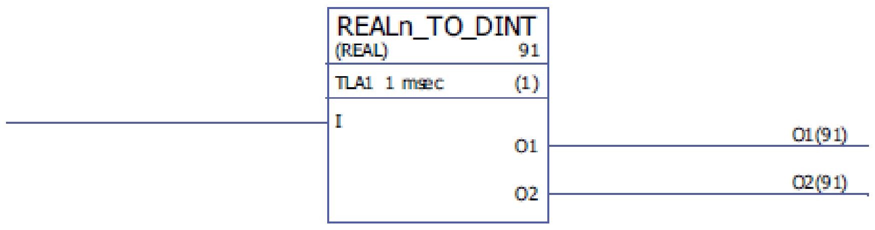
**Inputs** Input (I): REAL24

**Outputs** Output (O): REAL

## REALn_TO_DINT

### (10029)

**Illustration**



**Execution time** 6.45 µs

**Operation** Output (O) is the 32-bit integer equivalent of the REAL/REAL24 input (I). Output O1 is the integer value and output O2 is the fractional value.

The output value is limited to the maximum value of the data type range.

Example (from REAL to DINT):

When I = 2.04998779297, O1 = 2 and O2 = 3276.

**Inputs** The input data type is selected by the user.

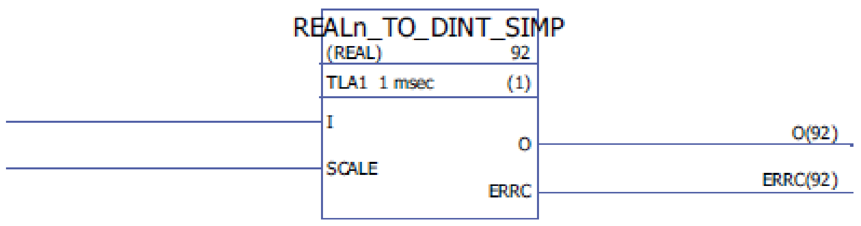
Input (I): REAL, REAL24

**Outputs** Output (O1, O2): DINT

## REALn_TO_DINT_SIMP

### (10028)

**Illustration**



**Execution time** 5.54 µs

**Operation**

Output (O) is the 32-bit integer equivalent of the REAL/REAL24 input (I) multiplied by the scale input (SCALE).

Error codes are indicated by the error output (ERRC) as follows:

| Error code | Description |
|---|---|
| 0 | No error |
| 1001 | The calculated integer value exceeds the minimum value. The output is set to the minimum value. |
| 1002 | The calculated integer value exceeds the maximum value. The output is set to the maximum value. |
| 1003 | Scale input is 0. The output is set to 0. |
| 1004 | Incorrect scale input, i.e. scale input is < 0 or is not a factor of 10. |

Example (from REAL to DINT):

When I = 2.04998779297and SCALE = 100, O = 204.

**Inputs**

The input data type is selected by the user.

Input (I): REAL, REAL24

Scale input (SCALE): DINT

**Outputs**

Output (O): DINT

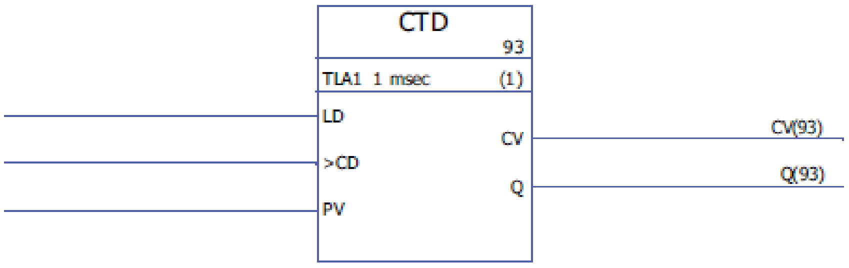
Error output (ERRC): DINT

## Counters

### CTD

### (10047)

**Illustration**



**Execution time** 0.92 µs

**Operation** The counter output (CV) value is decreased by 1 if the counter input (CD) value changes from 0 -> 1 and the load input (LD) value is 0. If the load input value is 1, the preset input (PV) value is stored as the counter output (CV) value. If the counter output has reached its minimum value -32768, the counter output remains unchanged.

The status output (Q) is 1 if the counter output (CV) value $\leq$ 0.

Example:

| LD | CD | PV | Q | $CV_{prev}$ | CV |
|---|---|---|---|---|---|
| 0 | 1 -> 0 | 10 | 0 | 5 | 5 |
| 0 | 0 -> 1 | 10 | 0 | 5 | 5 - 1 = 4 |
| 1 | 1 -> 0 | -2 | 1 | 4 | -2 |
| 1 | 0 -> 1 | 1 | 0 | -2 | 1 |
| 0 | 0 -> 1 | 5 | 1 | 1 | 1 -1 = 0 |
| 1 | 1 -> 0 | -32768 | 1 | 0 | -32768 |
| 0 | 0 -> 1 | 10 | 1 | -32768 | -32768 |
| $CV_{prev}$ is the previous cycle counter output value. | | | | | |

**Inputs** Load input (LD): Boolean

Counter input (CD): Boolean

Preset input (PV): INT

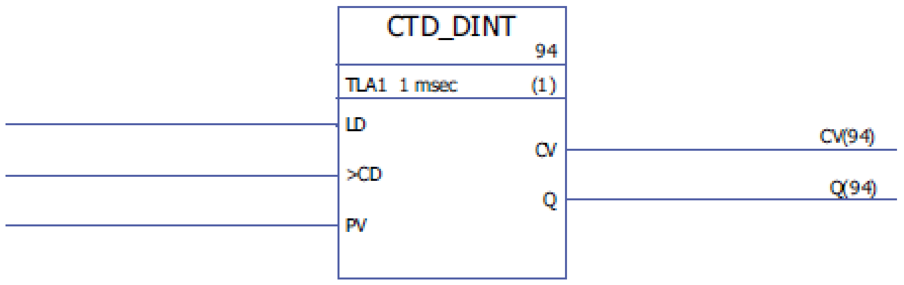
**Outputs** Counter output (CV): INT

Status output (Q): Boolean

## CTD_DINT

## (10046)

**Illustration**



**Execution time** 0.92 µs

**Operation**

The counter output (CV) value is decreased by 1 if the counter input (CD) value changes from 0 -> 1 and the load input (LD) value is 0. If the load input (LD) value is 1, the preset input (PV) value is stored as the counter output (CV) value. If the counter output has reached its minimum value -2147483648, the counter output remains unchanged.

The status output (Q) is 1 if the counter output (CV) value $\leq$ 0.

Example:

| LD | CD | PV | Q | $CV_{prev}$ | CV |
|---|---|---|---|---|---|
| 0 | 1 -> 0 | 10 | 0 | 5 | 5 |
| 0 | 0 -> 1 | 10 | 0 | 5 | 5 - 1 = 4 |
| 1 | 1 -> 0 | -2 | 1 | 4 | -2 |
| 1 | 0 -> 1 | 1 | 0 | -2 | 1 |
| 0 | 0 -> 1 | 5 | 1 | 1 | 1 -1 = 0 |
| 1 | 1 -> 0 | -2147483648 | 1 | 0 | -2147483648 |
| 0 | 0 -> 1 | 10 | 1 | -2147483648 | -2147483648 |
| $CV_{prev}$ is the previous cycle counter output value. | | | | | |

**Inputs**

Load input (LD): Boolean

Counter input (CD): Boolean

Preset input (PV): DINT

**Outputs**

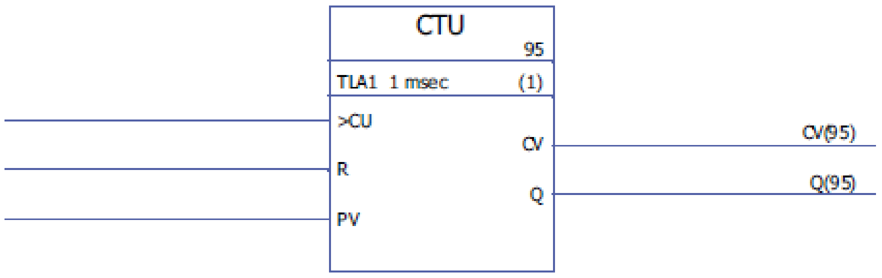
Counter output (CV): DINT

Status output (Q): Boolean

## CTU

## (10049)

**Illustration**



**Execution time**

0.92 µs

**Operation**

The counter output (CV) value is increased by 1 if the counter input (CU) value changes from 0 -> 1 and the reset input (R) value is 0. If the counter output has reached its maximum value 32767, the counter output remains unchanged.

The counter output (CV) is reset to 0 if the reset input (R) is 1.

The status output (Q) is 1 if the counter output (CV) value ≥ preset input (PV) value.

Example:

| R | CU | PV | Q | $CV_{prev}$ | CV |
|---|---|---|---|---|---|
| 0 | 1 -> 0 | 20 | 0 | 10 | 10 |
| 0 | 0 -> 1 | 11 | 1 | 10 | 10 + 1 = 11 |
| 1 | 1 -> 0 | 20 | 0 | 11 | 0 |
| 1 | 0 -> 1 | 5 | 0 | 0 | 0 |
| 0 | 0 -> 1 | 20 | 0 | 0 | 0 + 1 = 1 |
| 0 | 0 -> 1 | 30 | 1 | 32767 | 32767 |
| $CV_{prev}$ is the previous cycle counter output value. | | | | | |

**Inputs**

Counter input (CU): Boolean

Reset input (R): Boolean

Preset input (PV): INT

**Outputs**

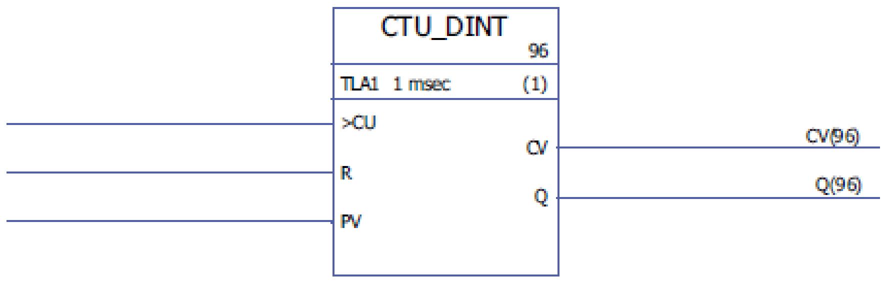
Counter output (CV): INT

Status output (Q): Boolean

## CTU_DINT

### (10048)

**Illustration**



**Execution time** 0.92 µs

**Operation**

The counter output (CV) value is increased by 1 if the counter input (CU) value changes from 0 -> 1 and the reset input (R) value is 0. If the counter output has reached its maximum value 2147483647, the counter output remains unchanged.

The counter output (CV) is reset to 0 if the reset input (R) is 1.

The status output (Q) is 1 if the counter output (CV) value ≥ preset input (PV) value.

Example:

| R | CU | PV | Q | $CV_{prev}$ | CV |
|---|---|---|---|---|---|
| 0 | 1 -> 0 | 20 | 0 | 10 | 10 |
| 0 | 0 -> 1 | 11 | 1 | 10 | 10 + 1 = 11 |
| 1 | 1 -> 0 | 20 | 0 | 11 | 0 |
| 1 | 0 -> 1 | 5 | 0 | 0 | 0 |
| 0 | 0 -> 1 | 20 | 0 | 0 | 0 + 1 = 1 |
| 0 | 0 -> 1 | 30 | 1 | 2147483647 | 2147483647 |
| $CV_{prev}$ is the previous cycle counter output value. | | | | | |

**Inputs**

Counter input (CU): Boolean

Reset input (R): Boolean

Preset input (PV): DINT

**Outputs**

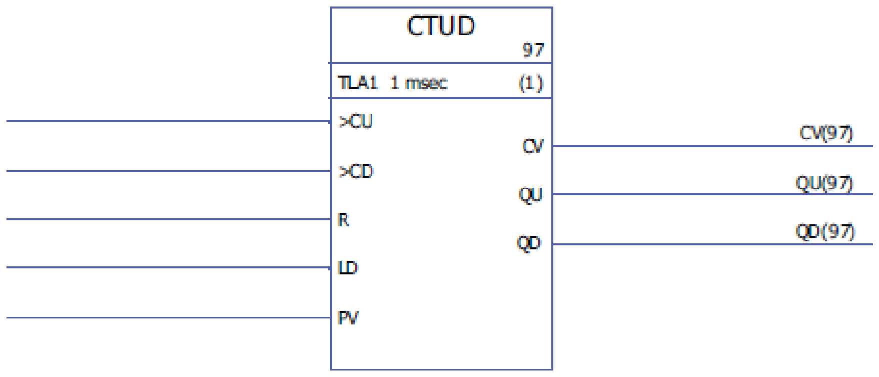
Counter output (CV): DINT

Status output (Q): Boolean

## CTUD

### (10051)

**Illustration**



| | |
|---|---|
| **Execution time** | 1.40 µs |

**Operation**

The counter output (CV) value is increased by 1 if the counter input (CU) value changes from 0 -> 1 and the reset input (R) is 0 and the load input (LD) is 0.

The counter output (CV) value is decreased by 1 if the counter input (CD) changes from 0 -> 1 and the load input (LD) is 0 and the reset input (R) is 0.

If the load input (LD) is 1, the preset input (PV) value is stored as the counter output (CV) value.

The counter output (CV) is reset to 0 if the reset input (R) is 1.

If the counter output has reached its minimum or maximum value, -32768 or +32767, the counter output remains unchanged until it is reset (R) or until the load input (LD) is set to 1.

The up counter status output (QU) is 1 if the counter output (CV) value $\geq$ preset input (PV) value.

The down counter status output (QD) is 1 if the counter output (CV) value $\leq$ 0.

Example:

| **CU** | **CD** | **R** | **LD** | **PV** | **QU** | **QD** | **$CV_{prev}$** | **CV** |
|---|---|---|---|---|---|---|---|---|
| 0 -> 0 | 0 -> 0 | 0 | 0 | 2 | 0 | 1 | 0 | 0 |
| 0 -> 0 | 0 -> 0 | 0 | 1 | 2 | 1 | 0 | 0 | 2 |
| 0 -> 0 | 0 -> 0 | 1 | 0 | 2 | 0 | 1 | 2 | 0 |
| 0 -> 0 | 0 -> 0 | 1 | 1 | 2 | 0 | 1 | 0 | 0 |
| 0 -> 0 | 0 -> 1 | 0 | 0 | 2 | 0 | 1 | 0 | 0 - 1 = -1 |
| 0 -> 0 | 1 -> 1 | 0 | 1 | 2 | 1 | 0 | -1 | 2 |
| 0 -> 0 | 1 -> 1 | 1 | 0 | 2 | 0 | 1 | 2 | 0 |
| 0 -> 0 | 1 -> 1 | 1 | 1 | 2 | 0 | 1 | 0 | 0 |
| 0 -> 1 | 1 -> 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 + 1 = 1 |
| 1 -> 1 | 0 -> 0 | 0 | 1 | 2 | 1 | 0 | 1 | 2 |
| 1 -> 1 | 0 -> 0 | 1 | 0 | 2 | 0 | 1 | 2 | 0 |
| 1 -> 1 | 0 -> 0 | 1 | 1 | 2 | 0 | 1 | 0 | 0 |
| 1 -> 1 | 0 -> 1 | 0 | 0 | 2 | 0 | 1 | 0 | 0 - 1 = -1 |
| 1 -> 1 | 1 -> 1 | 0 | 1 | 2 | 1 | 0 | -1 | 2 |
| 1 -> 1 | 1 -> 1 | 1 | 0 | 2 | 0 | 1 | 2 | 0 |
| 1 -> 1 | 1 -> 1 | 1 | 1 | 2 | 0 | 1 | 0 | 0 |
| $CV_{prev}$ is the previous cycle counter output value. | | | | | | | | |

**Inputs**

Up counter input (CU): Boolean

Down counter input (CD): Boolean

Reset input (R): Boolean

Load input (LD): Boolean

Preset input (PV): INT

**Outputs**

Counter output (CV): INT

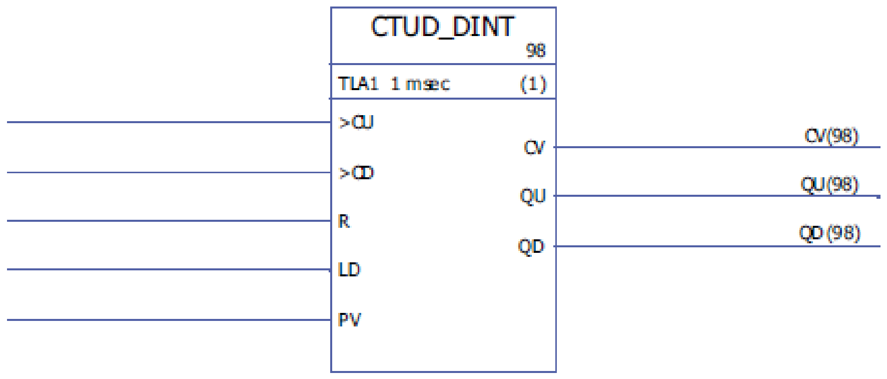
Up counter status output (QU): Boolean

Down counter status output (QD): Boolean

## CTUD_DINT

### (10050)

**Illustration**



**Execution time** 1.40 µs

**Operation**

The counter output (CV) value is increased by 1 if the counter input (CU) changes from 0 -> 1 and the reset input (R) is 0 and the load input (LD) is 0.

The counter output (CV) value is decreased by 1 if the counter input (CD) changes from 0 -> 1 and the load input (LD) is 0 and the reset input (R) is 0.

If the counter output has reached its minimum or maximum value, -2147483648 or +2147483647, the counter output remains unchanged until it is reset (R) or until the load input (LD) is set to 1.

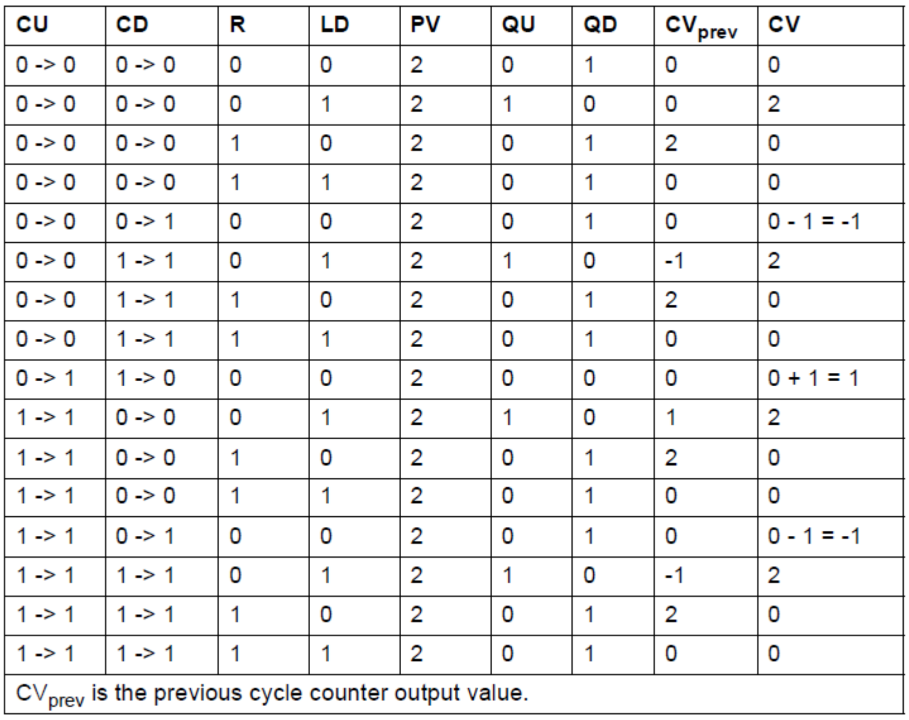
If the load input (LD) value is 1, the preset input (PV) value is stored as the counter output (CV) value.

The counter output (CV) is reset to 0 if the reset input (R) is 1.

The up counter status output (QU) is 1 if the counter output (CV) value $\geq$ preset input (PV) value.

The down counter status output (QD) is 1 if the counter output (CV) value $\leq$ 0.

Example:



| CU | CD | R | LD | PV | QU | QD | $CV_{prev}$ | CV |
|---|---|---|---|---|---|---|---|---|
| 0 -> 0 | 0 -> 0 | 0 | 0 | 2 | 0 | 1 | 0 | 0 |
| 0 -> 0 | 0 -> 0 | 0 | 1 | 2 | 1 | 0 | 0 | 2 |
| 0 -> 0 | 0 -> 0 | 1 | 0 | 2 | 0 | 1 | 2 | 0 |
| 0 -> 0 | 0 -> 0 | 1 | 1 | 2 | 0 | 1 | 0 | 0 |
| 0 -> 0 | 0 -> 1 | 0 | 0 | 2 | 0 | 1 | 0 | 0 - 1 = -1 |
| 0 -> 0 | 1 -> 1 | 0 | 1 | 2 | 1 | 0 | -1 | 2 |
| 0 -> 0 | 1 -> 1 | 1 | 0 | 2 | 0 | 1 | 2 | 0 |
| 0 -> 0 | 1 -> 1 | 1 | 1 | 2 | 0 | 1 | 0 | 0 |
| 0 -> 1 | 1 -> 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 + 1 = 1 |
| 1 -> 1 | 0 -> 0 | 0 | 1 | 2 | 1 | 0 | 1 | 2 |
| 1 -> 1 | 0 -> 0 | 1 | 0 | 2 | 0 | 1 | 2 | 0 |
| 1 -> 1 | 0 -> 0 | 1 | 1 | 2 | 0 | 1 | 0 | 0 |
| 1 -> 1 | 0 -> 1 | 0 | 0 | 2 | 0 | 1 | 0 | 0 - 1 = -1 |
| 1 -> 1 | 1 -> 1 | 0 | 1 | 2 | 1 | 0 | -1 | 2 |
| 1 -> 1 | 1 -> 1 | 1 | 0 | 2 | 0 | 1 | 2 | 0 |
| 1 -> 1 | 1 -> 1 | 1 | 1 | 2 | 0 | 1 | 0 | 0 |

$CV_{prev}$ is the previous cycle counter output value.

**Inputs**

Up counter input (CU): Boolean

Down counter input (CD): Boolean

Reset input (R): Boolean

Load input (LD): Boolean

Preset input (PV): DINT

**Outputs**

Counter output (CV): DINT

Up counter status output (QU): Boolean

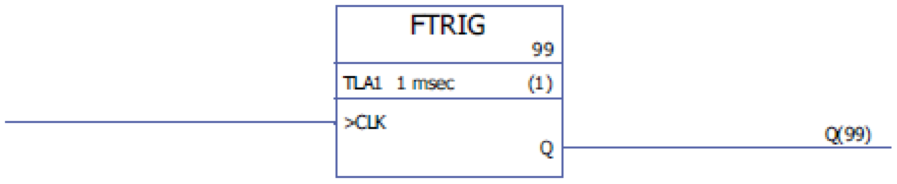
Down counter status output (QD): Boolean

## Edge & bistable

### FTRIG

### (10030)

**Illustration**



**Execution time** 0.38 µs

**Operation** The output (Q) is set to 1 when the clock input (CLK) changes from 1 to 0. The output is set back to 0 with the next execution of the block. Otherwise the output is 0.

| $CLK_{previous}$ | CLK | Q |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 1 (for one execution cycle time, returns to 0 at the next execution) |
| 1 | 1 | 0 |
| $CLK_{previous}$ is the previous cycle output value. | | |

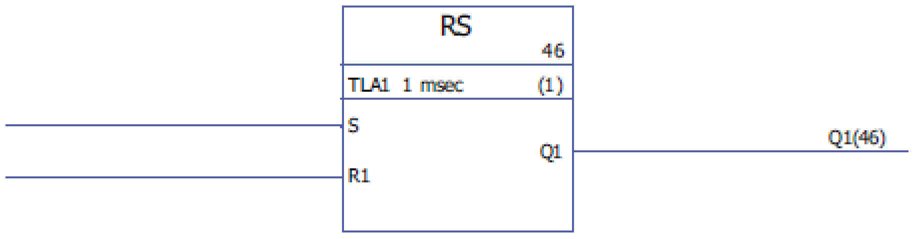
**Inputs** Clock input (CLK): Boolean

**Outputs** Output (Q): Boolean

## RS

## (10032)

**Illustration**



**Execution time** 0.38 µs

**Operation** The output (Q1) is 1 if the set input (S) is 1 and the reset input (R1) is 0. The output will retain the previous output state if the set input (S) and the reset input (R1) are 0. The output is 0 if the reset input is 1.

Truth table:

| S | R | $Q1_{previous}$ | Q1 |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 |
| 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 |
| 1 | 0 | 0 | 1 |
| 1 | 0 | 1 | 1 |
| 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 0 |
| $Q_{previous}$ is the previous cycle output value. | | | |

**Inputs** Set input (S): Boolean

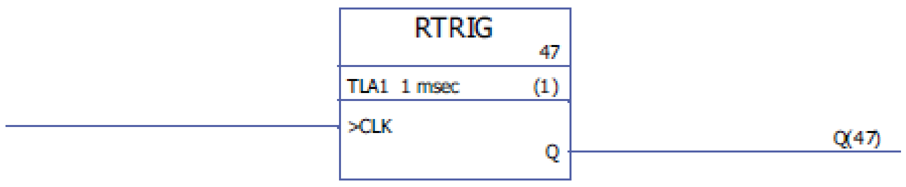
Reset input (R1): Boolean

**Outputs** Output (Q1): Boolean

## RTRIG

### (10031)

**Illustration**



**Execution time** 0.38 µs

**Operation** The output (Q) is set to 1 when the clock input (CLK) changes from 0 to 1. The output is set back to 0 with the next execution of the block. Otherwise the output is 0.

| $CLK_{previous}$ | CLK | Q |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 0 |
| 1 | 1 | 0 |
| $CLK_{previous}$ is the previous cycle output value. | | |

**Note:** The output (Q) is 1 after the first execution of the block after cold restart when the clock input (CLK) is 1. Otherwise the output is always 0 when the clock input is 1.

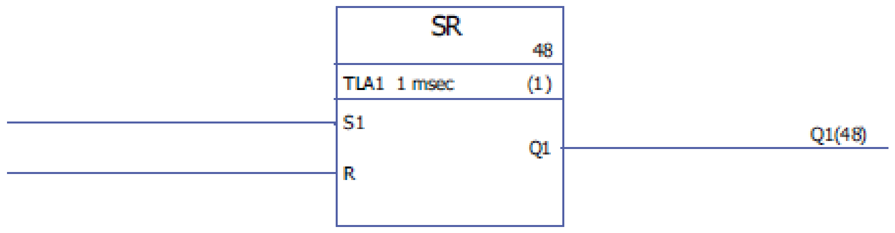
**Inputs** Clock input (CLK): Boolean

**Outputs** Output (Q): Boolean

## SR

## (10033)

**Illustration**



**Execution time** 0.38 µs

**Operation** The output (Q1) is 1 if the set input (S1) is 1. The output will retain the previous output state if the set input (S1) and the reset input (R) are 0. The output is 0 if the set input is 0 and the reset input is 1.

Truth table:

| S1 | R | $Q1_{previous}$ | Q1 |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 |
| 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 |
| 1 | 0 | 0 | 1 |
| 1 | 0 | 1 | 1 |
| 1 | 1 | 0 | 1 |
| 1 | 1 | 1 | 1 |
| $Q1_{previous}$ is the previous cycle output value. | | | |

**Inputs** Set input (S1): Boolean

Reset input (R): Boolean

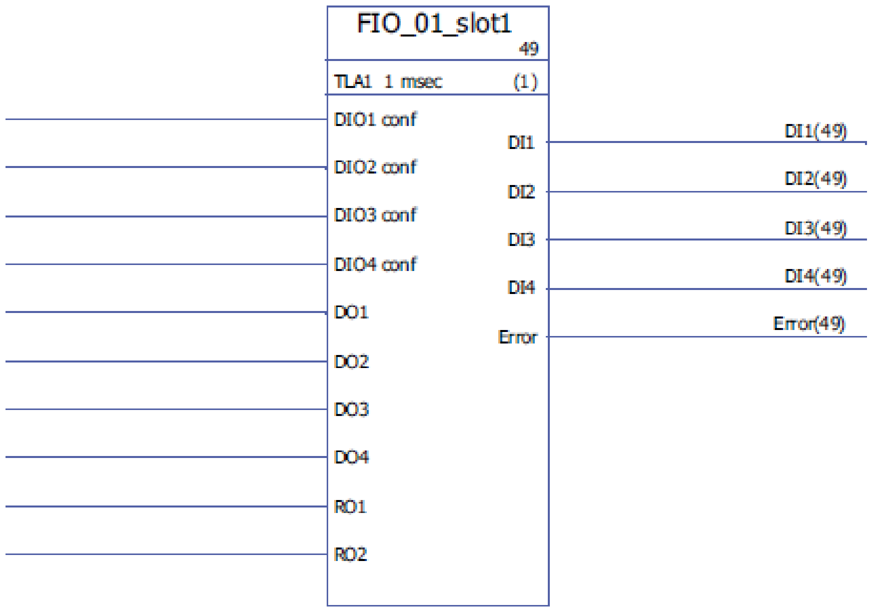
**Outputs** Output (Q1): Boolean

## Extensions

### FIO_01_slot1

### (10084)

**Illustration**



**Execution time** 8.6 µs

**Operation** The block controls the four digital inputs/outputs (DIO1…DIO4) and two relay outputs (RO1, RO2) of a FIO01 Digital I/O Extension mounted on slot 1 of the drive control unit.

The state of a DIOx conf input of the block determines whether the corresponding DIO on the FIO01 is an input or an output (0 = input, 1 = output). If the DIO is an output, the DOx input of the block defines its state.

The RO1 and RO2 inputs define the state of the relay outputs of the FIO01 (0 = not energised, 1 = energised).

The DIx outputs show the state of the DIOs.

**Inputs** Digital input/output mode selection (DIO1 conf … DIO4 conf): Boolean

Digital output state selection (DO1…DO4): Boolean

Relay output state selection (RO1, RO2): Boolean

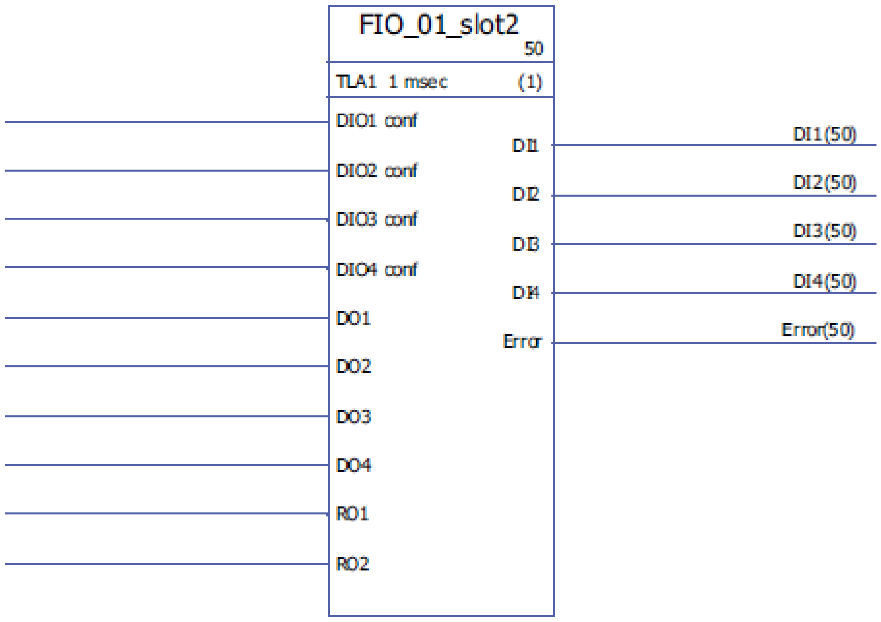
**Outputs** Digital input/output state (DI1…DI4): Boolean

Error output (Error): DINT (0 = No error; 1 = Application program memory full)

## FIO_01_slot2

### (10085)

**Illustration**

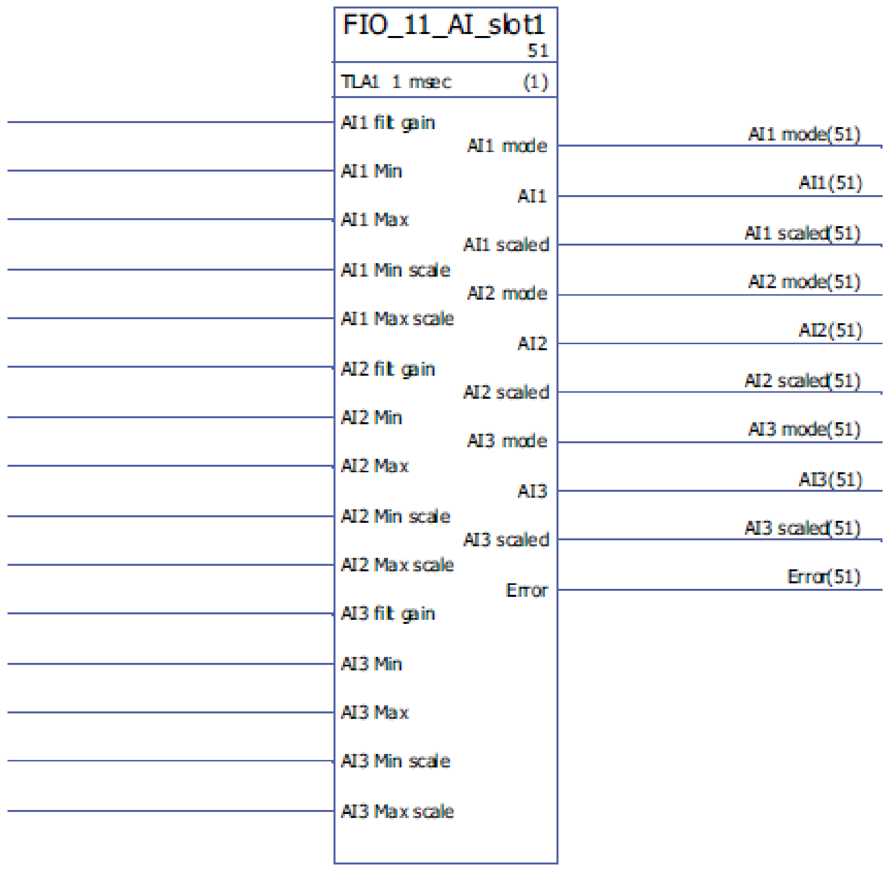


| | |
|---|---|
| **Execution time** | 8.6 µs |
| **Operation** | The block controls the four digital inputs/outputs (DIO1…DIO4) and two relay outputs (RO1, RO2) of a FIO01 Digital I/O Extension mounted on slot 2 of the drive control unit.<br>The state of a DIOx conf input of the block determines whether the corresponding DIO on the FIO01 is an input or an output (0 = input, 1 = output). If the DIO is an output, the DOx input of the block defines its state.<br>The RO1 and RO2 inputs define the state of the relay outputs of the FIO01 (0 = not energised, 1 = energised).<br>The DIx outputs show the state of the DIOs. |
| **Inputs** | Digital input/output mode selection (DIO1 conf … DIO4 conf): Boolean<br>Digital output state selection (DO1…DO4): Boolean<br>Relay output state selection (RO1, RO2): Boolean |
| **Outputs** | Digital input/output state (DI1…DI4): Boolean<br>Error output (Error): DINT (0 = No error; 1 = Application program memory full) |

## FIO_11_AI_slot1

## (10088)

**Illustration**



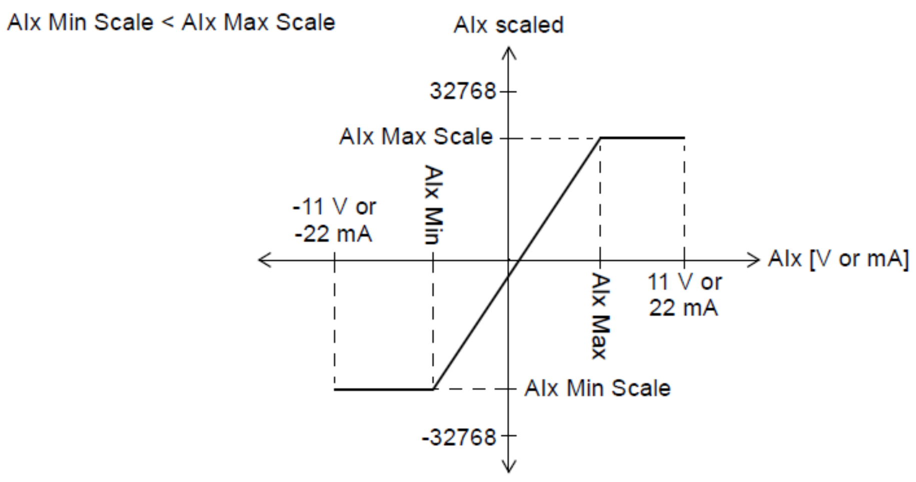
**Execution time** 11.1 µs

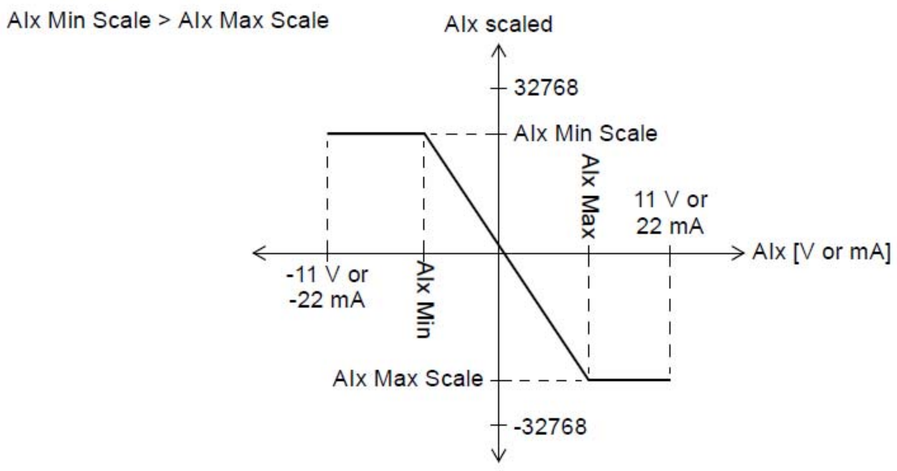
**Operation**

The block controls the three analogue inputs (AI1…AI3) of a FIO11 Analog I/O Extension mounted on slot 1 of the drive control unit.

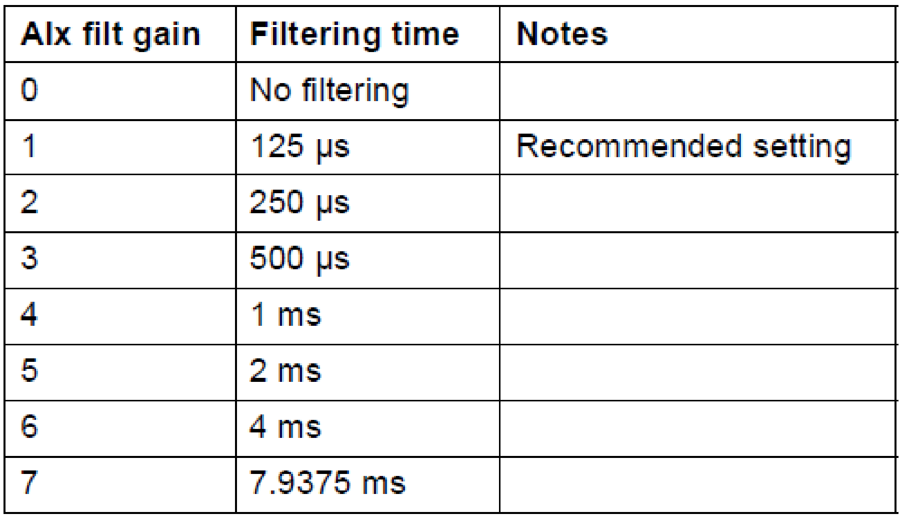
The block outputs both the unscaled (AIx) and scaled (AIx scaled) actual values of each analogue input. The scaling is based on the relationship between the ranges AIx min … AIx max and AIx min scale … AIx max scale.

AIx Min must be smaller than AIx Max; AIx Max Scale can be greater or smaller than AIx Min Scale.





The AIx filt gain inputs determine a filtering time for each input as follows:



| AIx filt gain | Filtering time | Notes |
|---|---|---|
| 0 | No filtering | |
| 1 | 125 µs | Recommended setting |
| 2 | 250 µs | |
| 3 | 500 µs | |
| 4 | 1 ms | |
| 5 | 2 ms | |
| 6 | 4 ms | |
| 7 | 7.9375 ms | |

The AIx mode outputs show whether the corresponding input is voltage (0) or current (1). The voltage/current selection is made using the hardware switches on the FIO11.

**Inputs**

Analogue input filter gain selection (AI1 filt gain … AI3 filt gain): INT

Minimum value of input signal (AI1 Min … AI3 Min): REAL (≥ 11 V or 22 mA)

Maximum value of input signal (AI1 Max … AI3 Max): REAL (≤ 11 V or 22 mA)

Minimum value of scaled output signal (AI1 Min scale … AI3 Min scale): REAL

Maximum value of scaled output signal (AI1 Max scale … AI3 Max scale): REAL

**Outputs**

Analogue input mode (voltage or current) (AI1 mode … AI3 mode): Boolean

Value of analogue input (AI1 … AI3): REAL

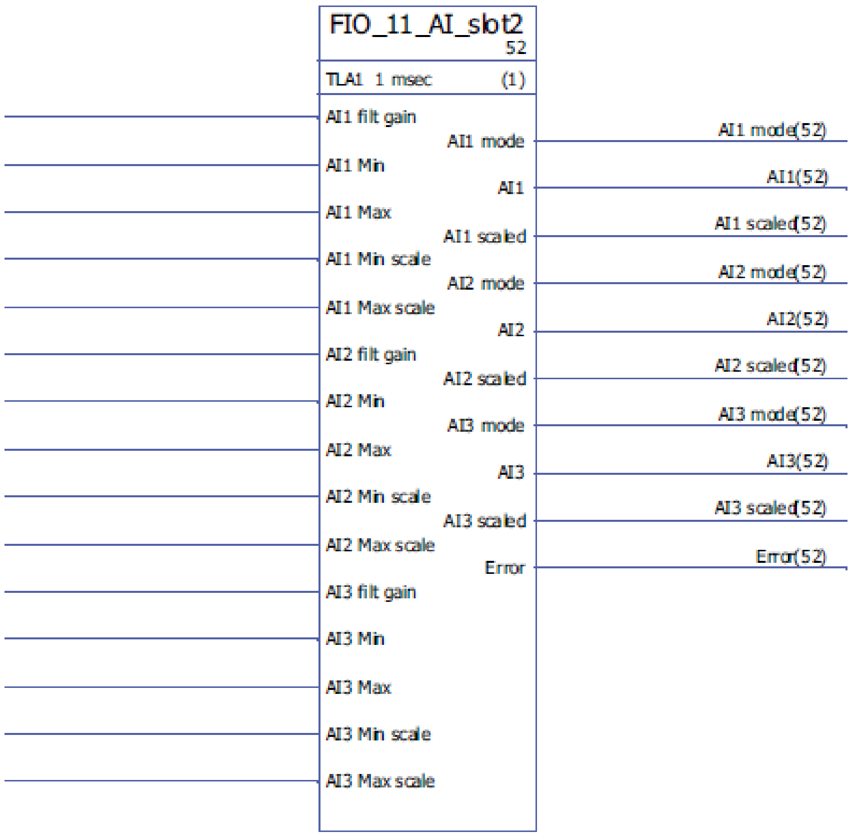
Scaled value of analogue input (AI1 scaled … AI3 scaled): REAL

Error output (Error): DINT (0 = No error; 1 = Application program memory full)

## FIO_11_AI_slot2

### (10089)

**Illustration**



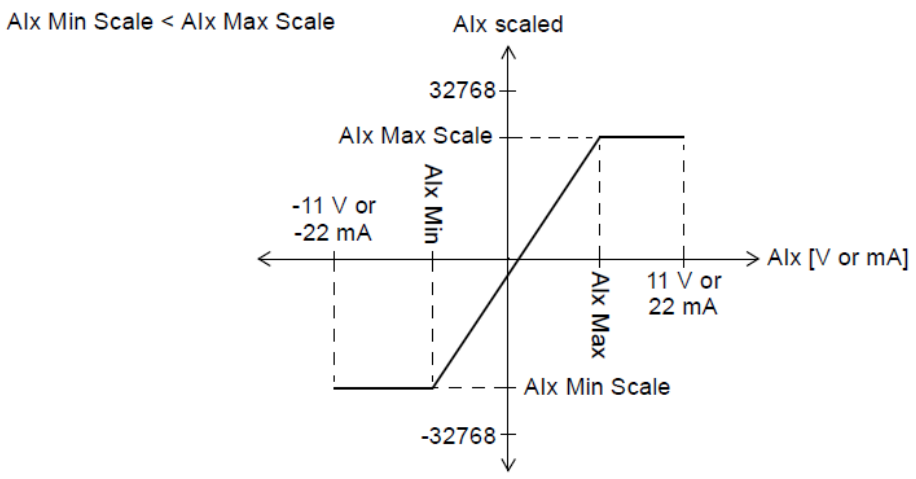
**Execution time** 11.1 µs

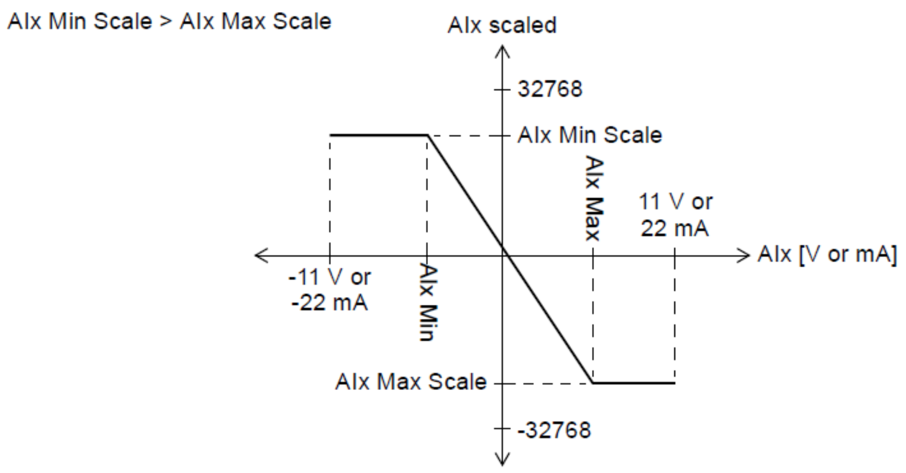
**Operation**

The block controls the three analogue inputs (AI1…AI3) of a FIO11 Analog I/O Extension mounted on slot 2 of the drive control unit.

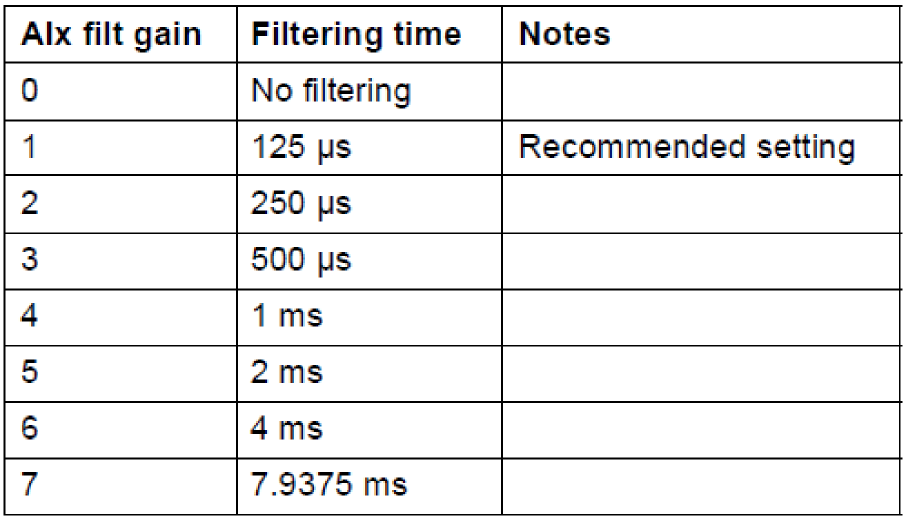
The block outputs both the unscaled (AIx) and scaled (AIx scaled) actual values of each analogue input. The scaling is based on the relationship between the ranges AIx min … AIx max and AIx min scale … AIx max scale.

AIx Min must be smaller than AIx Max; AIx Max Scale can be greater or smaller than AIx Min Scale.





The AIx filt gain inputs determine a filtering time for each input as follows:



| AIx filt gain | Filtering time | Notes |
|---|---|---|
| 0 | No filtering | |
| 1 | 125 µs | Recommended setting |
| 2 | 250 µs | |
| 3 | 500 µs | |
| 4 | 1 ms | |
| 5 | 2 ms | |
| 6 | 4 ms | |
| 7 | 7.9375 ms | |

The AIx mode outputs show whether the corresponding input is voltage (0) or current (1). The voltage/current selection is made using the hardware switches on the FIO11.

**Inputs**

Analogue input filter gain selection (AI1 filt gain … AI3 filt gain): INT
Minimum value of input signal (AI1 Min … AI3 Min): REAL (≥ 11 V or 22 mA)
Maximum value of input signal (AI1 Max … AI3 Max): REAL (≤ 11 V or 22 mA)
Minimum value of scaled output signal (AI1 Min scale … AI3 Min scale): REAL
Maximum value of scaled output signal (AI1 Max scale … AI3 Max scale): REAL

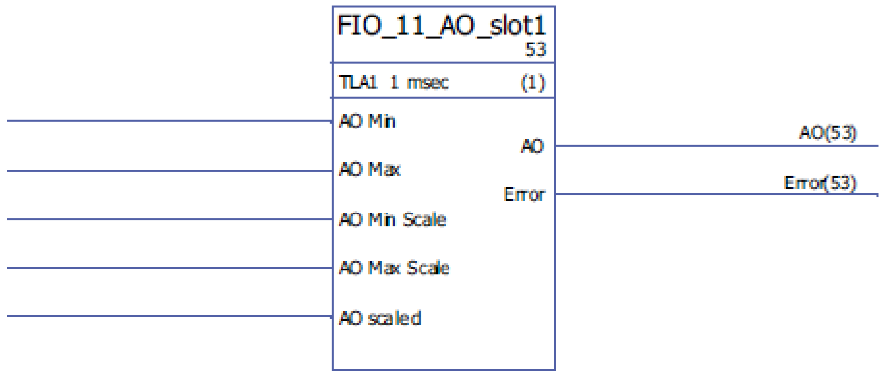
**Outputs**

Analogue input mode (voltage or current) (AI1 mode … AI3 mode): Boolean
Value of analogue input (AI1 … AI3): REAL
Scaled value of analogue input (AI1 scaled … AI3 scaled): REAL
Error output (Error): DINT (0 = No error; 1 = Application program memory full)

## FIO_11_AO_slot1

### (10090)

**Illustration**



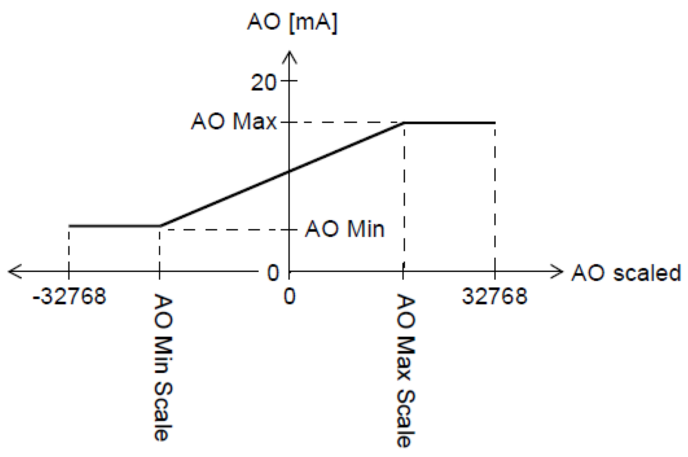
**Execution time** 4.9 µs

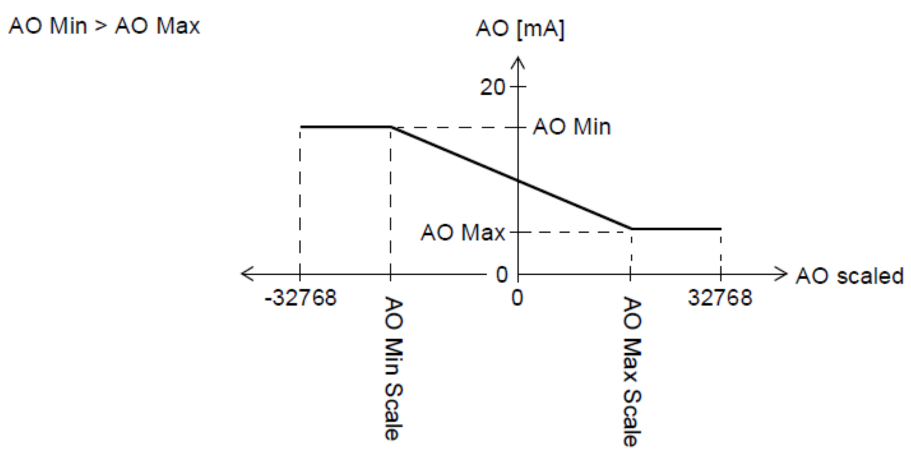
**Operation** The block controls the analogue output (AO1) of a FIO11 Analog I/O Extension mounted on slot 1 of the drive control unit.

The block converts the input signal (AO scaled) to a 0…20 mA signal (AO) that drives the analogue output; the input range AO Min Scale … AO Max Scale corresponds to the current signal range of AO Min … AO Max.

AO Min Scale must be smaller than AO Max Scale; AO Max can be greater or smaller than AO Min.

AO Min < AO Max





**Inputs**

Minimum current signal (AO Min): REAL (0…20 mA)
Maximum current signal (AO Max): REAL (0…20 mA)
Minimum input signal (AO Min Scale): REAL
Maximum input signal (AO Max Scale): REAL
Input signal (AO scaled): REAL

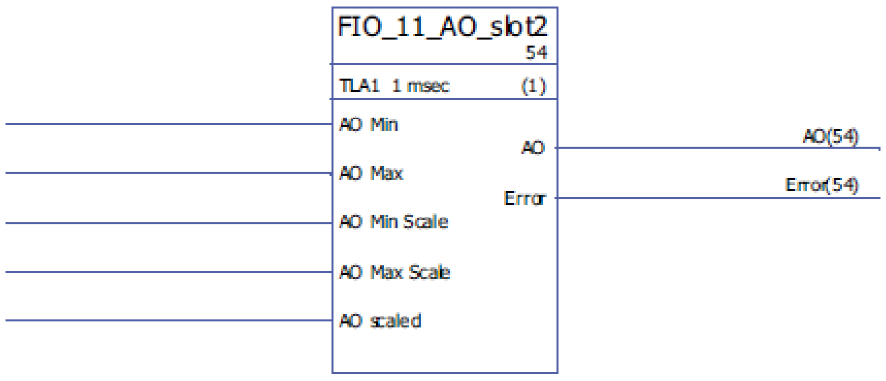
**Outputs**

Analogue output current value (AO): REAL
Error output (Error): DINT (0 = No error; 1 = Application program memory full)

## FIO_11_AO_slot2

## (10091)

**Illustration**



**Execution time**

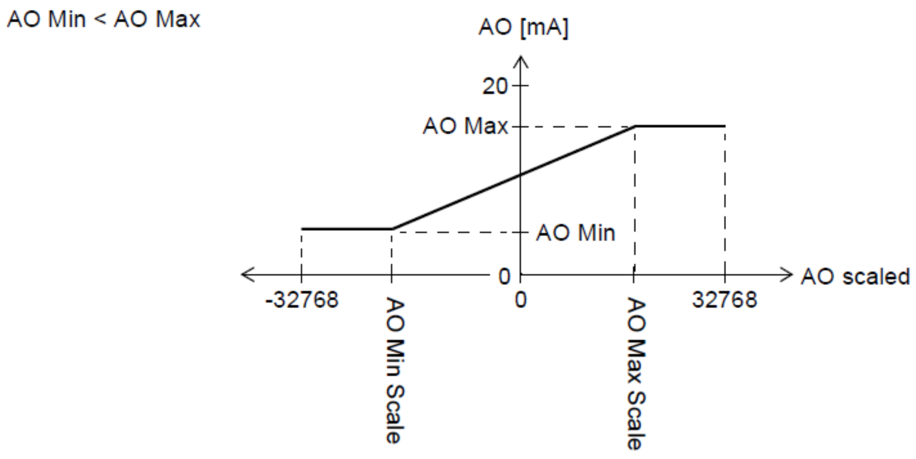
4.9 µs

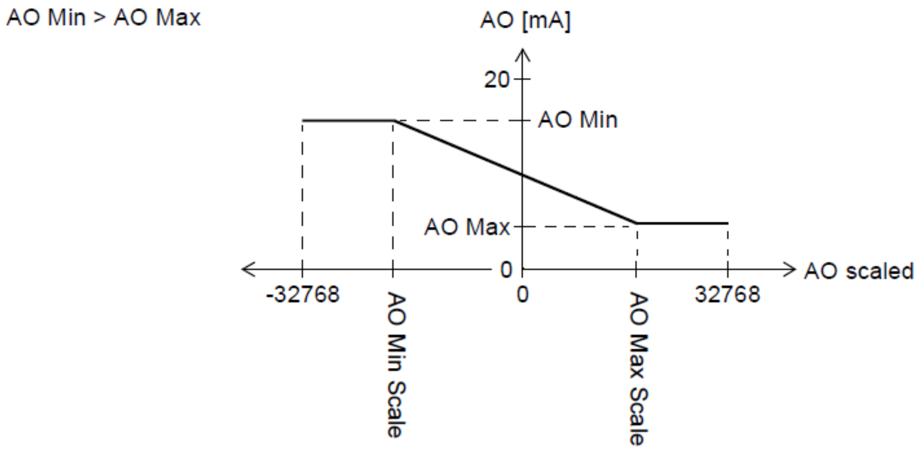
**Operation**

The block controls the analogue output (AO1) of a FIO11 Analog I/O Extension mounted on slot 2 of the drive control unit.

The block converts the input signal (AO scaled) to a 0…20 mA signal (AO) that drives the analogue output; the input range AO Min Scale … AO Max Scale corresponds to the current signal range of AO Min … AO Max.

AO Min Scale must be smaller than AO Max Scale; AO Max can be greater or smaller than AO Min.





**Inputs**

Minimum current signal (AO Min): REAL (0…20 mA)

Maximum current signal (AO Max): REAL (0…20 mA)

Minimum input signal (AO Min Scale): REAL

Maximum input signal (AO Max Scale): REAL

Input signal (AO scaled): REAL

**Outputs**

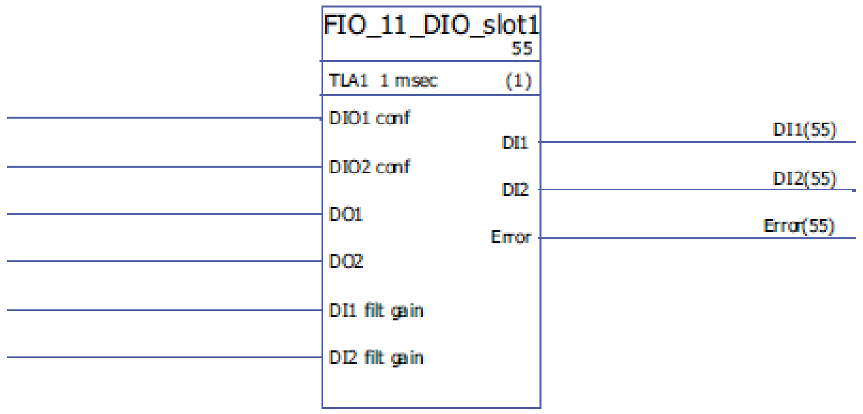
Analogue output current value (AO): REAL

Error output (Error): DINT (0 = No error; 1 = Application program memory full)

## FIO_11_DIO_slot1

### (10086)

**Illustration**



**Execution time** 6.0 µs

**Operation** The block controls the two digital inputs/outputs (DIO1, DIO2) of a FIO11 Digital I/O Extension mounted on slot 1 of the drive control unit.

The state of a DIOx conf input of the block determines whether the corresponding DIO on the FIO11 is an input or an output (0 = input, 1 = output). If the DIO is an output, the DOx input of the block defines its state.

The DIx outputs show the state of the DIOs.

The DIx filt gain inputs determine a filtering time for each input as follows:

| DIx filt gain | Filtering time |
|---|---|
| 0 | 7.5 µs |
| 1 | 195 µs |
| 2 | 780 µs |
| 3 | 4.680 ms |

**Inputs** Digital input/output mode selection (DIO1 conf, DIO2 conf): Boolean

Digital output state selection (DO1, DO2): Boolean

Digital input filter gain selection (DI1 filt gain, DI2 filt gain): INT

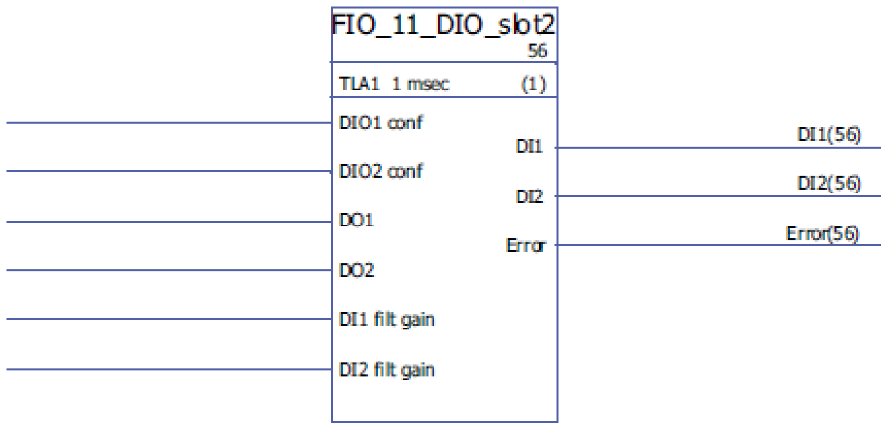
**Outputs** Digital input/output state (DI1, DI2): Boolean

Error output (Error): DINT (0 = No error; 1 = Application program memory full)

## FIO_11_DIO_slot2

### (10087)

**Illustration**



**Execution time**

6.0 µs

**Operation**

The block controls the two digital inputs/outputs (DIO1, DIO2) of a FIO11 Digital I/O Extension mounted on slot 2 of the drive control unit.

The state of a DIOx conf input of the block determines whether the corresponding DIO on the FIO11 is an input or an output (0 = input, 1 = output). If the DIO is an output, the DOx input of the block defines its state.

The DIx outputs show the state of the DIOs.

The DIx filt gain inputs determine a filtering time for each input as follows:

| DIx filt gain | Filtering time |
|---|---|
| 0 | 7.5 µs |
| 1 | 195 µs |
| 2 | 780 µs |
| 3 | 4.680 ms |

**Inputs**

Digital input/output mode selection (DIO1 conf, DIO2 conf): Boolean

Digital output state selection (DO1, DO2): Boolean

Digital input filter gain selection (DI1 filt gain, DI2 filt gain): INT

**Outputs**

Digital input/output state (DI1, DI2): Boolean

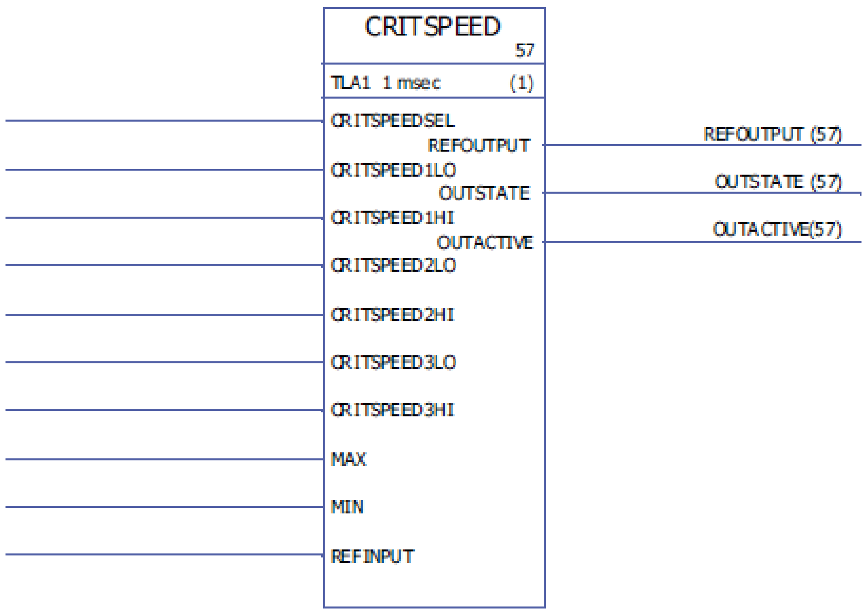
Error output (Error): DINT (0 = No error; 1 = Application program memory full)

# Feedback & algorithms

## CRITSPEED

### (10068)

**Illustration**



| | |
|---|---|
| **Execution time** | 4.50 µs |

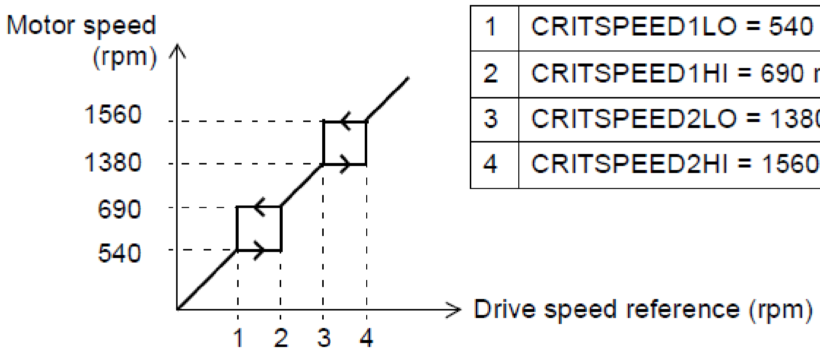
**Operation**

A critical speeds function block is available for applications where it is necessary to avoid certain motor speeds or speed bands because of e.g. mechanical resonance problems. The user can define three critical speeds or speed bands.

Example: An application has vibrations in the range of 540 to 690 rpm and 1380 to 1560 rpm. To make the drive made to jump over the vibration speed ranges:

- activate the critical speeds function (CRITSPEEDSEL = 1),

- set the critical speed ranges as in the figure below.



| | |
|---|---|
| 1 | CRITSPEED1LO = 540 rpm |
| 2 | CRITSPEED1HI = 690 rpm |
| 3 | CRITSPEED2LO = 1380 rpm |
| 4 | CRITSPEED2HI = 1560 rpm |

Output OUTACTIVE is set to 1 when the output reference (REFOUTPUT) is different from the input reference (REFINPUT).

The output is limited by the defined minimum and maximum limits (MIN and MAX).

Output OUTSTATE indicates in which critical speed range the operation point is.

**Inputs**

Critical speed activation input (CRITSPEEDSEL): Boolean

Minimum/maximum critical speed range input (CRITSPEEDNLO / CRITSPEEDNHI): REAL

Maximum/minimum input (MAX/MIN): REAL

Reference input (REFINPUT): REAL

**Outputs**

Reference output (REFOUTPUT): REAL

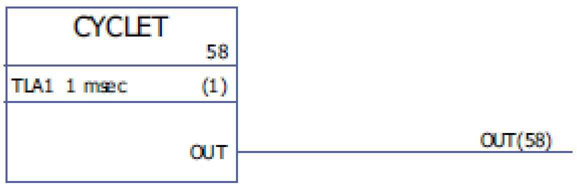
Output state (OUTSTATE): REAL

Output active (OUTACTIVE): Boolean

## CYCLET

### (10074)

**Illustration**



**Execution time**

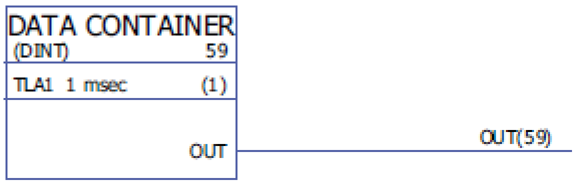
0.00 µs

| | |
|---|---|
| **Operation** | Output (OUT) is the time level of the CYCLET function block. |
| **Inputs** | - |
| **Outputs** | Output (OUT): DINT. 1 = 1 µs |

## DATA CONTAINER

### (10073)

**Illustration**



**Execution time** 0.00 µs

**Operation** Output (OUT) is an array of data used by the XTAB and YTAB tables in the block FUNG-1V .The array is defined by output pin.

**Inputs** -

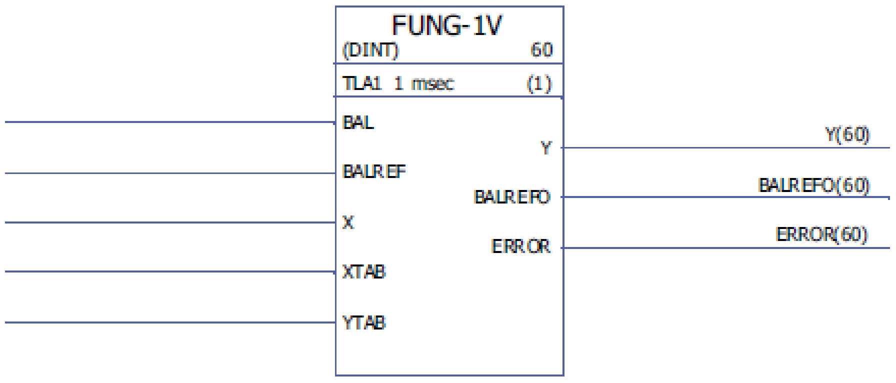
**Outputs** The output data type and the number of coordinate pairs are selected by the user.

Output (OUT): DINT, INT, REAL or REAL24

## FUNG-1V

### (10072)

**Illustration**



**Execution time**

9.29 µs

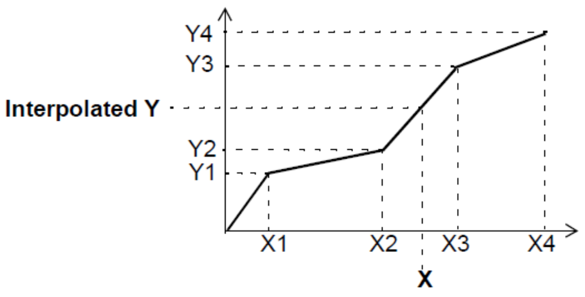
**Operation**

The output (Y) at the value of the input (X) is calculated with linear interpolation from a piecewise linear function.

$Y = Y_k + (X - X_k)(Y_{k+1} - Y_k) / (X_{k+1} - X_k)$

The piecewise linear function is defined by the X and Y vector tables (XTAB and YTAB). For each X-value in the XTAB table, there is a corresponding Y-value in the YTAB table. The values in XTAB and YTAB must be in ascending order (i.e. from low to high).

XTAB and YTAB values are defined with the DriveSPC tool.



| X table (XTAB) | Y table (YTAB) |
|---|---|
| X1 | Y1 |
| X2 | Y2 |
| X3 | Y3 |
| … | … |
| X9 | Y9 |

The balancing function (BAL) permits the output signal to track an external reference and gives a smooth return to the normal operation. If BAL is set to 1, output Y is set to the value of the balance reference input (BALREF). The X value which corresponds to this Y value is calculated with linear interpolation and it is indicated by the balance reference output (BALREFO).

If the X input is outside the range defined by the XTAB table, the output Y is set to the highest or lowest value in the YTAB table.

If BALREF is outside the range defined by the YTAB table when balancing is activated (BAL: 0 -> 1), the output Y is set to the value of the BALREF input and the BALREFO output is set to the highest or lowest value in the XTAB table.

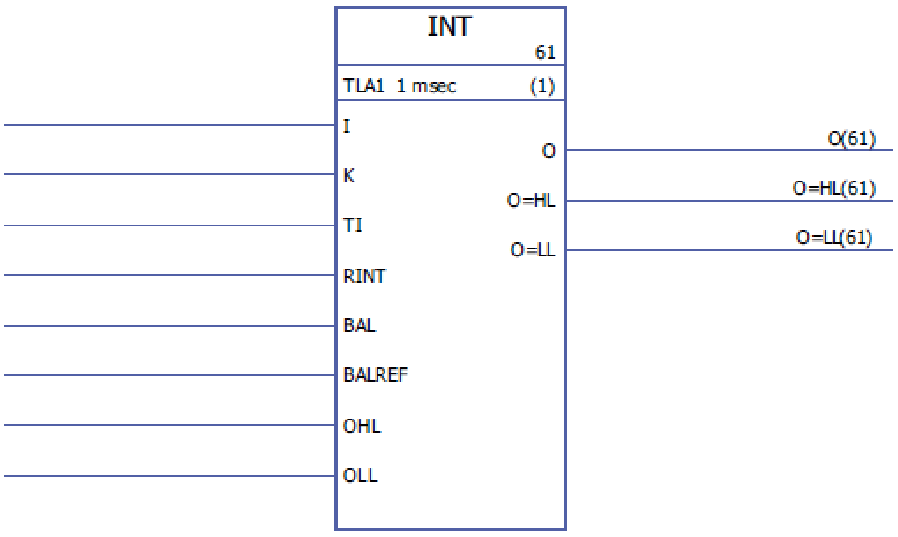
The ERROR output is set to 1 when the number of the XTAB and YTAB inputs are different. When ERROR is 1, the FUNG1V block will not function. XTAB and YTAB tables can be defined in the DATA CONTAINER block or the REG block.

| | |
|---|---|
| **Inputs** | The input data type is selected by the user.<br>Balance input (BAL): Boolean<br>Balance reference input (BALREF): DINT, INT, REAL, REAL24.<br>X value input (X): DINT, INT, REAL, REAL24<br>X table input (XTAB): DINT, INT, REAL, REAL24<br>Y table input (YTAB): DINT, INT, REAL, REAL24 |
| **Outputs** | Y value output (Y): DINT, INT, REAL, REAL24<br>Balance reference output (BALREFO): DINT, INT, REAL, REAL24<br>Error output (ERROR): Boolean |

## INT

### (10065)

**Illustration**



**Execution time** 4.73 µs

| | |
|---|---|
| **Operation** | The output (O) is the integrated value of the input (I): |

The output (O) is the integrated value of the input (I):

$O(t) = K/TI (\int I(t) dt)$

Where TI is the integration time constant and K is the integration gain.

The step response for the integration is:

$O(t) = K \times I(t) \times t/TI$

The transfer function for the integration is:

$G(s) = K\ 1/sTI$

The output value is limited according to the defined minimum and maximum limits (OLL and OHL). If the value is below the minimum value, output O = LL is set to 1. If the value exceeds the maximum value, output O = HL is set to 1. The output (O) retains its value when the input signal I(t) = 0.

The integration time constant is limited to value 2147483 ms. If the time constant is negative, zero time constant is used.

If the ratio between the cycle time and the integration time constant Ts/TI < 1, Ts/TI is set to 1.

The integrator is cleared when the reset input (RINT) is set to 1.

If BAL is set to 1, output O is set to the value of the input BALREF. When BAL is set back to 0, normal integration operation continues.

**Inputs**

Input (I): REAL

Gain input (K): REAL

Integration time constant input (TI): DINT, 0…2147483 ms

Integrator reset input (RINT): Boolean

Balance input (BAL): Boolean

Balance reference input (BALREF): REAL

Output high limit input (OHL): REAL

Output low limit input (OLL): REAL

**Outputs**

Output (O): REAL

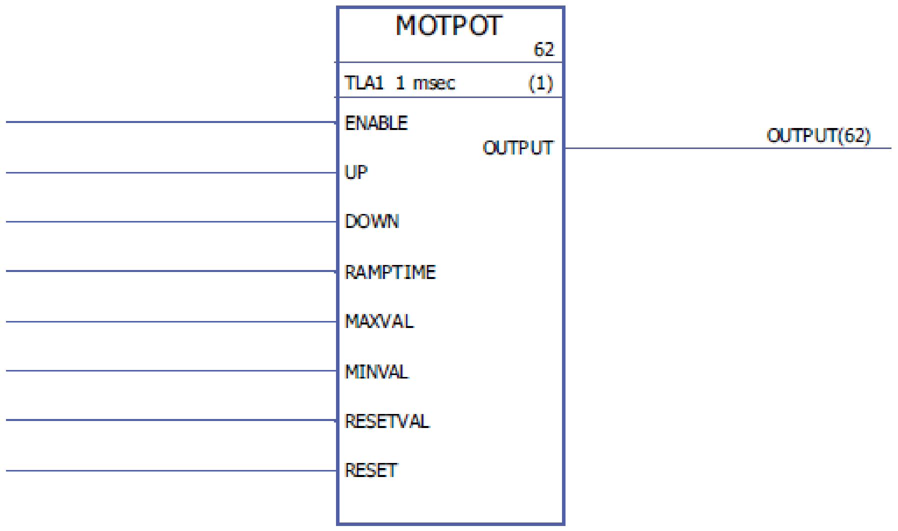
High limit output (O=HL): Boolean

Low limit output (O=LL): Boolean

## MOTPOT

### (10067)

**Illustration**



**Execution time** 2.92 µs

**Operation**

The motor potentiometer function controls the rate of change of the output from the minimum to the maximum value and vice versa.

The function is enabled by setting the ENABLE input to 1. If the up input (UP) is 1, the output reference (OUTPUT) is increased to the maximum value (MAXVAL) with the defined ramp time (RAMPTIME). If the down input (DOWN) is 1, the output value is decreased to the minimum value (MINVAL) with the defined ramp time. If the up and down inputs are activated/deactivated simultaneously, the output value is not increased/decreased.

If the RESET input is 1, the output will be reset to the value defined by the reset value input (RESETVAL) or to the value defined by the minimum input (MINVAL), whichever is higher.

If the ENABLE input is 0, the output is zero.

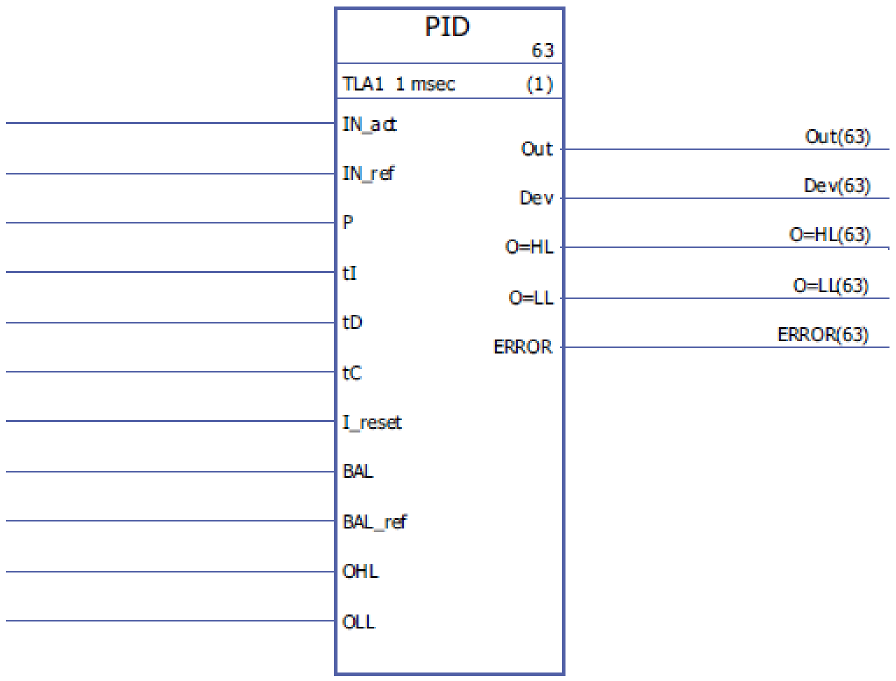
Digital inputs are normally used as up and down inputs.

| | |
|---|---|
| **Inputs** | Function enable input (ENABLE): Boolean |
| | Up input (UP): Boolean |
| | Down input (DOWN): Boolean |
| | Ramp time input (RAMPTIME): REAL (seconds) (i.e. the time required for the output to change from the minimum to the maximum value or from the maximum to the minimum value) |
| | Maximum reference input (MAXVAL): REAL |
| | Minimum reference input (MINVAL): REAL |
| | Reset value input (RESETVAL): REAL |
| | Reset input (RESET): Boolean |
| **Outputs** | Output (OUTPUT) REAL |

## PID

### (10075)

**Illustration**



| | |
|---|---|
| **Execution time** | 15.75 µs |

**Operation**

The PID controller can be used for closed-loop control systems. The controller includes anti-windup correction and output limitation.

The PID controller output (Out) before limitation is the sum of the proportional ($U_P$), integral ($U_I$) and derivative ($U_D$) terms:

$Out_{unlimited}(t) = U_P(t) + U_I(t) + U_D(t)$

$U_P(t) = P \times Dev(t)$

$U_I(t) = P/tI \times [\int Dev(\tau)d\tau + tC \times (Out(t) - Out_{unlimited}(t))]$

$U_D(t) = P \times tD \times d(Dev(t))/dt$

Integrator:

The integral term can be cleared by setting I_reset to 1. Note that the anti-windup correction is simultaneously disabled. When I_reset is 1, the controller acts as a PD controller.

If integration time constant tI is 0, the integral term will not be updated.

Smooth return to normal operation is guaranteed after errors or abrupt input value changes. This is achieved by adjusting the integral term so that the output will retain its previous value during these situations.

Limitation:

The output is limited by the defined minimum and maximum values, OLL and OHL:

If the actual value of the output reaches the specified minimum limit, output O=LL is set to 1.

If the actual value of the output reaches the specified maximum limit, output O=HL is set to 1.

Smooth return to normal operation after limitation is requested if and only if the antiwindup correction is not used, i.e. when tI = 0 or tC = 0.

Error codes:

Error codes are indicated by the error output (ERROR) as follows

| Error code | Description |
|---|---|
| 1 | The minimum limit (OLL) exceeds the maximum limit (OHL). |
| 2 | Overflow with Up, Ui, or Ud calculation |

Balancing:

The balancing function (BAL) permits the output signal to track an external reference and gives a smooth return to the normal operation. If BAL is set to 1, the output (Out) is set to the value of the balance reference input (BAL_ref). Balance reference is limited by the defined minimum and maximum limits (OLL and OHL).

Anti-windup:

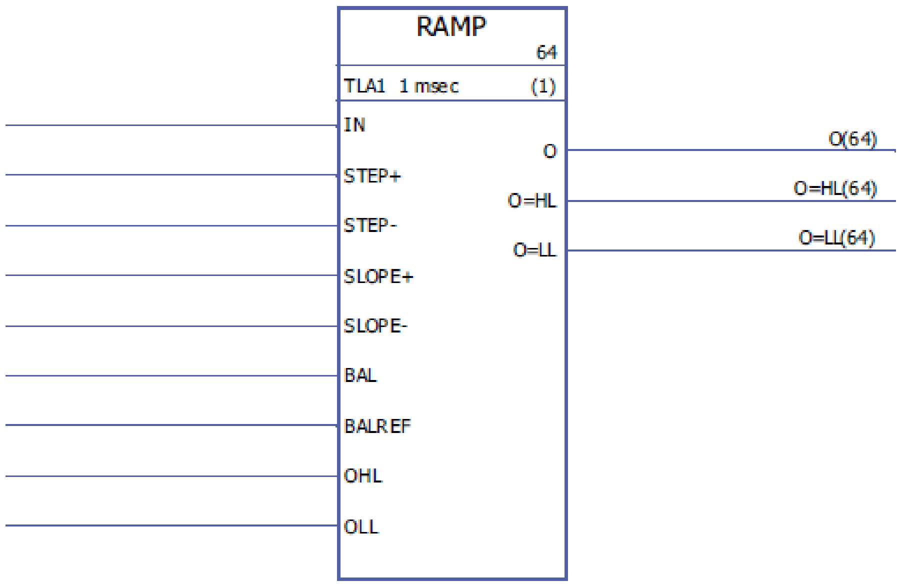
Anti-windup correction time constant is defined by input tC, which defines the time after which the difference between the unlimited and limited outputs is subtracted from the I-term during limitation. If tC = 0 or tI = 0, antiwindup correction is disabled.

| | |
|---|---|
| **Inputs** | Actual input (IN_act): REAL<br>Reference input (IN_ref): REAL<br>Proportional gain input (P): REAL<br>Integration time constant input (tI): REAL. 1 = 1 ms<br>Derivation time constant input (tD): REAL. 1 = 1 ms<br>Antiwind-up correction time constant input (tC): IQ6. 1 = 1 ms<br>Integrator reset input (I_reset): Boolean<br>Balance input (BAL): Boolean<br>Balance reference input (BAL_ref): REAL<br>Output high limit input (OHL): REAL<br>Output low limit input (OLL): REAL |
| **Outputs** | Output (Out): REAL<br>Deviation output (Dev): REAL (= actual -reference = IN_act - IN_ref)<br>High limit output (O=HL): Boolean<br>Low limit output (O=LL): Boolean<br>Error code output (ERROR): INT32 |

## RAMP

## (10066)

**Illustration**



**Execution time** 4.23 µs

**Operation**

Limits the rate of the change of the signal.

The input signal (IN) is connected directly to the output (O) if the input signal does not exceed the defined step change limits (STEP+ and STEP-). If the input signal change exceeds these limits, the output signal change is limited by the maximum step change (STEP+/STEP- depending on the direction of rotation). After this, the output signal is accelerated/decelerated by the defined ramp value (SLOPE+/SLOPE-) per second until the input and output signal values are equal.

The output is limited by the defined minimum and maximum values (OLL and OHL). If the actual value of the output falls below the specified minimum limit (OLL), output O=LL is set to 1. If the actual value of the output exceeds the specified maximum limit (OHL), output O=HL is set to 1.

If the balancing input (BAL) is set to 1, the output (O) is set to the value of the balance reference input (BAL_ref). Balancing reference is also limited by the minimum and maximum values (OLL and OHL).

**Inputs**

Input (IN): REAL

Maximum positive step change input (STEP+): REAL

Maximum negative step change input (STEP-): REAL

Ramp-up value per second input (SLOPE+ ): REAL

Ramp-down value per second input (SLOPE-): REAL

Balance input (BAL) : Boolean

Balance reference input ( BALREF): REAL

Output high limit input ( OHL): REAL

Output low limit input (OLL): REAL

**Outputs**

Output (O): REAL

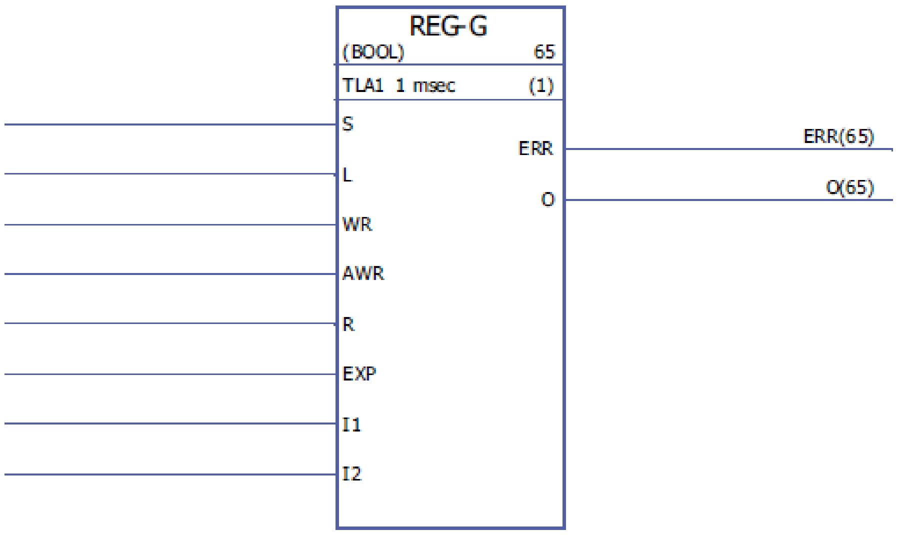
High limit output (O=HL): Boolean

Low limit output ( O=LL): Boolean

## REG-G

## (10102)

**Illustration**



**Execution time** -

**Operation**

Assembles individual variables to a single variable of array data type. The data type can
be INT, DINT, REAL16, REAL24 or Boolean.
When input S is set, data is continuously assembled at the group variable of the output.
The group variable of the output consists of group data from the EXP input and the values of the inputs I1…1n (in this order). The element acts as a latch when input S is reset; the latest data assembled then remains at the output.
If S is reset and L changes state from 0 to 1, an assembly is performed to output O during this program cycle. If S or R is set, L has no effect.
Data can be changed at an optional place by specifying the address (integer 1…C2) through the AWR input. The new data value is entered through the input to the specified
address when WR goes from 0 to 1. If AWR is 0 and WR goes to 1, array data is read from the input EXP to their respective places. Places corresponding to the ordinary inputs are not affected.
When input R is set, data at all places in the array register is cleared and all further entry
is prevented. R overrides both S and L.
If WR is set, the address at AWR is checked and if its value is greater than the number of inputs, or if it is negative, the error output ERR is set to 1. If the resulting output array
(EXP and the inputs combined) is longer than supported, ERR is set to 2. Otherwise ERR is 0.
Whenever an error is detected, ERR is set within one cycle. No place in the register is affected when an error occurs.

**Inputs**

Set (S): Boolean, INT, DINT, REAL, REAL24

Load (L): Boolean, INT, DINT, REAL, REAL24

Write (WR): Boolean, INT, DINT, REAL, REAL24

Write address (AWR): INT

Reset (R): Boolean

Expander (EXP): IArray

Data input (I1…I32): Boolean, INT, DINT, REAL, REAL24

**Outputs**

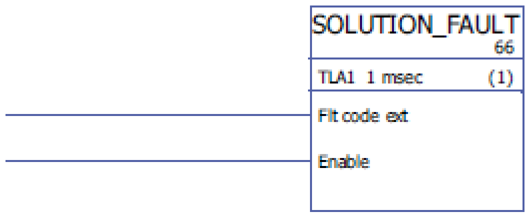
Error (ERR): INT

Array data output (O): OC1

## SOLUTION_FAULT

### (10097)

**Illustration**



**Execution time** -

**Operation** When the block is enabled (by setting the Enable input to 1), a fault (F-0317 SOLUTION FAULT) is generated by the drive. The value of the Flt code ext input is recorded by the fault logger.

**Inputs** Fault code extension (Flt code ext): DINT

Generate fault (Enable): Boolean

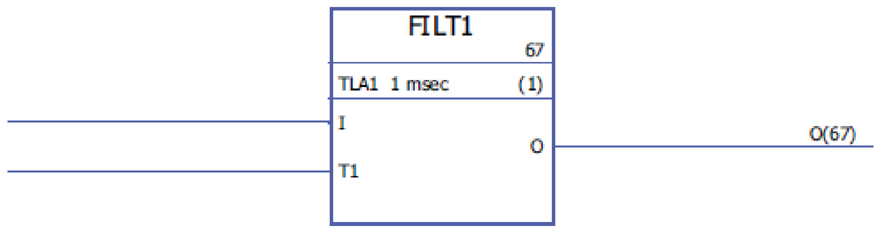
**Outputs** -

## Filters

### FILT1

### (10069)

**Illustration**



**Execution time** 7.59 µs

**Operation** The output (O) is the filtered value of the input (I) value and the previous output value ($O_{prev}$). The FILT1 block acts as 1st order low pass filter.

**Note:** Filter time constant (T1) must be selected so that T1/Ts < 32767. If the ratio exceeds 32767, it is considered as 32767. Ts is the cycle time of the program in ms.

If T1 < Ts, the output value is the input value.

The step response for a single pole low pass filter is:

$O (t) = I(t) \times (1 - e^{-t/T1})$

The transfer function for a single pole low pass filter is:

$G(s) = 1/ (1 + sT1)$

**Inputs** Input (I): REAL

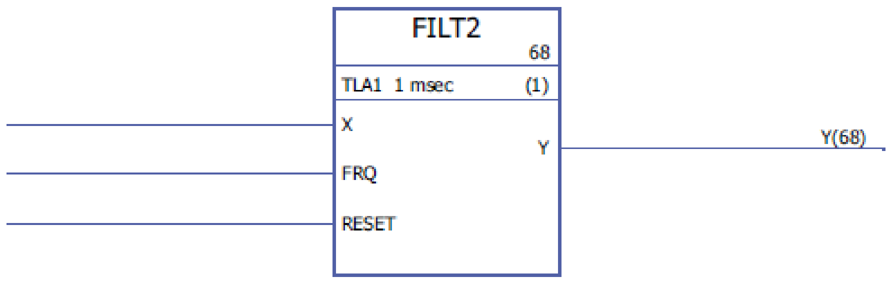
Filter time constant input (T1): DINT, 1 = 1 ms

**Outputs** Output (O): REAL

## FILT2

## (10070)

**Illustration**



**Execution time**

6.30 µs

**Operation**

The output (Y) is the filtered value of the input (X). The FILT2 block acts as a 2nd order low pass filter.

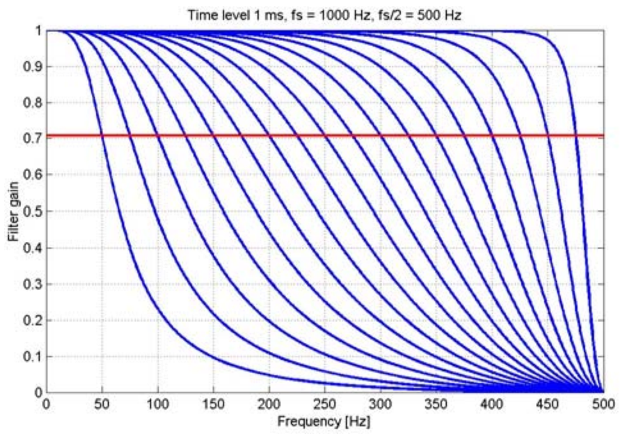
When the RESET input value is set to 1, the input is connected to the output without filtering.

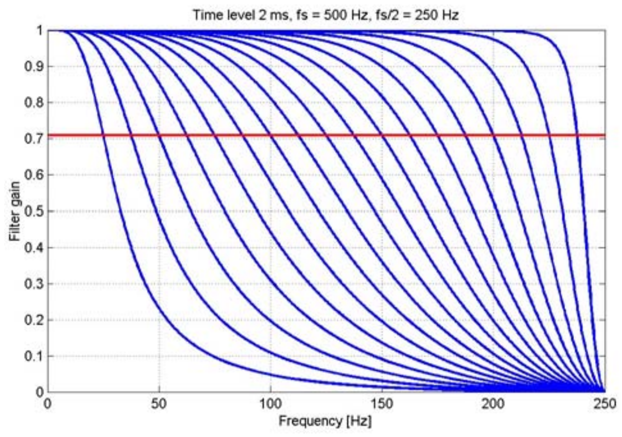
**Notes:**

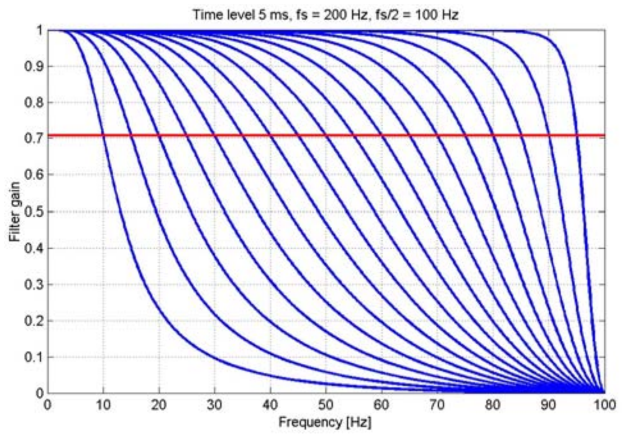
• The -3 dB cutoff frequency (FRQ) is limited to its maximum value (16383 Hz).

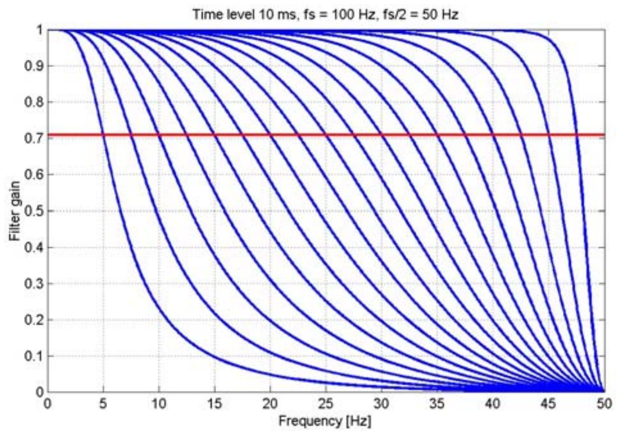
• The frequency of the input signal must be less than half of sampling frequency (fs) – any higher frequencies are aliased to the allowable range. The sampling frequency is defined by the time level of the block; for example, 1 ms corresponds to a sampling frequency of 1000 Hz.

The following diagrams show the frequency responses for 1, 2, 5 and 10 ms time levels. The 3 dB cutoff level is represented as the horizontal line at 0.7 gain.







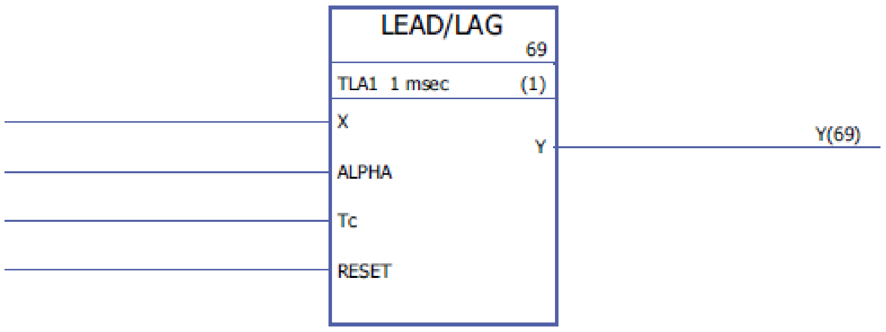


| | |
|---|---|
| **Inputs** | Input (X): REAL<br>-3 dB cutoff frequency input (FRQ): DINT (0…16383 Hz)<br>Reset input (RESET): Boolean |
| **Outputs** | Output (Y): REAL |

## LEAD/LAG

### (10071)

**Illustration**



**Execution time** 5.55 µs

**Operation**

The output (Y) is the filtered value of the input (X). When ALPHA > 1, the function block acts as a lead filter. When ALPHA < 1, the function block acts as a lag filter. When ALPHA = 1, no filtering occurs.

The transfer function for a lead/lag filter is:

$(1 + \text{ALPHA}T_c s) / (1 + T_c s)$

When RESET input is 1, the input value (X) is connected to the output (Y).

If ALPHA or Tc < 0, the negative input value is set to zero before filtering.

**Inputs**

Input (X): REAL

Lead/Lag filter type input (ALPHA): REAL

Time constant input (Tc): REAL

Reset input (RESET): Boolean

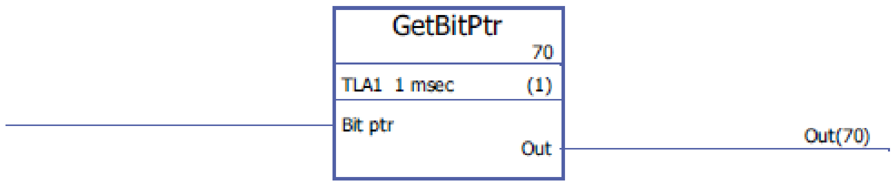
**Outputs**

Output (Y): REAL

## Parameters

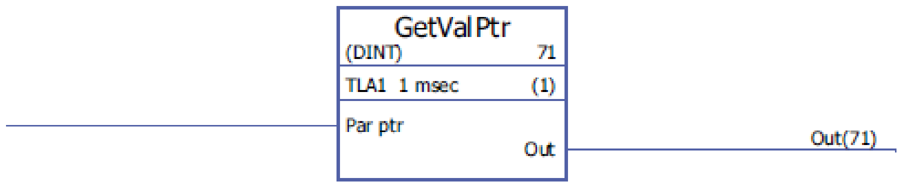
### GetBitPtr

#### (10099)

| | |
|---|---|
| **Illustration** |   GetBitPtr<br>70<br>TLA1 1 msec<br>(1)<br>Bit ptr<br>Out<br>Out(70) |
| **Execution time** | - |
| **Operation** | Reads the status of one bit within a parameter value cyclically.<br>The Bit ptr input specifies the parameter group, index and bit to be read.<br>The output (Out) provides the value of the bit. |
| **Inputs** | Parameter group, index and bit (Bit ptr): DINT |
| **Outputs** | Bit status (Out): DINT |

### GetValPtr

#### (10098)

| | |
|---|---|
| **Illustration** |   GetValPtr<br>(DINT)<br>71<br>TLA1 1 msec<br>(1)<br>Par ptr<br>Out<br>Out(71) |
| **Execution time** | - |
| **Operation** | Reads the value of a parameter cyclically.<br>The Par ptr input specifies the parameter group and index to be read.<br>The output (Out) provides the value of the parameter. |

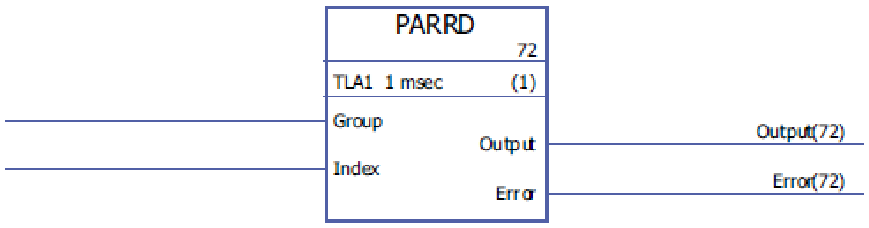
**Inputs** Parameter group and index (Par ptr): DINT

**Outputs** Parameter value (Out): DINT

## PARRD

### (10082)

**Illustration**



**Execution time** 6.00 µs

**Operation** Reads the value of a parameter (specified by the Group and Index inputs). If the parameter is a pointer parameter, the Output pin provides the number of the source parameter instead of its value.

Error codes are indicated by the error output (Error) as follows:

| Error code | Description |
|---|---|
| 0 | No error |
| ≠ 0 | Error |

See also blocks PARRDINTR and PARRDPTR.

**Inputs** Parameter group input (Group): DINT

Parameter index input (Index): DINT

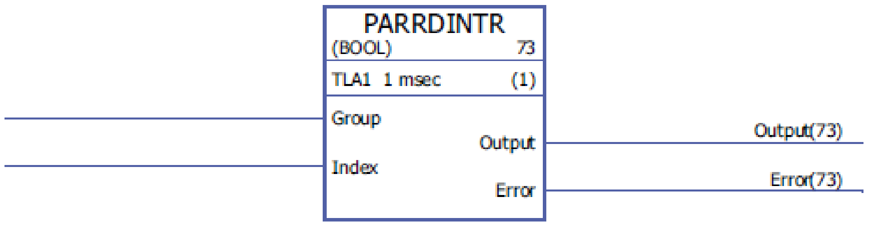
**Outputs** Output (Output): DINT

Error output (Error): DINT

## PARRDINTR

### (10101)

**Illustration**



**Execution time** -

**Operation** Reads the internal (non-scaled) value of a parameter (specified by the Group and Index inputs). The value is provided by the Output pin.

Error codes are indicated by the error output (Error) as follows:

| Error code | Description |
|---|---|
| 0 | No error or busy |
| ≠ 0 | Error |

Note: Using this block may cause incompatibility issues when upgrading the application to another firmware version.

**Inputs** Parameter group (Group): DINT

Parameter index (Index): DINT

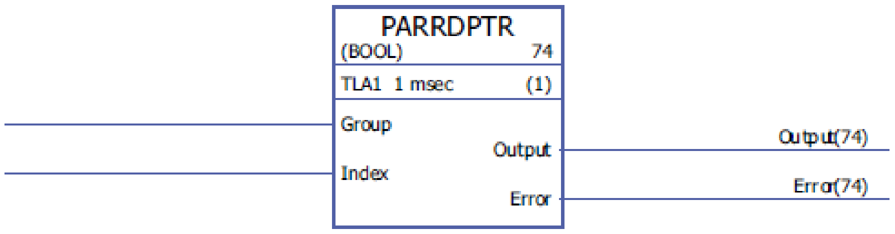
**Outputs** Output (Output): Boolean, INT, DINT, REAL, REAL24

Error output (Error): DINT

## PARRDPTR

### (10100)

**Illustration**



**Execution time** -

**Operation** Reads the internal (non-scaled) value of the source of a pointer parameter. The pointer parameter is specified using the Group and Index inputs.

The value of the source selected by the pointer parameter is provided by the Output pin.

Error codes are indicated by the error output (Error) as follows:

| Error code | Description |
|---|---|
| 0 | No error or busy |
| ≠ 0 | Error |

**Inputs** Parameter group (Group): DINT

Parameter index (Index): DINT

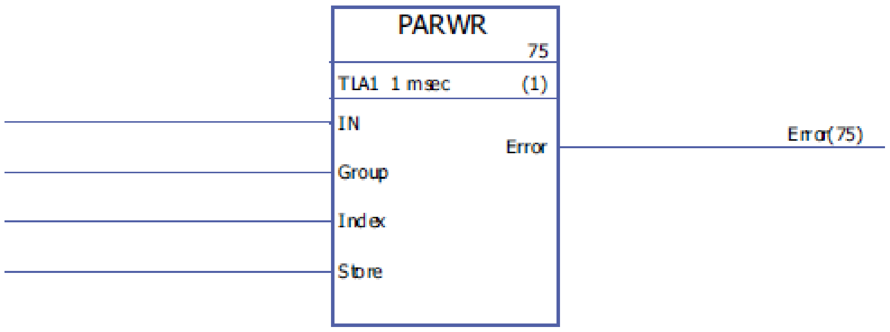
**Outputs** Output (Output): Boolean, INT, DINT, REAL, REAL24

Error output (Error): DINT

## PARWR

### (10080)

**Illustration**



**Execution time** 14.50 µs

**Operation**

The input value (IN) is written to the defined parameter (Group and Index).

The new parameter value is stored to the flash memory if the store input (Store) is 1.
**Note:** Cyclic parameter value storing can damage the memory unit. Parameter values should be stored only when necessary.

Error codes are indicated by the error output (Error) as follows:

| Error code | Description |
|---|---|
| 0 | No error |
| < > 0 | Error |

**Inputs**

Input (IN): DINT

Parameter group input (Group): DINT

Parameter index input (Index): DINT

Store input (Store): Boolean

**Outputs**

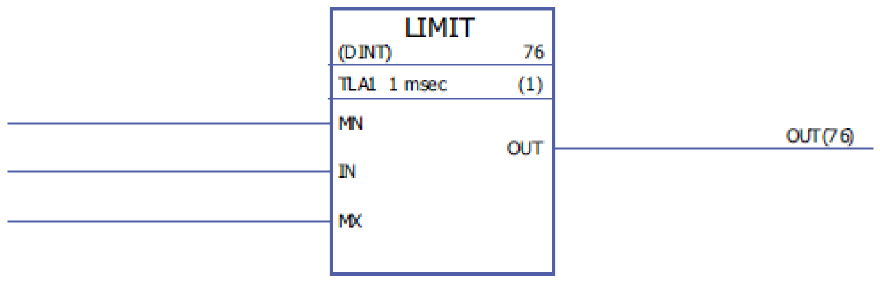
Error output (Error): DINT

## Selection

### LIMIT

### (10052)

**Illustration**

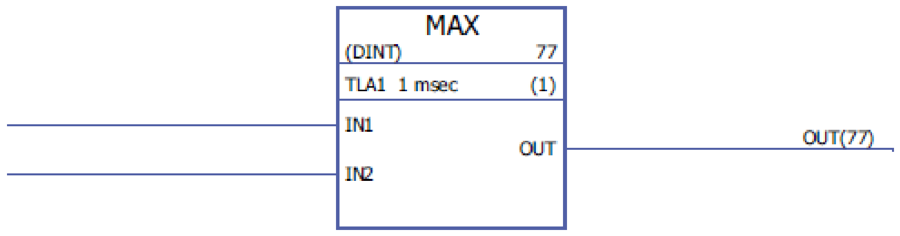


| | |
|---|---|
| **Execution time** | 0.53 µs |
| **Operation** | The output (OUT) is the limited input (IN) value. Input is limited according to the minimum (MN) and maximum (MX) values. |
| **Inputs** | The input data type is selected by the user.<br>Minimum input limit (MN): INT, DINT, REAL, REAL24<br>Input (IN): INT, DINT, REAL, REAL24<br>Maximum input limit (MX): INT, DINT, REAL, REAL24 |
| **Outputs** | Output (OUT): INT, DINT, REAL, REAL24 |

### MAX

### (10053)

**Illustration**



**Execution time** 0.81 µs (when two inputs are used) + 0.53 µs (for every additional input). When all inputs are used, the execution time is 16.73 µs.

**Operation** The output (OUT) is the highest input value (IN).

**Inputs** The input data type and the number of inputs (2…32) are selected by the user.

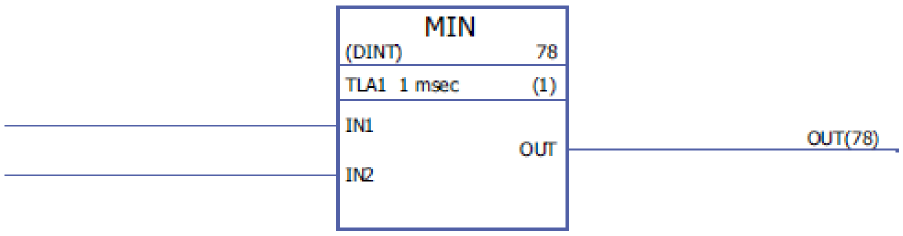
Input (IN1…IN32): INT, DINT, REAL, REAL24

**Outputs** Output (OUT): INT, DINT, REAL, REAL24

## MIN

## (10054)

**Illustration**



**Execution time** 0.81 µs (when two inputs are used) + 0.52 µs (for every additional input). When all inputs are used, the execution time is 16.50 µs.

**Operation** The output (OUT) is the lowest input value (IN).

**Inputs** The input data type and the number of inputs (2…32) are selected by the user.

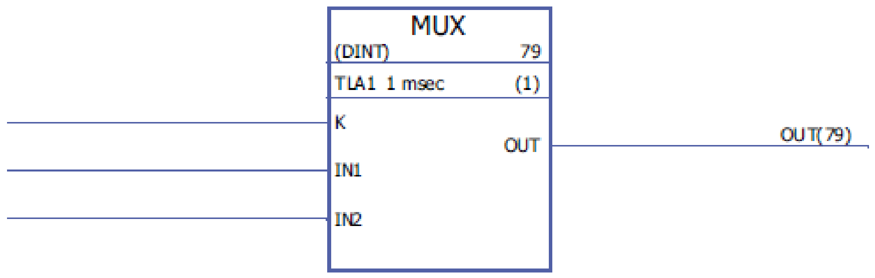
Input (IN1…IN32): INT, DINT, REAL, REAL24

**Outputs** Output (OUT): INT, DINT, REAL, REAL24

## MUX

## (10055)

**Illustration**

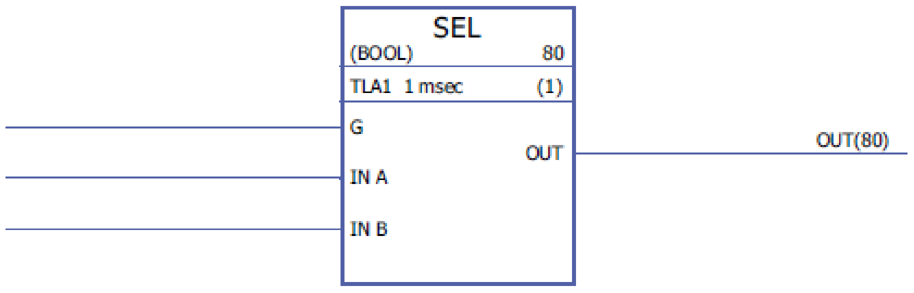


| | |
|---|---|
| **Execution time** | 0.70 µs |
| **Operation** | The value of an input (IN) selected by the address input (K) is stored to the output (OUT).<br>If the address input is 0, negative or exceeds the number of the inputs, the output is 0. |
| **Inputs** | The input data type and number of inputs (2…32) are selected by the user.<br>Address input (K): DINT<br>Input (IN1…IN32): INT, DINT, REAL, REAL24 |
| **Outputs** | Output (OUT): INT, DINT, REAL, REAL24 |

## SEL

## (10056)

**Illustration**



| | |
|---|---|
| **Execution time** | 1.53 µs |

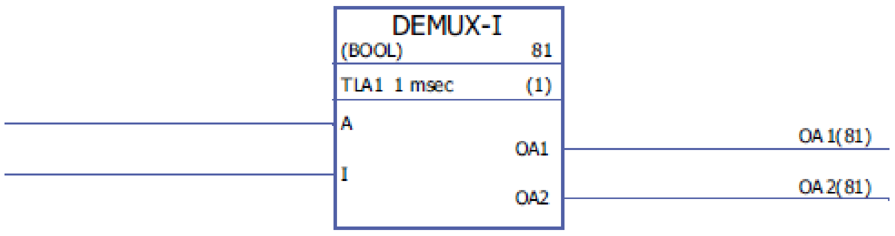
| | |
|---|---|
| **Operation** | The output (OUT) is the value of the input (IN) selected by the selection input (G).<br>If G = 0: OUT = IN A.<br>If G = 1: OUT = IN B. |
| **Inputs** | The input data type is selected by the user.<br>Selection input (G): Boolean<br>Input (IN A, IN B): Boolean, INT, DINT, REAL, REAL24 |
| **Outputs** | Output (OUT): Boolean, INT, DINT, REAL, REAL24 |

## Switch & Demux

### DEMUX-I

#### (10061)

**Illustration**



**Execution time** 1.38 µs (when two inputs are used) + 0.30 µs (for every additional input). When all inputs are used, the execution time is 10.38 µs.

**Operation** Input (I) value is stored to the output (OA1…OA32) selected by the address input (A). All other outputs are 0.

If the address input is 0, negative or exceeds the number of the outputs, all outputs are 0.

**Inputs** The input data type is selected by the user.

Address input (A): DINT

Input (I): INT, DINT, Boolean, REAL, REAL24

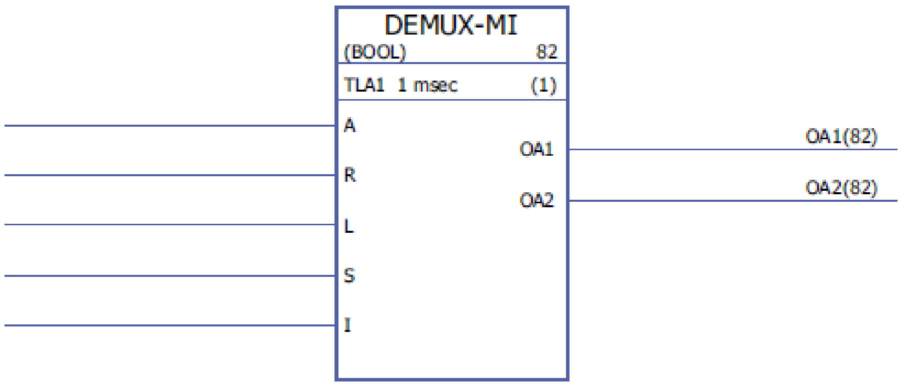
**Outputs** The number of the output channels (2…32) is selected by the user.

Output (OA1…OA32): INT, DINT, REAL, REAL24, Boolean

## DEMUX-MI

### (10062)

**Illustration**



**Execution time**

0.99 µs (when two inputs are used) + 0.25 µs (for every additional input). When all inputs are used, the execution time is 8.4 µs.

**Operation**

The input (I) value is stored to the output (OA1…OA32) selected by the address input (A) if the load input (L) or the set input (S) is 1. When the load input is set to 1, the input (I) value is stored to the output only once. When the set input is set to 1, the input (I) value is stored to the output every time the block is executed. The set input overrides the load input.

If the reset input (R) is 1, all connected outputs are 0.

If the address input is 0, negative or exceeds the number of the outputs, all outputs are 0.

Example:

| S | L | R | A | I | OA1 | OA2 | OA3 | OA4 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 2 | 150 | 0 | 150 | 0 | 0 |
| 0 | 0 | 0 | 2 | 120 | 0 | 150 | 0 | 0 |
| 0 | 1 | 0 | 3 | 100 | 0 | 150 | 100 | 0 |
| 1 | 0 | 0 | 1 | 200 | 200 | 150 | 100 | 0 |
| 1 | 1 | 0 | 4 | 250 | 200 | 150 | 100 | 250 |
| 1 | 1 | 1 | 2 | 300 | 0 | 0 | 0 | 0 |

**Inputs**

The input data type and the number of inputs (1…32) are selected by the user.

Address input (A): DINT

Reset input (R): Boolean

Load input (L): Boolean

Set input (S): Boolean

Input (I): DINT, INT, REAL, REAL24, Boolean

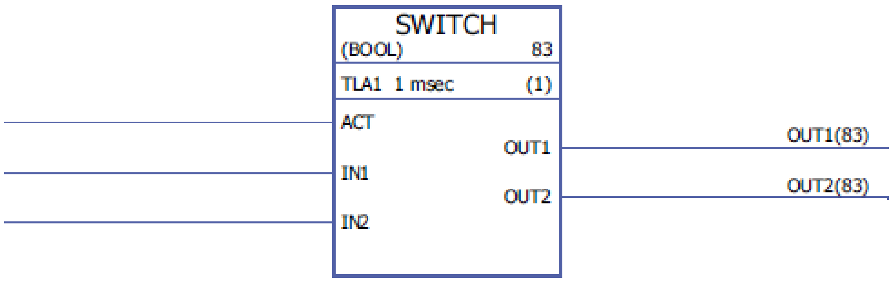
**Outputs** The number of the output channels (2…32) is selected by the user.

Output (OA1…OA32): DINT, INT, REAL, REAL24, Boolean

## SWITCH

### (10063)

**Illustration**



**Execution time** 0.68 µs (when two inputs are used) + 0.50 µs (for every additional input). When all inputs are used, the execution time is 15.80 µs.

**Operation** The output (OUT) is equal to the corresponding input (IN) if the activate input (ACT) is 1. Otherwise the output is 0.

**Inputs** The input data type and the number of inputs (1…32) are selected by the user.

Activate input (ACT): Boolean

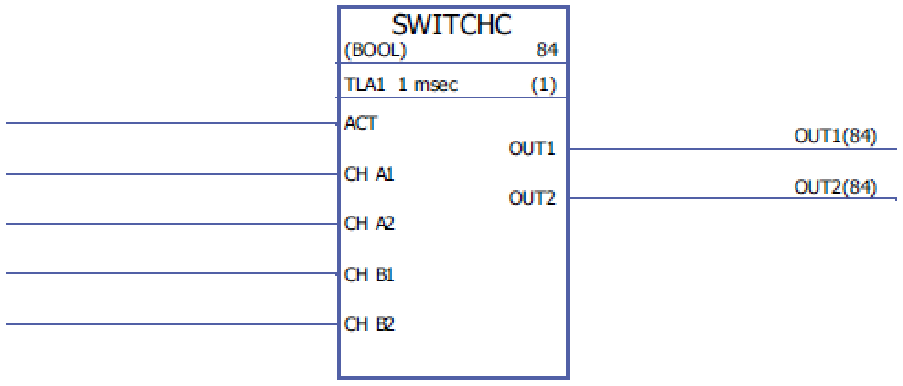
Input (IN1…IN32): INT, DINT, REAL, REAL24, Boolean

**Outputs** Output (OUT1…OUT32): INT, DINT, REAL, REAL24, Boolean

## SWITCHC

### (10064)

**Illustration**



**Execution time** 1.53 µs (when two inputs are used) + 0.73 µs (for every additional input). When all inputs are used, the execution time is 23.31 µs.

**Operation** The output (OUT) is equal to the corresponding channel A input (CH A1…32) if the activate input (ACT) is 0. The output is equal to the corresponding channel B input (CH B1…32) if the activate input (ACT) is 1.

**Inputs** The input data type and the number of inputs (1…32) are selected by the user.

Activate input (ACT): Boolean

Input (CH A1…CH A32, CH B1…CH B32): INT, DINT, REAL, REAL24, Boolean

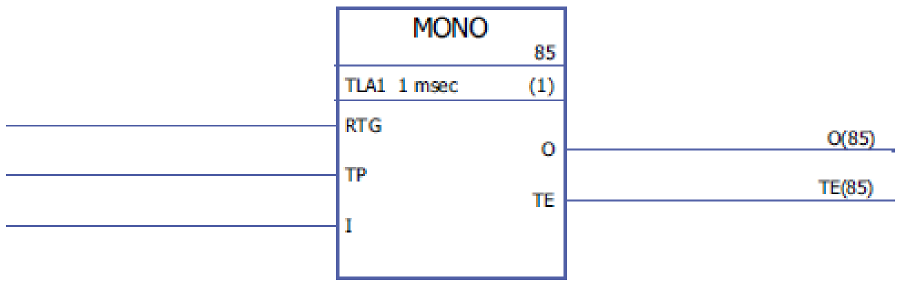
**Outputs** Output (OUT1…OUT32): INT, DINT, REAL, REAL24, Boolean

## Timers

### MONO

### (10057)

**Illustration**



**Execution time** 1.46 µs

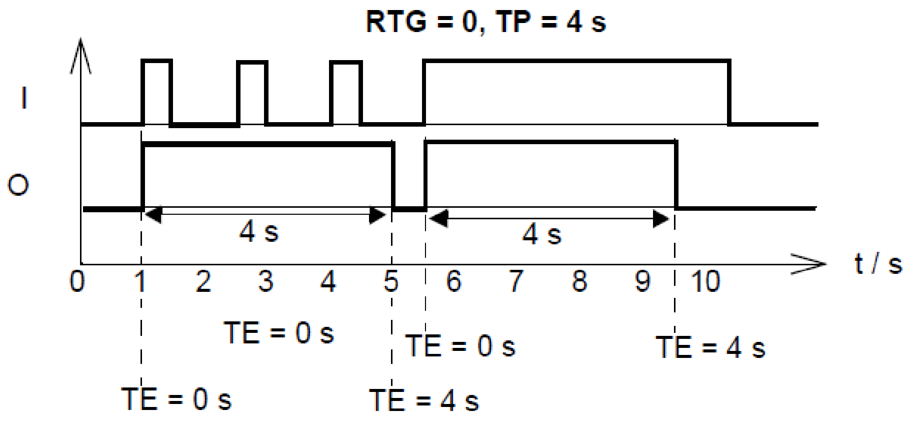
**Operation**

The output (O) is set to 1 and the timer is started, if the input (I) is set to 1. The output is reset to 0 when the time defined by the time pulse input (TP) has elapsed. Elapsed time (TE) count starts when the output is set to 1 and stops when the output is set to 0.

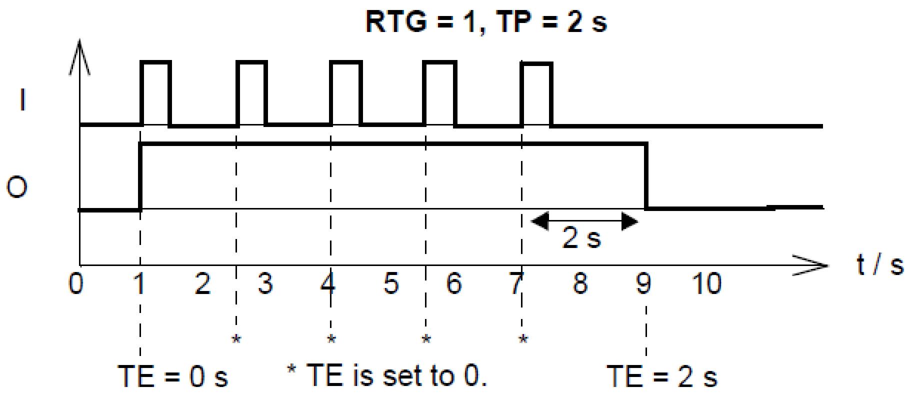
If RTG is 0, a new input pulse during the time defined by TP has no effect on the function. The function can be restarted only after the time defined by TP has elapsed.

If RTG is 1, a new input pulse during the time defined by TP restarts the timer and sets the elapsed time (TE) to 0.

Example 1: MONO is not re-triggable, i.e. RTG = 0.



Example 2: MONO is re-triggable, i.e. RTG = 1.



**Inputs**

Re-trigger input (RTG): Boolean

Time pulse input (TP): DINT (1 =  µs)

Input (I): Boolean

**Outputs**

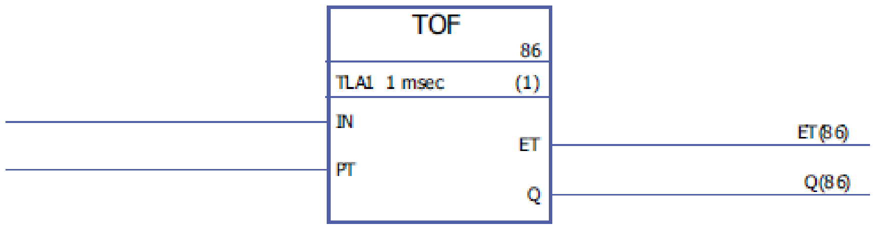
Output (O): Boolean

Time elapsed output (TE): DINT (1 = 1 µs)

## TOF

## (10058)

**Illustration**

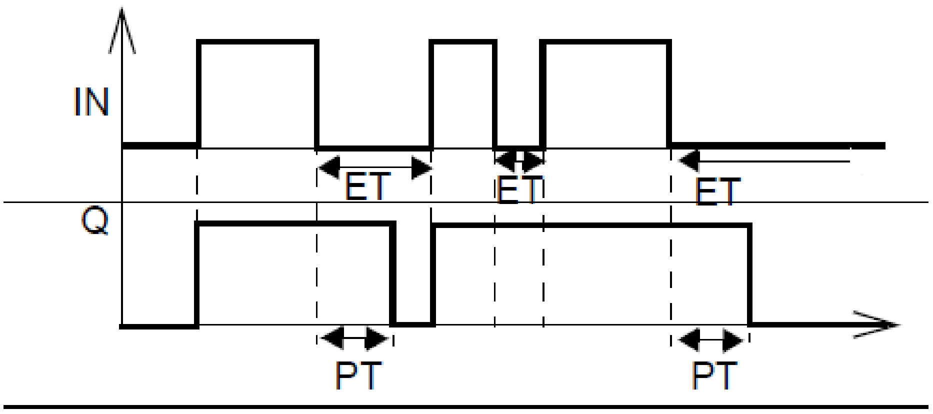


**Execution time** 1.10 µs

**Operation** The output (Q) is set to 1, when the input (IN) is set to 1. The output is reset to zero when the input has been 0 for a time defined by the pulse time input (PT).

Elapsed time count (ET) starts when the input is set to 0 and stops when the input is set to 1.

Example:



**Inputs**

Input (IN): Boolean

Pulse time input (PT): DINT (1 = 1 µs)

**Outputs**

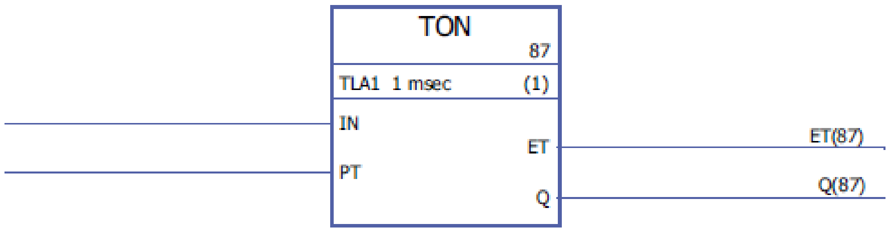
Elapsed time output (ET): DINT (1 = 1 µs)

Output (Q): Boolean

## TON

## (10059)

**Illustration**



**Execution time**

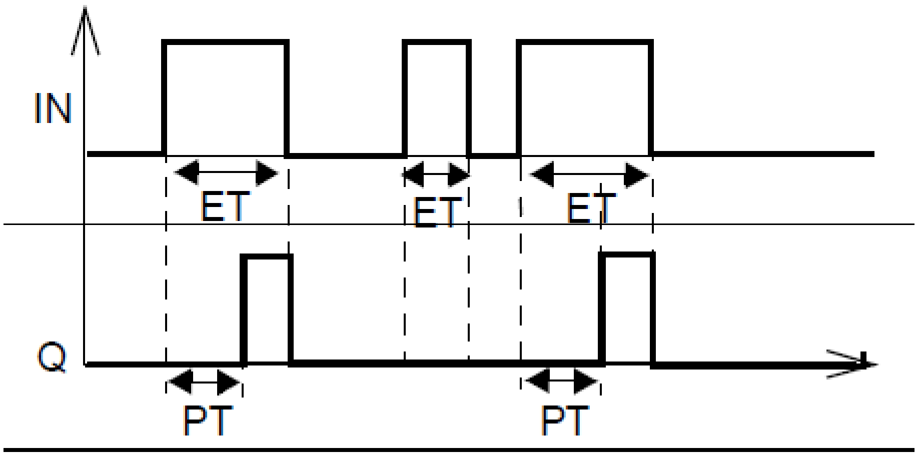
1.22 µs

**Operation**

The output (Q) is set to 1 when the input (IN) has been 1 for a time defined by the pulse time input (PT). The output is set to 0, when the input is set to 0.

Elapsed time count (ET) starts when the input is set to 1 and stops when the input is set to 0.

Example:



**Inputs**

Input (IN): Boolean

Pulse time input (PT): DINT (1 = 1 µs)

**Outputs**

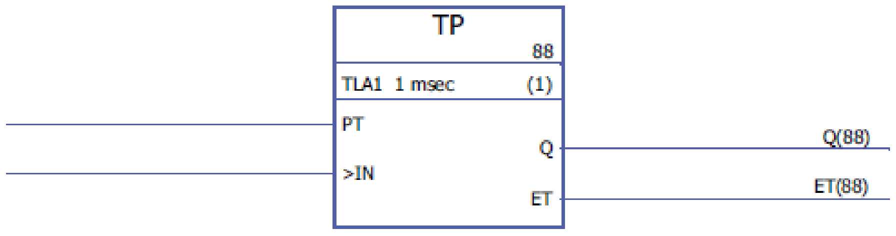
Elapsed time output (ET): DINT (1 = 1 µs)

Output (Q): Boolean

## TP

## (10060)

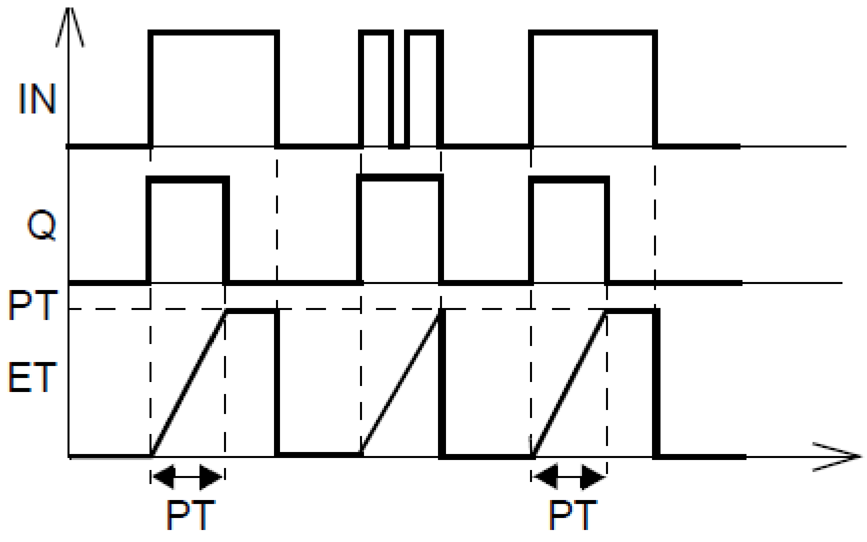
**Illustration**



**Execution time** 1.46 µs

**Operation** The output (Q) is set to 1 when the input (IN) is set to 1. The output is set to 0, when it has been 1 for a time defined by the pulse time input (PT).

Elapsed time count (ET) starts when the input is set to 1 and stops when the input is set to 0.



**Inputs** Pulse time input (PT): DINT (1 = 1 µs)

Input (IN): Boolean

**Outputs** Output (Q): Boolean

Elapsed time output (ET): DINT (1 = 1 µs)