Power, Control & Green Solutions

elsto Drives & Controls | Stokvis Group

Bonfiglioli
power, control and green solutions

AGILE and ACTIVE Cube

Application manual
PLC

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General Information about the Documentation

This application manual complements the Operating Instructions and the "Quick Start Guide" of the frequency inverter. The application manual contains all information relevant to creating PLC functions using the graphical programming environment or the function table.

For better clarity, the documentation is structured according to the customer-specific requirements made on the frequency inverter.

Quick Start Guide
The Quick Start Guide describes the basic steps required for mechanical and electrical installation of the frequency inverter. The guided commissioning supports you in the selection of necessary parameters and the software configuration of the frequency inverter.

Operating instructions
The operating instructions describe and document all functions of the frequency inverter. The parameters required for adapting the frequency inverter to specific applications as well as the wide range of additional functions are described in detail.

Application Manual
The application manual supplements the documentation for purposeful installation and commissioning of the frequency inverter. Information on various subjects connected with the use of the frequency inverter are described specific to the application.

Installation Instructions
Complementing the Brief Instructions and the Operating Instructions, the Installation Instructions provide information on how to install and use the additional/optional components.

If you need a copy of the documentation or additional information, contact your local representative of BONFIGLIOLI .

The following pictograms and signal words are used in the documentation:

Danger!
Danger refers to an immediate threat. Non-compliance with the precaution described may result in death, serious injury or material damage.

Warning!
Warning refers to a possible threat. Non-compliance with the warning may result in death, serious injury or material damage.

Caution!
Caution refers to an immediate hazard. Non-compliance may result in personal or material damage.

Attention!
Attention and the related text refer to a possible behavior or an undesired condition which can occur during operation.

Note
marks information which facilitates handling for you and supplements the corresponding part of the documentation.

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1 General Safety Instructions and Information on Use

Warning!

The specifications and instructions contained in the documentation must be complied with strictly during installation and commissioning. Before starting the relevant activity, read the documentation carefully and comply with the safety instructions. The term "Qualified Staff" refers to anybody who is familiar with the installation, assembly, commissioning and operation of the frequency inverter and has the proper qualification for the job.

1.1 General Information

Warning!

The DC-link circuit of the frequency inverter is charged during operation, i.e. there is always the risk of contact with high voltage. Frequency inverters are used for driving moving parts and they may become hot at the surface during operation.

Any unauthorized removal of the necessary covers, improper use, wrong installation or operation may result in serious injuries or material damage.

In order to avoid such injuries or damage, only qualified technical staff may carry out the transport, installation, commissioning, setup or maintenance work required. The standards EN 50178, IEC 60364 (Cenelec HD 384 or DIN VDE 0100), IEC 60664-1 (Cenelec HD 625 or VDE 0110-1) as well as the applicable national regulations must be complied with. The term „Qualified Staff‟ refers to anybody who is familiar with the installation, assembly, commissioning and operation of the frequency inverter as well as the possible hazards and has the proper qualification for the job.

Persons who are not familiar with the operation of the frequency inverter and children must not have access to the device.

1.2 Purpose of the Frequency Inverters

Warning!

The frequency inverters are electrical drive components intended for installation in industrial plants or machines. Commissioning and start of operation is not allowed until it has been verified that the machine meets the requirements of the EC Machinery Directive 2006/42/EEC and EN 60204. In accordance with the CE marking requirements, the frequency inverters comply with the Low Voltage Directive 2006/95/EC as well as EN 61800-5-1. The user shall be responsible for making sure that the requirements of the EMC Directive 2004/108/EEC are met. Frequency inverters are only available at specialized dealers and are exclusively intended for professional use as per EN 61000-3-2.

Purposes other than intended may result in the exclusion of warranty.

The frequency inverters are also marked with the UL label according to UL508c, which proves that they also meet the requirements of the CSA Standard C22.2-No. 14-95.

The technical data, connection specifications and information on ambient conditions are indicated on the name plate and in the documentation and must be complied with in any case. Anyone involved in any kind of work at the device must have read the instructions carefully and understood them before starting the work.

1.3 Transport and Storage

The frequency inverters must be transported and stored in an appropriate way. During transport and storage the devices must remain in their original packaging.
The units may only be stored in dry rooms which are protected against dust and moisture. The units may be exposed to little temperature deviations only. Observe the conditions according to EN 60721-3-1 for storage, EN 60721-3-2 for transport and the marking on the packaging.

The duration of storage without connection to the permissible nominal voltage may not exceed one year.

1.4 Handling and Installation

Warning!
Damaged or destroyed components must not be put into operation because they may be a health hazard.

The frequency inverters are to be used in accordance with the documentation as well as the applicable directives and standards.
They must be handled carefully and protected against mechanical stress.
Do not bend any components or change the isolating distances.
Do not touch electronic components or contacts. The devices are equipped with components which are sensitive to electrostatic energy and can be damaged if handled improperly. Any use of damaged or destroyed components shall be considered as a non-compliance with the applicable standards.
Removal of seal marks may cause restrictions on warranty.
Do not remove any warning signs from the device.

1.5 Electrical Installation

Warning!
Before any assembly or connection work, discharge the frequency inverter. Verify that the frequency inverter is discharged.

Do not touch the terminals because the capacitors may still be charged.

Comply with the information given in the operating instructions and on the frequency inverter label.

Comply with the rules for working on electrical installations.

Rules for working on electrical installation:

- Separate completely (isolate the installation from all possible sources of electrical power.
- Fix (protect against reconnection). Reconnection must be carried out by suitably qualified persons.
- Verify there is no electrical power. Verify that there is no voltage against earth on the plant component by measuring with measurement device or voltage tester.
- Ground and connect in a short circuit. Connect earth conductors.
- Protect against nearby power sources and delimit the working zone.

1) In plants with a nominal power up to 1 kV deviation from description may be possible.

When working at the frequency inverters, comply with the relevant accident prevention regulations, the applicable standards, standards governing work on systems with dangerous voltages (e.g. EN 50178), directives for electrical and mechanical equipment erection and other national directives.
Comply with the electrical installation instructions given in the documentation as well as the relevant directives.
Responsibility for compliance with and examination of the limit values of the EMC product norm EN 61800-3 for variable-speed electrical drive mechanisms is with the manu-facturer of the industrial plant or machine. The documentation contains information on EMC-conforming installation.
The cables connected to the frequency inverters may not be subjected to high-voltage insulation tests unless appropriate circuitry measures are taken before.
Do not connect any capacitive loads.

1.6 Information on Use

Warning!

The frequency inverter may be connected to power supply every 60 s. This must be considered when operating a mains contactor in jog operation mode. For commissioning or after an emergency stop, a non-recurrent, direct restart is permissible.

After a failure and restoration of the power supply, the motor may start unexpectedly if the auto start function is activated.

If staff is endangered, a restart of the motor must be prevented by means of external circuitry.

Before commissioning and the start of the operation, make sure to fix all covers and check the terminals. Check the additional monitoring and protective devices according to EN 60204 and applicable the safety directives (e.g. Working Machines Act, Accident Prevention Directives etc.).

No connection work may be performed, while the system is in operation.

1.6.1 Using external products

Please note, that Bonfiglioli Vectron does not take any responsibility for the compatibility of external products (e.g. motors, cables, filters, etc.).
To ensure the best system compatibility, Bonfiglioli Vectron offers components which simplify commissioning and provide the best tuning with each other during operation.
Using the device in combination with external products is carried out at your own risk.

1.7 Maintenance and Service

Warning!

Unauthorized opening and improper interventions can lead to personal injury or material damage. Repairs on the frequency inverters may only be carried out by the manu-facturer or persons authorized by the manufacturer.

Check protective equipment regularly.

Any repair work must be carried out by qualified electricians.

1.8 Disposal

The dispose of frequency inverter components must be carried out in accordance with the local and country-specific regulations and standards.

2 Description of System VPLC

With the PLC functions (VPLC), external digital signals and internal logic signals of the frequency inverter can be combined with one another. Via analog and mathematical functions, analog signals can be influenced or compared, the results are available for output. PLC functions are also referred to as instructions.
The results of the instructions can be used by other device functions (e.g. comparator) or output via digital outputs. The results can also be used as input values by other instructions.
The instructions can be configured via function blocks in VPLC.
The functions are processed from index to index (I).

VPLC:

- Up to 32 functions are possible.
- Each function block describes an instruction.
- The processing order corresponds to the order of indices 1 to max. 32.

Input settings (digital)

- Via a **digital** input buffer, digital signal sources (e.g. run signal, error signal) and digital inputs (e.g. IN2D) can be assigned to the instruction inputs. The input buffer enables 16 entries.

Input settings (analog)

- Via an **analog** input buffer, analog signal sources (e.g. frequencies) can be assigned to the instruction inputs. Via the input buffers 4 inputs each can be selected for frequencies, percentages, currents and voltages.

Analog output settings

- Via an output buffer, the output values of the instructions can be made generally (globally) available and used by other functions (e.g. start clockwise, data set change-over) or output via the digital outputs of the device. Up to 16 signal sources can be used as **digital** output buffer, 24 signal sources can be used as **analog** output buffer.
- All output values of the instructions have defined values when the frequency inverter is initialized. They are FALSE (digital instructions) or have value 0 (analog instructions) for all instruction outputs and all output buffer values. Inverted instruction outputs will be TRUE after initialization.
- Processing of the instructions can be activated via button "Start PLC" and deactivated via button "Stop PLC".

Consistent data

The input buffer and output buffer guarantee consistent data during the run time.

Each instruction is described by:

- Instruction (digital: AND, OR etc., analog: addition, absolute value function, etc).
- Inputs: Inputs of the instructions (digital, analog or position).
- Function block settings: These parameters enable, depending on the selected instruction, setting of delay times, factors or jumps between functions, for example.
- Outputs of instructions: The value of an output can be moved to the output buffer and is now generally (globally) available to other device functions.

Each instruction has two outputs O1 and O2 (O2 = O1 inverted) or O1 = Low word and O2 = High word).
The output values of instructions can also be used as input values in other instructions.

Values are interpreted as Percentage value internal
Internal values of the frequency inverter are processed as percentage value. Frequencies, Currents and voltage are converted.
Also Input- and Output buffer convert into percentage values.

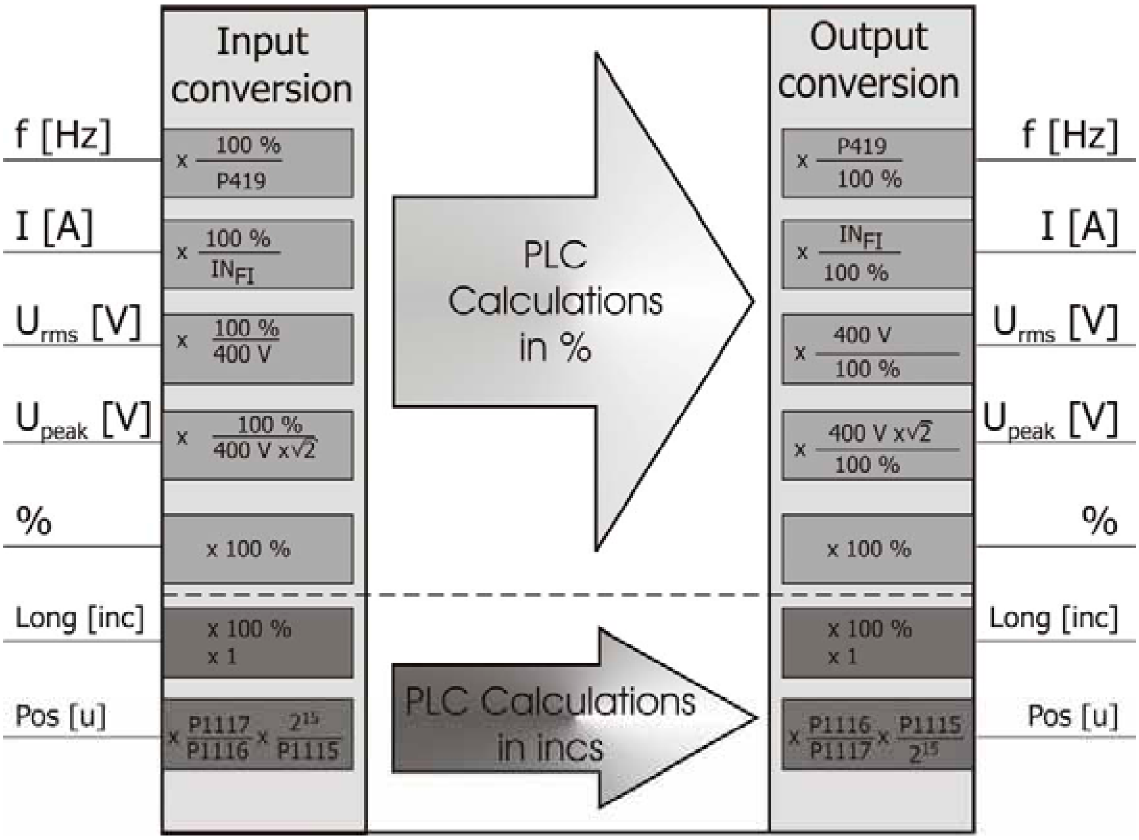
- Current: Refers to the inverter nominal current. The inverter nominal current refers to 100.00 %

- Frequency: Refers to *Maximum Frequency* **419**. *Maximum Frequency* **419** refers to 100.00 %
- Voltage: Refers to 400 V_{eff} (bzw. 400 √2 V_{peak}). The value refers to 100.00 %.

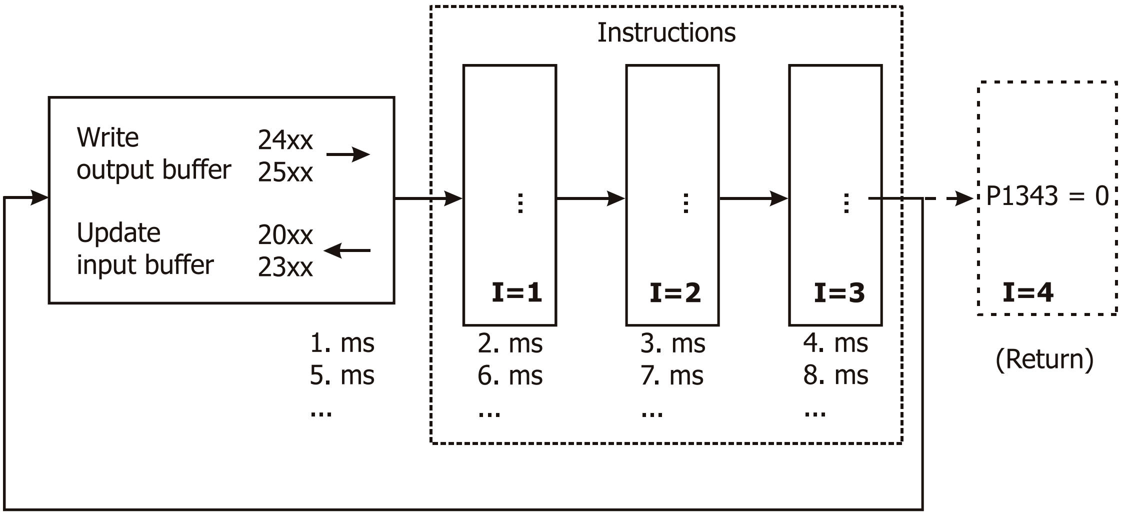
Mathematical functions use percentage values as input and output values.

Internal conversions

Internal values of the frequency inverter are processed as percentage value. Frequencies, Currents and voltage are converted.



2.1 Chronological processing



The instructions are processed cyclically. In the first step, the output buffer is written to the global variables, then the input buffer is written to the sources.

Then the instructions are processed, starting with Index 1.

A cycle is complete, if all used and successive instructions have been processed. Then the processing cycle is started again (write output buffer, update input buffer, index 1, index 2, …).

The processing time of each instruction is approx. 1 ms.
Additionally, 1 ms is required for writing the output signals 24xx/25xx and reading of input signals 20xx/23xx.
As a result, the cycle time is the total of instructions + 1 in milliseconds.

2.2 Creating a program with function blocks

2.2.1 Starting VPLC

In PC software VPlus click on button to start the editor for VPLC function blocks.

In menu Edit/VPLC settings, select the language for the user environment and the menu commands.

2.2.2 Saving a file

Click button to save the function block program as a VPLC file.

2.2.3 Function block (instruction)

Drag the required function blocks from the library into the editor window.

– Double-click the function block in order to set up an index for the function block.
– The function blocks are processed in the order of the indices.
– Wrong numbering will be reported by the syntax check .

– Depending on the function block, different settings are possible in fields P1 and P2.

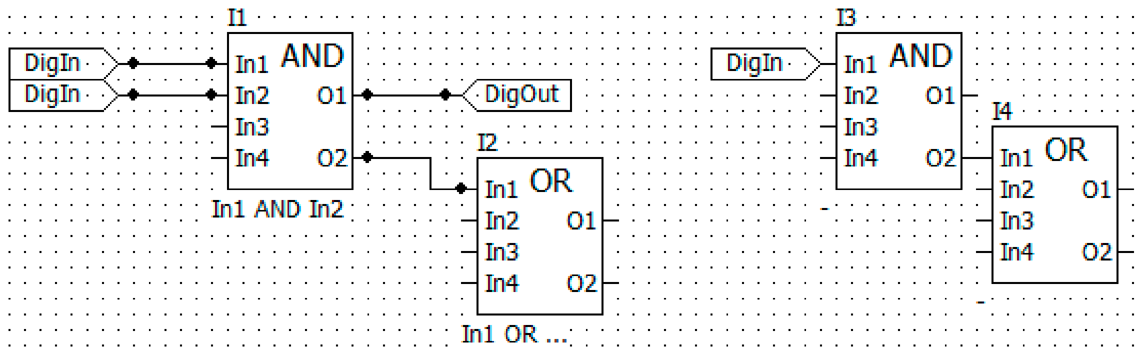
2.2.4 Wire

Using the wire tool to combine the blocks with one another in the editor.

– Use wire to connect the blocks for inputs and outputs to function blocks.
– Use wire to combine the function blocks with one another.

It is not possible to connect the connections of function blocks or inputs and outputs by arranging them on behind the other.

Correct connection Incorrect



– If the wire is shown in grey after the combination, the combination must be checked.

2.2.5 Digital input block

Combining a digital function block input with a digital input (terminal) or a frequency inverter control signal:

- Drag a block DigIn from the library to the function block input.
- Double-click the block DigIn.
- Select an input buffer for the PLC signal.
- As the global source, select the digital input or control signal to be applied to the functional module input.

2.2.6 Analog input block

Combining an analog function block input to a analog input (terminal) or a frequency inverter signal:

- Drag a block "Analog In" from the library to the function block input.
- Double-click the block "Analog In".
- Select a physical quantity or percent for the PLC signal.
- Select percent if a signal at the analog input (terminal) of the frequency inverter is to be applied to the function block input.
- As the global source, select the signal to be applied to the functional module input.

2.2.7 Digital output block

Combining a digital function block output with a device function or a digital output (terminal):

- Drag a block DigOut from the library to the function block output.
- Double-click the block DigOut. Select an output buffer.

Example:

Selected output buffer	Signal source for device function	Example of device function
1	2401	*Start Anticlockwise* **69** = 2401 – PLC-Output buffer 1
4	2404	*Error acknowledgment* **103** = 2404 – PLC-Output buffer 4
	Signal source for digital output (terminal)	Example of digital output (terminal)
1	80	AgilE: *Operation mode OUT1D (X13.5)* **531** = 80 – PLC-Output buffer 1
4	83	ACU: *Operation mode digital output 1* **530** = 83 – PLC-Output buffer 4

2.2.8 Analog output block

Combining an analog function block output with a device function or an analog output (terminal):

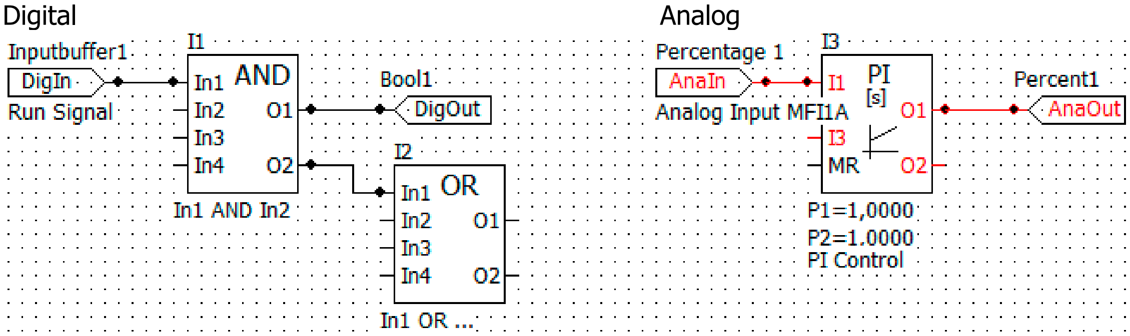
- Drag a block "Analog Out" from the library to the function block output.
- Double-click the block "Analog Out". Select an output buffer.

Example:

Selected output buffer	Signal source for device function	Example of device function
2	2502	AgilE: *Reference frequency source1* **475** = 2502 – PLC output frequency 2
	Signal source for analog output (terminal)	Example of analog output (terminal)
1	61	AgilE: *Analog: Source MFO1A* **553** = 61 – Abs. value PLC outp. percent 1

2.2.9 Example

Digital | Analog



Digital	Analog
Run Signal as Input Signal Output O1 via output buffer (Bool1).	Analogue input MFI1A as input value (Percentage 1). Output O1 via buffer Percentage 1 (Percent1).

2.2.10 Syntax check

Start the syntax check by clicking button . In the syntax check window, click on the error message in bottom area. The cause of the error is marked in the editor window.

2.2.11 Translation and download (to frequency inverter)

Click button to translate the function block program to parameter settings and download them to the frequency inverter. Only if this function executed will the data in the frequency inverter be changed. The syntax must be free from errors.

Before the translation and download, stop the PLC by clicking button .

2.2.12 Starting the PLC

Run the function block opened in the editor by clicking on button .

2.2.13 Stopping the PLC

Stop the started function block by clicking on button .

2.3 User environment

2.3.1 Tool bar and menu commands

		Function	Menu command
	New file	Create a new VPLC file.	File → New
	Open VPLC file	Open an existing VPLC file.	File → open
	Save file	Save the program created by means of function block as a VPLC file.	File → Save
	Select	Select function blocks or wire in editor.	–
	Place function block	Place function block selected in the library in the editor.	–
	Wire tool	Connect function block to one another or to inputs/outputs.	–
	Add comment	Insert a text field for comments in the editor.	–
	Undo	Undo the last action. Up to 16 actions can be undone.	Edit → Undo
	Redo	Redo a function undone before.	Edit → Redo
100%	Zoom	Increase or reduce the view in the editor.	–
	Syntax check	Check the function block program for errors. Click on the error message to mark the cause of the error in the editor.	–
	Translate and download	Translate the function block program to parameter values and download them to the frequency inverter.	PLC → Translate and download to frequency inverter
	Stop PLC	Stop the function block program.	–
	Start PLC	Start the function block program.	–

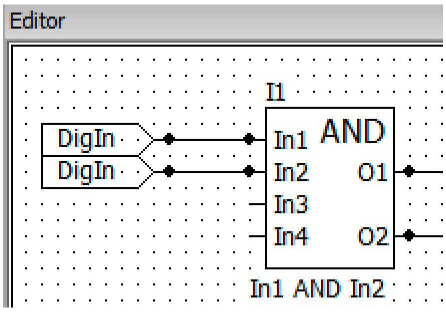
2.3.2 Other menu commands

Function		Menu command
Save a VPLC file under a new file name.		File → Save as
Export a VPLC file to a VCB file. The VCB file containing the parameter values created by the PLC functions can be edited in VPlus.		File → Export to VCB
Opens the print setup window. Prints the editor area.		File → Print
Adjust the page size of the editor.		File → Page setup
View the page as it will be when printed.		File → Print preview
Select all objects in editor.		Edit → Select all
Opens the VPLC setup window:		Edit → VPLC setup
Interface:	VPlus (auto) is displayed if VPLC was started in VPlus (default setting). COM: The available interfaces are displayed. Only if VPLC is started without VPlus.	
Language:	Select the language of the user environment and the menu commands.	
Apply texts from inverter:	The language selected at the frequency inverter is applied to the signal sources in VPLC.	
Show parameter values:	The values of fields P1 and P2 of the function block settings will be displayed below the function block.	
Sheet size:	Adjust the page size of the editor.	
The changes made with VPLC are deleted in the frequency inverter and reset to the default settings.		PLC → Delete
Apply the function block program to parameter values and download them to the frequency inverter. While edited in the editor, the function block program is not changed in the frequency inverter. Changes will only be applied to the frequency inverter by this command.		PLC → Translate and download to frequency inverter

Note:
Working on the sheet doesn't change the program inside the frequency inverter. Only via the Download Command the changes of the PLC program are loaded to the frequency inverter.

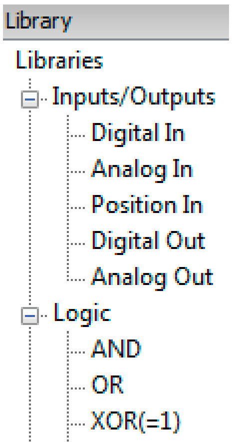
2.3.3 Editor

In the editor, PLC programs are displayed graphically.



2.3.4 Library

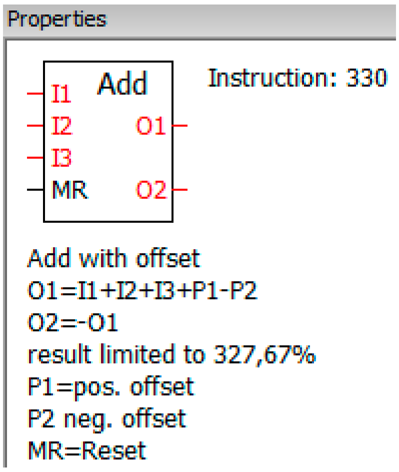
From the library, the blocks for inputs and outputs and function blocks can be dragged to the editor window.
Alternatively, you can click button "Activate function block". In this way, the function block selected in the library can be inserted in the editor window.



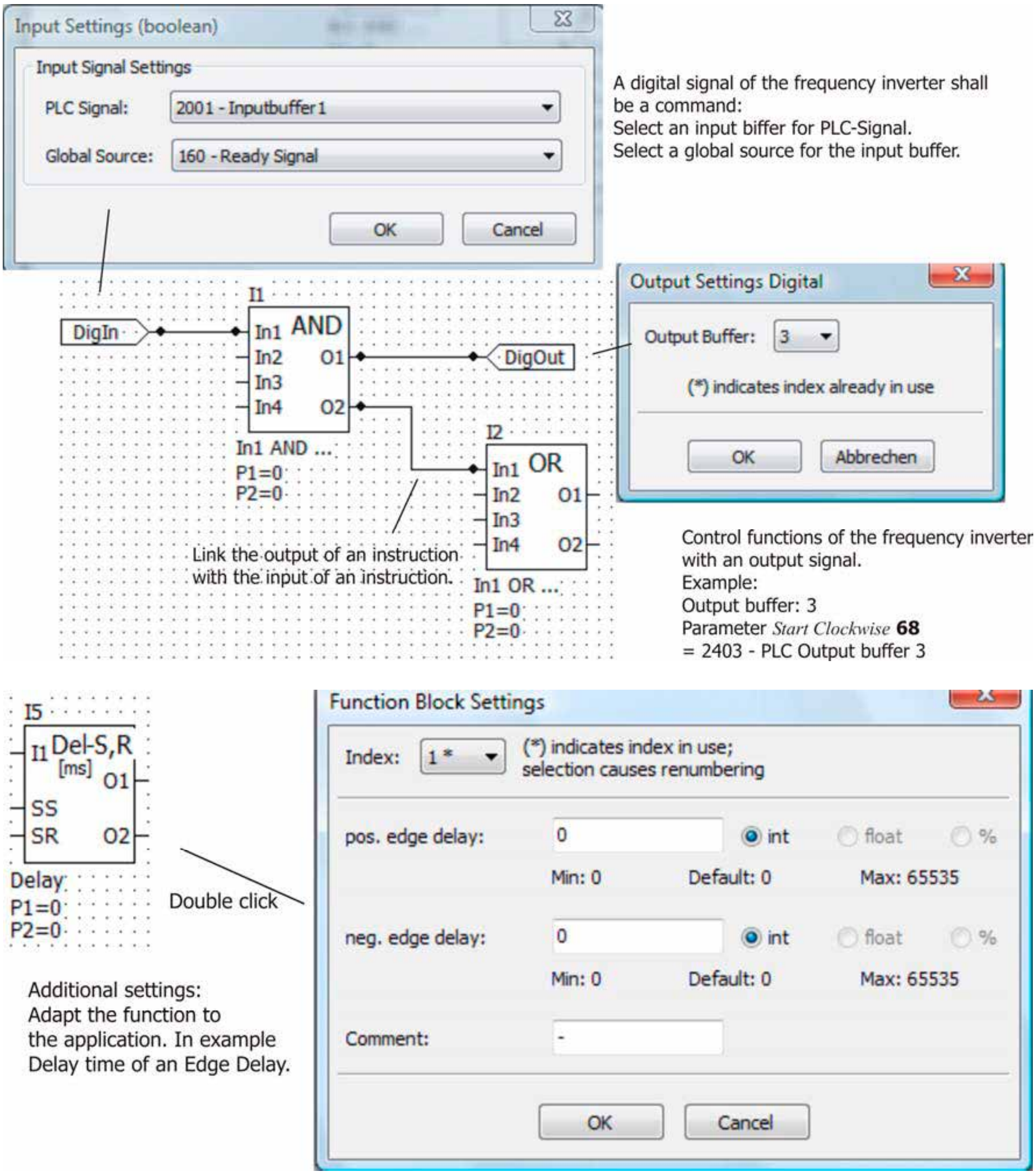
2.3.5 Properties

The properties of the function block selected in the library will be displayed.

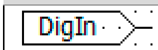
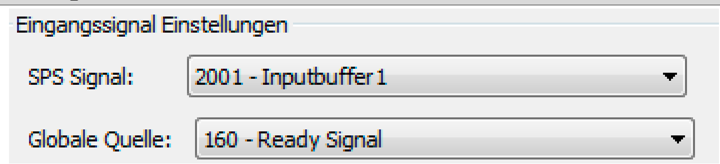
– Number of instruction
– Function of inputs (I) and outputs (O) of instruction
– Function of input fields P1 and P2. Via P1 and P2, the function block can be adjusted to the application.

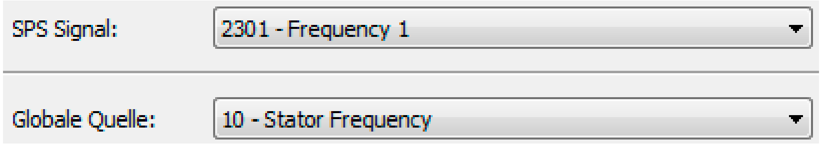
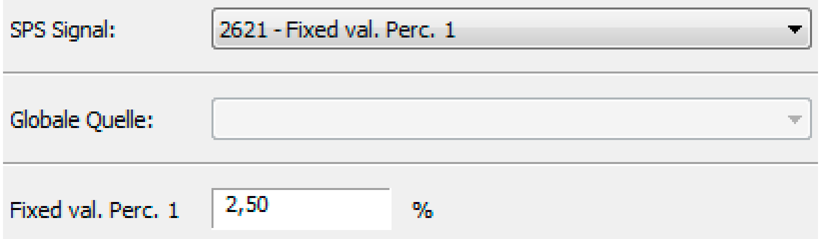


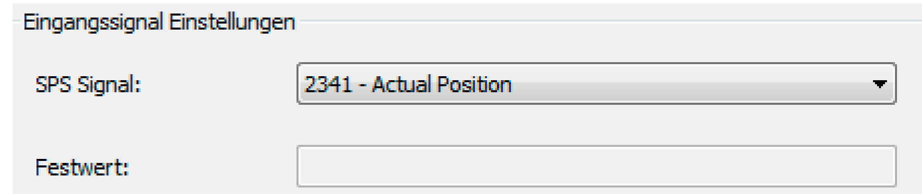
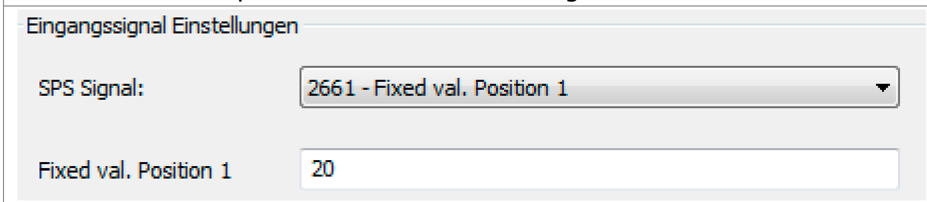
2.3.6 Settings: Inputs, outputs and function block

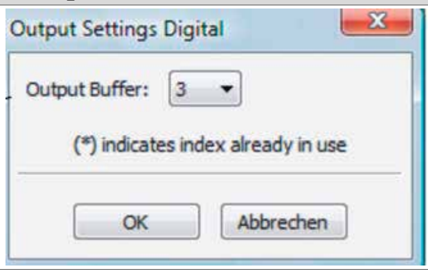


In the editor, double-click a block. The dialog window will be opened.

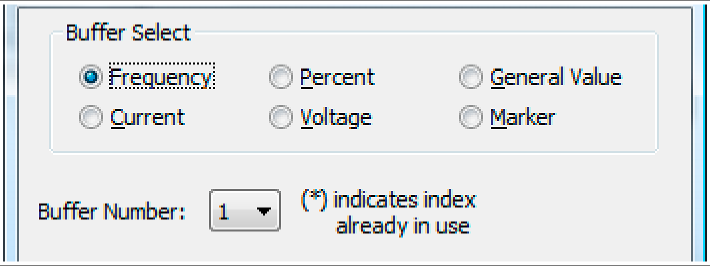
Block	Dialog window
	
	Assign a digital signal at the control terminals of the frequency inverter or a control signal to an input of a digital function block. • Select an input buffer for the PLC signal. • Select a digital signal as the global source.

Block	Dialog window
AnaIn	
	Assign an analog signal at the control terminals of the frequency inverter or an analog quantity (frequency, current, voltage or percentage) to an input of an analog function block. • Select an analog quantity for the PLC signal. • Select an analog signal of the frequency inverter as the global source.
	
	Enter a fixed analog value.

Block	Dialog window
PosIn	
	Assign the actual position value to an input of a function block. • Select the position value for the PLC signal.
	
	Assign a fixed position value to an input of a function block. • Select a signal source for the fixed value for the PLC signal. • Enter a fixed position value.

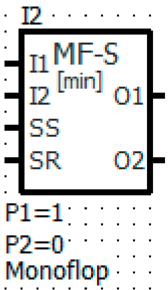
Block	Dialog window
DigOut	
	Write the output signal of a digital function block to the output buffer. With the output signal of the function block, this enables controlling device functions of the frequency inverter. Output buffers 1 to 16 correspond to signal sources PLC output buffer 2401 to 2416. Select the corresponding signal source for a device function.

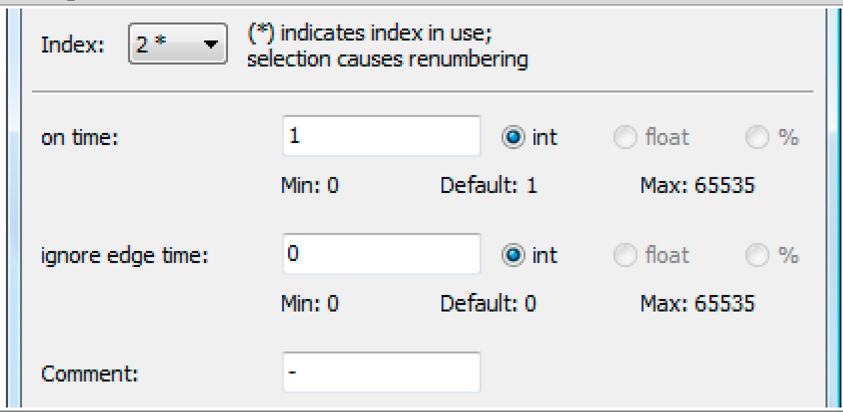
Block | Dialog window



Write the output signal of an analog function block to the output buffer. Output buffers 1 to 4 correspond to signal sources 25xx. The signal sources can be used for analog inputs of other function blocks or combined with device functions.
Percent Buffer Number 1 and 2 can be output via analog control terminals of the frequency inverter. Select Signal Source 61 – Amount PLC output 1 (Percent Buffer Number 1) or 62 - Amount PLC output 2 (Percent Buffer Number 2) for the parameter of the analog output. Signal sources 161 and 162 have a sign.

Block | Dialog window





The index (I) determines the order in which the instructions are processed.
Adjust the function block to the application via input fields P1 and P2. The functions of P1 and P2 depend on the function block.
In some instructions (i.e. mathematical operations) P1 and P2 can be display as Float, % or Int(ernal).
Changing the display does not change the value. For mathematical operations % or Float is recommended.
For Times (i.e. Monoflop) the internal Notation Int is recommended.

Correlation:

%	Float	Int
123.45 %	1.2345	12345

2.4 Starting the PLC functions

By default (factory setting), the PLC functions are stopped and must be started by clicking button "Start PLC". In stop mode, no instructions are processed and the output buffer is not written.
Run the following menu commands:

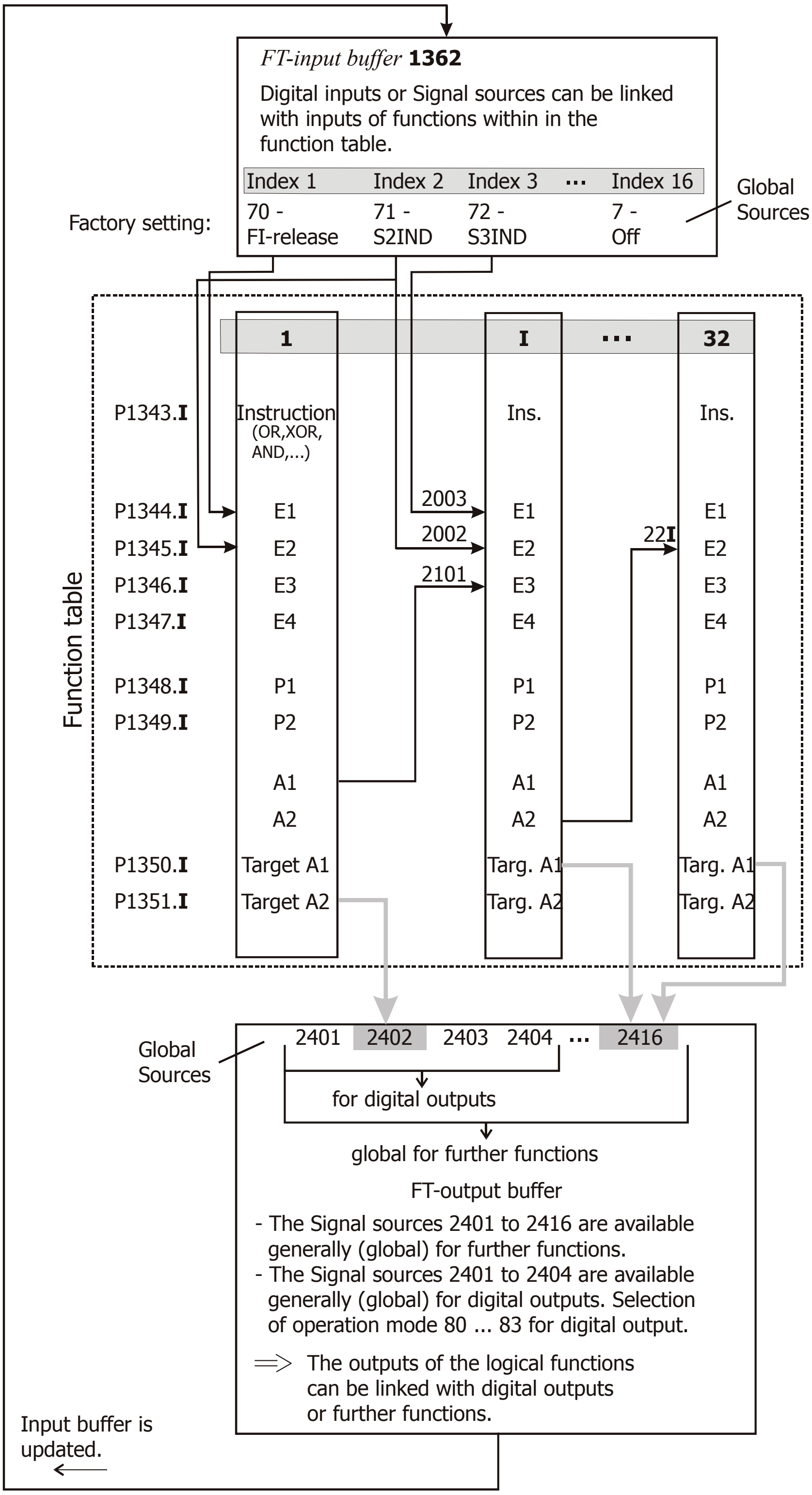
– Syntax check
– Translation and download (to frequency inverter)
– Start PLC

Note:
Instructions can only be edited in stop mode.

2.5 Principle for digital functions (input settings [Boolean])

The digital function processing principle is shown in the following diagram. The digital input buffer comprises 16 PLC signals which can be assigned to global sources. The values in the input buffer are available to the instructions as sources.
The instructions can be combined with up to 4 input values. The outputs of the instructions can be used as inputs of other instructions (non-negated outputs O1 and negated outputs O2).
The instructions are processed one after the other, starting with instruction 1. When the processing cycle jumps back to start, the output buffer is written and the input buffer is updated.
Jump functions enable branching off to certain instructions (indices). The instruction parameters of the jump function additionally enable selective writing of the output buffer and updating of the input buffer.

Digital signal sources for the inputs of digital instructions



Abbreviations used:

I:	Index of instruction (1 ... 32)
In:	Input of an instruction
O1, O2:	Outputs for combinations with other instructions or outputs for global combinations

At first, the output buffer is updated. Then, the input buffer is updated. The values of the global sources are applied to the output buffer. Then, the global input values in the input buffer are updated.

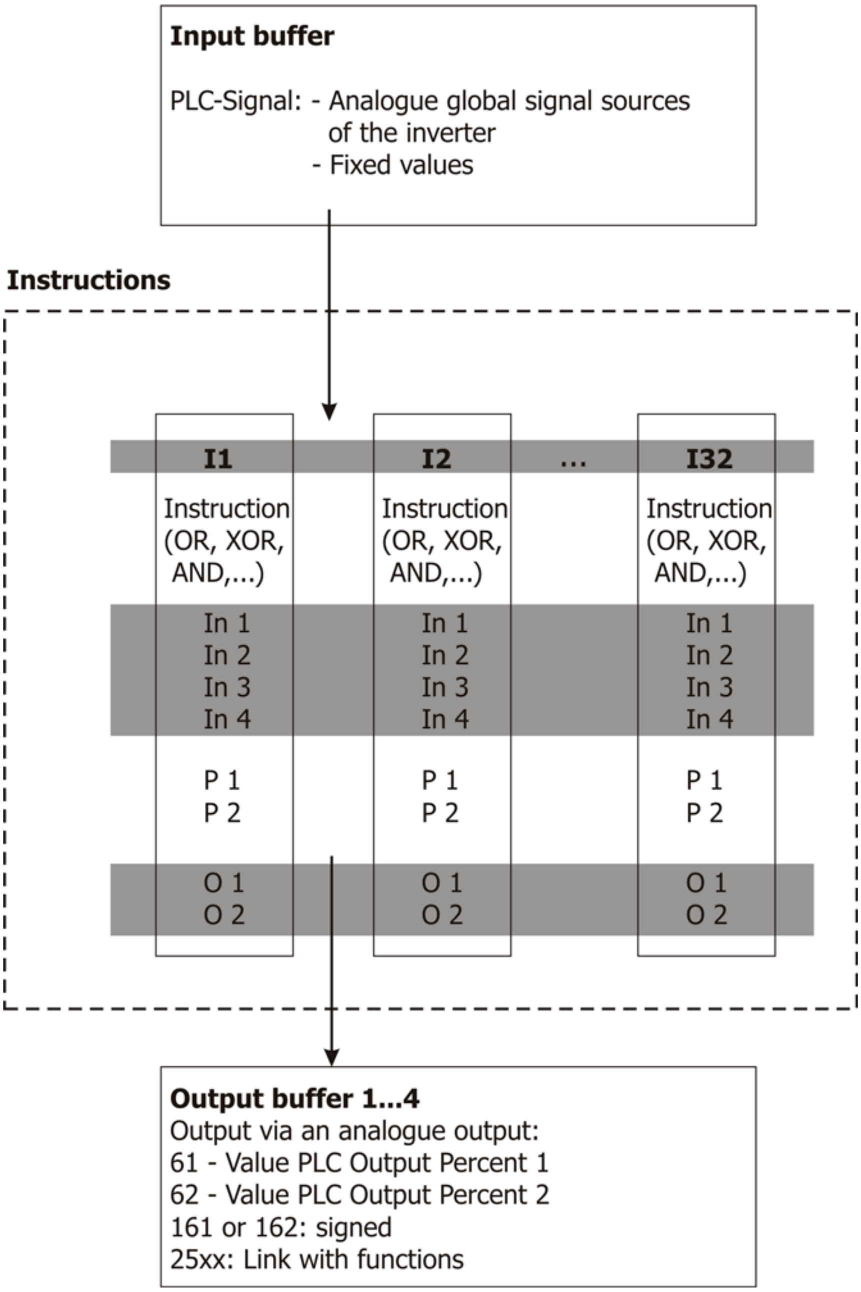
2.6 Principle for analog functions

The analog function processing principle is shown in the following diagram. The analog input buffer comprises fixed values or PLC signals which can be assigned to global signal sources. The values in the input buffer are available to the inputs of the instructions as sources.
Depending on the type of instructions, two function block settings (P1 and P2) are used for adjusting special instruction functions. The outputs of the instructions can be used as inputs by other functions).
In addition, the outputs can be used as a source for global variables.
The instructions are processed one after the other, starting with instruction 1. When the processing cycle jumps back to start, the output buffer is written and the input buffer is updated.
Jump functions enable branching off to certain instructions (indices). The settings of the jump function additionally enable selective writing of the output buffer and updating of the input buffer.

Analog functions can process the following values:

- Frequency
- Current
- Percent
- Voltage
- Position
- Positioning ramp gradient

Analog signal sources and fixed values for the inputs of analog instructions and the output signals of the instructions



Abbreviations used:

I:	Index of instruction (1 … 32)
In:	Input of an instruction
O1, O2:	Outputs for combinations with other instructions or for global combinations (e.g. output via an analog output of the frequency inverter)

2.7 Input buffer and output buffer for digital signals

Input buffer:
The input buffer is updated and the output buffer is written at a defined point of time. In this way it is ensured that the processing within a cycle in performed based on the same input data and inconsistent statuses are avoided.

Output buffer:
For digital outputs (control terminals) of the device, signal sources 2401 to 2404 are available (corresponds to operation modes 80 … 83 for digital outputs). Operation modes 2401 to 2416 are available to other functions, e.g. comparators.

At the start of a cycle, the input buffer is read and kept in the memory until the next return jump. Then, the instructions are processed. The output buffer is written at the end of the cycle and is available in the global sources after that.
By selective use of the jump function, the input buffer and output buffer can be updated either separately or jointly. This enables setting the digital output signals at certain times (selected by the user) during the processing.

Note:
The input and output buffers are set and written during the **return jump**. This is done in one processing cycle. The output buffer is written **first**, **after that** the input buffer is set.

2.8 Input buffer and output buffer for analog signals

The input buffer is updated and the output buffer is written at a defined point of time. In this way it is ensured that the processing within a cycle in performed based on the same input data and inconsistent statuses are avoided.

- Consistent values; values of identical points of time are processed
- Clear arrangement thanks to limited number of signals
- Conversion to percent values; functions process percent values
- Four indices

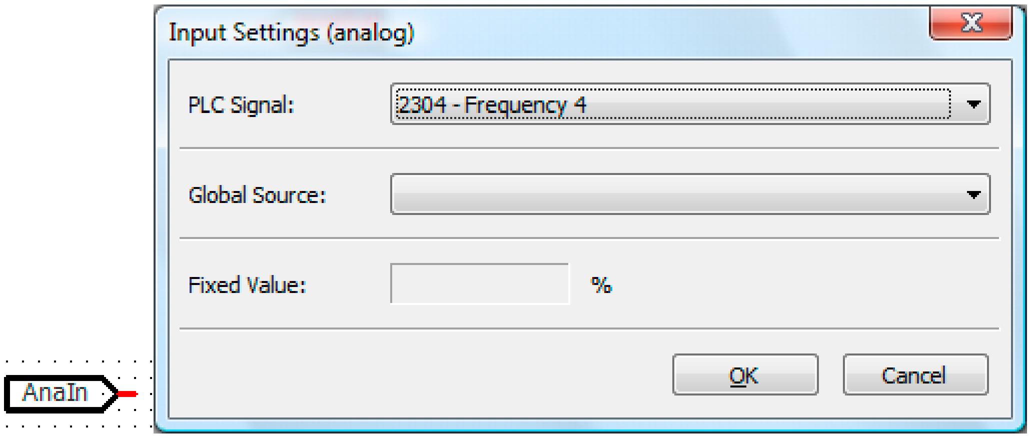
In order to write an analog output, you will have to select an output buffer first. Then, the signal must be assigned to the device function.
For analog outputs of the device, the following operation modes are available:

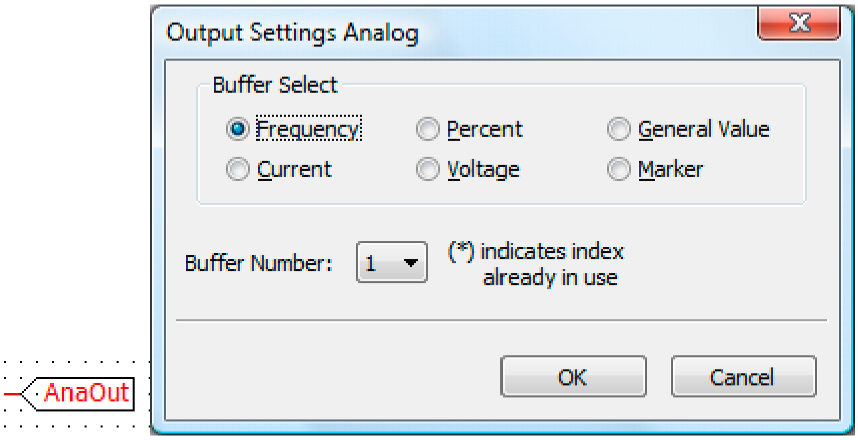
- 61 – "Abs. value PLC outp. percent 1"
- 62 – "Abs. value PLC outp. percent 2"
- 161 – "PLC outp. percent 1"
- 162 – "PLC outp. percent 2"

Based on these values, the input buffer is read at the start of a cycle and kept in the memory until the end of the cycle. Then, the instructions are processed. The output buffer is written at the end of the cycle and is available in the global sources after that. When the input buffer is updated, the output buffer is updated and the cycle restarts.
By selective use of the jump function, the input buffer and output buffer can be updated either separately or jointly. This enables setting the output signals at certain times (selected by the user) during the processing.

The output values of instructions can be saved in the following signal sources of the output buffer. The signal sources 25xx can be used as input values by other instructions.

Signal sources of output buffer	
2501 ... 2504	Output frequency buffer number 1...4
2511 ... 2514	Output current buffer number 1...4
2521 ... 2524	Output percent buffer number 1...4
2531 ... 2534	Output voltage buffer number 1...4
2551 ... 2554	Output general value buffer number 1...4
2561 ... 2564	Output flag buffer number 1...4

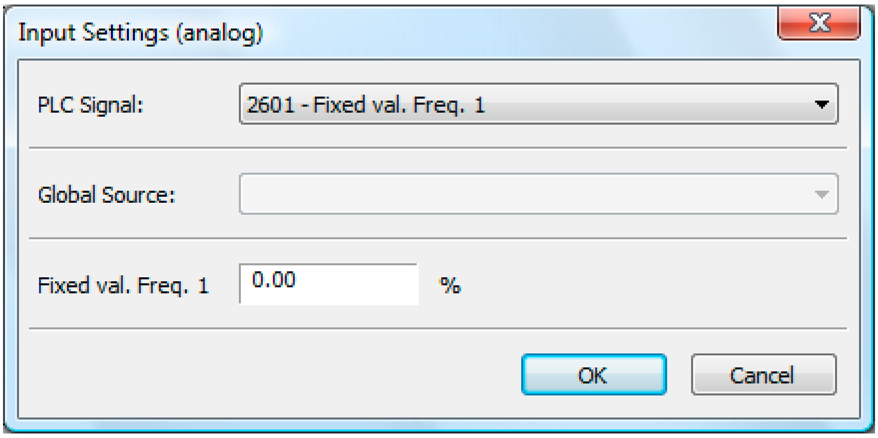




2.8.1 Fixed analog values

For the fixed values of the input buffer, values for physical quantities can be entered.

No.	Fixed value
2601...2604	Fixed frequency values
2611...2614	Fixed current values
2621...2624	Fixed percent values
2631...2644	Fixed voltage values
2651...2654	Fixed general values



For PLC signal Fixed General Value of the input buffer, values without physical unit can be entered. The setting range is -327.68% … +327.68%.

3 Overview of instructions

- C is a configurable constant value.
- V is a variable input value.
- P1 and P2 are input fields in the function block setup for adapting the function to the application

Digital functions		
0 -	Off (last table item)	Return jump to Instruction 1 (in Index 1). Last function processed in function table. See chapter 2.1.
Boolean operations		**Digital functions**
1 -	AND	Up to 4 inputs are AND combined with one another. Output is TRUE if all inputs are TRUE. See chapter 0.
2 -	OR	Up to 4 inputs are OR combined with one another. Output is logic TRUE if at least one input is TRUE. See chapter 4.3.2.
3 -	XOR (=1)	Up to 4 inputs are EXCLUSIVE OR-combined with one another. Output is TRUE only if exactly one input is TRUE. See chapter 4.3.3.
4 -	XOR (=1)||(=3)	Up to 4 inputs are EXCLUSIVE OR-combined with one another. The output is TRUE if TRUE is present on an odd number of inputs. The output is FALSE if TRUE is present on a straight number of inputs. See chapter 4.3.4.
Flip-Flop types		**Digital functions**
10 -	RS-Flip-Flop Superior	Input 1: Set; TRUE sets output to TRUE. Input 2: Reset; TRUE sets output to FALSE. Input 3: Superior Set; TRUE sets output to TRUE. Input 4: Superior Reset; TRUE sets output to FALSE. FALSE at Set and Reset: Last output signal state is maintained. See chapter 4.4.1.
20 -	Toggle Flip-Flop Superior	Output signal changes with the positive pulse edge at input 1 or with the negative pulse edge at input 2. TRUE at Superior-Set input (input 3) sets output TRUE. TRUE at Superior Reset input (input 4) sets output FALSE. See chapter 4.4.3.
30 -	D Flip-Flop Superior	If a positive edge is received at input 1 (clock pulse input C, Clock) the signal present at input 2 (data input D) is transferred to the output. TRUE at Superior-Set input (input 3) sets output TRUE. TRUE at Superior Reset input (input 4) sets output FALSE. See chapter 4.4.5.
Delays		**Digital functions**
40 -	Delay Superior ms (retriggerable)	The positive edge at input 1 is delayed by the time set in P1 and the negative edge is delayed by the time set in P2 before switching them through to the output. The delay time starts again with each edge. Times are indicated in milliseconds [ms]. TRUE at Superior-Set input (input 3) sets output TRUE. TRUE at Superior Reset input (input 4) sets output FALSE. See chapter 4.5.1.
41 -	Delay Superior s (retriggerable)	As in operation mode 40, the unit of the times set in P1 and P2 is seconds [s]. See chapter 4.5.1.
42 -	Delay Superior min (retriggerable)	As in operation mode 40, the unit of the times set in P1 and P2 is minutes [min]. See chapter 4.5.1.
50 -	Delay Superior ms (non-retriggerable)	The positive edge at input 1 is delayed by the time set in P1 and the negative edge is delayed by the time set in P2 before switching them through to the output. During the delay time, edges will be ignored. Times are indicated in milliseconds [ms]. TRUE at Superior-Set input (input 3) sets output TRUE. TRUE at Superior Reset input (input 4) sets output FALSE. See chapter 4.5.3.
51 -	Delay Superior s (non-retriggerable)	As in operation mode 50, the unit of the times set in P1 and P2 is seconds [s]. See chapter 4.5.3.

52 -	Delay Superior min (non-retriggerable)	As in operation mode 50, the unit of the times set in P1 and P2 is minutes [min]. See chapter 4.5.3.
Timer functions		**Digital functions**
60 -	Monoflop Superior ms (retriggerable)	Output signal becomes TRUE with positive clock edge at input 1 or with negative clock edge at input 2. The time set in P1 is the On-Time (High) and the time set in P2 is the ignore edge time (Low). The time is indicated in milliseconds [ms]. The set on-time and the ignore edge time start again with each edge. TRUE at Superior-Set input (input 3) sets output TRUE. TRUE at Superior Reset input (input 4) sets output FALSE. See chapter 4.6.1.
61 -	Monoflop Superior s (retriggerable)	As in operation mode 60, the unit of the times set in P1 and P2 is seconds [s]. See chapter 4.6.1.
62 -	Monoflop Superior min (retriggerable)	As in operation mode 60, the unit of the times set in P1 and P2 is minutes [min]. See chapter 4.6.1.
70 -	Monoflop Superior ms (non-retriggerable)	Output signal becomes TRUE with positive clock edge at input 1 or with negative clock edge at input 2. The time set in P1 is the On-Time (High) and the time set in P2 is the ignore edge time (Low). The time is indicated in milliseconds [ms]. Edges during the selected ON time and the ignore edge time will be ignored. TRUE at Superior-Set input (input 3) sets output TRUE. TRUE at Superior Reset input (input 4) sets output FALSE. See chapter 4.6.3.
71 -	Monoflop Superior s (non-retriggerable)	As in operation mode 70, the unit of the times set in P1 and P2 is seconds [s]. See chapter 4.6.3.
72 -	Monoflop Superior min (non-retriggerable)	As in operation mode 70, the unit of the times set in P1 and P2 is minutes [min]. See chapter 4.6.3.
80 -	Clock generator Superior ms	As long as input 1 is TRUE and input 2 is FALSE, the set pulse pattern is output. The clock pattern is defined by the on-time and the off-time. The time set in P1 is the on-time (High) and the time set in P2 is the off-time (Low). The time is indicated in milliseconds [ms]. TRUE at Superior-Set input (input 3) sets output TRUE. TRUE at Superior Reset input (input 4) sets output FALSE. See chapter 4.6.5.
81 -	Clock generator Superior s	As in operation mode 80, the unit of the times set in P1 and P2 is seconds [s]. See chapter 4.6.5.
82 -	Clock generator Superior min	As in operation mode 80, the unit of the times set in P1 and P2 is minutes [min]. See chapter 4.6.5.
Digital switches		**Digital functions**
90 -	Digital Multiplexer	Depending on the current data set, the input values are forwarded to the output values Data set = 1: Output 1 = Input 1, Data set = 2: Output 1 = Input 2, Data set = 3: Output 1 = Input 3, Data set = 4: Output 1 = Input 4 See chapter 4.7.1.
91 -	Dataset changeover	Switching-over of data set depending on input signals. See chapter 4.8.1.
Error functions		**Digital functions**
95 -	Triggering of an error.	A user error is triggered via one of the inputs I1 … I4. The behavior (error cut-off, shut-down, emergency stop) after triggering can be set up via P2. See chapter 4.9.1.
96 -	Acknowledging an error.	Output 1 indicates if an acknowledgeable error message is present. Via inputs I1 or I2, the error message can be acknowledged. See chapter 4.9.2.
Zero operation		**Digital functions**
99 -	NOP	Zero operation. The function does not carry out an operation. See chapter 4.11.1.

Jump function		**Digital functions**
100 -	Jump function	Branching off to index (table column). See chapter 4.12.1.
101 -	Jump function for loops	A function indicated as jump target in P1 is executed as often as indicated in P2. Via the inputs , the loop can be stopped or restarted. See chapter 4.12.2.
110 … 182		Like instruction types 10 … 82. Evaluation of Master-Set/Master-Reset instead of Superior-Set/Superior-Reset.
Analog functions:		
Debouncer		**Analog functions:**
97 -	Debouncer	The input value will be forwarded to the output only if it has had a constant value for the configured delay (P1: pos. edge, P2: neg. edge).See chapter 4.10.1.
Bit functions for analog input values		**Analog functions:**
200 -	Bit NOT operation	At output 1 O1, the bitwise inverted value of input I1 is output. See chapter 5.11.1.
201 -	Bit AND/NAND operation	The input value at I1 is AND combined. Via P2, you can select: P2=1: Combination with input value I2 P2=2: Combination with a mask permanently set up in P1, P2=3: Combination with I2 and P1 See chapter 5.11.3.
202 -	Bit OR/NOR operation	The input value at I1 is OR combined. Via P2, you can select: P2=1: Combination with input value I2 P2=2: Combination with a mask permanently set up in P1, P2=3: Combination with I2 and P1 See chapter 5.11.2.
203 -	Bit XOR/XNOR operation	The input value at I1 is Exclusive-OR combined. Via P2, you can select: P2=1: Combination with input value I2 P2=2: Combination with a mask permanently set up in P1, P2=3: Combination with I2 and combination of result with P1 See chapter 5.11.4.
210 -	Bit shift right	The input value at I1 is shifted to the right bitwise by the number of shifts (P2). Left side is filled with zeroes. See chapter 5.11.5.
211 -	Bit arithmetical shift right	The input value at I1 is shifted to the right bitwise by the number of shifts (P2). The most significant bit (sign bit) is maintained. See chapter 5.11.6.
212 -	Bit shift left	The input value at I1 is shifted to the left bitwise by the number of shifts (P2). Right side is filled with zeroes. See chapter 5.11.7.
213 -	Bit roll right	The input value at I1 is shifted to the right bitwise by the number of shifts (P2). On the left side, the bits leaving on the right side will be inserted. See chapter 5.11.8.
220 -	Output one bit	A selected bit of input value 1 is output at output 1. The bit is selected via P1. See chapter 5.11.9.
221 -	Unite four bits to form a word	The state of input 1 is copied to the bit of the output specified via P1, the state of input 2 to the next bit, etc. See chapter5.11.10.
222 -	Add two bits to a word	The states at inputs I2 and I3 are inserted in certain bits of the input value 1. The bits are defined by P1 and P2. See chapter 5.11.11.
Comparators		**Analog functions**
301 -	Comparator (2 inp.)	Input values I1 and I2 are compared. Via P1 and P2, a hysteresis can be adjusted. See chapter 5.2.1.
302 -	Comparator (2 inp.), absolute value	Like operation mode 301, but the absolute values at inputs I1 and I2 are compared. See chapter 5.2.1.
303 -	Comparator (inp. with const.)	Two switching thresholds are adjusted. If the upper threshold P1 is exceeded, the output is switched on. If the lower threshold P2 is deceeded, the output is switched off. See chapter 5.2.2.
304 -	Comparator absolute value inp. with const.	Like operation mode 303, but the absolute value at input I1 (variable) is compared to switching thresholds P1 and P2 (constants). See chapter 5.2.2.

308 -	Comparator, active motion block	A motion block range is set up and it is checked if a motion block from this area is active in the case of table positioning. O1 is TRUE if a motion block from range P1 to P2 (motion block from … to …) is active. See chapter 5.2.3. Not available for all device series.
309 -	Comparator (Position)	Input values I1 and I2 are compared. Via P1 and P2, a hysteresis can be adjusted. Suitable for position values. See chapter 5.2.4.
310 -	Analog hysteresis	Signal at I3 saves actual value at I1. Via I2 (variable) and P1 (constant), a hysteresis can be set up. If the value of I1 is within the hysteresis, the saved value is output. If the value of I1 is outside of the hysteresis, the current value of I1 is output. See chapter 5.2.5.
311 -	Window comparator (2V)	It is checked if I1 is in the adjusted range (window) around I2. See chapter 5.2.6.
312 -	Window comparator (2V), absolute value	Like operation mode 311, but the absolute values of inputs I1 and I2 are compared. See chapter 5.2.6.
313 -	Window comparator (VC)	A value range (window) is adjusted and it is checked if I1 is within this constant range. See chapter 5.2.7.
314 -	Window comparator (VC), absolute value	Like operation mode 313, but the absolute value of input I1 (variable) is compared to window values P1 (constant) and P2 (constant). See chapter 5.2.7.
320 -	Min / Max	Based on variables I1 and I2 as well as the constants P1 and P2, the minimum or maximum value is determined and output at O1. See chapter 5.2.8.
321 -	Min / Max for position values	Based on variables I1 and I2 (position values) as well as constants P1 and P2, the minimum or maximum value is determined and output. See chapter 5.2.9.
322 -	Min / Max in time window	One of the following values is output at output O1: – the minimum input value at I1 determined over a certain period of time – the maximum input value at I1 determined over a certain period of time – the current input value at I1 See chapter 5.2.10.
323 -	Min / Max in time window for positions	One of the following values is output: – the minimum position value at I1 determined over a certain period of time – the maximum position value at I1 determined over a certain period of time – the current position value at I1 See chapter 5.2.11.
Mathematical functions		**Analog functions**
330 -	Addition with offset	The input values at I1 and I2 are added up and the input value I3 is subtracted. Via P1 and P2, you can specify a positive offset (is added to the result) and a negative offset (is subtracted from the result), respectively. See chapter 5.3.1.1.
331 -	Addition position with offset	The input values at I1 (Long) and I2 (Long) are added up and the input value I3 (Long) is subtracted. In addition, an offset can be specified via P. See chapter 5.3.1.2.
332 -	Multiplication	The input values at I1 and I2 as well as parameter value P1 are multiplied. See chapter 5.3.2.1.
333 -	Multiplication by long result	The input values at I1 and I2 as well as parameter value P1 are multiplied. The result is divided into low-word and high-word and output at outputs O1 and O2. See chapter 5.3.2.2.

334 -	Multiplication by fraction	The input value at I1 is multiplied by the parameter value P1 and divided by parameter value P2. See chapter 5.3.2.3.
335 -	Multiplication long with per-cent	The input value at I1 (long) is multiplied by the parameter value I2 (percentage) and divided by parameter value P2. See chapter 5.3.2.4.
336 -	Division	The input value at I1 is divided by the input value at I2 and the input value at I3. See chapter 5.3.3.1.
337 -	Division by const.	The input value at I1 is divided by the parameter value P1. See chap-ter 0.
338 -	Reciprocal	The parameter value P1 is divided by the input value at I1. See chap-ter 5.3.3.3.
339 -	Multiplication and division	The input value at I1 is multiplied by the input value at I2 and the result is divided by the input value at I3. See chapter 5.3.4.
340 -	Average	The average is calculated from the input values at I1, I2 and I3. See chapter 5.3.5.
341 -	Absolute value 2D vector	The absolute value is formed from the orthogonal (square-angle) input values at I1 and I2. See chapter 5.3.6.
342 -	Absolute value 3D vector	The absolute value is formed from the orthogonal (square-angle) input values at I1, I2 and I3. See chapter 5.3.7.
350 -	Integrator	The input value at I1 is integrated. See chapter 5.3.8.
351 -	Differentiator	The input value at I1 is differentiated. See chapter 5.3.9.
360 -	Absolute value function	The absolute value of the input value at I1 is calculated. See chapter 5.3.10.
361 -	SQR (I1)	The input value at I1 is squared. See chapter 5.3.11.
362 -	Cube (I1)	The input value at I1 is cubed. See chapter 5.3.12.
363 -	Square root	The square root is calculated from the input value at I1. See chapter 5.3.13.
364 -	Modulo	Multiplication and division. O1 = result , O2 = modulo. See chapter 5.3.14.
Controller		**Analog functions**
370 -	P controller	The control deviation (I1 – I2) is multiplied by the amplification P1. See chapter 5.4.1.
371 -	PI-Controller (ms)	The control deviation (I1 – I2) is multiplied by the amplification P1 an the I component (total of control deviation over time) is added. The integral time is indicated in milliseconds [ms]. See chapter 5.4.2.
372 -	PI-Controller (s)	The control deviation (I1 – I2) is multiplied by the amplification P1 an the I component (total of control deviation over time) is added. The integral time is indicated in seconds [s]. See chapter 5.4.3.
373 -	PD(T1)-Controller (ms)	The control deviation (I1 – I2) is multiplied by the amplification P1. The D component is added. See chapter 5.4.4.
374 -	PID(T1) con-troller (ms)	The control deviation (I1 – I2) is multiplied by the amplification (=1). The I component and the D component are added. To adjust another amplification, a P-controller must be connected in series. The integral time is indicated in milliseconds [ms]. See chapter 5.4.5.
375 -	PID(T1) con-troller (s)	The control deviation (I1 – I2) is multiplied by the amplification (=1). The I component and the D component are added. To adjust another amplification, a P-controller must be connected in series. The integral time is indicated in seconds [s]. See chapter5.4.6
Filters		**Analog functions**
380 -	PT1 element	The input value at I1 is filtered according to the set filter time con-stant. See chapter 5.5.1.
381 -	Time average	The average is calculated from the input values at I1 (over a certain period of time). See chapter 5.5.2.
382 -	Ramp limitation	The output value follows the input value at a limited ramp gradient. The ramp gradient can be adjusted. See chapter 5.5.3.
383 -	Spike filter	Input spikes are filtered out of the input value at I1. See chapter 5.5.4.

Analog switch		**Analog functions**
390 -	Analog multiplexer	One of the values I1, I2, P1 or P2 is output. See chapter 5.6.2.
391 -	Analog changeover switch	Depending on the active data set, one of the input values (I1 … I4) is output. See chapter 5.6.1.
392 -	Analog multiplexer for position values (data set number)	One of the values I1, I2, or P (P1|P2) is output. See chapter 5.6.3
393 -	Analog changeover switch for position values	Depending on the active data set, one of the input values (I1 … I4) is output. See chapter 5.6.4.
Parameter access (reading and writing parameters)		**Analog functions**
401 -	Writing frequency parameters	The input value is converted from percent to Hz and written as long parameter. See chapter 5.7.1.1.
402 -	Write current parameter	The input value is converted from percent to A and written as int parameter. See chapter 5.7.1.2.
403 -	Write voltage parameter (eff.)	The effective value at the input is converted from percent to V and written as int parameter. See chapter 5.7.1.3.
404 -	Write voltage parameter (peak)	The peak value at the input is converted from percent to V and written as int parameter. See chapter 5.7.1.4.
405 -	Write percent parameter	The input value is not changed and written as int parameter. See chapter 5.7.1.5.
406 -	Write position parameter	The input value is not changed and written as long parameter. See chapter 5.7.1.6.
407 -	Write long parameter	The input value is put together from of low-word and high-word, not changed and output as long parameter. For use for any long parameter types. See chapter 5.7.1.7.
408 -	Write word parameter	The input value is not changed and written as int parameter. See chapter 5.7.1.8.
421 -	Read frequency parameter	The function reads the value of the parameter set up in P1 "Parameter number" and P2 "Data set/index". The value is converted to a frequency value. See chapter5.7.2.1
422 -	Read current parameter	The function reads the value of the parameter set up in P1 "Parameter number" and P2 "Data set/index". The value is converted to a current value. See chapter5.7.2.2
423 -	Read voltage parameter (eff.)	The function reads the value of the parameter set up in P1 "Parameter number" and P2 "Data set/index". The value is converted to a voltage value. See chapter5.7.2.3
424 -	Read voltage parameter (peak)	The function reads the value of the parameter set up in P1 "Parameter number" and P2 "Data set/index". The value is converted to a voltage value See chapter5.7.2.4
425 -	Read percent parameter	The function reads the value of the parameter set up in P1 "Parameter number" and P2 "Data set/index". The value is converted to a percent value. See chapter5.7.2.5
426 -	Read position parameter	The function reads the value of the parameter set up in P1 "Parameter number" and P2 "Data set/index". The value is converted to a position value. See chapter5.7.2.6
427 -	Read long parameter	The function reads the value of the parameter set up in P1 "Parameter number" and P2 "Data set/index". The value is converted to a position value. See chapter5.7.2.7
428 -	Read word parameter	The function reads the value of the parameter set up in P1 "Parameter number" and P2 "Data set/index". The value is converted to a percent value. See chapter 5.7.2.8.

Limiter		**Analog functions**
440 -	Limitation (const.)	Limitation to fixed values. The input value at I1 is limited to P1 (upper limit) and P2 (lower limit) and output. See chapter 5.8.1.
441 -	Limitation (variable)	Limitation to variable limits. The input value at I1 is limited to I1 (upper limit) and I2 (lower limit) and output. See chapter 5.8.2.
Counters		**Analog functions**
450 -	Up/Down counter	With each positive edge at I1, the output value of the counter is increased by 100.00%/P1. With each positive edge at I2, the output value of the counter is reduced by 100.00%/P1. See chapter 5.9.1.
451 -	Counter with analog output	The stopwatch is running if I1 = "TRUE" and I2 = "FALSE". I3 determines the direction. I4 resets the stopwatch to the start value P1. With P2, a divisor can be set up to scale the output value. See chapter 5.9.2.
Positioning functions		**Analog functions**
The availability of positioning functions depends on the device series.		
501 -	Start motion block as single motion	The motion block selected with P1 is started. Input I1 defines the target position. Input I2 defines the reference speed. See chapter 5.10.1.
502 -	Start motion block in automatic mode	The motion block selected with P1 is started. Input I1 defines the target position. Input I2 defines the reference speed. See chapter 5.10.2.
503 -	Stop motion block	The current motion block is stopped if the release at input I3 is set. See chapter 5.10.3.
504 -	Continue motion block	The stopped motion block is continued if the release at input I3 is set. See chapter 5.10.4.
505 -	Resume Motion Block	A motion block stopped by an error cut-off or mains-off is continued if the release at input I3 is set. See chapter 5.10.5.
506 -	Start homing	The homing operation defined in P1 is started if the release at input I3 is set. See chapter 5.10.6.
507 -	Check state.	While a motion block is running output O1 is set to TRUE. See chapter 5.10.7.

3.1 Inputs and outputs

3.1.1 Inputs of digital functions

The digital functions use digital input signals and digital output signals.

Instruction		Input 1	Input 2	Input 3	Input 4
1 -	AND	Input 1	Input 2	Input 3	Input 4
2 -	OR	Input 1	Input 2	Input 3	Input 4
3 -	XOR (=1)	Input 1	Input 2	Input 3	Input 4
4 -	XOR (=1)||(=3)	Input 1	Input 2	Input 3	Input 4
10 -	RS Flip-Flop Superior	Set	Reset	Superior-Set	Superior-Reset
20 -	Toggle Flip-Flop Superior	Input +	Input -	Superior-Set	Superior-Reset
30 -	D Flip-Flop Superior	Clock input C	Data input D	Superior-Set	Superior-Reset
4x -	Delay Superior (retriggerable)	Input	-	Superior-Set	Superior-Reset
5x -	Delay Superior (non-retriggerable)	Input	-	Superior-Set	Superior-Reset
6x -	Monoflop Superior (retriggerable)	Input +	Input -	Superior-Set	Superior-Reset
7x -	Monoflop Superior (non-retriggerable)	Input +	Input -	Superior-Set	Superior-Reset
8x -	Clock generator Superior	Input +	Input -	Superior-Set	Superior-Reset
90 -	Digital multiplexer	Input 1	Input 2	Input 3	Input 4
91 -	Dataset changeover	Input 1	Input 2	Input 3	Input 4
95 -	Triggering of an error.	Trigger	Trigger	Trigger	Trigger
96 -	Acknowledging an error.	Acknowledge	Acknowledge	-	-
97 -	Debouncer	Input	-	Master-Set	Master-Reset
99 -	NOP	-	-	-	-
100 -	Jump function	Activate jump function	Jump target	Update input buffer	Update output buffer
101 -	Jump function for loops	Finish loop	Restart loop	Update input buffer	Update output buffer
110 -	RS Flip-Flop Master	Set	Reset	Master-Set	Master-Reset
120 -	Toggle Flip-Flop Master	Input +	Input -	Master-Set	Master-Reset
130 -	D Flip-Flop Master	Clock input C	Data input D	Master-Set	Master-Reset
14x -	Delay Master (retriggerable)	Input	-	Master-Set	Master-Reset
15x -	Delay Master (non-retriggerable)	Input	-	Master-Set	Master-Reset
16x -	Monoflop Master (retriggerable)	Input +	Input -	Master-Set	Master-Reset
17x -	Monoflop Master (non-retriggerable)	Input +	Input -	Master-Set	Master-Reset
18x -	Clock generator Master	Input +	Input -	Master-Set	Master-Reset

Note:
In instruction types 40 to 82 and 140 to 182 the "x" is used as a placeholder in the table. The instruction types can be parameterized in three different time bases:
0: milliseconds [ms],
1: seconds [s],
2: minutes [min].

3.1.2 Inputs and outputs of analog functions

The analog functions use at least one analog input signal or output signal. Depending on the instruction, the inputs and outputs have different functions.

Instruction		Input				Output		Parameters	
		1	2	3	4	O1	O2	P1	P1
200 -	Bit NOT operation	%	-	b	b	%	%	-	-
201 -	Bit AND/NAND operation	%	%	b	b	%	%	%	i
202 -	Bit OR/NOR operation	%	%	b	b	%	%	%	i
203 -	Bit XOR/XNOR operation	%	%	b	b	%	%	%	i
210 -	Bit shift right	%	-	b	b	%	%	-	i
211 -	Bit arithmetical shift right	%	-	b	b	%	%	-	i
212 -	Bit shift left	%	-	b	b	%	%	-	i
213 -	Bit roll right	%	-	b	b	%	%	-	i
220 -	output one bit	%	-	b	b	b	b	i	-
221 -	Unite four bits to form a word	b	b	b	b	%	%	i	-
222 -	Add two bits to a word	%	b	b	b	%	%	i	i
301 -	Comp. 2 inp.	%	%	b	b	b	b	xxxx%	xxxx%
302 -	Comp. 2 inp., abs. val.	%	%	b	b	b	b	%	%
303 -	Comp. inp. with const.	%	-	b	b	b	b	%	%
304 -	Comp. inp. with const., abs. val.	%	-	b	b	b	b	%	%
308 -	Comp. active motion block	-	-	b	b	b	b	i	i
309 -	Comp. (Position)	Pos	Pos	b	b	b	b	Pos	Pos
310 -	Analog hysteresis	%	%	b	b	%	%	%	%
311 -	W. comp (2V)	%	%	b	b	b	b	%	%
312 -	W. comp (2V), abs.val.	%	%	b	b	b	b	%	%
313 -	W. comp (VC)	%	-	b	b	b	b	%	%
314 -	W. comp (VC), abs.val.	%	-	b	b	b	b	%	%
320 -	Min / Max	%	%	b	b	%	%	%	%
321 -	Min / Max for position values	Pos	Pos	b	b	Pos	Pos	Pos	Pos
322 -	Min / Max in time window	%	-	b	b	%	%	-	-
323 -	Min / Max in time window for positions	Pos	-	b	b	Pos	Pos	-	-
330 -	Add. with offset	%	%	%	b	%	%	%	%
331 -	Add. position with offset	Pos	Pos	Pos	b	Pos	Pos	Pos	Pos
332 -	Mult.	%	%	-	b	%	%	%	-
333 -	Mult. with long result	%	%	-	b	%	%	%	-
334 -	Mult. with fraction	%	-	-	b	%	%	%	%
335 -	Mult. long with percent	long	%	%	b	%	%	%	%
336 -	Div.	%	-	-	b	%	%	%	%
337 -	Div. by const.	%	-	-	b	%	%	%	%
338 -	Reciprocal	%	%	%	b	%	%	%	%
339 -	Mult. & Div	%	%	%	b	%	%	%	%
340 -	Average	%	%	%	b	%	%	i	i
341 -	Absolute value 2D vector	%	%	-	b	%	%	%	%
342 -	Absolute value 3D vector	%	%	%	b	%	%	%	%

Instruction	Input				Output		Parameters	
	1	2	3	4	O1	O2	P1	P1
350 - Integrator	%	%	b	b	%	%	i	i
351 - Differentiator	%	-	-	b	%	%	%	-
360 - Absolute value function	%	-	-	b	%	%	-	-
361 - SQR (I1)	%	-	-	b	%	%	-	%
362 - Cube (I1)	%	-	-	b	%	%	-	%
363 - Square root	%	-	-	b	%	%	-	%
364 - Modulo	%	%	%	b	%	%	%	%
370 - P controller	%	%	-	b	%	%	i	%
371 - PI-Controller (ms)	%	%	%	b	%	%	i	i
372 - PI-Controller (s)	%	%	%	b	%	%	i	i
373 - PD(T1)-Controller (ms)	%	%	%	b	%	%	i	i
374 - PID(T1) controller (ms)	%	%	%	b	%	%	i	i
375 - PID(T1) controller (s)	%	%	%	b	%	%	i	i
380 - PT1 element	%	%	b	b	%	%	i	-
381 - Time average	%	-	-	b	%	%	-	-
382 - Ramp limitation	%	%	b	b	%	%	%	i
383 - Spike filter	%	%	b	b	%	%	-	-
390 - Analog multiplexer	%	%	b	b	%	%	%	%
391 - Analog changeover switch	%	%	%	%	%	%	-	-
392 - Analog multiplexer for position values (data set number)	Pos	Pos	b	b	Pos	Pos	Pos	Pos
393 - Analog changeover switch for position values	Pos	Pos	Pos	Pos	Pos	Pos	-	-
401 - Writing frequency parameters	%	b	b	b	b	b	i	i
402 - Write current parameter	%	b	b	b	b	b	i	i
403 - Write voltage parameter (eff.)	%	b	b	b	b	b	i	i
404 - Write voltage parameter (peak)	%	b	b	b	b	b	i	i
405 - Write percent parameter	%	b	b	b	b	b	i	i
406 - Write position parameter	Pos	Pos	b	b	b	b	i	i
407 - Write long parameter	%	%	b	b	b	b	i	i
408 - Write word parameter	int	b	b	b	b	b	i	i
421 - Read frequency parameter	-	-	b	-	%	%	i	i
422 - Read current parameter	-	-	b	-	%	%	i	i
423 - Read voltage parameter (eff.)	-	-	b	-	%	%	i	i
424 - Read voltage parameter (peak)	-	-	b	-	%	%	i	i
425 - Read percent parameter	-	-	b	-	%	%	i	i
426 - Read position parameter	-	-	b	-	%	%	i	i
427 - Read long parameter	-	-	b	-	%	%	i	i
428 - Read word parameter	-	-	b	-	%	%	i	i
440 - Limiter (const.)	%	-	-	b	%	%	%	%
441 - Limiter (variable)	%	%	%	b	%	%	-	-
450 - Up/Down counter	b	b	b	b	%	%	i	i

Instruction		Input				Output		Parameters	
		1	2	3	4	O1	O2	P1	P1
451 -	Counter with analog output	b	b	b	b	%	%	i	i
501 -	Start motion block as single motion	Pos	%	b	b	Pos	Pos	i	-
502 -	Start motion block in automatic mode	Pos	%	b	b	Pos	Pos	i	-
503 -	Stop motion block	-	-	b	b	Pos	Pos	-	-
504 -	Continue motion block	-	-	b	b	Pos	Pos	-	-
505 -	Resume motion block	-	-	b	b	Pos	Pos	-	-
506 -	Start homing	-	-	b	b	Pos	Pos	i	-
507 -	Check state.	-	-	-	b	b	b	-	-

3.2 Combination of inputs and outputs of instructions

Inputs
Each instruction has 4 inputs. The inputs can be combined with outputs of other instructions or digital inputs or global signal sources.

Outputs
Each instruction has 2 outputs. The two outputs can:
- be combined with inputs of other instructions,
- combined with device functions,
- output via digital or analog outputs of the device.

In the case of digital functions, output 2 has the negated logic state of input 1.

Note:
Instructions can only be edited in stop mode. If you try to make any changes while the function table is not in stop mode, an error will be displayed in VPlus and VPLC. The attempted change will not be applied.

3.2.1 Inputs

The inputs can either be combined with the input buffer, fixed values, the outputs of other instructions (normal or inverted) or the global output variables (digital: output buffer or analog: outp. frequency, outp. current, etc.).

Note:
Note that the output buffer is updated only with a write operation (e.g. during return jump). The value used originates from the last write operation of the output buffer.

Possible signal sources for the inputs of instructions	
6	TRUE
7	FALSE
Combination with digital signal source of input buffer	
2001 … 2016	Input buffer 1 … 16
Combination with analog signal source or actual value	
2301 … 2304	Frequency 1 … 4
2311 … 2314	Current 1 … 4
2321 … 2324	Percent 1 … 4
2331 … 2334	Voltage 1 … 4

Possible signal sources for the inputs of instructions	
2341	Actual position of table positioning
2351 … 2354	General source 1 … 4
Combination with constants	
2380 … 2392	Auxiliary values (constants) and global flags (status signals)
Combination with digital global signal source of output buffer	
2401 … 2416	Output buffer 1 … 16
Combination with analog output of an instruction	
2501 … 2504	Outp. frequency 1 … 4
2511 … 2514	Outp. current 1 … 4
2521 … 2524	Outp. percent 1 … 4
2531 … 2534	Outp. voltage 1 … 4
2551 … 2554	Outp. user 1 … 4
2561 … 2564	Flag 1 … 4
Combination with fixed analog value	
2601 … 2604	Fixed frequ. 1 … 4
2611 … 2614	Fixed current 1 … 4
2621 … 2624	Fixed perc. 1 … 4
2631 … 2634	Fixed eff. volt. 1 … 4
2641 … 2644	Fixed peak volt. 1 … 4
2651 … 2654	Fixed gen. 1 … 4
2661 … 2664	Fixed position 1 … 4
2671 … 2674	Fixed speed pos. 1 … 4
2681 … 2684	Fixed ramp pos. 1 … 4

2380 … 2392 – Auxiliary values (constants) and global flags (status signals)

2380 - "0.00 (zero percent)":
The auxiliary quantity has constant value 0%.
2381 - "100.00 (one hundred percent)":
The auxiliary quantity has constant value 100%

2382 - "327.67 (maximum value)":
The auxiliary quantity has constant value 327.67%

2383 - "0XFFF (for bitwise combination)":
The auxiliary quantity has constant hexadecimal value 0xFFFF and can be used for bitwise combinations.

2384 - "Fmax (100)":
Auxiliary quantity has constant value 100% of F_{max} (of parameter *Maximum frequency* **419**).

2385 - "Rated motor current in current data set":
The auxiliary quantity is referred to parameter value *Rated current* **371** in the current data set. The constant value is applied to the input of the instruction: 100% corresponds to the value of the rated motor current.

2386 - "Short-time overload current (ILIMIT)":
The auxiliary quantity is referred to the type-dependent overload current. The constant value is applied to the input of the instruction: 100% corresponds to the value of the overcurrent.

2387 - "INIT":
The status signal is TRUE for 64 ms:

- after cut-in of supply voltage, or
- after start of the PLC functions.

Otherwise, the signal status is "FALSE". The status signal cam be combined with Master Set and Master Reset inputs and is used for initializing the functions.

2388 - "RESET":
The status signal is TRUE for 64 ms:

- after cut-in of supply voltage, or
- after start of the PLC functions or
- after disabling of the output stages.

Otherwise, the signal status is "FALSE". The status signal cam be combined with Master Set and Master Reset inputs and is used for initializing the functions.

2389 - "IDLE":
The status signal is TRUE if the output stages are disabled.

2390 - "Controller release":
The status signal is TRUE if the output stages are enabled and the magnetizing process has been completed (flux forming finished; drive working).

2391 - "Controller release inverted ":
Inverted status signal of "Controller release".

2392 - "Error_acknowledgeable":
Status signal is TRUE if current error messages can be acknowledged.

3.2.2 Combining input buffer with inputs

3.2.2.1 Digital

If the signal of a digital input (e.g. IN2D) or a signal source (e.g. 162 - Error Signal) is to be applied to the input of an instruction, an input buffer must be set up on this digital input or signal source. As a result, the digital input or signal source is available for the inputs of the instructions.

1st example: Combination of an instruction input with a digital input: The signal at digital input I4ND is to be applied to input 3 of an instruction.

Input signal settings (Boolean)

– PLC signal: e.g. 2003 - Input buffer 3
– Global source: 74-IN4D

3.2.2.2 Analog

Combination of a signal source with the input of an instruction
The signal of an analog input (e. g. MFI1A) or and analog signal source (e. g. "10 - Stator frequency") is to be applied to the input of an instruction:

- In dialog window "Input settings (analog)" select a PLC signal 2301...2334.
- Select a global source.

As a result, the analog input or signal source is available for the inputs of the instructions.

PLC signal
2301 … 2304 - Frequency 1 … 4
2311 … 2314 - Current 1 … 4
2321 … 2324 - Percent 1 … 4
2331 … 2334 - Voltage 1 … 4
2351 … 2354 - General source 1…4

Example: Combination of an instruction input with a signal source: The stator frequency is to be applied to the input of an instruction:

- In dialog window "Input settings (analog)" select a PLC signal 2301-Frequency 1...2304-Frequency 4.
- Select global source "10 Stator frequency".

Combination of a fixed value with the input of an instruction
A fixed analog value (e.g. fixed frequency value) is to be applied to the input of an instruction:

- In dialog window "Input settings (analog)" select a PLC signal 2601...2654.
- Enter a value.

Signal source
2601 … 2604 - Fixed freq. 1 … 4
2611 … 2614 - Fixed current 1 … 4
2621 … 2624 - Fixed perc. 1 … 4
2631 … 2634 - Fixed eff. volt. 1 … 4
2641 … 2644 - Fixed peak. volt. 1 … 4

2651 … 2654 - Fixed gen. 1 … 4
2661 … 2664 - Fixed position 1 … 4
2671 … 2674 - Fixed speed pos. 1 … 4
2681 … 2684 - Fixed ramp pos. 1 … 4

Example: Combination of an instruction input with a fixed value: An adjusted current value is to be applied to an input of an instruction:

- In dialog window "Input settings (analog)" select a PLC signal 2611-Fixed current 1...2164-Fixed current 2.
- Enter a current value [A] value.

3.2.3 Combining instructions with one another

The outputs of the instructions can be combined with inputs by instructions. Use the wire tool.

3.2.4 Activating device functions via the output buffer

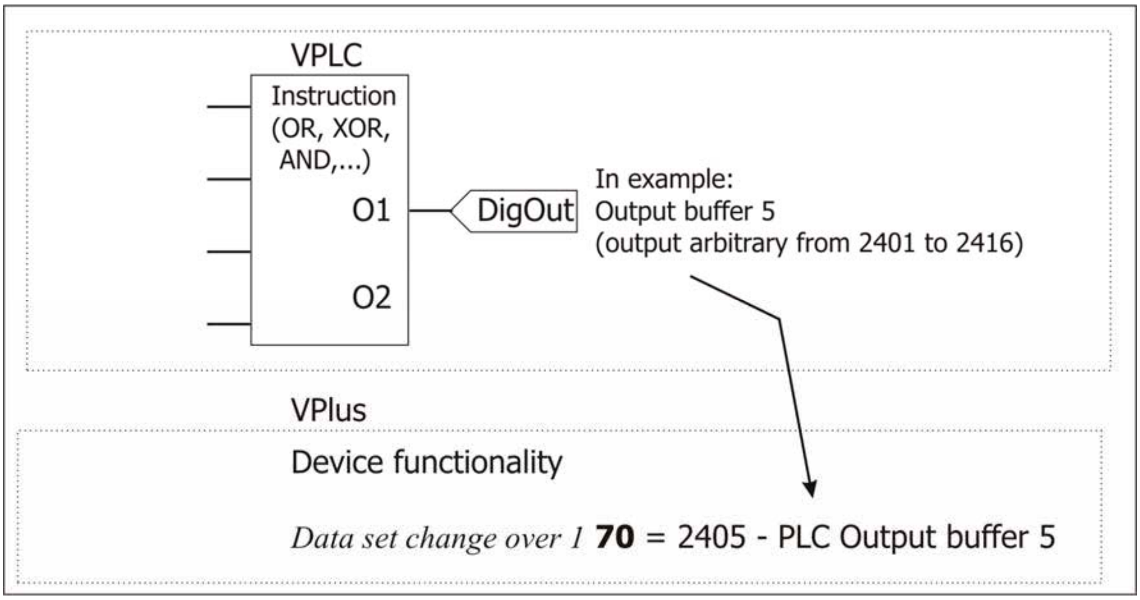
If the logic state of an output is to activate a device function, an output buffer must be selected for the digital output of the instruction. For the device function, the corresponding signal source "2401 - PLC Output buffer 1" ... "2416 - PLC output buffer 16" must be selected. If, for example, output buffer 3 was selected for the digital output of the instruction, signal source "2403 - Output buffer 3" must be selected for a device function.

As a result, the output is generally (globally) available to other device functions. The selected signal source must also be assigned to the device function to be activated. Up to 16 signal sources can be used for further processing of logic states of the instruction outputs. A signal source can be assigned to several outputs of instructions.

Example 1: Combination of an instruction output with a device function:
The function "Start anticlockwise" is to be activated via the output of an instruction.

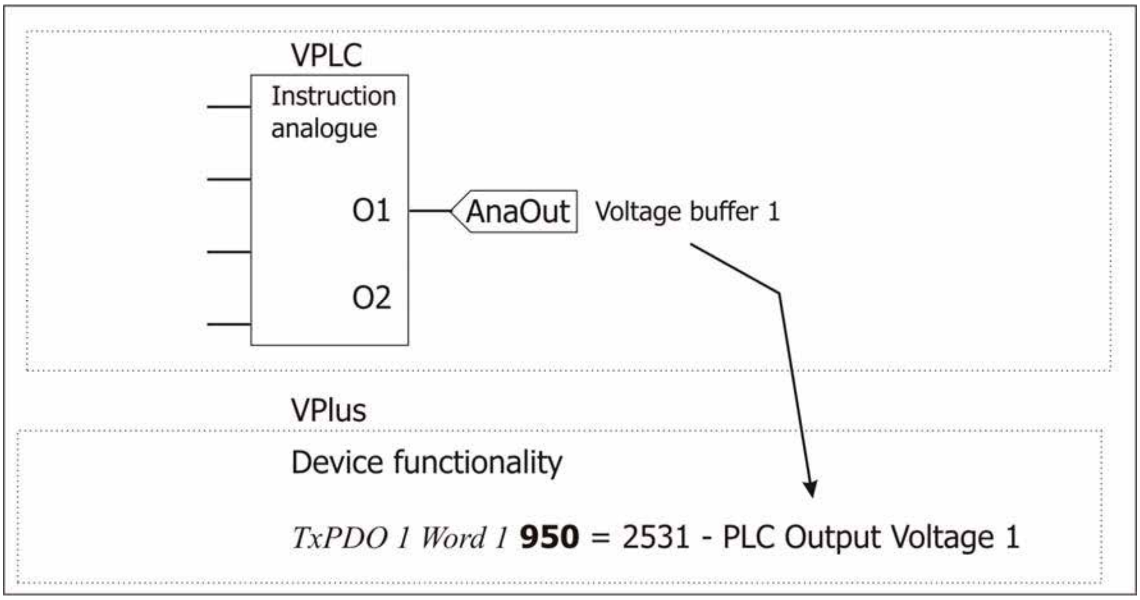
- Dialog window "Settings for digital outputs": Output buffer 1 (other selection also possible). As a result, the output is generally (globally) available to other device functions.
- *Start Anticlockwise* **69** = "2401 - PLC-Output Buffer 1" (according to above selection).

Example 2: Combination of an instruction output with a device function:
The output of an instruction is needed for combination with a device function. This function is no PLC function. The output of the instruction is to be defined as a general (global) signal source and activate the device function "Switch data set 1".



- Select an output buffer for the output of the instructions, e. g. output buffer 5.
  As a result, the signal source is generally (globally) available for processing by other device functions. It is also possible to choose another signal source from signal sources 2401 to 2416 for the parameter.
- For parameter *Switch Data Set 1* **70**, select signal source "2405 - FT-Output buffer 5".

Example 3: The output value of instruction 1 is to be transmitted via system bus. Depending on the device series, an extension module with system bus must be installed.

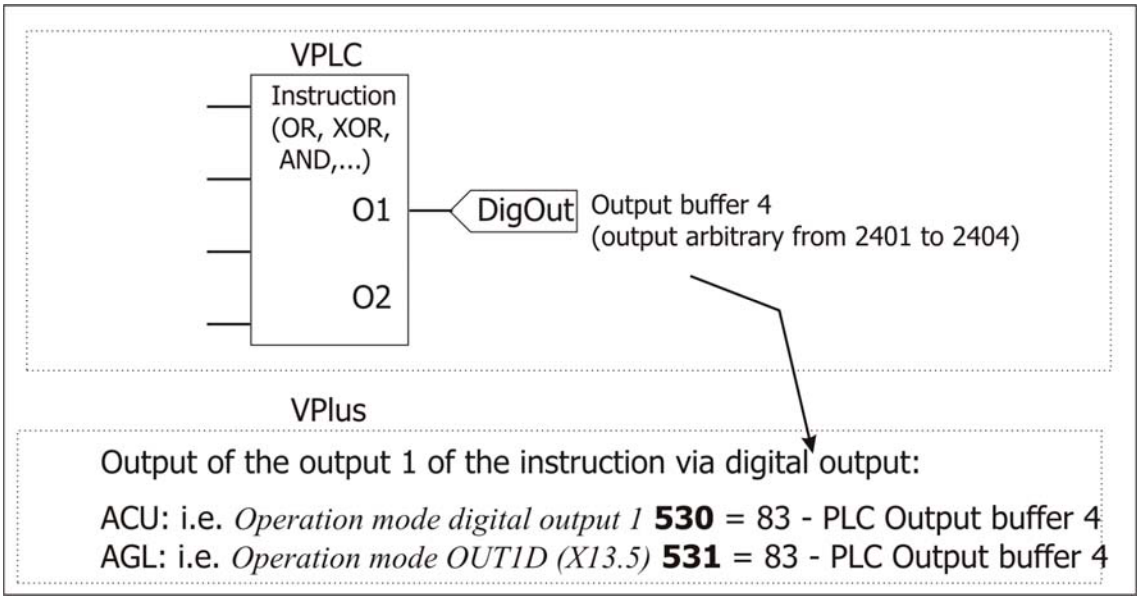


3.2.5 Controlling a digital output via the output buffer

The outputs of the instructions can be output via digital outputs once they have been defined as general (global) signal sources.
The following signal sources can be selected for the parameters of the digital outputs.

Outputs of Instructions as signal sources for digital outputs		Operation Mode Digital Output	
		Non-negated	Negated
PLC output buffer 1		80	180
PLC output buffer 2		81	181
PLC output buffer 3		82	182
PLC output buffer 4		83	183

Example: Selection of signal source for digital output:
The output signal of an instruction is to be output via a digital output.



The output of the instruction must be defined as a general (global) signal source:

- Select an output buffer for the output of the instructions (e.g. 4).

As a result, the signal source is generally (globally) available for processing by other device functions and has the logic state of the output of the instruction. You can also select another output buffer.

For a digital output, choose the general (global) signal source which contains the output value of the instruction:

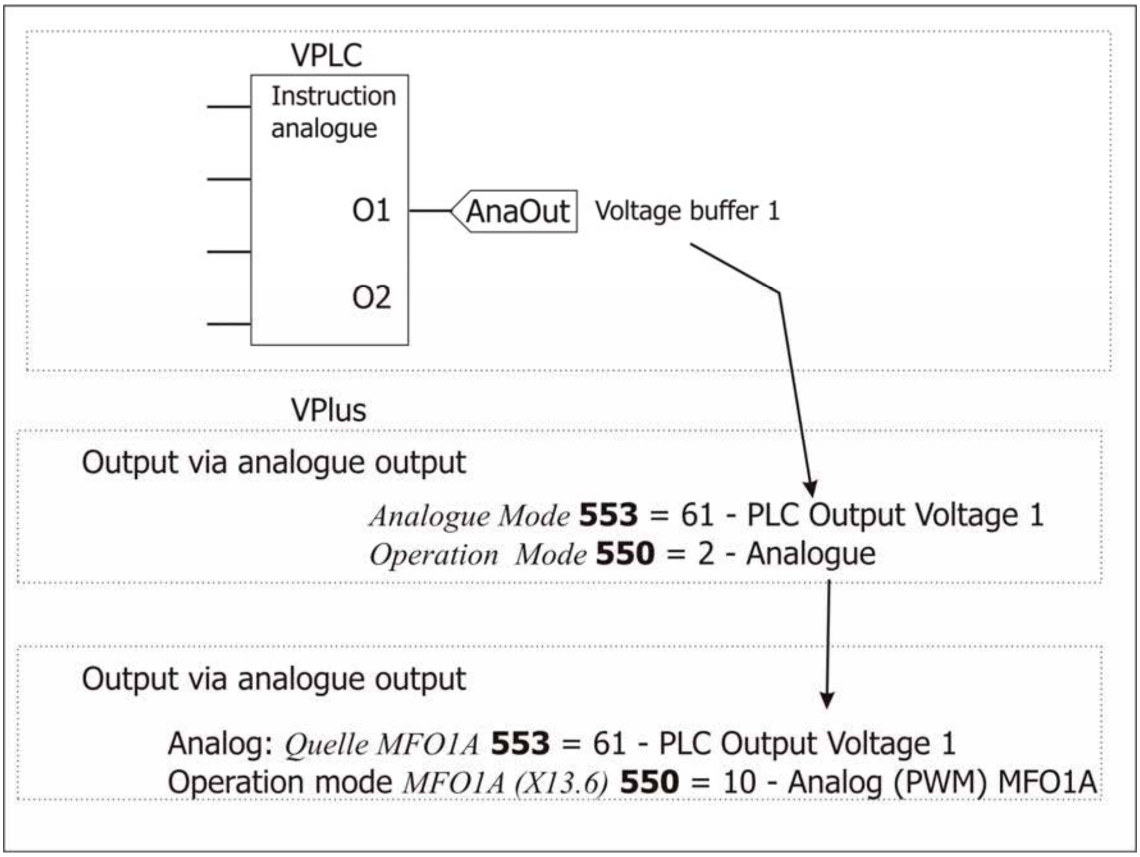
- For the parameter of a digital output choose the PLC output buffer signal (e.g. "83 PLC output buffer 4").

3.2.6 Controlling an analog output via the output buffer

The outputs of the analog instructions can be output via analog outputs once they have been defined as general (global) signal sources.

VPLC, AnaOut		**VPlus** Analog range 553 (ACU) Analog: *Source MF01A* **553** (AGL)
Buffer percent Buffer number 1	→	61 – Abs. value PLC outp. percent 1 161 – PLC outp. percent 1
Buffer percent Buffer number 2	→	62 – Abs. value PLC outp. percent 2 162 – PLC outp. percent 2

Example: The output signal of an instruction is to be output via analog output MFO1A of the device.



4 Description of digital functions

In the following, you will find explanations and examples of the individual digital functions. The term "digital function" is defined as follows:
A digital function has at least one digital input value but not analog input value. The output value is always digital.
The following symbols are used in the diagrams:

	edge evaluation
	level evaluation
	negated output

0	"Low" state. Representation of signal statuses in logic tables.
1	"High" state. Representation of signal statuses in logic tables.
FALSE	"Low" state. Representation of signal statuses in function descriptions.
TRUE	"High" state. Representation of signal statuses in function descriptions.
x	any state ("Don't care" – 0 or 1).
$0 \rightarrow 1$	positive edge.
$1 \rightarrow 0$	negative edge.
Q_{n-1}	last state is maintained.
$\overline{Q_{n-1}}$	last state is negated ("toggle").
O_n	non-negated output
$\overline{O_n}$	negated output
P1	VPLC: Input field in function block setup, Function table: Parameter *FT Parameter 1* **1348**
P2	VPLC: Input field in function block setup, Function table: Parameter *FT Parameter 2* **1349**

Note:
For better clarity, output O_n (non-negated) is used in the descriptions. The negated output $\overline{O_n}$ is available in each function and can be used.

For digital functions, note:
- Unused inputs must be set to "7 - Off".
  Exception: Unused inputs of the instruction "**AND**" must be set to "6 - On".
- In all functions, output 2 has the inverted logic state of input 1.
- Clock inputs (T, C) evaluate signal edges.
- Set/Superior-Set/Master-Set inputs and Reset/Superior-Reset/Master-Reset inputs evaluate logic states.
- Reset has priority over Set.
- Times set for P1 and P2, are limited internally to a max. value of 24 days.

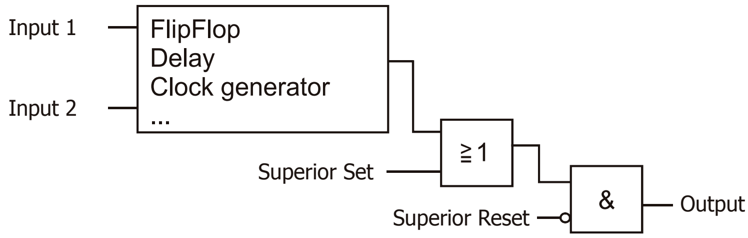
Via the library, the logic function can be selected.

4.1 Superior/Master

Most instructions also enable setting of selective output statuses by overriding inputs. This may be used, for example, for initialization of a plant status.
There are two variants of instructions with overriding inputs.

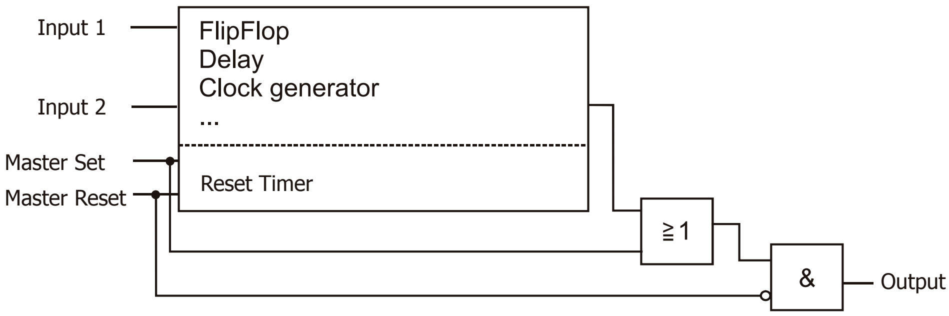
Superior

- The function sequence is processed further internally in the instruction. The overriding inputs change the instruction output only for the time in which the overriding signal is present.
- During the set/reset phase, edges will also be detected and processed internally. If the Superior Set/Superior Reset Signal is no longer present, the output will take the value which would result without the Set/Reset Phase.
- The processing sequence can be compared to a series connection of the function and a logic AND operation with the superior inputs.



Master

- The function sequence is interrupted. The overriding inputs change the instruction output as from the time at which the overriding signal is present.
- Set/Reset signals are not evaluated as long as a Master-Set/Master-Reset is present.
- The processing sequence can be compared to a parallel connection of the function and the master inputs.



Superior	**Master**	
Superior-Set	Master-Set	TRUE at Superior-Set/Master-Set switches instruction output 1 to TRUE directly.
Superior Reset	Master Reset	TRUE at Superior-Reset/Master-Reset switches instruction output 1 to FALSE directly. Reset has a higher priority than set.

4.2 P1 and P2 for chronological behavior and jump target

The chronological behavior of the instructions or a jump target can be set up via P1 and P2.

4.2.1 Chronological behavior

The setup of P1 and P2 affects the following instructions:

40 … 42 / 140 … 142 50 … 52 / 150 … 152	Delay
60 … 62 / 160 … 162 70 … 72 / 170 … 172	Monoflop
80 … 82 / 180 … 182	Clock generator

The units of P1 and P2 may be set to milliseconds [ms], seconds [s] or minutes [min]. The unit of the entered value depends on the instruction.

Note:
Time set for P1 and P2,

– are limited internally to the maximum value of 24 days
– are not continued when the frequency is switched off and on again. The sequence is restarted from the beginning after re-activation.

4.2.2 Jump target

The evaluation of P1 and P2 affects the following instruction:

100	Jump function

Description	Min.	Max.
P1	1	32
P2	1	32

4.2.3 Overview table

The meaning of the settings for P1 and P2, depending on the selection of the application is summarized in the following table.

Instruction		P1	P2
40 - 140 -	delay ms (retriggerable)	delay pos. edge [ms]	delay neg. edge [ms]
41 - 141 -	delay s (retriggerable)	delay pos. edge [s]	delay neg. edge [s]
42 - 142 -	delay min (retriggerable)	delay pos. edge [min]	delay neg. edge [min]
50 - 150 -	delay ms (non-retriggerable)	delay pos. edge [ms]	delay neg. edge [ms]
51 - 151 -	delay s (non-retriggerable)	delay pos. edge [s]	delay neg. edge [s]
52 - 152 -	delay min (non-retriggerable)	delay pos. edge [min]	delay neg. edge [min]
60 - 160 -	Monoflop ms (retriggerable)	ON time [ms]	ignore edge time [ms]
61 - 161 -	Monoflop s (retriggerable)	ON time [s]	ignore edge time [s]
62 - 162 -	Monoflop min (retriggerable)	ON time [min]	ignore edge time [min]
70 - 170 -	Monoflop ms (non-retriggerable)	ON time [ms]	ignore edge time [ms]
71 - 171 -	Monoflop s (non-retriggerable)	ON time [s]	ignore edge time [s]

Instruction		P1	P2
72 - 172 -	Monoflop min (non-retriggerable)	ON time [min]	ignore edge time [min]
80 - 180 -	Clock Generator ms	ON time [ms]	OFF time [ms]
81 - 181 -	Clock Generator s	ON time [s]	OFF time [s]
82 - 182 -	Clock Generator min	ON time [min]	OFF time [min]
100 -	Jump function	Jump target 1	Jump target 2

Note:
Operation modes < 40 to 82 use Superior inputs, operation modes < 140 to 182 use Master inputs as overriding inputs.

Note:
In all other instructions not listed in the above table, the setting of P1 and P2 does not affect the instruction.

4.3 Boolean operations

The following table shows the logic combinations of the implemented Boolean functions. Logic 0s are indicated as dots.

Inputs				Output depending on logic function			
I1	I2	I3	I4	AND	OR	XOR 1	XOR 1 || 3
.	.	.	.	.	.	.	.
.	.	.	1	.	1	1	1
.	.	1	.	.	1	1	1
.	.	1	1	.	1	.	.
.	1	.	.	.	1	1	1
.	1	.	1	.	1	.	.
.	1	1	.	.	1	.	.
.	1	1	1	.	1	.	1
1	.	.	.	.	1	1	1
1	.	.	1	.	1	.	.
1	.	1	.	.	1	.	.
1	.	1	1	.	1	.	1
1	1	.	.	.	1	.	.
1	1	.	1	.	1	.	1
1	1	1	.	.	1	.	1
1	1	1	1	1	1	.	.

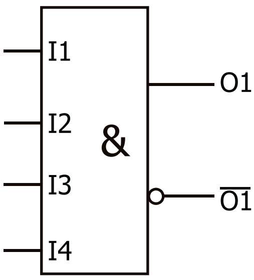
4.3.1 [1] AND operation

	Type	Function		Type	Function
I1	b	input value 1	O1	b	O1 = AND (I1 I2 I3 I4)
I2	b	input value 2	O2	b	negated output O2 = $\overline{\text{O1}}$
I3	b	input value 3	P1		
I4	b	input value 4	P2		

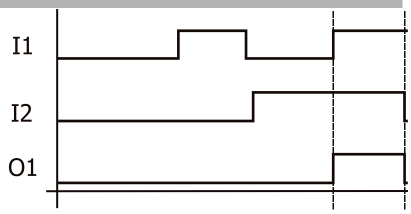
Description:
The inputs are AND-combined with one another. The inputs of the instruction are the assigned signal sources. Output is TRUE if all inputs are TRUE. As soon as one input is FALSE, the output will be FALSE. Via the output buffer, the output signal is globally available.

Note:
Unused inputs must be set to "6 - TRUE". For example, I3 and I4 must be set to "6 - TRUE" if inputs I1 and I2 are to be combined by the AND operation.

AND operation



I1	I2	I1
0	0	0
0	1	0
1	0	0
1	1	1



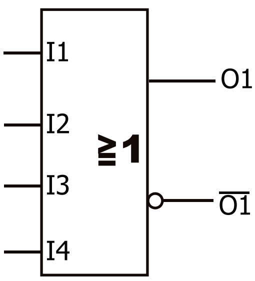
4.3.2 [2] OR operation

	Type	Function		Type	Function
I1	b	input value 1	O1	b	O1 = OR (I1 I2 I3 I4)
I2	b	input value 2	O2	b	negated output O2 = $\overline{\text{O1}}$
I3	b	input value 3	P1		
I4	b	input value 4	P2		

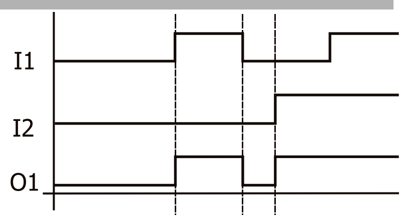
Description:
The inputs are OR-combined with one another. The inputs of the instruction are the assigned signal sources. Output is logic TRUE if at least one input is TRUE. If all inputs are FALSE, the output will be FALSE. Via the output buffer, the output signal is globally available.

Note:
Unused inputs must be set to "7 - FALSE" (factory setting). For example, I3 and I4 must be set to "7 - FALSE" if inputs I1 and I2 are to be combined by the OR operation.

OR operation



I1	I2	O1
0	0	0
0	1	1
1	0	1
1	1	1

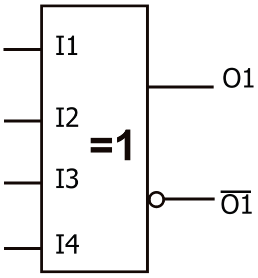


4.3.3 [3] XOR 1 operation

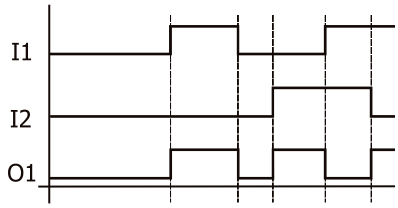
	Type	Function		Type	Function
I1	b	input value 1	O1	b	O1 = XOR1 (I1 I2 I3 I4)
I2	b	input value 2	O2	b	negated output O2 = $\overline{O1}$
I3	b	input value 3	P1		
I4	b	input value 4	P2		

Description:
The inputs are XOR-linked to one another. The inputs of the instruction are the assigned signal sources. Output is logic TRUE if exactly one input is TRUE. Via the output buffer, the output signal is globally available.

XOR 1 operation



I1	I2	I2
0	0	0
0	1	1
1	0	1
1	1	0

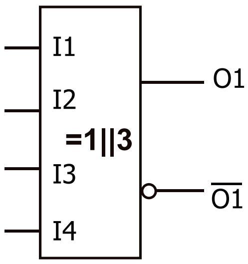


4.3.4 [4] XOR 1||3 operation

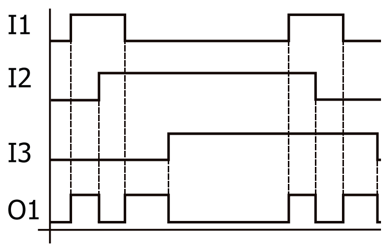
	Type	Function		Type	Function
I1	b	input value 1	O1	b	O1 = XOR3 (I1 I2 I3 I4)
I2	b	input value 2	O2	b	negated output O2 = $\overline{O1}$
I3	b	input value 3	P1		
I4	b	input value 4	P2		

Description:
The inputs are XOR-linked to one another. The inputs of the instruction are the assigned signal sources. The output is TRUE if TRUE is present on an odd number of inputs. Via the output buffer, the output signal is globally available.

XOR 1||3 link



I1	I2	I3	O1
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1



4.4 Flip-Flop types

4.4.1 [10] RS-Flip-Flop, Superior

	Type	Function
I1	b	Set input
I2	b	Reset input
I3	b	Superior Set input
I4	b	Superior Reset input

	Type	Function
O1	b	output O1
O2	b	negated output O2 = $\overline{O1}$
P1		
P2		

Description:
The inputs of the instruction are the assigned signal sources.

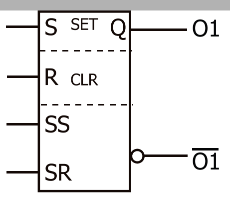
TRUE at the Set input sets the output to TRUE. TRUE at the Reset input sets the output to FALSE. If FALSE is present on both inputs, the current status of the output signal is maintained. TRUE at the Superior Set input sets the output to TRUE. TRUE at the Superior Reset input sets the output to FALSE.

Priority:
Superior Reset (highest priority)
Superior Set
Reset
Set (lowest priority)

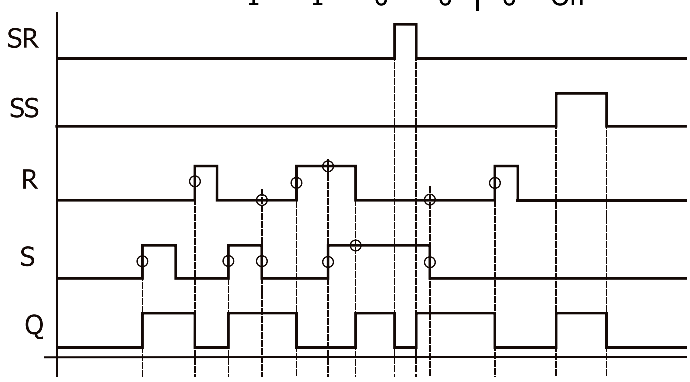
Via the output buffer, the output signal is globally available.

Inputs Superior Set and Superior Reset are connected in series with the function. Levels at Set input I1 and Reset input I2 are processed internally. As soon as the Superior Set or Superior Reset is reset, the output is switched to the internally saved value.

RS-Flip-Flop, Superior



S	R	SS	SR	O1 Q	State
x	x	X	1	0	Off (Superior)
X	X	1	0	1	On (Superior)
0	0	0	0	Q_{n-1}	Hold
0	1	0	0	0	Reset
1	0	0	0	1	Set
1	1	0	0	0	Off



Set:	TRUE at the S input sets the output to TRUE.
Save:	If all inputs are FALSE, the output remains unchanged.
Reset:	If R input is TRUE, the output is set to logic FALSE.
Off:	If both inputs are set to TRUE, the output is FALSE.
Superior-Set:	SS, set output to TRUE.
Superior-Reset:	SR, set output to FALSE (CLR).

4.4.2 [110] RS-Flip-Flop, Master

	Type	Function		Type	Function
I1	b	Set input	O1	b	output O1
I2	b	Reset input	O2	b	negated output O2 = $\overline{O1}$
I3	b	Master Set input	P1		
I4	b	Master Reset input	P2		

Description:
The inputs of the instruction are the assigned signal sources.

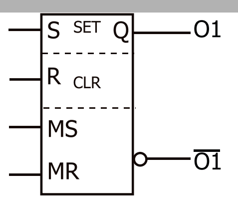
TRUE at the Set input sets the output to TRUE. TRUE at the Reset input sets the output to FALSE. If FALSE is present on both inputs, the current status of the output signal is maintained. TRUE at the Master Set input sets the output to TRUE. TRUE at the Master Reset input sets the output to FALSE.

Priority:
Master Reset (highest priority)
Master Set
Reset
Set (lowest priority)

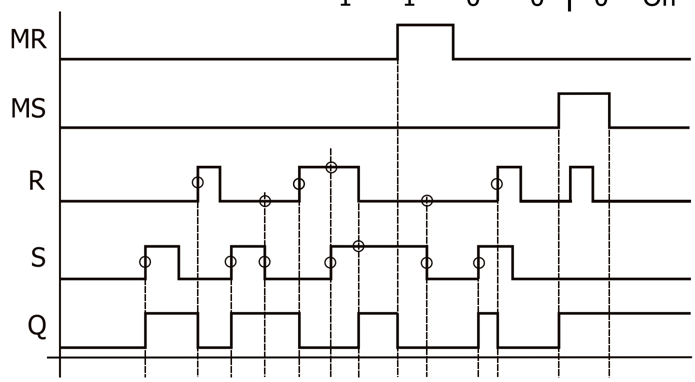
Via the output buffer, the output signal is globally available.

Master Set and Master Reset are connected parallel with the function and change the state of the function as soon as the signal is present.

RS-Flip-Flop, Master



S	R	MS	MR	O1 Q	State
x	x	X	1	0	Off (Master)
X	X	1	0	1	On (Master)
0	0	0	0	Q_{n-1}	Hold
0	1	0	0	0	Reset
1	0	0	0	1	Set
1	1	0	0	0	Off



Set:	TRUE at the S input sets the output to TRUE.
Save:	If all inputs are FALSE, the output remains unchanged.
Reset:	If R input is TRUE, the output is set to logic FALSE.
Off:	If both inputs are set to TRUE, the output is FALSE.
Master-Set:	MS, set output to TRUE.
Master-Reset:	MR, set output to FALSE (CLR).

4.4.3 [20] Toggle-Flip-Flop, Superior

	Type	Function
I1	b	Toggle 1
I2	b	Toggle 2
I3	b	Superior Set input
I4	b	Superior Reset input

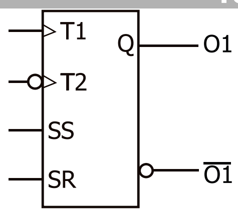
	Type	Function
O1	b	output O1
O2	b	negated output O2 = $\overline{O1}$
P1		
P2		

Description:
Output signal changes with the positive pulse edge at input T1 or with the negative pulse edge at input T2.
TRUE at the Superior Set input sets the output to TRUE. TRUE at the Superior Reset input sets the output to FALSE.

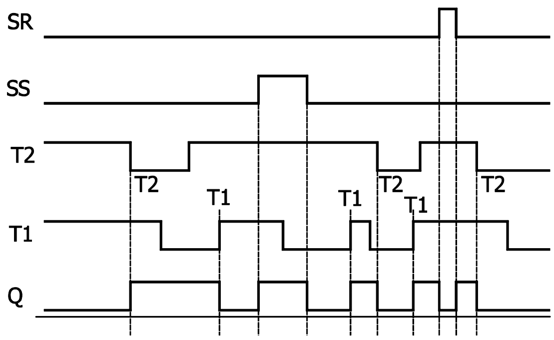
Via the output buffer, the output signal is globally available.

Inputs Superior Set and Superior Reset are connected in series with the function. Levels on T1-input I1 and T2 input I2 are processed internally. As soon as the Superior Set or Superior Reset is reset, the output is switched to the internally saved value.

Toggle-Flip-Flop, Superior



T1	T2	SS	SR	O1 Q	State
x	x	X	1	0	Off (Superior)
X	X	1	0	1	On (Superior)
0	0	0	0	Q_{n-1}	Hold
0	1	0	0	Q_{n-1}	Hold
0→1	x	0	0	$\overline{Q_{n-1}}$	Toggle
1	0	0	0	Q_{n-1}	Hold
1	1	0	0	Q_{n-1}	Hold
x	0→1	0	0	$\overline{Q_{n-1}}$	Toggle



4.4.4 [120] Toggle-Flip-Flop, Master

	Type	Function
I1	b	Toggle 1
I2	b	Toggle 2
I3	b	Master Set input
I4	b	Master Reset input

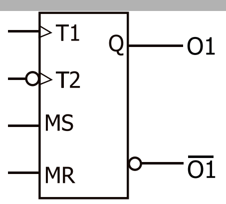
	Type	Function
O1	b	output O1
O2	b	negated output O2 = $\overline{O1}$
P1		
P2		

Description:
Output signal changes with the positive pulse edge at input T1 or with the negative pulse edge at input T2.
TRUE at the Master Set input sets the output to TRUE. TRUE at the Master Reset input sets the output to FALSE.

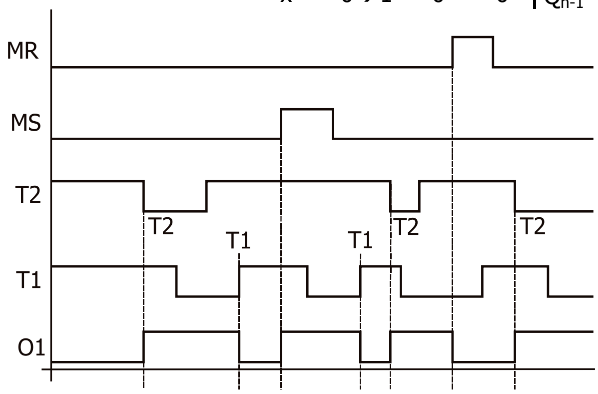
Via the output buffer, the output signal is globally available.

Master Set and Master Reset are connected parallel with the function and change the state of the function as soon as the signal is present.

Toggle-Flip-Flop, Master



T1	T2	MS	MR	O1 Q	State
x	x	X	1	0	Off (Master)
X	X	1	0	1	On (Master)
0	0	0	0	Q_{n-1}	Hold
0	1	0	0	Q_{n-1}	Hold
0→1	x	0	0	$\overline{Q_{n-1}}$	Toggle
1	0	0	0	Q_{n-1}	Hold
1	1	0	0	Q_{n-1}	Hold
x	0→1	0	0	$\overline{Q_{n-1}}$	Toggle



4.4.5 [30] D-Flip-Flop, Superior

	Type	Function
I1	b	C, Clock
I2	b	D, Data input
I3	b	Superior Set input
I4	b	Superior Reset input

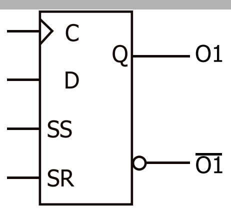
	Type	Function
O1	b	output O1
O2	b	negated output O2 = $\overline{O1}$
P1		
P2		

Description:
If a positive edge is received at input 1 (clock pulse input C, Clock) the signal is transferred from signal input 2 (data input D) to the output.
TRUE at the Superior Set input sets the output to TRUE. TRUE at the Superior Reset input sets the output to FALSE.

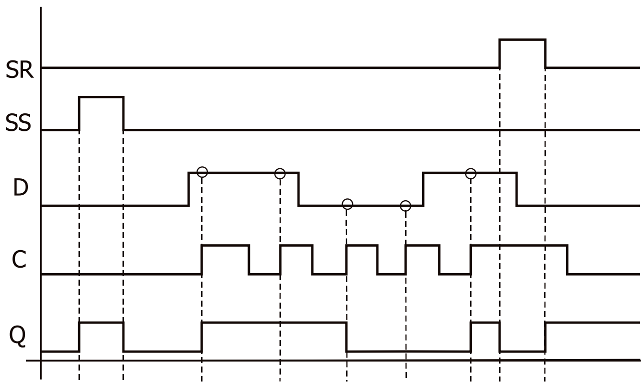
Via the output buffer, the output signal is globally available.

Inputs Superior Set and Superior Reset are connected in series with the function. Levels on C input I1 and D input I2 are processed internally. As soon as the Superior Set or Superior Reset is reset, the output is switched to the internally saved value.

D-Flip-Flop, Superior



C	D	SS	SR	O1 Q	State
x	x	x	1	0	Off (Superior)
x	x	1	0	1	On (Superior)
x	x	0	0	Q_{n-1}	Hold
0→1	0	0	0	0	Sample
0→1	1	0	0	1	Sample



4.4.6 [130] D-Flip-Flop, Master

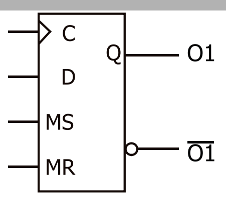
	Type	Function		Type	Function
I1	b	C, Clock	O1	b	output O1
I2	b	D, Data input	O2	b	negated output O2 = $\overline{O1}$
I3	b	Master Set input	P1		
I4	b	Master Reset input	P2		

Description:
If a positive edge is received at input 1 (clock pulse input C, Clock) the signal is transferred from signal input 2 (data input D) to the output.
TRUE at the Master Set input sets the output to TRUE. TRUE at the Master Reset input sets the output to FALSE.

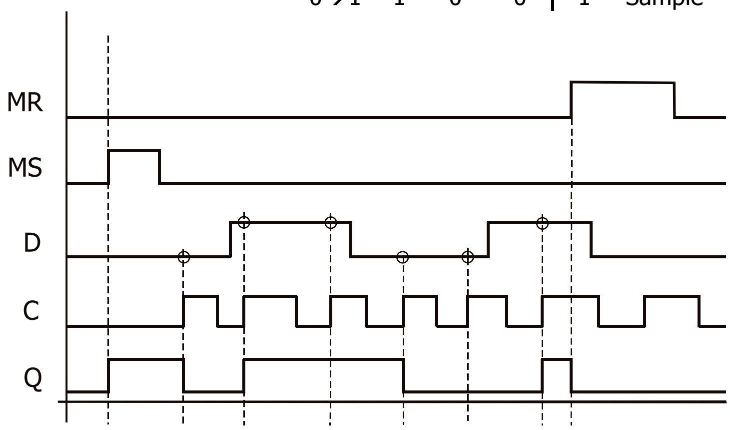
Via the output buffer, the output signal is globally available.

Master Set and Master Reset are connected parallel with the function and change the state of the function as soon as the signal is present.

D-Flip-Flop, Master



C	D	MS	MR	O1 Q	State
x	x	x	1	0	Off (Master)
x	x	1	0	1	On (Master)
x	x	0	0	Q_{n-1}	Hold
0→1	0	0	0	0	Sample
0→1	1	0	0	1	Sample

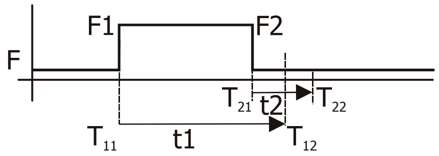


4.5 Delays

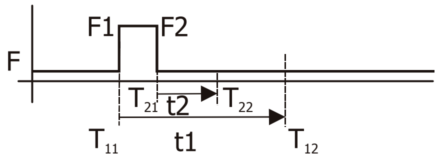
The delays can be used for delaying edges for a certain time. Two separate timers are available for the rising and the falling edge.

If the delay times are different, this may result in an edge F1 at time T_{11} has a later switching time T_{12} than an edge F2 at the time T_{21} with switching time T_{22}. In this case, no edge is switched at the output, as this would result in the input and output being inverted to on another.

$T_{22} > T_{12}$



$T_{22} < T_{12}$



The delays are implemented both as "retriggerable" and as "non-retriggerable".

Retriggerable means that a new edge (with the same direction) during the processing will restart the delay, the switching time for the edge will be recalculated ("last edge dominant"). The level of the input and output are not relevant to the calculation of the switching times.

Retriggerable should be selected if, in the case of several consecutive signals with a short interval between them, only the last signal is to be executed, or if, in the case of continuous signals, brief signal disturbances (flickering) are to be filtered out. The level of the input and output are not relevant to the calculation of the switching times.

Non-retriggerable means that a new edge (with the same direction) during the processing will not restart the delay, the originally calculated switching time is maintained ("first edge dominant").

Non-retriggerable should be used if an edge is to start a process, and the process should not be stopped before the end of the delay.

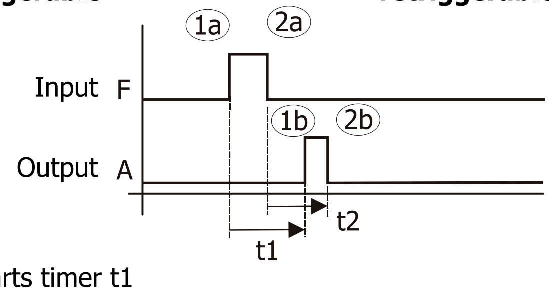
Note:
The units of the set times is milliseconds [ms], seconds [s] or minutes [min]. Internally, the values for delays are limited to 24 days.

Example 1

1 square pulse

On time input (F): 500 ms
Delay, positive edge: 1000 ms
Delay, negative edge: 800 ms

non-retriggerable **retriggerable**



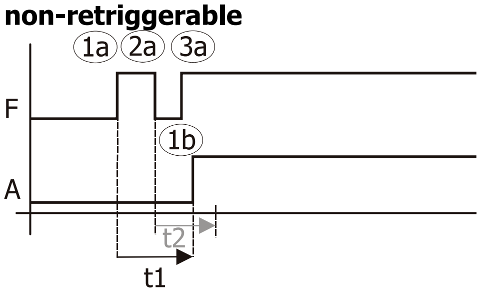
Edge 1a starts timer t1
Edge 2a starts timer t2
Edge 1b is output after a delay of t1 (referred to 1a)
Edge 2b is output after a delay of t2 (referred to 2a)

Example 2

1 square pulse followed by positive edge

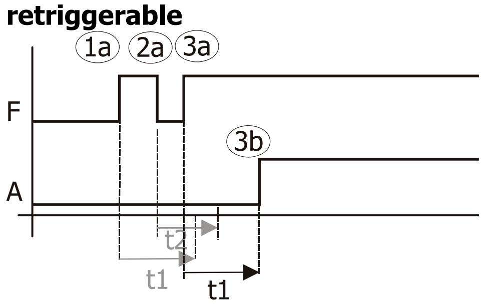
On time input (F): 500 ms
Off time input (F): 350 ms
Delay, positive edge: 1000 ms
Delay, negative edge: 800 ms

non-retriggerable



1a starts timer t1
2a starts timer t2
1b is output after t1
3a (continuous signal) stops execution of 2a

retriggerable

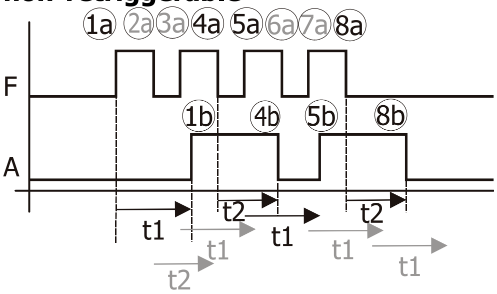


1a starts timer t1
2a starts timer t2
3a starts timer t1 again (retrigger)
3b is output after t1 (referred to 3a)

Example 3

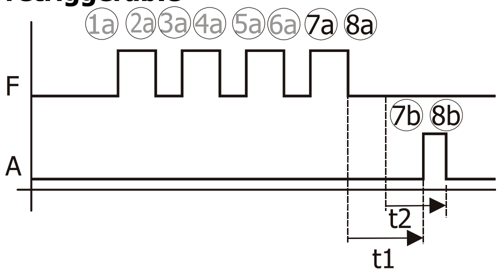
4 consecutive square pulses
On times and delays as in example 2

non-retriggerable



1a starts timer t1
2a starts timer t2
3a stops execution of 2a
1b is output after time t1
4a starts timer t2
5a starts timer t1
4b is output after time t2
6a to 8b: repeated as from 2a

retriggerable

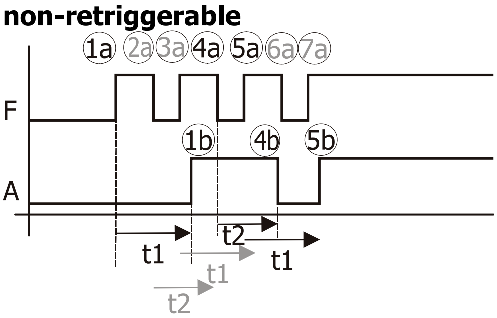


1a starts timer t1
2a starts timer t2
3a starts timer t1 again (retrigger)
4a starts timer t2 again (retrigger)
5a...10a restart timer t1 and t2
9b is output after t1 (referred to 9a)

Example 4

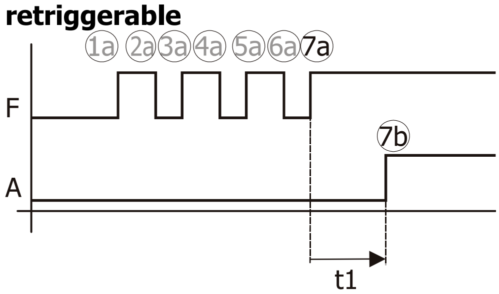
3 consecutive square pulse followed by positive edge
On times and delays as in example 2

non-retriggerable



Processing as in example 3. Edge 5a switches output "High". Edges 6a and 7a are filtered out due to the quick succession.

retriggerable



Processing as in example 3. The last positive edge (7a) maintains the output signals on "High" level.

4.5.1 [40,41,42] Delay (retriggerable), Superior

	Type	Function
I1	b	F, edge
I2		
I3	b	Superior Set input
I4	b	Superior Reset input

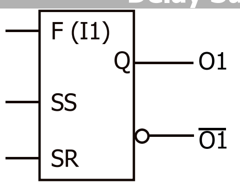
	Type	Function
O1	b	output O1
O2	b	negated output O2 = $\overline{O1}$
P1	t	On delay t1
P2	t	Off delay t2

Description:
The positive edge at input 1 is transferred to the output after delay t1, the negative edge after delay t2. The delay time starts again with each edge.
TRUE at the Superior Set input sets the output to TRUE. TRUE at the Superior Reset input sets the output to FALSE.

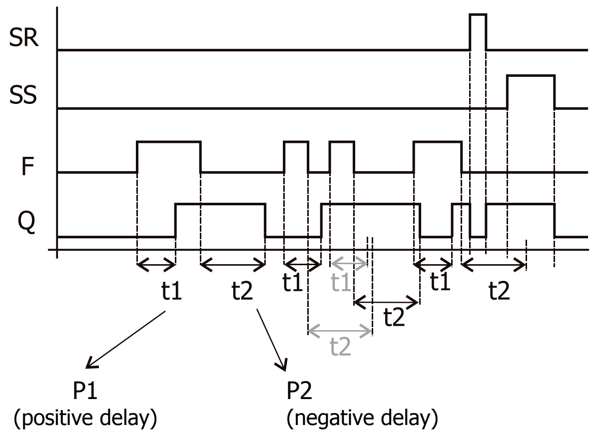
Via the output buffer, the output signal is globally available.

Inputs Superior Set and Superior Reset are connected in series with the function. Levels at input I1 are processed internally. As soon as the Superior Set or Superior Reset is reset, the output is switched to the internally saved value.

Delay Superior (retriggerable), Superior



F	SS	SR	O1 Q	State
x	x	1	0	Off (Superior)
x	1	0	1	On (Superior)
0→1	0	0	t1	On delay t1
1→0	0	0	t2	Off delay t2



4.5.2 [140,141,142] Delay (retriggerable), Master

	Type	Function		Type	Function
I1	b	F, edge	O1	b	output O1
I2			O2	b	negated output O2 = $\overline{O1}$
I3	b	Master Set input	P1	t	On delay t1
I4	b	Master Reset input	P2	t	Off delay t2

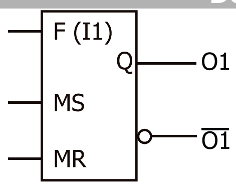
140 [ms], 141 [s] or 142 [min]

Description:
The positive edge at input 1 is transferred to the output after delay t1 (P1), the negative edge after delay t2 (P2). The delay time starts again with each edge.
TRUE at the Master Set input sets the output to TRUE. TRUE at the Master Reset input sets the output to FALSE.

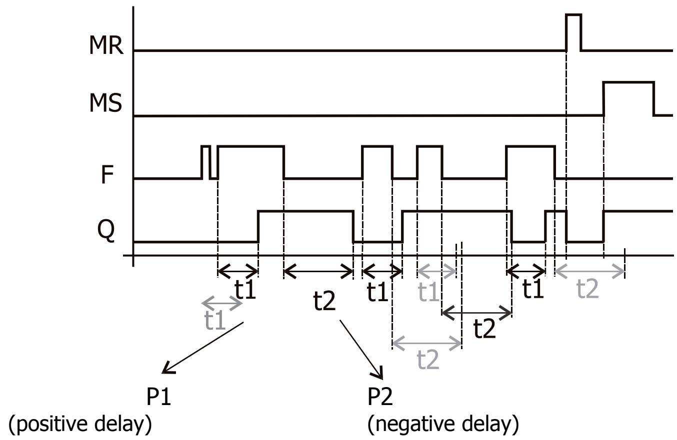
Via the output buffer, the output signal is globally available.

Master Set and Master Reset are connected parallel with the function and change the state of the function as soon as the signal is present.

Delay (retriggerable), Master



F	MS	MR	O1 Q	State
x	x	1	0	Off (Master)
x	1	0	1	On (Master)
0→1	0	0	t1	On delay t1
1→0	0	0	t2	Off delay t2



4.5.3 [50,51,52] Delay (non-retriggerable), Superior

	Type	Function
I1	b	F, edge
I2		
I3	b	Superior Set input
I4	b	Superior Reset input

	Type	Function
O1	b	output O1
O2	b	negated output O2 = $\overline{O1}$
P1	t	On delay t1
P2	t	Off delay t2

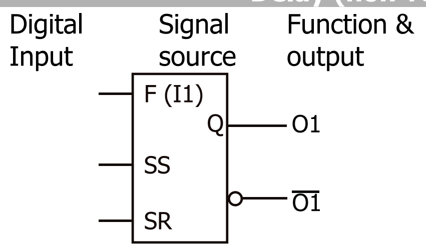
50 [ms], 51 [s] or 52 [min]

Description:
The positive edge at input 1 is transferred to the output after delay t1 (P1), the negative edge after delay t2 (P2). The delay time starts again with each edge.
TRUE at the Superior Set input sets the output to TRUE. TRUE at the Superior Reset input sets the output to FALSE.

Via the output buffer, the output signal is globally available.

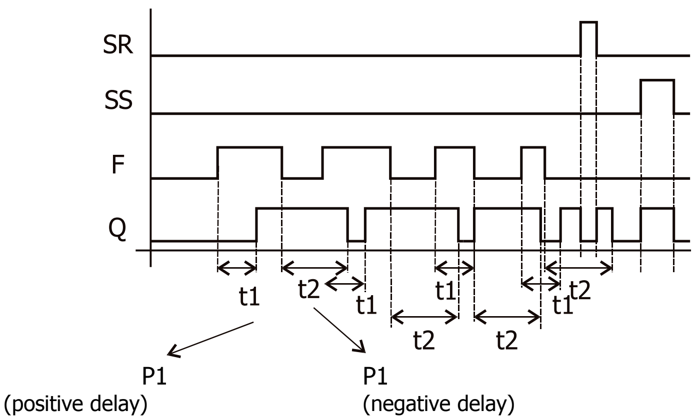
Inputs Superior Set and Superior Reset are connected in series with the function. Levels at input I1 are processed internally. As soon as the Superior Set or Superior Reset is reset, the output is switched to the internally saved value.

Delay (non-retriggerable), Superior



Logic table

F	SS	SR	O1 Q	State
x	x	1	0	Off (Superior)
x	1	0	1	On (Superior)
0→1	0	0	t1	On delay t1
1→0	0	0	t2	Off delay t2



4.5.4 [150,151,152] Delay (non-retriggerable), Master

	Type	Function
I1	b	F, edge
I2		
I3	b	Master Set input
I4	b	Master Reset input

	Type	Function
O1	b	output O1
O2	b	negated output O2 = $\overline{O1}$
P1	t	On delay t1
P2	t	Off delay t2

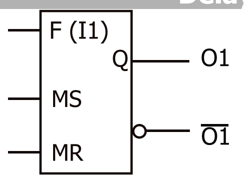
150 [ms], 151 [s] or 152 [min]

Description:
The positive edge at input 1 is transferred to the output after delay t1 (P1), the negative edge after delay t2 (P2). The delay time starts again with each edge.
TRUE at the Master Set input sets the output to TRUE. TRUE at the Master Reset input sets the output to FALSE.

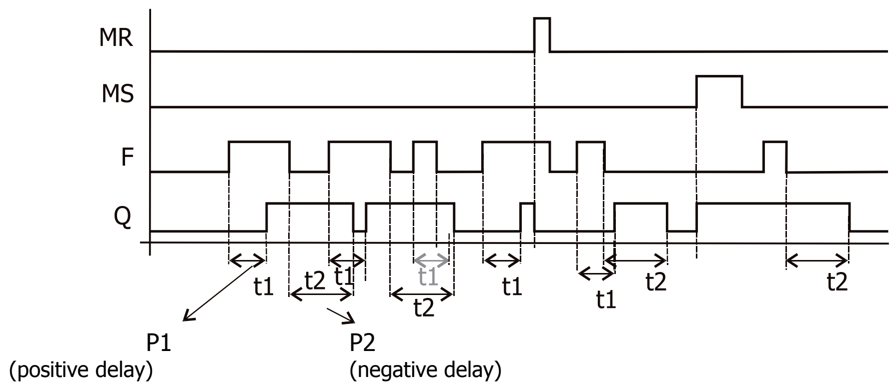
Via the output buffer, the output signal is globally available.

Master Set and Master Reset are connected parallel with the function and change the state of the function as soon as the signal is present.

Delay (non-retriggerable), Master



F	MS	MR	O1 Q	State
x	x	1	0	Off (Master)
x	1	0	1	On (Master)
0→1	0	0	t1	On delay t1
1→0	0	0	t2	Off delay t2



4.6 Timer functions

4.6.1 [60,61,62] Monoflop (retriggerable), Superior

	Type	Function
I1	b	M, Monoflop edge 1
I2	b	$\overline{M}$, Monoflop edge 2
I3	b	Superior Set input
I4	b	Superior Reset input

	Type	Function
O1	b	output O1
O2	b	negated output O2 = - $\overline{O1}$
P1	t	On-time (High)
P2	t	ignore edge time

60 [ms], 61 [s] or 62 [min]

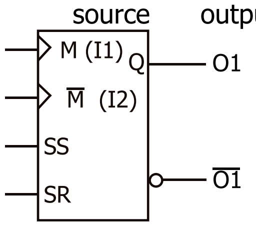
Description:
Output signal becomes TRUE with positive clock edge at input 1 or with negative clock edge at input 2. The time set in P1 is the On-Time (High) and the time set in P2 is the ignore edge time (Low). The set on-time starts again with each edge.
TRUE at the Superior Set input sets the output to TRUE. TRUE at the Superior Reset input sets the output to FALSE.

Via the output buffer, the output signal is globally available.

Inputs Superior Set and Superior Reset are connected in series with the function. Levels on Monoflop inputs I1 and I2 As soon as the Superior Set or Superior Reset is reset, the output is switched to the internally saved value.

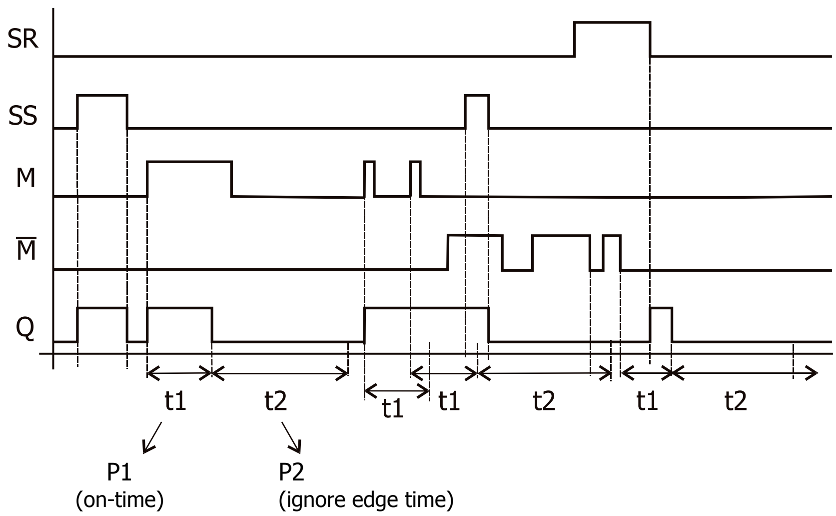
Monoflop (retriggerable), Superior

Digital Input	Signal source	Function & output



Logic table

M	$\overline{M}$	SS	SR	O1 Q	State
x	x	x	1	0	Off (Superior)
x	x	1	0	1	On (Superior)
0→1	x	0	0	⎍	Pulse
x	0→1	0	0	⎍	Pulse



4.6.2 [160,161,162] Monoflop (retriggerable), Master

	Type	Function		Type	Function
I1	b	M, Monoflop edge 1	O1	b	output O1
I2	b	$\overline{M}$, Monoflop edge 2	O2	b	negated output O2 = $\overline{O1}$
I3	b	Master Set input	P1	t	On-time (High)
I4	b	Master Reset input	P2	t	ignore edge time

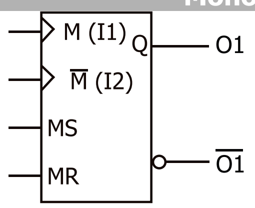
160 [ms], 161 [s] or 162 [min]

Description:
Output signal becomes TRUE with positive clock edge at input 1 or with negative clock edge at input 2. The time set in P1 is the On-Time (High) and the time set in P2 is the ignore edge time (Low). The set on-time starts again with each edge.
TRUE at the Master Set input sets the output to TRUE. TRUE at the Master Reset input sets the output to FALSE.

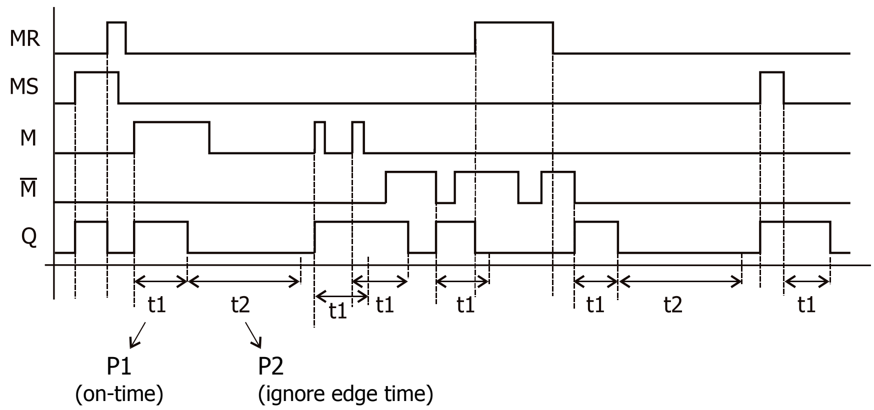
Via the output buffer, the output signal is globally available.

Master Set and Master Reset are connected parallel with the function and change the state of the function as soon as the signal is present.

Monoflop (retriggerable), Master



M	$\overline{M}$	MS	MR	O1 Q	State
x	x	x	1	0	Off (Master)
x	x	1	0	1	On (Master)
0→1	x	0	0		Pulse
x	0→1	0	0		Pulse



4.6.3 [70,71,72] Monoflop (non-retriggerable), Superior

	Type	Function
I1	b	M, Monoflop edge 1
I2	b	$\overline{M}$, Monoflop edge 2
I3	b	Superior Set input
I4	b	Superior Reset input

	Type	Function
O1	b	output O1
O2	b	negated output O2 = $\overline{O1}$
P1	t	On-time (High)
P2	t	ignore edge time

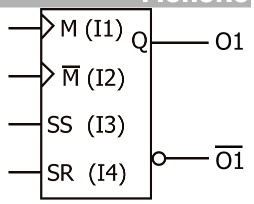
70 [ms], 71 [s] or 72 [min]

Description:
Output signal becomes TRUE with positive clock edge at input 1 or with negative clock edge at input 2. The time set in P1 is the On-Time (High) and the time set in P2 is the ignore edge time (Low). The set on-time starts again with each edge.
TRUE at the Superior Set input sets the output to TRUE. TRUE at the Superior Reset input sets the output to FALSE.

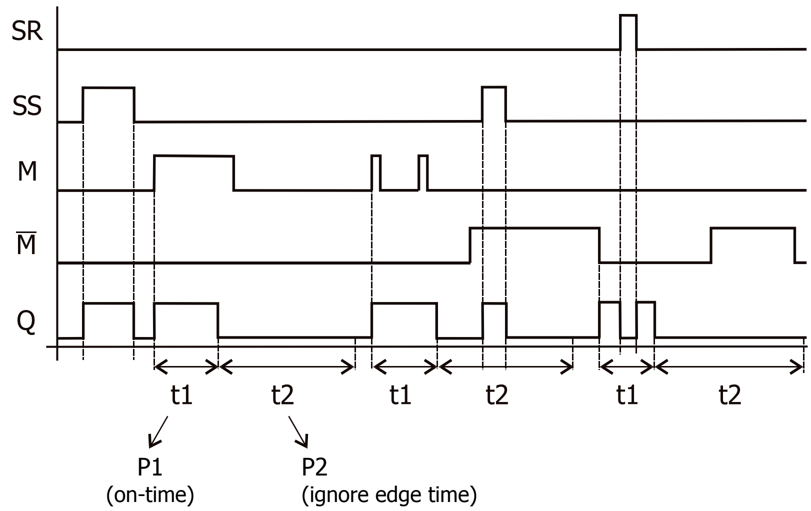
Via the output buffer, the output signal is globally available.

Inputs Superior Set and Superior Reset are connected in series with the function. Levels on Monoflop inputs I1 and I2 As soon as the Superior Set or Superior Reset is reset, the output is switched to the internally saved value.

Monoflop (non-retriggerable), Superior



I1 M	I2 $\overline{M}$	I3 SS	I4 SR	O1 Q	State
x	x	x	1	0	Off (Superior)
x	x	1	0	1	On (Superior)
0→1	x	0	0		Pulse
x	0→1	0	0		Pulse



4.6.4 [170,171,172] Monoflop (non-retriggerable), Master

	Type	Function
I1	b	M, Monoflop edge 1
I2	b	$\overline{M}$, Monoflop edge 2
I3	b	Master Set input
I4	b	Master Reset input

	Type	Function
O1	b	output O1
O2	b	negated output O2 = $\overline{O1}$
P1	t	On-time (High)
P2	t	ignore edge time

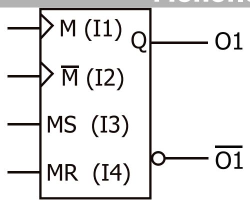
170 [ms], 171 [s] or 172 [min]

Description:
Output signal becomes TRUE with positive clock edge at input 1 or with negative clock edge at input 2. The time set in P1 is the On-Time (High) and the time set in P2 is the ignore edge time (Low). The set on-time starts again with each edge.
TRUE at the Master Set input sets the output to TRUE. TRUE at the Master Reset input sets the output to FALSE.

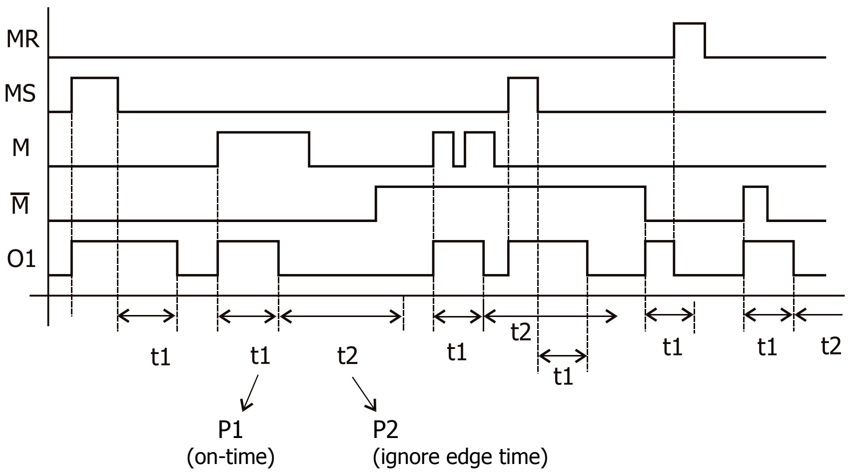
Via the output buffer, the output signal is globally available.

Master Set and Master Reset are connected parallel with the function and change the state of the function as soon as the signal is present.

Monoflop (non-retriggerable), Master



I1 M	I2 $\overline{M}$	I3 MS	I4 MR	O1 Q	State
x	x	x	1	0	Off (Master)
x	x	1	0	1	On (Master)
0→1	x	0	0	⎍	Pulse
x	1→0	0	0	⎍	Pulse



4.6.5 [80,81,82] Clock generator Superior

	Type	Function
I1	b	S clock generator 1
I2	b	$\overline{S}$ Clock generator 2
I3	b	Superior Set input
I4	b	Superior Reset input

	Type	Function
O1	b	output O1
O2	b	negated output O2 = $\overline{O1}$
P1	t	On-time (High)
P2	t	Off time (Low)

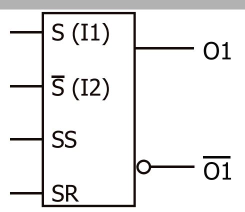
80 [ms], 81 [s] or 82 [min]

Description:
As long as input 1 is TRUE and input 2 is FALSE, the set pulse pattern is output. The pulse pattern at the output always starts with TRUE. The clock pattern is defined by the on-time and the off-time. The time set in P1 is the on-time (High) and the time set in P2 is the off-time (Low).

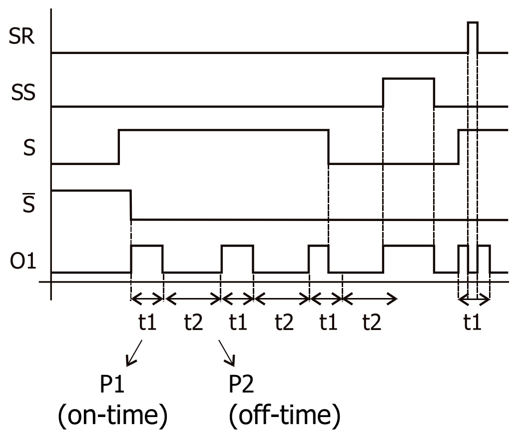
Via the output buffer, the output signal is globally available.

Inputs Superior Set and Superior Reset are connected in series with the function. Levels at Set input I1 and Reset input I2 are processed internally. As soon as the Superior Set or Superior Reset is reset, the output is switched to the internally saved value.

Clock generator



S	$\overline{S}$	SS	SR		O1 Q	State
x	x	x	1		0	Off (Superior)
x	X	1	0		1	On (Superior)
x	1	0	0		0	Off
0	x	0	0		0	Off
1	0	0	0	t1	1	Clock On
1	0	0	0	t2	0	Clock Off



4.6.6 [180,181,182] Clock generator, Master

	Type	Function
I1	b	S clock generator 1
I2	b	$\overline{S}$ Clock generator 2
I3	b	Master Set input
I4	b	Master Reset input

	Type	Function
O1	b	output O1
O2	b	negated output O2 = $\overline{O1}$
P1	t	On-time (High)
P2	t	Off time (Low)

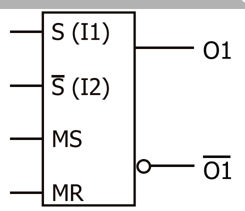
180 [ms], 181 [s] or 182 [min]

Description:
As long as input 1 is TRUE and input 2 is FALSE, the set pulse pattern is output. The pulse pattern at the output always starts with TRUE. The clock pattern is defined by the on-time and the off-time. The time set in P1 is the on-time (High) and the time set in P2 is the off-time (Low).

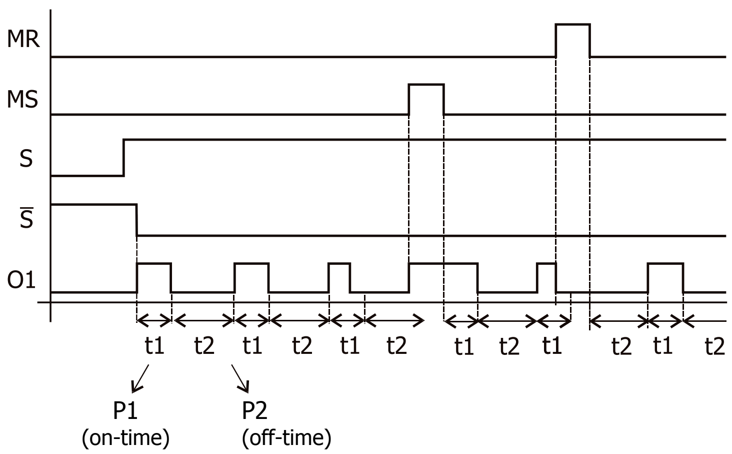
Via the output buffer, the output signal is globally available.

Master Set and Master Reset are connected parallel with the function and change the state of the function as soon as the signal is present.

Clock generator, Master



S	$\overline{S}$	MS	MR		O1 Q	State
x	x	x	1		0	Off (Master)
x	X	1	0		1	On (Master)
x	1	0	0		0	Off
0	x	0	0		0	Off
1	0	0	0	t1	1	Clock On
1	0	0	0	t2	0	Clock Off



4.7 Digital multiplexer

4.7.1 [90] Digital Multiplexer (Data Set Number)

	Type	Function
I1	b	Input data set 1
I2	b	Input data set 2
I3	b	Input data set 3
I4	b	Input data set 4

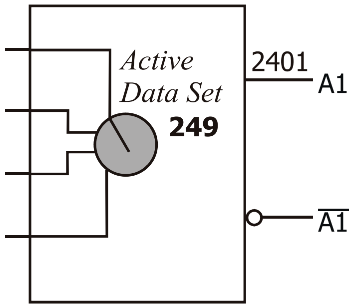
	Type	Function
O1	b	output O1
O2	b	negated output O2 = $\overline{O1}$
P1		
P2		

Description:
Depending on the current data set, the input values are forwarded to the outputs .

Parameter *Active data set* **249** shows the selected data set.

Digital Multiplexer (Data Set Number)

Active Data Set **249**	2401
1	E1
2	E2
3	E3
4	E4



4.8 Switch

4.8.1 [91] Switch Data Set

	Type	Function
I1	b	Input 1 (highest priority)
I2	b	Input 2
I3	b	Input 3
I4	b	Input 4 (lowest priority)

	Type	Function
O1	-	-
O2	-	-
P1	-	-
P2	-	-

Description:
A data set is selected via the input values.

Switch data set

I1	I2	I3	I4	Data Set
1	x	x	x	1
0	1	x	x	2
0	0	1	x	3
0	0	0	1	4
0	0	0	0	Data set via contacts

4.9 Error functions

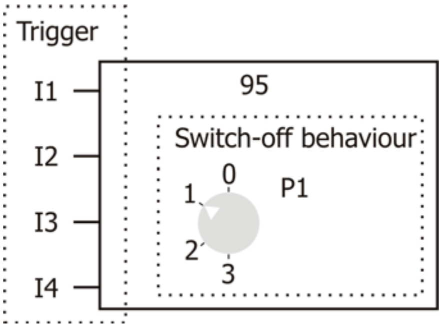
4.9.1 [95] Triggering of an error

	Type	Function
I1	b	Triggering user error 1
I2	b	Triggering user error 2
I3	b	Triggering user error 3
I4	b	Triggering user error 4

	Type	Function
O1	-	-
O2	-	-
P1	i	Shut-down behavior
P2	-	-

Description:
If one of the inputs is TRUE, the relevant user error is triggered. The output stages are disabled. The error is not acknowledgeable as long the input remains TRUE.
The function can be used, for example, for stopping the drive by external events.
Via P1, the shut-down behavior can be adjusted. The error cut-off can be effected immediately, or the drive can be shut down first.

- P1 = 0: No error cut-off (deactivated)
- P1 = 1: Shut-down and error cut-off.
- P1 = 2: Emergency stop and error cut-off.
- P1 = 3: Error cut-off immediately.



Value	Logic state				Trigger User error	Function
P1	I1	I2	I3	I4		
"0"	1	0	0	0	1	No error cut-off
	0	1	0	0	2	
	0	0	1	0	3	
	0	0	0	1	4	
"1"	1	0	0	0	1	Shut-down and error cut-off
	0	1	0	0	2	
	0	0	1	0	3	
	0	0	0	1	4	
"2"	1	0	0	0	1	Emergency stop and error cut-off
	0	1	0	0	2	
	0	0	1	0	3	
	0	0	0	1	4	
"3"	1	0	0	0	1	Error cut-off immediately
	0	1	0	0	2	
	0	0	1	0	3	
	0	0	0	1	4	

One of the following error messages is displayed after a user error was triggered:

Error	Description
F3031	User error 1 PLC
F3032	User error 2 PLC
F3033	User error 3 PLC
F3034	User error 4 PLC

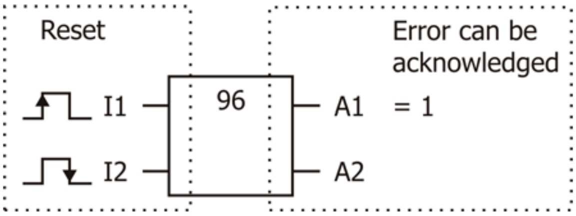
The inputs are evaluated with priority I1, I2, I3, I4. For example, I1 has priority over I2 if both inputs are TRUE.

4.9.2 [96] Acknowledging an error

	Type	Function
I1	b	Input error reset +
I2	b	Input error reset -
I3	-	-
I4	-	-

	Type	Function
O1	b	"Message can be acknowl-edged".
O2	b	inverted output = O1
P1	-	-
P2	-	-

Description:
Output 1 becomes TRUE if an acknowledgeable error message is present.
With each positive edge at input 1 or negative edge at input 2 an attempt is made to acknowledge an present error message. If the message cannot be acknowledged (yet), there is no reaction.



O1	I1	I2	Function
1	0→1	x	Acknowl-edge fault.
0			None
1	x	1→0	Acknowl-edge fault.
0			None
I1	x	x	Automatic Error Acknowledg-ment

Note:
If output 1 is connected with input 1, faults are acknowledged automatically.

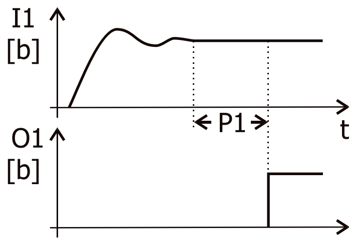
4.10 Debouncer

4.10.1 [97] Debouncer

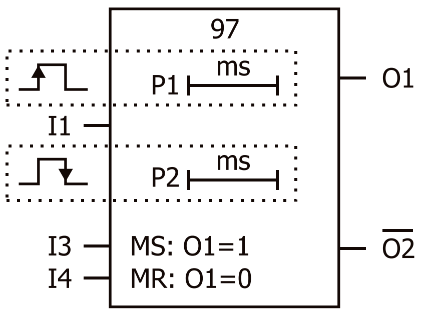
	Type	Function
I1	b	input value 1
I2	-	-
I3	b	Master Set
I4	b	Master Reset

	Type	Function
O1	b	Debounced input value 1
O2	b	inverted output = O1
P1	i	delay positive edge in ms
P2	i	delay negative edge in ms

Description:
The input value will be forwarded to the output only if it has had a constant value for the configured delay.
The delay for the positive edge of the input signal can be set via P1. The delay for the negative edge of the input signal can be set via P2.



Master Set: TRUE at I3 sets O1 to TRUE.
Master-Reset: TRUE at I4 sets O1 to FALSE.
Master Reset has priority over Master Set.



4.11 No operation

4.11.1 [99] NOP (no operation)

Description:
This function can be used as a placeholder if it is expected that function will be added to the programming later. It does not carry out an operation.

4.12 Jump functions

4.12.1 [100] Jump function

	Type	Function		Type	Function
I1	b	Jump function active	O1		
I2	b	Jump target P1/P2	O2		
I3	b	Update input buffer	P1	i	Jump target P1
I4	b	Update output buffer	P2	i	Jump target P2

Description:
This function enables jumps in the sequence of the instructions to other instructions.

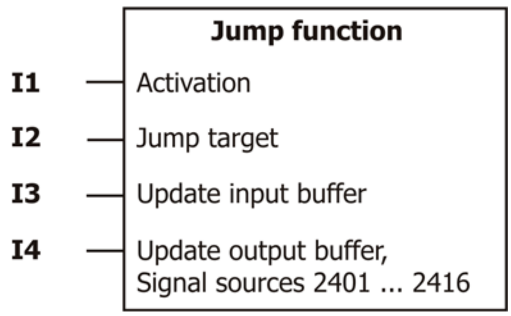
Activation
Input 1 activates the jump function
Input 1 = TRUE: jump function is executed
Input 1 = FALSE: jump function is not executed

Jump target
Input 2 defines the jump target of which parameter – P1 or P2 – is to be applied.
Input 2 = TRUE: Jump to instruction set in P1.
Input 2 = FALSE: Jump to instruction set in P2.

Updating of input buffer
TRUE at input 3 results in the input buffer being updated. The values of the digital inputs and signal sources in the input buffer are updated.

Updating of output buffer (output buffer values)
TRUE at input 4 results in the values of the output values "2401 - PLC output buffer 1" to "2416 - PLC output buffer 16" being updated. The updated values are available to digital outputs and functions linked to instruction outputs (e.g. Start Clockwise, Switch Data Set).

Jump function



I1	I2	I3	I4	Jump
0	x	x	x	Jump to next instruction (index I + 1)
1	1	x	x	Jump to instruction set in P1.
1	0	x	x	Jump to instruction set in P2.

I1	I2	I3	I4	Update
x	x	1	x	Update input buffer (2001 … 2016).
x	x	x	1	Update output buffer (2401 … 2416).

Note:
At first, the output buffer is written and the input buffer is set. Then, the jump event is evaluated (based on the updated buffers) and executed.

4.12.2 [101] Jump function for loops

	Type	Function
I1	b	Finish loop
I2	b	Restart loop
I3	b	Update input buffer
I4	b	Update output buffer

	Type	Function
O1	-	-
O2	-	-
P1	i	Jump target (index)
P2	i	number of repetitions

Description:
An instruction indicated as jump target in P1 is executed as often as indicated in P2. Via the inputs, the loop can be stopped or restarted.

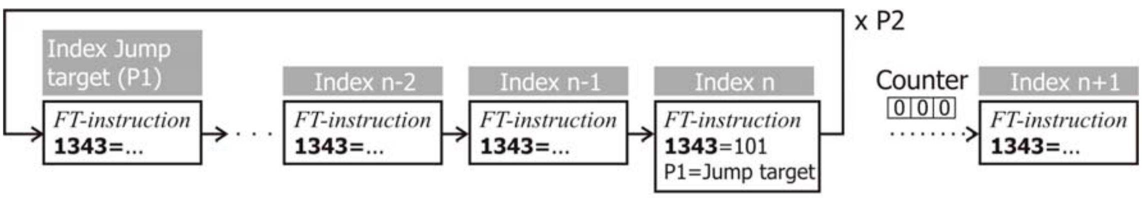
- With P1, the jump target (the instruction to be executed repeatedly) is defined.
- With P2, the number of repetitions is defined.

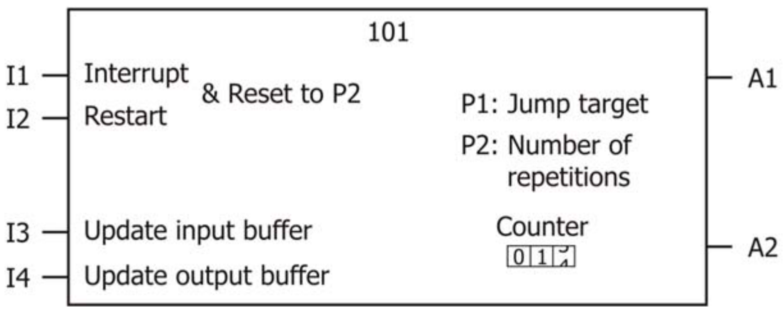
Die jump function can be at the end of a series of instructions to be processed repeatedly.
An internal counter is set to the value of P2 and counted down each time the instructions specified in P1 are called.

- If input I1 is TRUE, the loop is stopped before it is finished. The jump is not executed and the internal counter is reset to the start value P2.
- If input I2 is TRUE, the loop is restarted. The jump is executed and the internal counter is reset to the start value P2.
- If input 3 is TRUE, the input buffer is updated.
- If input 4 is TRUE, the output buffer is updated.

I1	I2	I3	I4	Function
1	0	0	0	Stop, reset to start value P2
0	1	0	0	Restart, reset to start value P2
0	0	1	0	Update input buffer
0	0	0	1	Update output buffer

I2 (restart) has priority over I1 (stop).





5 Description of analog functions

In the following, you will find explanations and examples of the individual analog functions. The term "analog function" is defined as follows:
An analog function has at least one analog input or output value. Other inputs are used as digital signal, depending on the function.

If the function has an analog output value (O1), the second output value (O2) is the inverted (negative) value.
If the function has both analog and Boolean inputs, the analog inputs are assigned the smaller ordinal numbers (I1 = analog, I4 = Boolean)

In the examples, the standard links of the input buffer are used. You can also parameterize other settings for the individual instructions.

Note:
In the case of some functions, output O2 is not used as an inverted output, but written with function-specific values. These functions are marked with "Long" for long variable.

In the descriptions, the following abbreviations are used:

b	Boolean	(TRUE / FALSE) = 1 Bit
%	Percentage	with/or without sign (int/unit) = 2 Byte = 16 Bit
L	Long	Variable of type long = 4 byte = 32 bits
i	Any number	
0	"Low" state. Representation of signal statuses in logic tables.	
1	"High" state. Representation of signal statuses in logic tables.	
Off	"Low" state. Representation of signal statuses in function descriptions.	
On	"High" state. Representation of signal statuses in function descriptions.	

5.1 Behavior

The behavior of the instructions can be set up via P1 and P2. The function of these parameters depends on the selected instruction.

Description	Min.	Max.
P1	0	65535
P2	0	65535

5.2 Comparators

5.2.1 [301,302] Comparator (comparison of two variables)

	Type	Function		Type	Function
I1	%	Comparative value 1	O1	b	Output I1 > I2
I2	%	Comparative value 2	O2	b	O1 inverted
I3	b	Master-Set	P1	%	positive hysteresis (xxx.xx%)
I4	b	Master Reset	P2	%	negat. hysteresis (xxx.xx%)

Comparison of two variables

Description:
This function compares inputs I1 and I2.
O1 is TRUE if I1 > I2.
O1 is FALSE if I1 < I2.

If a hysteresis (P1 and P2) is set up:
O1 is TRUE if I1 > (I2 + P1).
O1 is FALSE if I1 < (I2 - P2).

The comparator has three working ranges:

Range 1	(I2 + P1) < I1	O1 = TRUE
Range 2	(I2 - P2) < I1 < (I2 + P1)	O1 remains unchanged.
Range 3	I1 < (I2 - P2)	O1 = FALSE
		O2 = $\overline{O1}$

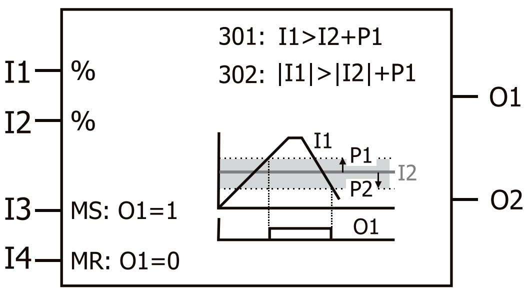
Description:
This function compares the absolute values of inputs I1 and I2.
O1 is TRUE if |I1| > |I2|.
O1 is FALSE if |I1| < |I2|.

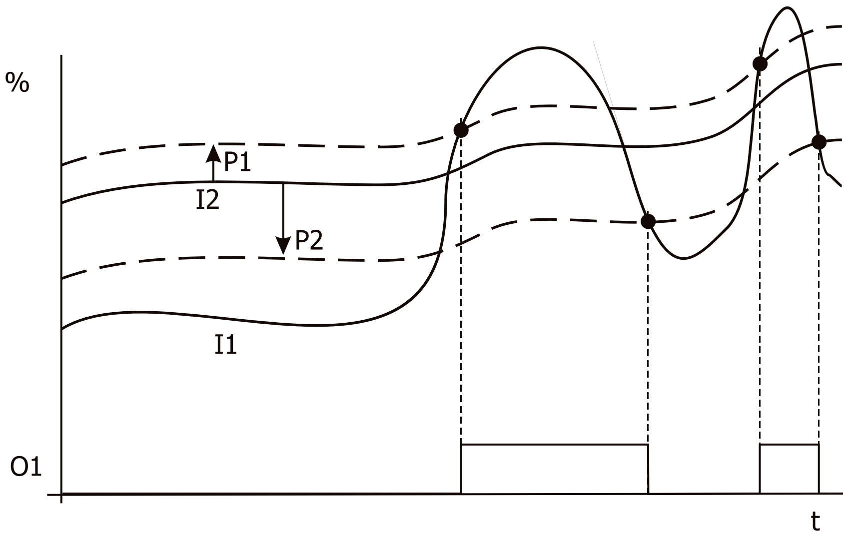
If a hysteresis (P1 and P2) is set up:
O1 is TRUE if |I1| > (|I2| + P1).
O1 is FALSE if |I1| < (|I2| - P2).

The comparator has three working ranges:

Range 1	(|I2| + P1) < |I1|	O1 = TRUE
Range 2	(|I2| - P2) < |I1| < (|I2| + P1)	O1 remains unchanged.
Range 3	|I1| < (|I2| - P2)	O1 = FALSE
		O2 = $\overline{O1}$

The output value can be changed by means of the two Boolean inputs I3 and I4:
Master Set sets output O1 to TRUE.
Master Reset sets output O1 to FALSE. Master Reset has priority over Master Set.





Note:
This function compares inputs I1 and I2. Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

5.2.2 [303,304] Comparator (comparison of constant to variable)

	Type	Function		Type	Function
I1	%	Comparative value 1	O1	b	Output I1 > P1
I2	-	-	O2	b	O1 inverted
I3	b	Master-Set	P1	%	upper threshold (xxx.xx%)
I4	b	Master Reset	P2	%	lower threshold (xxx.xx%)

"303 - Comp." (input with constant)
"304 - Comp." (input with constant), abs. value

– **303 - Comp.**

Description:
This function compares input I1 to the switching thresholds P1 and P2.
O1 is TRUE if I1 > P1 (upper threshold).
O1 is FALSE if I1 < P2 (lower threshold).
O1 remains unchanged if I1 is in the range between P2 and P1.

The comparator has three working ranges:

Range 1	P1 < I1	O1 = TRUE
Range 2	P2 < I1 < P1	O1 remains unchanged.
Range 3	I1 < P2	O1 = FALSE
		O2 = $\overline{O1}$

Special case:
P2 (lower threshold) is set higher than P1 (upper threshold) (thresholds exchanged):
O1 is TRUE if I1 > P1.
O1 will be reset if P1 is deceeded again and P2 was not exceeded.
O1 is also reset if P2 is exceeded first and then deceeded again.

– **304 - Comp. (input with constant), abs. value**

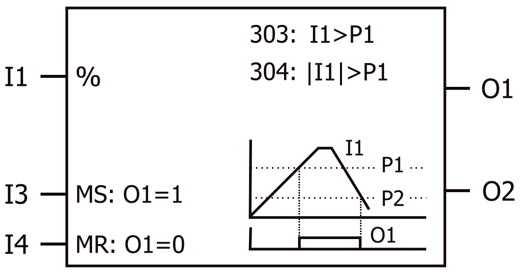
Description:
This function compares the absolute value of input I1 to the switching thresholds P1 and P2.
O1 is TRUE is |I1| > P1 (upper threshold).
O1 is FALSE if |I1| < P2 (lower threshold).
O1 remains unchanged if |I1| is in the range between P2 and P1.

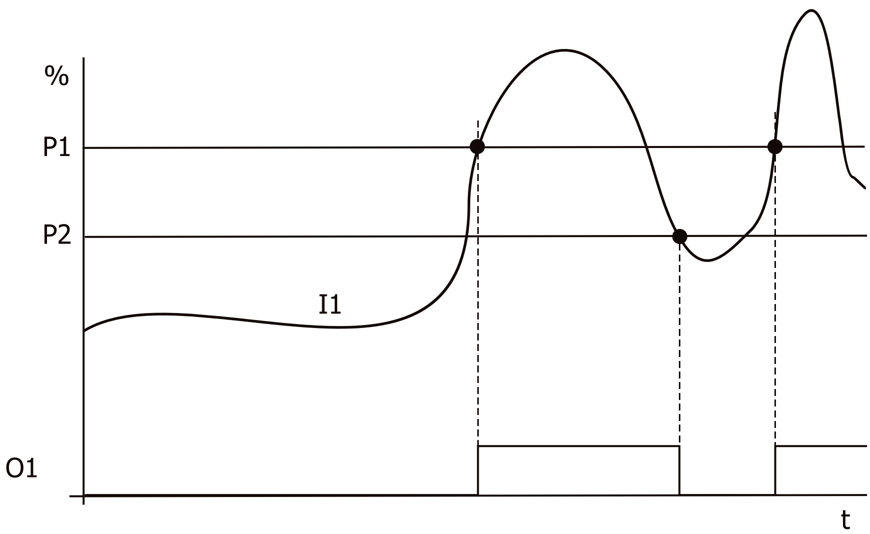
The comparator has three working ranges:

Range 1	P1 < |I1|	O1 = TRUE
Range 2	P2 < |I1| < P1	O1 remains unchanged.
Range 3	|I1| < P2	O1 = FALSE
		O2 = $\overline{O1}$

Special case:
P2 (lower threshold) is set higher than P1 (upper threshold) (thresholds exchanged):
O1 is TRUE if |I1| > P1.
O1 will be reset if P1 is deceeded again and P2 was not exceeded.
O1 is also reset if P2 is exceeded first and then deceeded again.

The output value can be changed by means of the two Boolean inputs I3 and I4:
Master Set sets output O1 to TRUE.
Master Reset sets output O1 to FALSE. Master Reset has priority over Master Set.





Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

5.2.3 [308] Comparator for motion blocks

	Type	Function
I1	-	-
I2	-	-
I3	b	Master-Set
I4	b	Master Reset

	Type	Function
O1	b	P1 < current motion block < P2
O2	b	O1 inverted
P1	i	Motion block from
P2	i	Motion block to

Description:
This function compares the two parameters P1 and P2 to the current motion block of the table positioning. If the current motion block is within the two defined parameters, the output is set to TRUE.

The output of the comparator is TRUE if a motion block is active in the table positioning in the range P1 … P2.

The output value can be changed by means of the two Boolean inputs I3 and I4:
Master Set sets output O1 to TRUE.
Master Reset sets output O1 to FALSE. Master Reset has priority over Master Set.

Examples:

	P1	P2	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
P1<P2	5	7																																
P1>P2	20	10																																

: O1 = TRUE

Special case: P1 > P2:
O1 = TRUE if a motion block from ranges 1 to P2 or P1 to 32 is active.

5.2.4 [309] Position comparator (long)

	Type	Function
I1	L	Comparative value 1
I2	L	Comparative value 2
I3	b	Master-Set
I4	b	Master Reset

	Type	Function
O1	b	Output I1 > I2
O2	b	O1 inverted
P1	%	positive hysteresis (low word)
P2	%	negative hysteresis (low word)

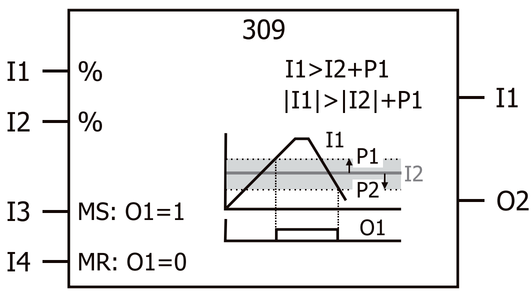
Description:
This function compares inputs I1 and I2. This function is intended for long variables (positions, ramps of table positioning).
O1 is TRUE if I1 > I2.
O1 is FALSE if I1 < I2.

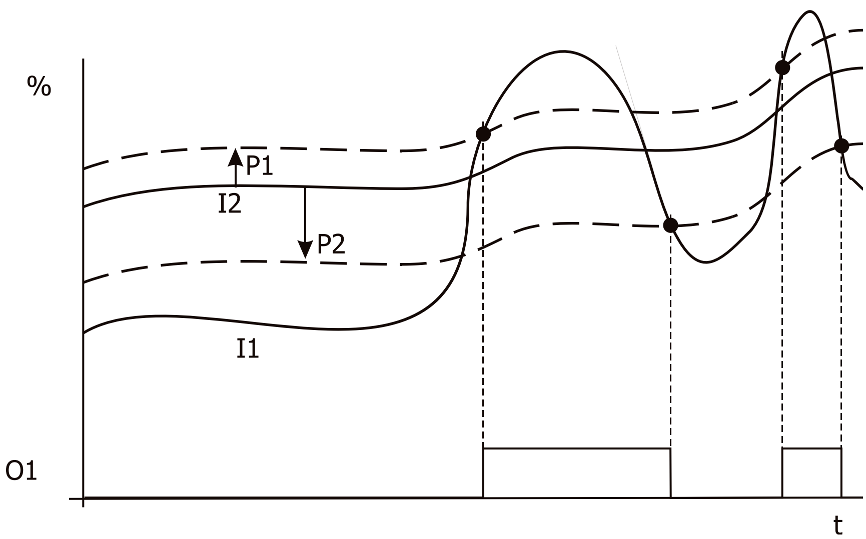
If a hysteresis (P1 and P2) is set up:
O1 is TRUE if I1 > (I2 + P1).
O1 is FALSE if I1 < (I2 - P2).
O1 remains unchanged if I1 is in the range of the hysteresis: (I2 - P2) < I1 < (I2 + P1).

The comparator has three working ranges:

Range 1	(I2 + P1) < I1	O1 = TRUE
Range 2	(I2 - P2) < I1 < (I2 + P1)	O1 remains unchanged.
Range 3	I1 < (I2 - P2)	O1 = FALSE
		O2 = $\overline{O1}$

The output value can be changed by means of the two Boolean inputs:
- Master Set sets output O1 to TRUE.
- Master Reset sets output O1 to FALSE. Master Reset has priority over Master Set.





5.2.5 [310] Analog hysteresis

	Type	Function
I1	%	Input value
I2	%	Variable hysteresis
I3	b	Start
I4	b	Master Reset

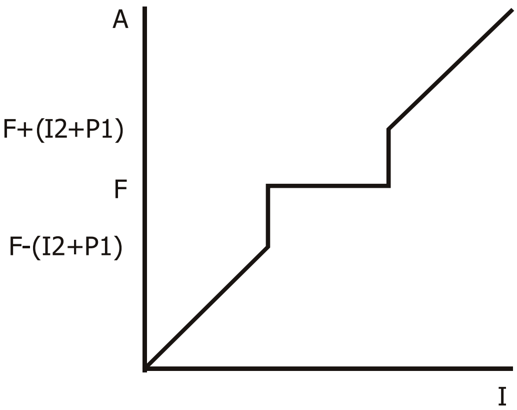
	Type	Function
O1	b	Output
O2	b	O1 inverted
P1	%	Constant hysteresis
P2	-	-

Description:
Signal (status-controlled) at I3 saves actual value at I1. The hysteresis values I2 (variable) and P1 (constant) are added to and subtracted from the saved value. If the value of I1 is within the hysteresis, the saved value is output. If the value of I1 is outside of the hysteresis, the current value of I1 is output.

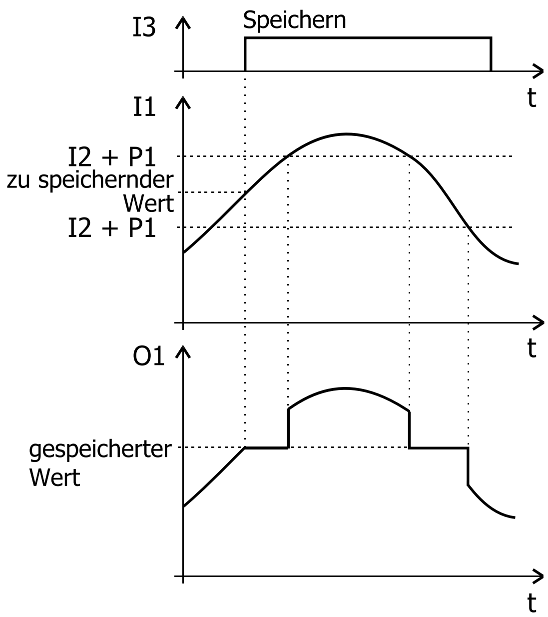
If the start input I3 is set, the input value I1 is maintained (F = I1).
I1 > F + (I2 + P1) → O1 = I1
I1 < F - (I2 + P1) → O1 = I1
F - (I2 + P1) < **I1** < F + (I2 + P1) → O1 = F

Master Reset sets output O1 to FALSE.
If Master Reset is reset, the process must be started again via I3.

Output A = f(input E)



Output A = f(t)



I3	I4	Function
1	0	Keep I1 at O1 constant.
x	1	Set O1 to FALSE.

Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

5.2.6 [311,312] Window comparator (comparison of two variables)

	Type	Function
I1	%	Comparative value 1
I2	%	Comparative value 2
I3	b	Master-Set
I4	b	Master Reset

	Type	Function
O1	b	Output I1 > I2
O2	b	O1 inverted
P1	%	positive window (xxx.xx%)
P2	%	negative window (xxx.xx%)

"311 – W. Comp (2 V)" (Window comparator, two variables)
"312 – W. Comp (2 V)" absolute value" (Window comparator, two variables, absolute value)

– **311 – W. comp (2 V)**

Description:
It is checked if I1 is in the adjusted range (window) around I2.
O1 is TRUE if I1 is in the range of I2. The range is set up with P1 (positive window) and P2 (negative window).
O1 is FALSE if I1 is outside of this range.

The comparator has three working ranges:

Range 1	(I2 + P1) < I1	O1 = FALSE
Range 2	(I2 - P2) < I1 < (I2 + P1)	O1 = TRUE
Range 3	I1 < (I2 - P2)	O1 = FALSE

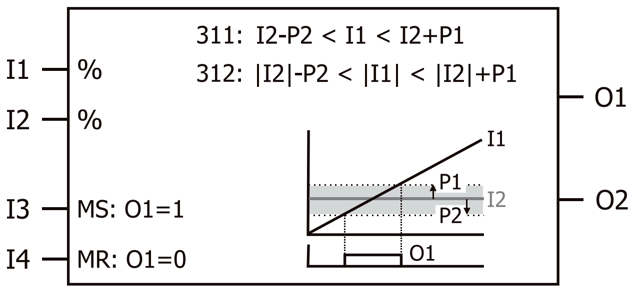
– **312 – W. comp (2 V), absolute value**

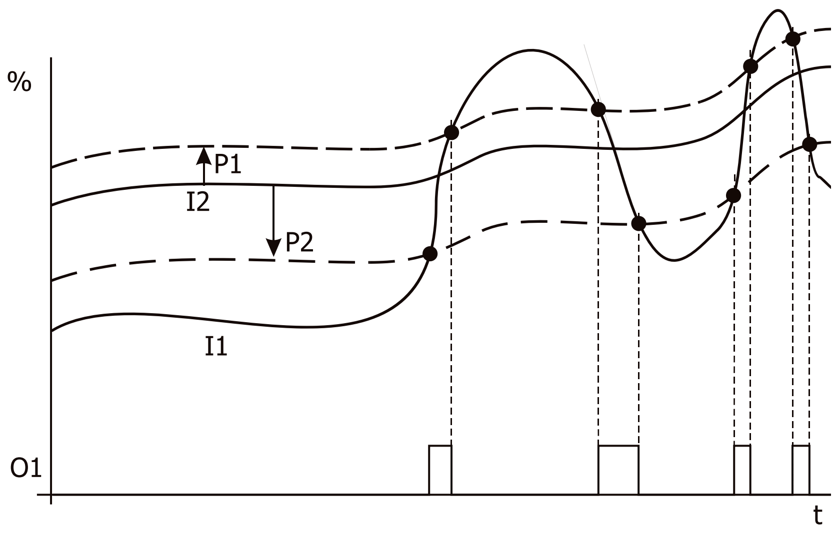
Description:
It is checked if the absolute value I1 is in the adjusted range (window) around absolute value of I2.
O1 is TRUE if |I1| is in the range of |I2|. The range is set up with P1 (positive window) and P2 (negative window).
O1 is FALSE if |I1| is outside of this range.

The comparator has three working ranges:

Range 1	(|I2| + P1) < |I1|	O1 = FALSE
Range 2	(|I2| - P2) < |I1| < (|I2| + P1)	O1 = TRUE
Range 3	|I1| < (|I2| - P2)	O1 = FALSE

The output value can be changed by means of the two Boolean inputs I3 and I4:
Master Set sets output O1 to TRUE.
Master Reset sets output O1 to FALSE. Master Reset has priority over Master Set.





Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

5.2.7 [313,314] Window comparator (comparison of constant to variable)

	Type	Function
I1	%	Comparative value 1
I2	-	-
I3	b	Master-Set
I4	b	Master Reset

	Type	Function
O1	b	Output I1 > I2
O2	b	O1 inverted
P1	%	positive window (xxx.xx%)
P2	%	negative window (xxx.xx%)

"313 - Window comparator (V C)", comparison of variable to constant
"314 - Window comparator (V C)", absolute value", comparison of variable to constant

– **313 - Window comparator (V C)**

Description:
Via P1 and P2, a value range (window) is adjusted and it is checked if I1 is within this constant range.
O1 is TRUE if I1 is in the range of from P2 to P1.
O1 is FALSE if I1 is outside of this range.

The comparator has three working ranges:

Range 1	P1 < I1	O1 = FALSE
Range 2	P2 < I1 < P1	O1 = TRUE
Range 3	I1 < P2	O1 = FALSE
		O2 = $\overline{O1}$

Special case:
P2 (negative window) is greater than P1 (positive window) (limits exchanged):
O1 is TRUE if I1 < P1 or I1 > P2.
O1 is FALSE if I1 is in the range of from P1 to P2 (window).

– **314 - Window comparator (V C), absolute value", comparison of variable to constant**

Description:

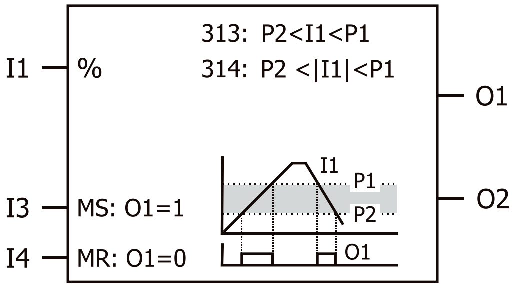
Via P1 and P2, a value range (window) is adjusted and it is checked if the absolute value of I1 is within this range.
O1 is TRUE if |I1| is in the range of from P2 to P1.
O1 is FALSE if |I1| is outside of this range.

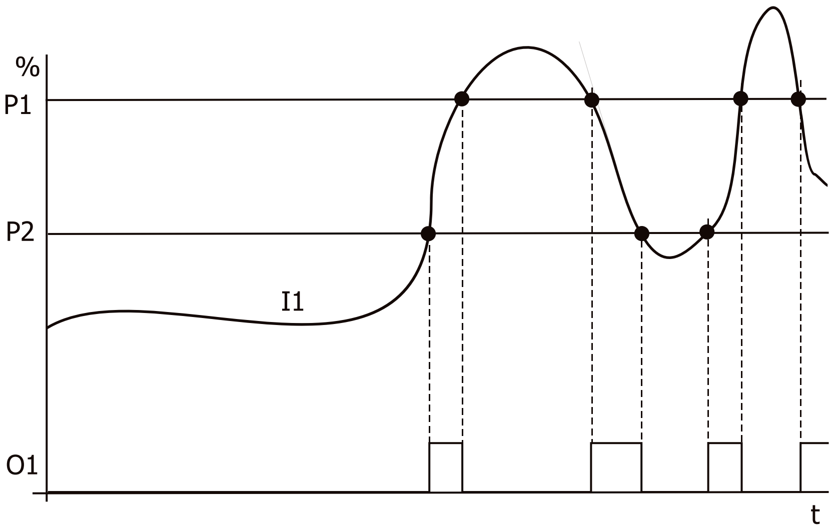
The comparator has three working ranges:

Range 1	P1 < |I1|	O1 = FALSE
Range 2	P2 < |I1| < P1	O1 = TRUE
Range 3	|I1| < P2	O1 = FALSE
		$O2 = \overline{O1}$

Special case:
P2 (negative window) is greater than P1 (positive window) (limits exchanged):
O1 is TRUE if |I1| < P1 or |I1| > P2.
O1 is FALSE if |I1| is in the range of from P1 to P2 (window).

The output value can be changed by means of the two Boolean inputs:
Master Set sets output O1 to TRUE.
Master Reset sets output O1 to FALSE. Master Reset has priority over Master Set.





Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

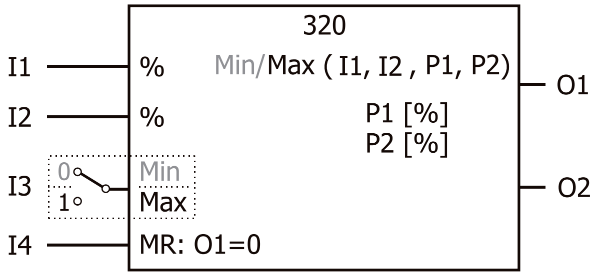
5.2.8 [320] Min/Max

	Type	Function
I1	%	input value 1
I2	%	input value 2
I3	b	FALSE=Min/TRUE=Max
I4	b	Master Reset

	Type	Function
O1	%	Min or Max (I1;I2;P1;P2)
O2	%	O1 inverted
P1	%	Constant value P1
P2	%	Constant value P2

Description:
Based on variables I1 and I2 as well as the constants P1 and P2, the minimum or maximum value is determined and output at O1.
The **maximum** value is output if I3 is TRUE.
The **minimum** value is output if I3 is FALSE.

I3 = FALSE: O1 = -O2 = Minimum (I1, I2, P1, P2)
I3 = TRUE: O1 = -O2 = Maximum (I1, I2, P1, P2)



Note:
P1 and P2 are not evaluated when the maximum or minimum value is determined if they are set to 0.
I2 is not evaluated when the maximum or minimum value is determined if I2 is connected to signal source "9 - Zero".

As long as status TRUE is present at I4 (Master Reset), the output value is FALSE.

Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

5.2.9 [321] Min / Max for position values (Long)

	Type	Function
I1	Pos	input value 1
I2	Pos	input value 2
I3	b	FALSE=Min/TRUE=Max
I4	b	Master Reset

	Type	Function	
O1	Pos	Min or Max (I1;I2;P)	Low word
O2	Pos		High word
P1	Pos	Constant value	Low word
P2	Pos		High word

Description:
Based on variables I1 and I2 as well as constant P, the minimum or maximum value is determined and output.
The **maximum** value is output if I3 is TRUE.
The **minimum** value is output if I3 is FALSE.

I3 = FALSE: O = Minimum (I1, I2, P)
I3 = TRUE: O = Maximum (I1, I2, P)
with O1, P1: Low word
O2, P2 High word

Note:
P1 and P2 are not evaluated when the maximum or minimum value is determined if they are set to 0.
I2 is not evaluated when the maximum or minimum value is determined if I2 is connected to signal source "9 - Zero".

Note:
Output value O2 is **not** the inverted value of O1.
The output can be combined with inputs for position values (Long).
The function can also be used for ramp settings in configurations x40.

5.2.10 [322] Min/Max in time window

	Type	Function
I1	%	input value 1
I2	-	-
I3	b	FALSE=Min/TRUE=Max
I4	b	Master Reset

	Type	Function
O1	%	Min or Max
O2	%	O1 inverted
P1	-	-
P2	-	-

Description:
The **minimum** input value at I1 determined over a certain period of time, is output to Output O1 if I3 is TRUE and I4 is FALSE.
Or:
The **maximum** input value at I1 determined over a certain period of time, is output to Output O1 if I3 is FALSE and I4 is FALSE.
Or:
The current input value at I1 is output to O1, if I4 is TRUE.

The signal status at I3 determines if the minimum or maximum input value is output. FALSE must be present at I4.

The period of time for the minimum or maximum value measurement is determined by a signal at I4. The measurement of the maximum or minimum value starts with a negative edge at I4. The measurement is restarted with each negative edge.

I3	I4	O1=
0	0	Minimum (I1)
1	0	Maximum (I1)
x	1	O1

Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

5.2.11 [323] Min/Max for positions (Long) in time window

	Type	Function
I1	Pos	input value 1
I2	-	-
I3	b	FALSE=Min/TRUE=Max
I4	b	Master Reset

	Type	Function	
O1	Pos	Min or Max (I1)	Low word
O2	Pos		High word
P1	-	-	
P2	-	-	

Description:
The **minimum** position value at I1 determined over a certain period of time, is output if I3 is TRUE and I4 is FALSE.
Or:
The **maximum** position value at I1 determined over a certain period of time, is output if I3 is FALSE and I4 is FALSE.
Or:
The current position value at I1 is output, if I4 is TRUE.

The signal status at I3 determines if the minimum or maximum position value is output. FALSE must be present at I4.

The period of time for the minimum or maximum value measurement is determined by a signal at I4. The measurement of the maximum or minimum value starts with a negative edge at I4. The measurement is restarted with each negative edge at I4.

I3	I4	O=
0	0	Minimum (I1)
1	0	Maximum (I1)
x	1	I1

Note:
Output value I2 is **not** the inverted value of O1.
The output can be combined with inputs for position values (Long).
The function can also be used for ramp settings in configurations x40. The availability of configurations x40 depends on the device series.

5.3 Mathematical functions

	Description	Formula	Limits
330	Addition and subtraction of input values and an offset.	$O1 = -O2 = I1 + I2 - I3 + P1 - P2$	±327.67%
331	Addition and subtraction of position values and offset. Result Long.	$O = I1 + I2 - I3 + P$ O1, P1 = Low word O2, P2 = High word	0 … (2^{32}-1)
332	Multiplication of the input values and a factor.	$O1 = -O2 = I1 \times I2 \times P1$	±327.67%
333	Multiplication of position values and offset. Result Long.	$O2 \mid O1 = I1 \times I2 \times P1$ O1 = Low word O2 = High word	0 … (2^{32}-1)
334	Multiplication of input value by a constant fraction.	$O1 = -O2 = I1 \times \frac{P1}{P2}$	±327.67%
335	Multiplication of long input value by percentage divided by a constant.	$O1 = -O2 = \frac{I1 \times I2}{P1}$	0 … (2^{32}-1)
336	Division of an input value by variable input values.	$O1 = -O2 = \frac{I1}{I2 \times I3}$	+P1 - P2 [±327.67%]
337	Division of input value by constant.	$O1 = -O2 = \frac{I1}{P1}$	± P2 [±327.67%]
338	Division of a constant by the input value (reciprocal).	$O1 = -O2 = \frac{P1}{I1}$	± P2 [±327.67%]
339	Combined multiplication and division.	$O1 = -O2 = \frac{I1 \times I2}{I3}$	+P1 - P2 [±327.67%]
340	Average from 3 input values. Multiplication by constant fraction as correction factor.	$O1 = -O2 = \frac{I1 + I2 + I3}{3} \times \frac{P1}{P2}$	±327.67%
341	Absolute value of two orthogonal components. Multiplication by constant fraction.	$O1 = -O2 = \sqrt{I1^2 + I2^2} \times \frac{P1}{P2}$	±327.67%
342	Absolute value of three orthogonal components. Multiplication by constant fraction.	$O1 = -O2 = \sqrt{I1^2 + I2^2 + I3^2} \times \frac{P1}{P2}$	±327.67%
350	Integrator	$O1 = -O2 = \frac{1}{P1} \int I1 dt + I2$	±327.67%
351	Differentiator (D-element)	$O1 = -O2 = \frac{1}{P1} \times \frac{dI1}{dt}$	±327.67%
360	Absolute value function	$O1 = -O2 = \lvert I1 \rvert$	±327.67%
361	Input value squared.	$O1 = -O2 = I1^2$	+ P2 [±327.67%]
362	Input value cubed.	$O1 = -O2 = I1^3$	± P2 [±327.67%]
363	Square root of input value.	$O1 = -O2 = \sqrt{\lvert I1 \rvert} \times \frac{\lvert I1 \rvert}{I1};$ $+I1 \Rightarrow O1 = +\sqrt{\lvert I1 \rvert}$ $-I1 \Rightarrow O1 = -\sqrt{\lvert I1 \rvert}$	± P2 [±327.67%]
364	Modulo, multiplication and division, result with remainder	$O1, O2 = \frac{I1 \times I2 \times P1}{I3 \times P2};$ $O1 = Ergebnis$ $O2 = Rest$	±327.67%

5.3.1 Addition and subtraction

5.3.1.1 [330] Add. O1=-O2=I1+I2-I3+P1-P2

	Type	Function
I1	%	positive input I1
I2	%	positive input I2
I3	%	negative input I3
I4	b	Master Reset

	Type	Function
O1	%	$O1 = I1 + I2 - I3 + P1 - P2$
O2	%	inverted output = -1
P1	%	positive offset
P2	%	negative offset

Description:
This function adds inputs I1 and I2 and subtracts input I3. In addition, a positive and negative offset can be defined via P1 and P2, respectively.

$$O1 = -O2 = I1 + I2 - I3 + P1 - P2$$

The result of the addition is limited to ±327.67%. Interim results are not limited.

As long as status TRUE is present at I4 (Master Reset), the output value at O1 is 0.

Example:
I1=3240 (=32.40%)
I2=5613 (=56.13%)
I3=27028 (=270.28%)
P1=390 (=3.90%)
P2=322 (=3.22%)

O1 = 32.40% + 56,13% - 270.28% + 3.90% - 3.22%
= -181,07%

Input for parameters, e.g.:
32.40%
P2 = 390

Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

5.3.1.2 [331] Addition position with offset

	Type	Function
I1	Pos	positive input I1
I2	Pos	positive input I2
I3	Pos	negative input I3
I4	b	Master Reset

	Type	Function	
O1	Pos	$O = I1 + I2 - I3 + P$	Low word
O2	Pos		High word
P1	Pos	Positions offset P	Low word
P2	Pos		High word

Description:
This function adds inputs I1 and I2 and subtracts input I3. In addition, an offset can be specified.

$$O2 \mid O1 = I1 + I2 - I3 + P2 \mid P1\,;$$

$$O2 \mid O1 = \text{High-word} \mid \text{Low-word}\,;$$
$$P2 \mid P1 = \text{High-word} \mid \text{Low-word}$$

The output value comprises a High word (O1) and a Low word (O2). The positions offset which is added is also separated in High word and Low word.

As long as status TRUE is present at I4 (Master Reset), the output value is 0.

Note:
Output value O2 is **not** the inverted value of O1.
The output can be combined with inputs for position values (Long).
The function can also be used for ramp settings in configurations x40.
The availability of configuration x40 depends on the device series.

Example:

I1= 35468240	O	= 35468240 + 5613 + 27028 + 270000
I2= 5613		= 35770881
I3= 27028		= $221D201_{hex}$
P= 270000 = $41EB0_{hex}$		O1= $D201_{hex}$ [= 53761]
P1= $1EB0_{hex}$ = 7856		O2= 0221_{hex} [= 545]
P2= 0004_{hex} = 4		

5.3.2 Multiplication

5.3.2.1 [332] Multiplication

	Type	Function		Type	Function
I1	%	input value 1	O1	%	$O1 = I1 \times I2 \times P1$
I2	%	input value 2	O2	%	inverted output = -1
I3	-	-	P1	%	Factor (numerator)
I4	b	Master Reset	P2	-	-

Description:
This function multiplies inputs I1 by I2 and by factor P1.
$O1 = -O2 = I1 \times I2 \times P1$

The result of the multiplication is limited to ±327.67%.

As long as status TRUE is present at I4 (Master Reset), the output value O1 is 0.

Note:
100.00% * 100.00% = 100.00%

Example:

I1=3240 (=32.40%)	O1	= 32.40% * 3.58% * 270.00%
I2=358 (=3.58%)		= 0.324 * 0.0358 * 2.70
P1=270 (=270.00%)		= 0.0313 = 3.13%

Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

5.3.2.2 [333] Multiplication, Long result

	Type	Function		Type	Function	
I1	%	positive input I1	O1	%	$O = I1 \times I2 \times P1$	Low word
I2	%	positive input I2	O2	%		High word
I3	-	-	P1	%	Factor	
I4	b	Master Reset	P2	-	-	

Description:
Inputs I1 and I2 as well as Factor P1 are multiplied by one another.
The result at the output is divided in a High word (O1) and a Low word (O2).
$O2 \mid O1 = I1 \times I2 \times P1$; $O2 \mid O1 = High-word \mid Low-word$

The result of the multiplication (long) is not limited.

As long as status TRUE is present at I4 (Master Reset), the output value is 0.

If P1 is set to value 0, O = I1 x I2 is calculated.

Note:
The output value at O2 is **not** the inverted value of O1.

The output can be combined with inputs for position values (Long).
The function can also be used for ramp settings in configurations x40.

Example:

I1=24000 (=240.00%)	O	= 240.00% * 310.00% * 630.00%
I2=31000 (=310.00%)		= (2.4000 * 3.1000 * 6,3000)
P1=63000 (=630.00%)		= 4687.20%
		= $726F0_{hex}$
		O1= $26F0_{hex}$ [= 9968]
		O2= 0007_{hex} [= 7]

Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

5.3.2.3 [334] Mult. by fraction

	Type	Function		Type	Function
I1	%	input value 1	O1	%	$O1 = I1 \times \frac{P1}{P2}$
I2	-	-	O2	%	inverted output = -1
I3	-	-	P1	%	Factor numerator
I4	b	Master Reset	P2	%	Factor denominator

Description:
The input value at I1 is multiplied by the parameter value P1 and divided by parameter value P2.

$$O1 = -O2 = I1 \times \frac{P1}{P2}$$

The result of the multiplication is limited to ±327.67%.

As long as status TRUE is present at I4 (Master Reset), the output value O1 is 0.

Example:

I1=14000 (=140.00%)	O1	= 140.00% * 150.00% / 32.33%
P1=15000 (=150.00%)		= (1.4000 * 1.5000 / 0.3233 = 6,4955)
P2=3233 (=32.33%)		= 649.55%, limited to 327.67%

Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345
If P2 is set to value 0, the output has the value 327.67%. The sign is applied from the input value.

5.3.2.4 [335] Mult. long * percent

	Type	Function		Type	Function	
I1	Long	input value 1	O1	Pos	$O = I1 \times \frac{I2}{P1}$	Low word
I2	%	input value 2	O2	Pos		High word
I3	-	-	P1	%	Denominator	
I4	b	Master Reset	P2	-	-	

Description:
The input value at I1 (long) is multiplied by the parameter value I2 (percentage) and divided by parameter value P1.

$$O = I1 \times \frac{I2}{P1}$$

The output value comprises a High word (O1) and a Low word (O2).
$O2 \mid O1 = High - word \mid Low - word$

The result of the multiplication (long) is not limited.

As long as status TRUE is present at I4 (Master Reset), the output value is 0.

The output value at O2 is **not** the inverted value of O1.
The output can be combined with inputs for position values (Long).

Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

5.3.3 Division

5.3.3.1 [336] Division

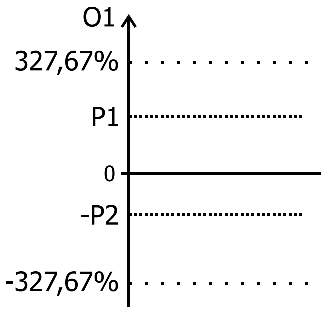
	Type	Function
I1	%	Input (numerator)
I2	%	Input (denominator 1)
I3	%	Input (denominator 2)
I4	b	Master Reset

	Type	Function
O1	%	$O1 = \frac{I1}{I2 \times I3}$
O2	%	inverted output = -1
P1	%	upper limit
P2	%	lower limit

Description:
The input value at I1 is divided by the product from input values I2 and I3.

$$O1 = -O2 = \frac{I1}{I2 \times I3}$$

The result of the division is limited to -P2 and +P1 (max. to ±327.67%).



P2 is the negative limit (-P2), even if only a positive value can be entered for P2.

As long as status TRUE is present at I4 (Master Reset), the output value O1 is 0.

Signal source "9 - Zero" or the value 0 at input I2 or I3 deactivates these inputs. In this case, no division by the input values at I2 and I3 is carried out. The input values are processed as I2=1 and I3=1.

Example:

I1=14000 (=140.00%)	O1	= 140.00% / 130.00% / 32.33%
I2=3000 (=30.00%)		= (1.4000 / 0.3000 / 0.3233)
I3=3233 (=32.33%)		= |14434.47%| limit
		= 327.67%

Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

If EI2 or I3 has value 0, output O1 has value I1.

5.3.3.2 [337] Division by constant

	Type	Function
I1	%	Input (numerator)
I2	-	-
I3	-	-
I4	b	Master Reset

	Type	Function
O1	%	$O1 = \frac{I1}{P1}$
O2	%	inverted output = -1
P1	%	Constant (denominator)
P2	%	upper and lower limit

Description:
The input value at I1 is divided by the parameter value P1.

$$O1 = -O2 = \frac{I1}{P1}$$

The result of the division is limited to ±P2 (max. to ±327.67%).

As long as status TRUE is present at I4 (Master Reset), the output value O1 is 0.

Example:
I1=14000 (=140.00%)
P1=4000 (=40.00%)

O1 = 140.00% / 40.00%
= (1.4000 / 0.4000)
= |350.00%| limit
= 327.67%

Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

If P1 is set to value 0, the output has the value 327.67%. The sign is applied from the input value.

5.3.3.3 [338] Division P1 by I1, reciprocal

	Type	Function
I1	%	Input (denominator)
I2	-	-
I3	-	-
I4	b	Master Reset

	Type	Function
O1	%	$O1 = \frac{P1}{I1}$
O2	%	inverted output = -1
P1	%	Constant (numerator)
P2	%	upper and lower limit

Description:
The parameter value P1 is divided by the input value at I1 (reciprocal).

$$O1 = -O2 = \frac{P1}{I1}$$

The result of the division is limited to ±P2 (max. to ±327.67%).

As long as status TRUE is present at I4 (Master Reset), the output value O1 is 0.

Example:
I1=14000 (=140.00%)
P1=4000 (=40.00%)

O1 = 40.00% / 140.00%
= (0.4000 / 1.4000)
= 28.57%

Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

If I1 has value 0, output O1 has value 327.67% or the value of P2.

5.3.4 [339] Multiplication and division

	Type	Function		Type	Function
I1	%	Input (numerator 1)	O1	%	$O1 = \frac{I1 \times I2}{I3}$
I2	%	Input (numerator 2)	O2	%	inverted output = -1
I3	%	Input (denominator)	P1	%	upper limit
I4	b	Master Reset	P2	%	lower limit

Description:
The input value at I1 is multiplied by the input value at I2 and the result is divided by the input value at I3.

$$O1 = -O2 = \frac{I1 \times I2}{I3}$$

The result of the division is limited to -P2 … +P1 (max. to ±327.67%).

As long as status TRUE is present at I4 (Master Reset), the output value O1 is 0.

Example:

I1=14000 (=140.00%)	O1	= 140.00% * 40.00% / 20.00%
I2=4000 (=40.00%)		= (1.4000 * 0.4000 / 0.2000)
I3=2000 (=20.00%)		= 280.00%

Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

5.3.5 [340] Average function

	Type	Function		Type	Function
I1	%	Input 1	O1	%	$O1 = \frac{I1 + I2 + I3}{3} \times \frac{P1}{P2}$
I2	%	Input 2	O2	%	inverted output = -1
I3	%	Input 3	P1	i	Factor numerator
I4	b	Master Reset	P2	i	Factor denominator

Description:
The average is calculated from the input values at I1, I2 and I3.
Parameters P1 and P2 can be adjusted as correction factors.

$$O1 = -O2 = \frac{I1 + I2 + I3}{3} \times \frac{P1}{P2}$$

As long as status TRUE is present at I4 (Master Reset), the output value O1 is 0.

Example:

I1=14000 (=140.00%)	O1	= (140.00% + 40.00% + 20.00%) / 3 * 5/4
I2=4000 (=40.00%)		= 200% /3 * 5/4
I3=2000 (=20.00%)		= 83.33%
P1= 5		
P2= 4		

If the average is to be calculated from two input values only, I1 and I2 must be used and I3 must be set to FALSE.

$$O1 = \frac{I1 + I2}{2} \times \frac{P1}{P2}$$

Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

5.3.6 [341] Absolute value of two orthogonal components (2 D vector)

	Type	Function
I1	%	input value 1
I2	%	input value 2
I3	-	-
I4	b	Master Reset

	Type	Function
O1	%	$O1 = \sqrt{I1^2 + I2^2} \times \frac{P1}{P2}$
O2	%	inverted output = -1
P1	%	Constant (numerator)
P2	%	Constant (denominator)

Description:
The absolute value is formed from the orthogonal (square-angle) input values at I1 and I2.

The absolute value is multiplied by the constant $\frac{P1}{P2}$.

$$O1 = -O2 = \sqrt{I1^2 + I2^2} \times \frac{P1}{P2}$$

As long as status TRUE is present at I4 (Master Reset), the output value O1 is 0.

Example:
I1=14000 (=140.00%)
I2=4000 (=40.00%)
P1= 500 (= 5.00%)
P2= 10000 (= 100.00%)

$$O1 = \sqrt{140{,}00\%^2 + 40{,}00\%^2} \times \frac{5{,}00\%}{100{,}00\%}$$
$$= \sqrt{212{,}00\%} \times \frac{5{,}00\%}{100{,}00\%}$$
$$= 7{,}28\%$$

Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

5.3.7 [342] Absolute value of three orthogonal components (3 D vector)

	Type	Function
I1	%	input value 1
I2	%	input value 2
I3	%	input value 3
I4	b	Master Reset

	Type	Function
O1	%	$O1 = \sqrt{I1^2 + I2^2 + I3^2} \times \frac{P1}{P2}$
O2	%	inverted output = -1
P1	%	Constant (numerator)
P2	%	Constant (denominator)

Description:
The absolute value is formed from the orthogonal (square-angle) input values at I1, I2 and I3.

The absolute value is multiplied by the constants $\frac{P1}{P2}$.

$$O1 = -O2 = \sqrt{I1^2 + I2^2 + I3^2} \times \frac{P1}{P2}$$

As long as status TRUE is present at I4 (Master Reset), the output value O1 is 0.

Example:

I1=14000 (=140.00%)
I2=4000 (=40.00%)
I3=3000 (=30.00%)
P1= 500 (= 5.00%)
P2= 10000 (= 100.00%)

$$O1 = \sqrt{140{,}00\%^2 + 40{,}00\%^2 + 30{,}00\%^2} \times \frac{5{,}00\%}{100{,}00\%}$$
$$= \sqrt{221{,}00\%} \times \frac{5{,}00\%}{100{,}00\%}$$
$$= 7{,}43\%$$

Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

5.3.8 [350] Integrator

	Type	Function
I1	%	Integration quantity
I2	%	Start value
I3	b	Master Set
I4	b	Master Reset

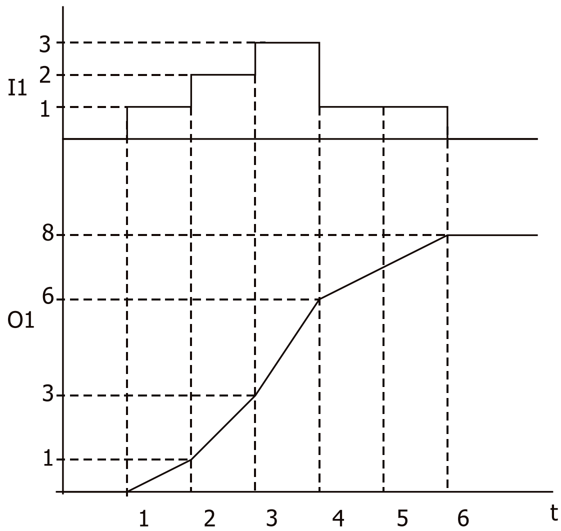
	Type	Function
O1	%	$O1 = \frac{1}{P1}\int I1dt + I2$
O2	%	inverted output = -1
P1	%	Integration time in ms (denominator)
P2	-	-

Description:
The input value at I1 is integrated.
The integration time constant P1 indicates how long it takes in the case of a constant input value until the output value reaches the input value.

$$O1 = -O2 = \frac{1}{P1}\int I1dt + I2$$

If the integrator is to be stopped, input 2 must be combined with the output and the Master Set input (I3) must be activated.

Master Set: TRUE sets the integrator to the start value (I2). The start value can be defined via input I2.
Master-Reset: TRUE sets the integrator to 0.
Master Reset has priority over Master Set.



t	I1	i=1	i=2	i=3
1	1	0	0	0
2	2	1	0.5	0.33
3	3	3	3/2	1
4	1	6	3	2
5	1	7	3.5	2.33
6	0	8	4	2.67

Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

5.3.9 [351] Differentiator (D-element)

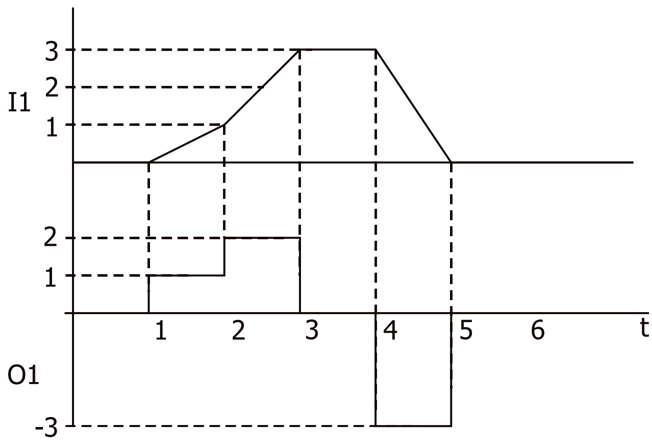
	Type	Function
I1	%	Differentiation quantity
I2	-	-
I3	-	-
I4	b	Master Reset

	Type	Function
O1	%	$O1 = P1 \times \frac{dI1}{dt}$
O2	%	inverted output = -1
P1	%	Derivative action time in ms
P2	-	-

Description:
The input value at I1 is differentiated.
The derivative action time indicates how long a linear ramp must rise until it has the same value as the output of the differentiator.

$$O1 = -O2 = P1 \times \frac{dI1}{dt}$$

If an integrator and a differentiator are connected in series, a p-element is obtained with amplification V = Td/Ti.
If, for example, the output value is limited in the case of a jump at the input, the limited value will be output longer.
In the case of a jump at the input, the jump height/sampling time is assumed as the ramp gradient.



As long as status TRUE is present at I4 (Master Reset), the output value O1 is 0.

Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

5.3.10 [360] Absolute value function

	Type	Function
I1	%	Input value
I2	-	-
I3	-	-
I4	b	Master Reset

	Type	Function
O1	%	$O1 = \|I1\|$
O2	%	inverted output = -1
P1	-	-
P2	-	-

Description:
The absolute value of the input value at I1 is calculated. The output value at O1 is always positive.

$$O1 = -O2 = |I1|$$

As long as status TRUE is present at I4 (Master Reset), the output value O1 is 0.

Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

5.3.11 [361] X², SQR (I1)

	Type	Function
I1	%	Input value
I2	-	-
I3	-	-
I4	b	Master Reset

	Type	Function
O1	%	$O1 = I1^2$
O2	%	inverted output = -1
P1	-	-
P2	%	Limitation of output value

Description:
The input value at I1 is squared.
$O1 = -O2 = I1^2$

Example: I1 = 130.00%; O1 = $I1^2$ = 169.00%

The output value is limited to the adjusted value of P2.

As long as status TRUE is present at I4 (Master Reset), the output value O1 is 0.

Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

5.3.12 [362] X³, (Cube (I1)

	Type	Function
I1	%	Input value
I2	-	-
I3	-	-
I4	b	Master Reset

	Type	Function
O1	%	$O1 = I1^3$
O2	%	inverted output = -1
P1	-	-
P2	%	Limitation of output value

Description:
The input value at I1 is cubed.
$O1 = -O2 = I1^3$

Example: I1 = 130.00%; O1 = $I1^3$ = 219.70%

The output value is limited to ±P2.

As long as status TRUE is present at I4 (Master Reset), the output value O1 is 0.

Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

5.3.13 [363] √X, square root of I1

	Type	Function
I1	%	Input value
I2	-	-
I3	-	-
I4	b	Master Reset

	Type	Function
O1	%	$O1 = \sqrt{I1}$
O2	%	inverted output = -1
P1	-	-
P2	%	Limitation of output value

Description:
The square root is calculated from the input value at I1.
$O1 = -O2 = \sqrt{I1}$

Note:
Since the square root of a negative number has no real result, the square root of the absolute value of the input value is worked out and the sign is applied to the output value.

$$O1 = \sqrt{|I1|}\ ; \qquad +I1 \Rightarrow O1 = +\sqrt{|I1|} \qquad -I1 \Rightarrow O1 = -\sqrt{|I1|}$$

Example:	Positive input value	I1 = 130.00%	O1 = 114.02%
	Negative input value	I1 = -130.00%	O1 = -114.02%

The output value is limited to ±P2.

As long as status TRUE is present at I4 (Master Reset), the output value O1 is 0.

Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

5.3.14 [364] Modulo

	Type	Function		Type	Function
I1	%	Input (numerator 1)	O1	%	$O1, O2 = \frac{I1 \times I2 \times P1}{I3 \times P2}$
I2	%	Input (numerator 2)	O2	%	
I3	%	Input (denominator 1)	P1	%	Numerator 3
I4	b	Master Reset	P2	%	Denominator 2

Description:
The input value at I1 is multiplied by the input value at I2 and parameter value P1 and the result is divided by the input value at I3 and parameter value P2.

$$O1, O2 = \frac{I1 \times I2 \times P1}{I3 \times P2}$$

O1 = Result in front of decimal point,
O2 = Result behind decimal point

Example 1:
I1= 110% P1 = 100.00%
I2= 100% P2 = 100.00%
I3= 32%

$$\frac{110{,}00\% \times 100{,}00\% \times 100{,}00\%}{32{,}00\% \times 100{,}00\%} = \frac{1{,}1}{0{,}32} = 3{,}4375 = 343{,}75\%$$
$$\Rightarrow O1 = 343{,}00\%, O2 = 0{,}75\%$$

Example 2:
I1= 110% P1 = 1.00%
I2= 100% P2 = 100.00%
I3= 32%

$$\frac{110{,}00\% \times 100{,}00\% \times 1{,}00\%}{32{,}00\% \times 100{,}00\%} = \frac{0{,}011}{0{,}32} = 0{,}034375 = 3{,}43\%$$
$$\Rightarrow O1 = 3{,}00\%, O2 = 0{,}43\%$$

Example 3:
I1= 220% P1 = 100.00%
I2= 100% P2 = 10.00%
I3= 12%

$$\frac{220{,}00\% \times 100{,}00\% \times 100{,}00\%}{12{,}00\% \times 10{,}00\%} = \frac{2{,}2}{1{,}2} = 1{,}8333 = 183{,}33\%$$
$$\Rightarrow O1 = 183\%, O2 = 0{,}33\%$$

Example 4:

I1= 22000 P1 = 10 (factory setting)
I2= FALSE P2 = 10 (factory setting)
I3= 1200

$$\frac{220{,}00\% \times 100{,}00\% \times 100{,}00\%}{12{,}00\% \times 10{,}00\%} = \frac{2{,}2}{1{,}2} = 1{,}8333 = 183{,}33\%$$
$$\Rightarrow O1 = 183\%, O2 = 0{,}33\%$$

If position values are used as input quantities instead of percentages, this will be interpreted as follows:

$$\frac{22000\,u \times [FALSE] \times 10}{1200\,u \times 10} = \frac{22}{1{,}2} = 18{,}3333 = 1833{,}33\%$$
$$\Rightarrow O1 = 367{,}67\%\ (Begrenzung), O2 = 0{,}33\%$$

Parameters P1 and P2 can also be used to scale the result:
O1 = Result "in front of decimal point"/scaling P1 (division)
O2 = Result "behind decimal point"/scaling P2 (multiplication)

5.4 Controller

Controllers can be built up from individual elements. This can be used for limiting the output values of the individual elements.

5.4.1 [370] P controller

	Type	Function
I1	%	Input (reference value)
I2	%	Input (actual value)
I3	-	-
I4	b	Master Reset

	Type	Function
O1	%	$O1 = P1 \times (I1 - I2)$
O2	%	inverted output = -1
P1	i	P amplification (x.xx)
P2	%	Limitation of output value

Description:
The control deviation (I1-I2) is multiplied by the amplification P1.

$$O1 = -O2 = P1 \times (I1 - I2)$$

The output value is limited to ±P2.

As long as status TRUE is present at I4 (Master Reset), the output value I1 is 0.

Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345
The amplification is entered with two decimals:
displayed value 123 = function value 1.23

5.4.2 [371] PI controller (Tn in milliseconds)

	Type	Function		Type	Function
I1	%	Input (reference value)	O1	%	$O1 = P1 \times (I1 - I2) + \frac{P1}{P2} \int (I1 - I2)dt$
I2	%	Input (actual value)	O2	%	inverted output = -1
I3	%	Limitation of output values	P1	i	P amplification
I4	b	Master Reset	P2	i	Integral time in ms

Description:
The control deviation (I1- I2) is multiplied by the amplification P1. The I controller adds up the control deviation over time. The I component is added. When the integral time has elapsed, the I component reaches the same value again so that the output value is doubled.

$$O1 = -O2 = P1 \times (I1 - I2) + \frac{P1}{P2} \int (I1 - I2)dt$$

The output value is limited to the value at input I3.

As long as status TRUE is present at I4 (Master Reset), the output value I1 and the I component are 0.

Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

5.4.3 [372] PI controller (Tn in seconds)

	Type	Function		Type	Function
I1	%	Input (reference value)	O1	%	$O1 = P1 \times (I1 - I2) + \frac{P1}{P2} \int (I1 - I2)dt$
I2	%	Input (actual value)	O2	%	inverted output = -1
I3	%	Limitation of output values	P1	i	P amplification
I4	b	Master Reset	P2	i	Integral time in s

Description:
The control deviation (I1 - I2) is multiplied by the amplification P1. The I controller adds up the control deviation over time. The I component is added. When the integral time has elapsed, the I component reaches the same value again so that the output value is doubled.

$$O1 = -O2 = P1 \times (I1 - I2) + \frac{P1}{P2} \int (I1 - I2)dt$$

The output value is limited to the value at input I3.

As long as status TRUE is present at I4 (Master Reset), the output value O1 and the I component are 0.

Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

5.4.4 [373] PD(T1) controller

	Type	Function
I1	%	Input (reference value)
I2	%	Input (actual value)
I3	%	Limitation of output values
I4	b	Master Reset

	Type	Function
O1	%	$O1 = P1 \times (I1 - I2) + P1 \times P2 \times \frac{d(I1 - I2)}{dt}$
O2	%	inverted output = -1
P1	i	P amplification
P2	i	Derivative action time in ms

Description:
The control deviation (I1- I2) is multiplied by the amplification P1. The D component is added.

$$O1 = -O2 = P1 \times (I1 - I2) + P1 \times P2 \times \frac{d(I1 - I2)}{dt}$$

The output value is limited to the value at input I3.
The input can be combined with a fixed value, for example.

As long as status TRUE is present at I4 (Master Reset), the output value O1 is 0.

The time constant T1 of the PD(T1) controller corresponds to the sampling time.

Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

5.4.5 [374] PID(T1) controller (Tn in milliseconds)

	Type	Function
I1	%	Input (reference value)
I2	%	Input (actual value)
I3	%	Limitation of output values
I4	b	Master Reset

	Type	Function
O1	%	$O1 = (I1 - I2) + \frac{1}{P1} \int (I1 - I2) dt + P2 \times \frac{d(I1 - I2)}{dt}$
O2	%	inverted output = -1
P1	i	Integral time in ms
P2	i	Derivative action time in ms

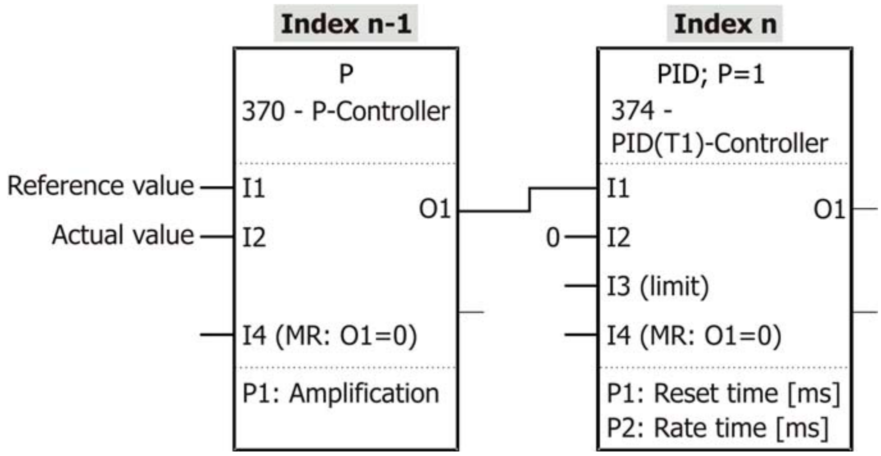
Description:
The control deviation (I1 – I2) is multiplied by the amplification (=1). The I component and the D component are added.

$$O1 = -O2 = (I1 - I2) + \frac{1}{P1} \int (I1 - I2) dt + P2 \times \frac{d(I1 - I2)}{dt}$$

In instruction "374 PID(T1) controller", the integral time P1 (I component) and the derivative action time P2 (D component) can be adjusted. The amplification P1 is set to the fixed value 1. In order to set up another amplification, a P controller (instruction "370 - P controller) must be connected to the input of the PID(T1) controller.

Note:
In the P controller (instruction 370), P1 is the amplification. In the PID(T1) controller, P1 is the integral time.

PID controller and series-connected P controller for setting up an amplification:



Index n-1: Index n:

$$O1 = -O2 = \quad P1_{n-1} \times (I1_{n-1} - I2_{n-1}) \quad + \quad \frac{P1_{n-1}}{P1_n} \int (I1_{n-1} - I2_{n-1})dt + P1_{n-1} \times P2_n \times \frac{d(I1_{n-1} - I2_{n-1})}{dt}$$

- Set amplification in P controller.
- Set integral time and derivative action time in PID controller.

Note:
If the amplification of the PID controller is to be 1 , no P controller must be connected in series.

If a value of 100.00% is applied to the input in the form of a jump, the output value is the total of the three components:
– P component: 100.00% constant
– I component: Ramp reaching the value of 100.00% after integral time P1.
– D component: Pulse of length of a sampling step and level $\frac{P2}{T1} \times 100\%$; $T1 = \text{Abtastzeit}$
  If the pulse level exceeds the limitation of the output value, the pulse will be output longer.

The output value is limited to the value at input I3.
Input I3 can be combined with a fixed value, for example.

As long as status TRUE is present at I4 (Master Reset), the output value O1 and the I component are 0.

Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

5.4.6 [375] PID(T1) controller (Tn in seconds)

	Type	Function
I1	%	Input (reference value)
I2	%	Input (actual value)
I3	%	Limitation of output values
I4	b	Master Reset

	Type	Function
O1	%	$O1 = (I1 - I2) + \frac{1}{P1} \int (I1 - I2)dt + P2 \times \frac{d(I1 - I2)}{dt}$
O2	%	inverted output = -1
P1	i	Integral time in s
P2	i	Derivative action time in ms

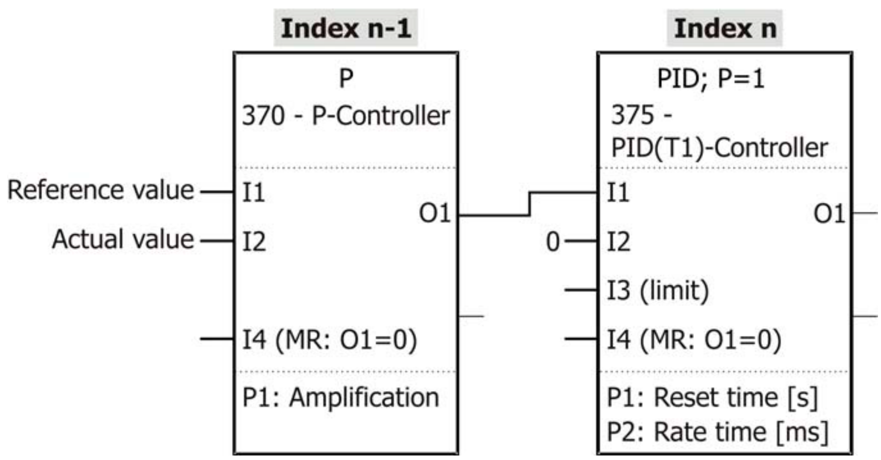
Description:
The control deviation (I1 – I2) is multiplied by the amplification (=1). The I component and the D component are added.

$$O1 = -O2 = (I1 - I2) + \frac{1}{P1} \int (I1 - I2)dt + P2 \times \frac{d(I1 - I2)}{dt}$$

In instruction "375 PID(T1) controller", the integral time P1 (I component) and the derivative action time P2 (D component) can be adjusted. The amplification P1 is set to the fixed value 1. In order to set up another amplification, a P controller (instruction "370 - P controller) must be connected to the input of the PID(T1) controller.

Note:
In the P controller (instruction 370), P1 is the amplification. In the PID(T1) controller, P1 is the integral time.

PID controller and series-connected P controller for setting up an amplification:



Index n-1: Index n:

$$O1 = -O2 = P1_{n-1} \times \left(I1_{n-1} - I2_{n-1}\right) + \frac{P1_{n-1}}{P1_n} \int \left(I1_{n-1} - I2_{n-1}\right) dt + P1_{n-1} \times P2_n \times \frac{d\left(I1_{n-1} - I2_{n-1}\right)}{dt}$$

- Set amplification in P controller.
- Set integral time and derivative action time in PID controller.

Note:
If the amplification of the PID controller is to be 1 , no P controller must be connected in series.

If a value of 100.00% is applied to the input in the form of a jump, the output value is the total of the three components:
- P component: 100.00% constant
- I component: Ramp reaching the value of 100.00% after integral time P1.
- D component: Pulse of length of a sampling step and level $\frac{P2}{T1} \times 100\%$; $T1 = \text{Abtastzeit}$

  If the pulse level exceeds the limitation of the output value, the pulse will be output longer.

The output value is limited to the value at input I3.
The input can be combined with a fixed value, for example.

As long as status TRUE is present at I4 (Master Reset), the output value O1 and the I component are 0.

Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

5.5 Filters

5.5.1 [380] PT1 element

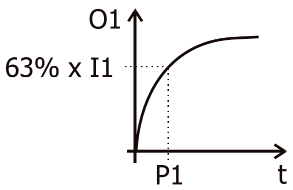
	Type	Function
I1	%	Input value
I2	%	Start value
I3	b	Master Set
I4	b	Master Reset

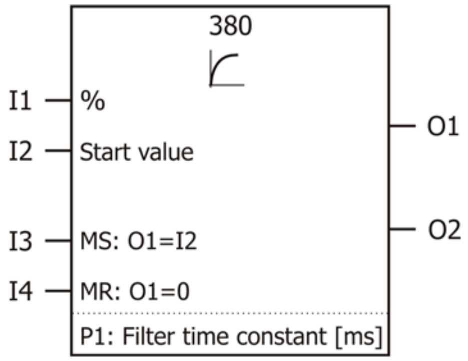
	Type	Function
O1	%	$O1 = I1 \times (1 - e^{-\frac{t}{P1}})$
O2	%	inverted output = -1
P1	i	Filter time constant in ms
P2	-	-

Description:
The input value at I1 is filtered.

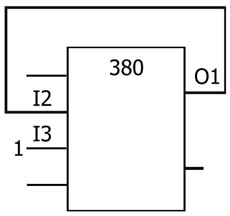
$$O1 = -O2 = I1 \times (1 - e^{-\frac{t}{P1}})$$

- The filter time constant P1 indicates how long it takes in the case of a constant input value until the output value (starting from zero) reaches 63% of the input value.
- Master Set: TRUE sets the output to the start value. The start value can be defined via input I2.
- Master-Reset: TRUE sets the output to 0.
- Master Reset has priority over Master Set.





If the filter is to be stopped, input 2 must be combined with the output and the Master Set input (I3) must be activated.
I2=O1, I3=TRUE



Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

5.5.2 [381] Time average

	Type	Function
I1	%	Input value
I2	-	-
I3	-	-
I4	b	Master Reset

	Type	Function
O1	%	$O1 = \frac{\sum_{i=1}^{n} I1_i}{n} = \frac{I1_1 + I1_2 + I1_3 + \ldots + I1_n}{n}$
O2	%	inverted output = -1
P1	-	-
P2	-	-

Description:

– The function determines the average value over a period of time. The output value is up-dated with each cycle.
– Master Reset is FALSE: The output value is the average of all input values since the last negative edge from Master Reset.
– Master Reset is TRUE: The output value is the same as the input value.

$$O1 = -O2 = \frac{\sum_{i=1}^{n} I1_i}{n} = \frac{I1_1 + I1_2 + I1_3 + ... + I1_n}{n}$$

I4	O1=
0	Average of I4
1	I4

Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

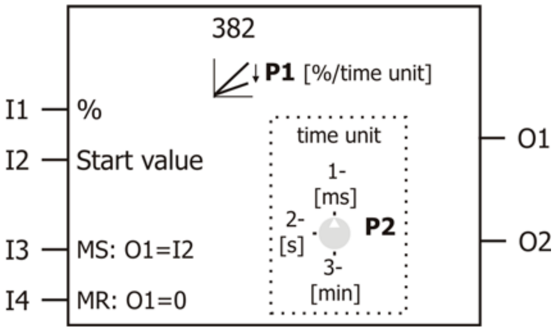
5.5.3 [382] Ramp limitation

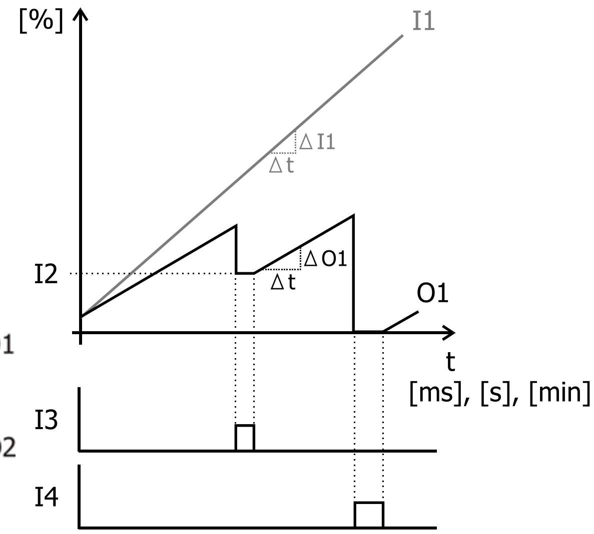
	Type	Function
I1	%	Input value
I2	%	Start value
I3	b	Master Set
I4	b	Master Reset

	Type	Function
O1	%	I1 with limited ramp gradient
O2	%	inverted output = -1
P1	%	Ramp gradient [% per time unit]
P2	i	Time unit: 1: [ms], 2: [s], 3: [min]

Description:
The output value follows the input value at a limited ramp gradient.

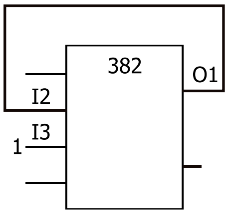
– P1 indicates the percentage by which the output value may change per unit of time.
– P2 indicates the unit of P1:
  1: in percent per millisecond [%/ms],
  2: in percent per second [%/s],
  3: in percent per minute [%/min].
– Master Set: TRUE sets the output to the start value. The start value can be defined via input I2.
– Master-Reset: TRUE sets output O1 to 0.
– Master Reset has priority over Master Set.





I3	I4	O1=	
0	0	I1	(ramp gradient limited)
0→1	0	I2	
x	0→1	0	

If the ramp is to be stopped, input 2 must be combined with the output and the Master Set input (I3) must be activated.
I2=O1, I3=TRUE



Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

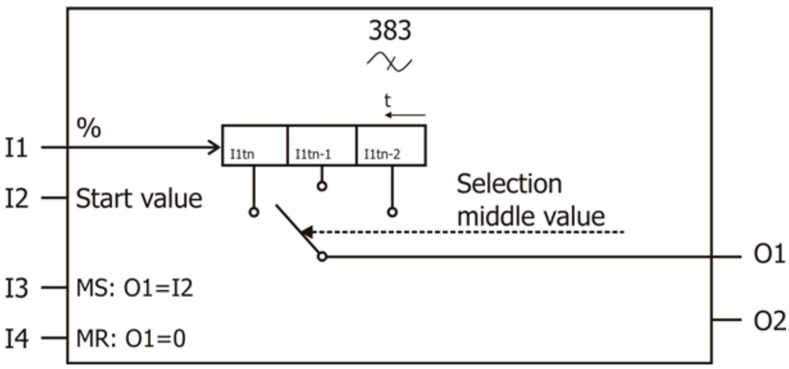
5.5.4 [383] Spike filter (average of three)

	Type	Function		Type	Function
I1	%	Input value	O1	%	Output average of $I1_{(tn-2)}, I1_{(tn-1)}, I1_{(tn)}$
I2	%	Start value	O2	%	inverted output = -1
I3	b	Master Set	P1	-	-
I4	b	Master Reset	P2	-	-

Description:
The input value at I1 is filtered.
The average of the current input value and the two previous input values is output. In this way individual input spikes are suppressed.

- Master Set: TRUE sets the output to the start value. The start value can be defined via input I2.
- Master-Reset: TRUE sets the output to 0.
- Master Reset has priority over Master Set.

I3	I4	O1=	
0	0	I1	(average of last 3 values)
0→1	0	I2	
x	0→1	0	



Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

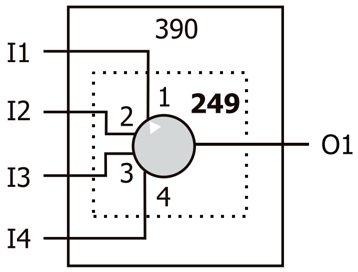
5.6 Analog switch

5.6.1 [390] Analog multiplexer (data set number)

	Type	Function
I1	%	input value 1
I2	%	input value 2
I3	%	input value 3
I4	%	input value 4

	Type	Function
O1	%	I1, I2, I3 or I4
O2	%	inverted output = -1
P1	-	-
P2	-	-

Description:
Depending on the active data set (parameter *active data set* **249**), one of the input values is output.



Active data set **249**	**O1=**
1	I1
2	I2
3	I3
4	I4

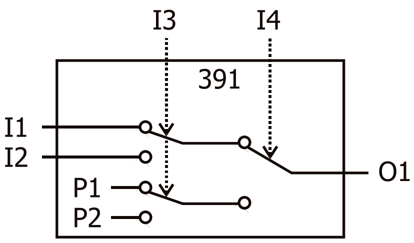
Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

5.6.2 [391] Analog changeover switch

	Type	Function
I1	%	input value 1
I2	%	input value 2
I3	b	Selection of value 1 or value 2
I4	b	Selection of I or P

	Type	Function
O1	%	I1, I2, P1 or P2
O2	%	inverted output = -1
P1	%	Fixed value 1
P2	%	Fixed value 2

Description:
One of the values I1, I2, P1 or P2 is output. Via I4, it is defined if an input value (I1, I2) or a fixed value (P1, P2) is output. Via I3 it is defined if value 1 or 2 is output.



The input values and fixed values are selected according to the following table:

I3	I4	O1=
0	0	I1
1	0	I2
0	1	P1
1	1	P2

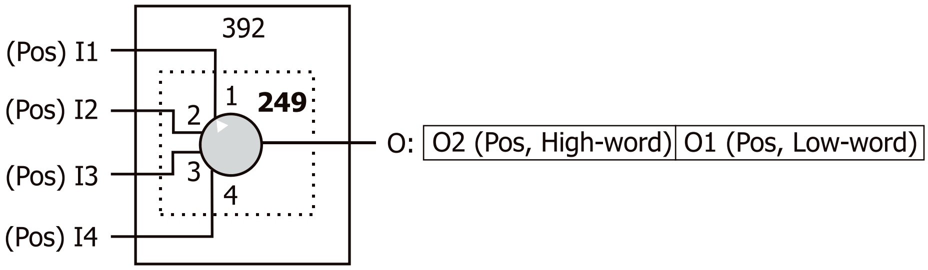
Note:
Percentages [%] have two decimals.
For example: Value 12345_{IN} = 123.45% = 1.2345

5.6.3 [392] MUX for position values (data set number), Multiplexer

	Type	Function
I1	Pos.	input value 1
I2	Pos.	input value 2
I3	Pos.	input value 3
I4	Pos.	input value 4

	Type	Function	
O1	Pos.	I1, I2, I3 or I4	Low word
O2	Pos.		High word
P1	-	-	
P2	-	-	

Description:
Depending on the active data set (parameter *active data set* **249**), one of the input values is output at the output.



Active data set **249**	**O=**
1	I1
2	I2
3	I3
4	I4

O = O2 | O1 = High – word | Low – word

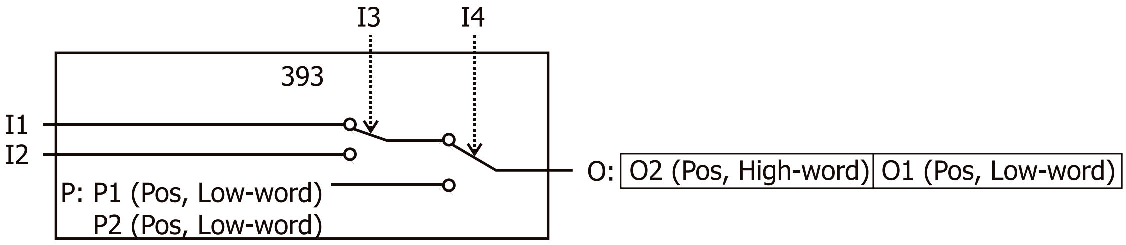
Note:
Output value O2 is **not** the inverted value of O1.
The output can be combined with inputs for position values (Long).
The function can also be used for ramp settings in configurations x40.
The output has value 0 if an input combined with FALSE is selected by the active data set.

5.6.4 [393] Changeover switch for position values (Long)

	Type	Function
I1	Pos	input value 1
I2	Pos	input value 2
I3	b	Selection value 1 or 2
I4	b	Selection of I or P

	Type	Function	
O1	Pos	I1, I2 or (P2|P1)	Low word
O2	Pos		High word
P1	Pos	Fixed value P	Low word
P2	Pos		High word

Description:
One of the values I1, I2, or P is output. Via I4 it is defined if an input value or the fixed value is output. Via I3 it is defined if value 1 or 2 is output.



The output value is determined according to the following table:

I3	I4	O=
0	0	I1
1	0	I2
x	1	P2|P1

P2 | P1 = High – word | Low – word

Note:
Output value O2 is **not** the inverted value of O1.
The output can be combined with inputs for position values (Long).
The function can also be used for ramp settings in configurations x40.
The availability of configuration x40 depends on the device series.

5.7 Parameter access

5.7.1 Writing parameters

Parameters can be written from the PLC functions. This is done in two steps.

- The PLC function puts the write request, including all data, on a list.
- This list is processed in non-realtime system. In this process, redundant write commands on the same parameter are deleted. The list can contain a maximum of 8 write commands.

The output is TRUE if the list is full and cannot accept any more write commands.
If the parameter number is outside of the range 0 … 1599, only the status of the buffer is checked and the output is set, if applicable.
Any errors during the write process will be ignored.
If input I4 "Wait" is TRUE, zero operations (NOP) will be inserted if the write buffer is full until the write command can be entered in the buffer. If input I4 "Wait" is FALSE, write commands may be lost in the case of a buffer overflow.

If input I2 "Delete buffer" is TRUE, the write buffer will be deleted first before the new write command is entered.

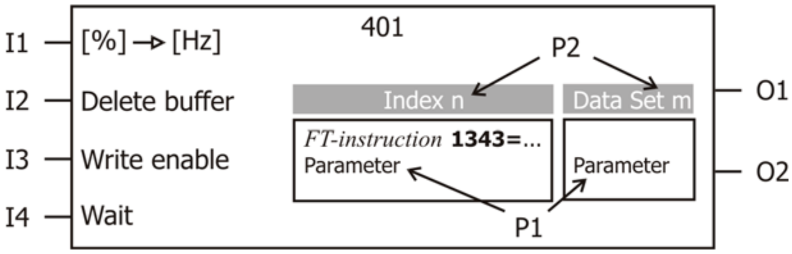
The target parameter of the write command is defined by P1. The target data set is defined by P2.

5.7.1.1 [401] Write frequency parameter

	Type	Function
I1	%	input value 1
I2	b	Delete buffer
I3	b	Write release
I4	b	Wait until writing is finished

	Type	Function
O1	b	I1[Hz]
O2	b	inverted output = -1
P1	i	Parameter number
P2	i	Data set (0 … 9) or index

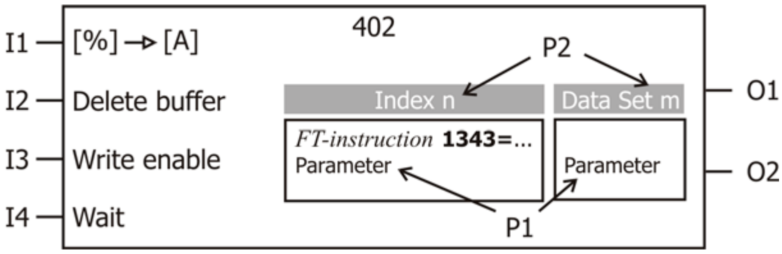
Description:
The input value is converted from percent to Hz and written as long parameter.
$I1[\%] \rightarrow I1[Hz]$
123.45% = 123.45 Hz



5.7.1.2 [402] Write current parameter

	Type	Function		Type	Function
I1	%	input value 1	O1	b	I1[A]
I2	b	Delete buffer	O2	b	inverted output = -1
I3	b	Write release	P1	i	Parameter number
I4	b	Wait until writing is finished	P2	i	Data set (0 … 9) or index

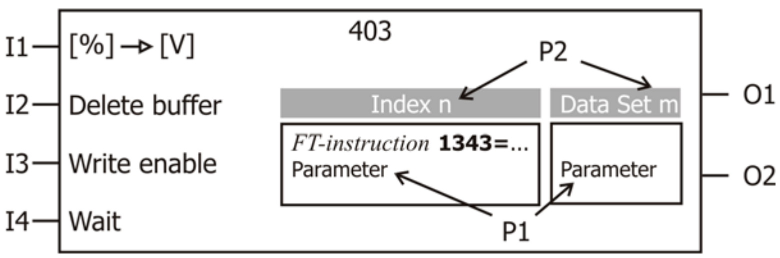
Description:
The input value is converted from percent to A and written as int parameter.
I1[%] → I1[A]
123.45% = 123.45 A



5.7.1.3 [403] Write voltage parameter (eff.)

	Type	Function		Type	Function
I1	%	input value 1	O1	b	I1[%] → I1[V]
I2	b	Delete buffer	O2	b	inverted output = -1
I3	b	Write release	P1	i	Parameter number
I4	b	Wait until writing is finished	P2	i	Data set (0 … 9) or index

Description:
The effective value at the input is converted from percent to V and written as int parameter.
I1[%] → I1[V]
123.45% = 123.45 V

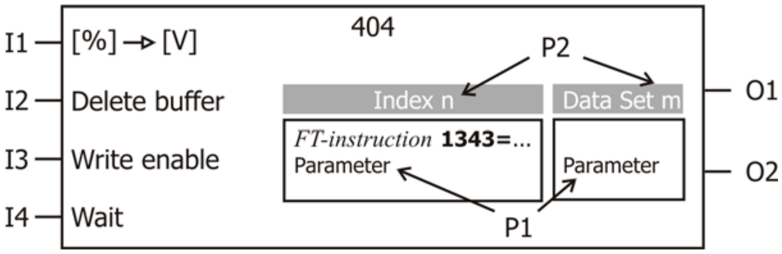


5.7.1.4 [404] Write voltage parameter (peak)

	Type	Function
I1	%	input value 1
I2	b	Delete buffer
I3	b	Write release
I4	b	Wait until writing is finished

	Type	Function
O1	b	O1[%] → O1[V]
O2	b	inverted output = -1
P1	i	Parameter number
P2	i	Data set (0 … 9) or index

Description:
The peak value at the input is converted from percent to V and written as int parameter.
I1[%] → I1[V]
123.45% = 123.45 V

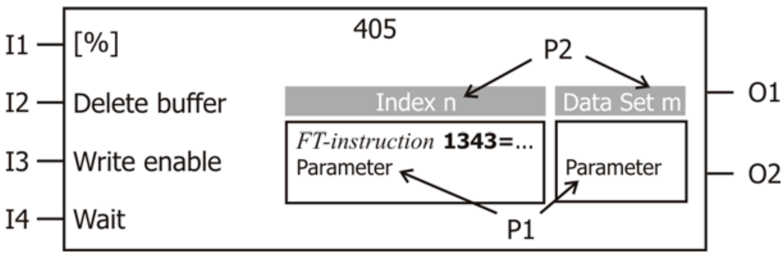


5.7.1.5 [405] Write percentage parameter

	Type	Function
I1	%	input value 1
I2	b	Delete buffer
I3	b	Write release
I4	b	Wait until writing is finished

	Type	Function
O1	b	I1[int]
O2	b	inverted output = -1
P1	i	Parameter number
P2	i	Data set (0 … 9) or index

Description:
The input value is not changed and written as int parameter. In this way, this function can also be used for any other (int) parameter types.



5.7.1.6 [406] Write position parameter

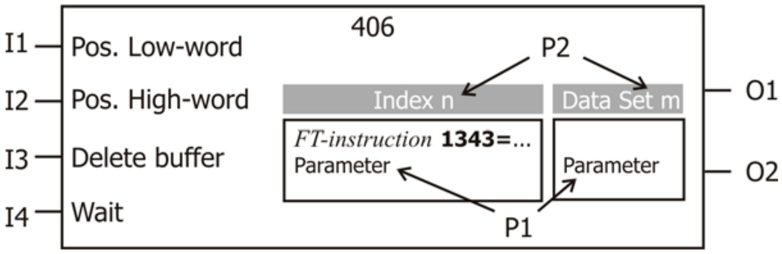
	Type	Function	
I1	Pos	Input value	Low word
I2	Pos		High word
I3	b	Write enable	
I4	b	Wait until writing is finished	

	Type	Function
O1	b	O1 = I2|I1
O2	b	inverted output = -1
P1	i	Parameter number
P2	i	Data set (0 … 9) or index

Description:
The input value is not changed and written as long parameter. In this way, this function can be used for any long parameter types.
O1 = I2|I1 (High-word|Low-word)

I1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1																
I2	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0																
O1	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1

(For the bits, example values are entered here.)



5.7.1.7 [407] Write long parameter

	Type	Function	
I1	%	Input value	Low word
I2	%		High word
I3	b	Write enable	
I4	b	Wait until writing is finished	

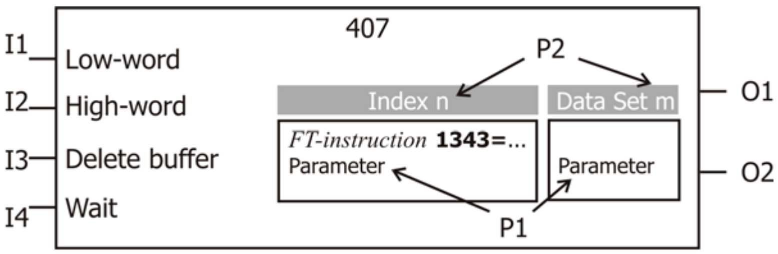
	Type	Function
O1	b	O1 = I2|I1
O2	b	inverted output = -1
P1	i	Parameter number
P2	i	Data set (0 … 9) or index

Description:
The input value is put together from of low-word and high-word, not changed and output as long parameter. In this way, this function can be used for any long parameter types.

O1 = I2|I1 (High-word|Low-word)

I1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1																
I2	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0																
O1	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1

(For the bits, example values are entered here.)

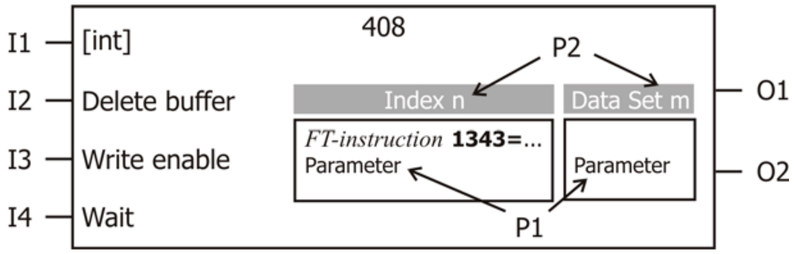


5.7.1.8 [408] Write word parameter

	Type	Function
I1	int	input value 1
I2	b	Delete buffer
I3	b	Write release
I4	b	Wait until writing is finished

	Type	Function
O1	b	I1[int]
O2	b	inverted output = -1
P1	i	Parameter number
P2	i	Data set (0 … 9) or index

Description:
The input value is not changed and written as int parameter. In this way, this function can also be used for any other (int) parameter types.



5.7.2 Reading parameters

Read access enables direct reading of all parameters of the frequency inverter. This is useful if the parameter is not connected to a source. Since the read access is effected to the non-realtime system of the frequency inverter, an instruction may take longer than 1 ms. The instruction is processed for the duration of the parameter access even if this takes longer than 1 ms.

If a non-permissible data set or index is selected, it will be replaced by one of the following data sets or indices.

Data Set/ Index	Data set related parameters	Non-data set related parameters
0	Instead, data set 1 is used. Instead, index 1 is used.	Data set 0
1...4/ 1…max. index	Value of data set 1…4 Value from index 1…max. Index	Data set 0
Invalid value	Instead, data set 1 (or index 1) is used.	Data set 0

All data sets are accessed from the RAM. Internal access to the EEPROM and RAM is done in the same way.

5.7.2.1 [421] Read frequency parameter

	Type	Function		Type	Function
I1	-	-	O1	%	Parameter value [Hz]
I2	-	-	O2	%	inverted output = -1
I3	b	Release read access	P1	i	Parameter number
I4	-	-	P2	i	Data set (0 … 4)/index

Description:
The function reads the value of the parameter set up in P1 "Parameter number" and P2 "Data set/index". The value is converted to a frequency value. Via Input I3 read access is enabled.

I3 = 0: No read access.
I3 = 1: The parameter value is read. The instruction is executed until the value is read.

5.7.2.2 [422] Read current parameter

	Type	Function		Type	Function
I1	-	-	O1	%	Parameter value [A]
I2	-	-	O2	%	inverted output = -1
I3	b	Release read access	P1	i	Parameter number
I4	-	-	P2	i	Data set (0 … 4)/index

Description:
The function reads the value of the parameter set up in P1 "Parameter number" and P2 "Data set/index". The value is converted to a current value. Via Input I3 read access is enabled.

I3 = 0: No read access.
I3 = 1: The parameter value is read. The instruction is executed until the value is read.

5.7.2.3 [423] Read voltage parameter (eff.)

	Type	Function
I1	-	-
I2	-	-
I3	b	Release read access
I4	-	-

	Type	Function
O1	%	Parameter value [V]
O2	%	inverted output = -1
P1	i	Parameter number
P2	i	Data set (0 … 4)/index

Description:
The function reads the value of the parameter set up in P1 "Parameter number" and P2 "Data set/index". The value is converted to a voltage value. Via Input I3 read access is enabled.

I3 = 0: No read access.
I3 = 1: The parameter value is read. The instruction is executed until the value is read.

5.7.2.4 [424] Read voltage parameter (peak)

	Type	Function
I1	-	-
I2	-	-
I3	b	Release read access
I4	-	-

	Type	Function
O1	%	Parameter value [V]
O2	%	inverted output = -1
P1	i	Parameter number
P2	i	Data set (0 … 4)/index

Description:
The function reads the value of the parameter set up in P1 "Parameter number" and P2 "Data set/index". The value is converted to a voltage value. Via Input I3 read access is enabled.

I3 = 0: No read access.
I3 = 1: The parameter value is read. The instruction is executed until the value is read.

5.7.2.5 [425] Read percent parameter

	Type	Function
I1	-	-
I2	-	-
I3	b	Release read access
I4	-	-

	Type	Function
O1	%	Parameter value [%]
O2	%	inverted output = -1
P1	i	Parameter number
P2	i	Data set (0 … 4)/index

Description:
The function reads the value of the parameter set up in P1 "Parameter number" and P2 "Data set/index". The value is converted to a percent value. Via Input I3 read access is enabled.

I3 = 0: No read access.
I3 = 1: The parameter value is read. The instruction is executed until the value is read.

5.7.2.6 [426] Read position parameter

	Type	Function
I1	-	-
I2	-	-
I3	b	Release read access
I4	-	-

	Type	Function	
O1	%	Position value	Low word
O2	%		High word
P1	i	Parameter number	
P2	i	Data set (0 … 4)/index	

Description:
The function reads the value of the parameter set up in P1 "Parameter number" and P2 "Data set/index". The value is converted to a position value. Via Input I3 read access is enabled.

I3 = 0: No read access.
I3 = 1: The parameter value is read. The instruction is executed until the value is read.

5.7.2.7 [427] Read long parameter

	Type	Function
I1	-	-
I2	-	-
I3	b	Release read access
I4	-	-

	Type	Function	
O1	%	Long value	Low word
O2	%		High word
P1	i	Parameter number	
P2	i	Data set (0 … 4)/index	

Description:
The function reads the value of the parameter set up in P1 "Parameter number" and P2 "Data set/index". The value is converted to a long value. Via Input I3 read access is enabled.

I3 = 0: No read access.
I3 = 1: The parameter value is read. The instruction is executed until the value is read.

5.7.2.8 [428] Read word parameter

	Type	Function
I1	-	-
I2	-	-
I3	b	Release read access
I4	-	-

	Type	Function
O1	%	Parameter value [%]
O2	%	inverted output = -1
P1	i	Parameter number
P2	i	Data set (0 … 4)/index

Description:
The function reads the value of the parameter set up in P1 "Parameter number" and P2 "Data set/index". The value is converted to a percent value. Via Input I3 read access is enabled.

I3 = 0: No read access.
I3 = 1: The parameter value is read. The instruction is executed until the value is read.

5.8 Limiters

5.8.1 [440] Limiter (Const.)

	Type	Function
I1	%	input value 1
I2	-	-
I3	-	-
I4	b	Master Reset

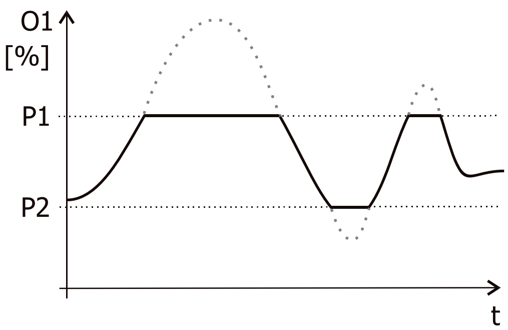
	Type	Function
O1	%	$O1 = I1_{P2}^{P1}$
O2	%	inverted output = -1
P1	%	upper limit
P2	%	lower limit

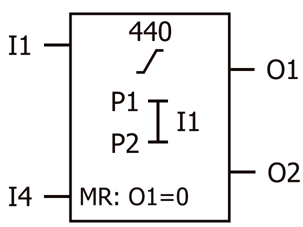
Description:
The input value at I1 is limited to P1 (upper limit) and P2 (lower limit) and output.

$$O1 = I1_{P2}^{P1}$$

As long as status TRUE is present at I4 (Master Reset), the output value O1 is 0.

Note:
P2 can only be entered as a positive value.





5.8.2 [441] Limiter (variable)

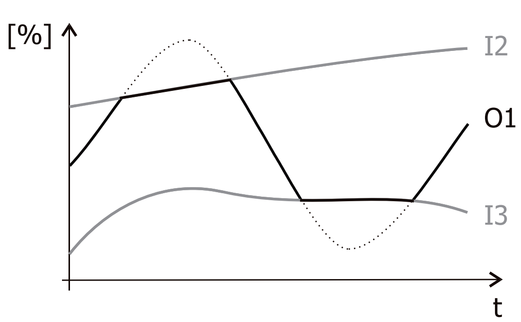
	Type	Function
I1	%	input value 1
I2	%	upper limit
I3	%	lower limit
I4	b	Master Reset

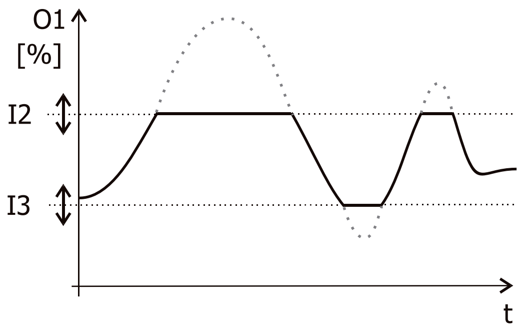
	Type	Function
O1	%	$O1 = I1_{I3\updownarrow}^{I2\updownarrow}$
O2	%	inverted output = -1
P1	-	-
P2	-	-

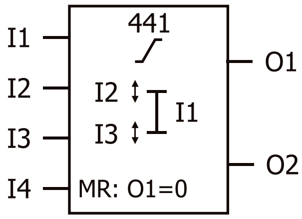
Description:
The input value at I1 is limited to I1 (upper limit) and I2 (lower limit) and output.

$O1 = I1_{I3\updownarrow}^{I2\updownarrow}$

As long as status TRUE is present at I4 (Master Reset), the output value O1 is 0.







5.9 Counters

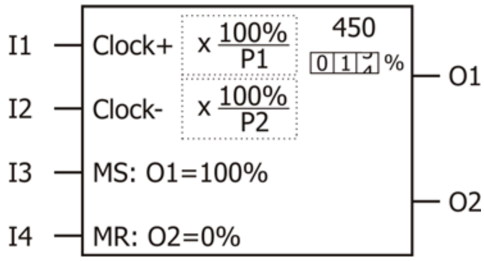
5.9.1 [450] Up/Down counter with analog output

	Type	Function
I1	b	Up counter
I2	b	Down counter
I3	b	Master Set
I4	b	Master Reset

	Type	Function
O1	%	O1= counter I1 - counter I2
O2	%	inverted output = -1
P1	i	Steps up for 100.00%
P2	i	Steps down for 100.00%

Description:

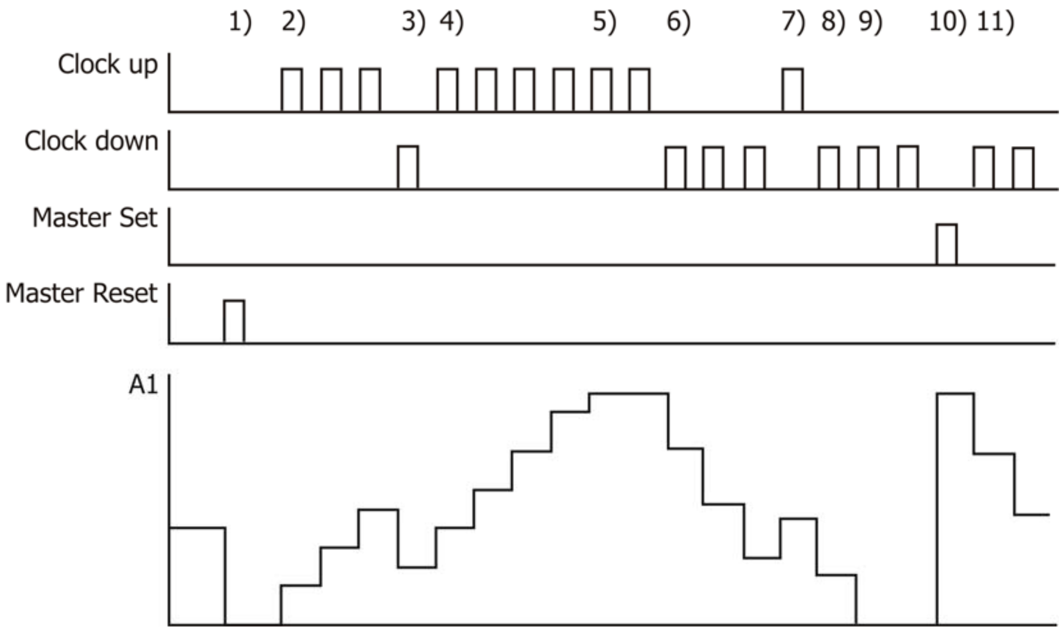
- Each positive edge at I1 increases the output value O1 by 100.00%/P1.
- Each positive edge at I2 reduces the output value O1 by 100.00%/P2.
- The output value is limited to the range 0.00% … 100.00%.
- Master Set (I3) sets the output to 100.00%. This input has priority over edges at I1 or I2.
- Master Reset (I4) sets the output to 0.00%. This input has priority over edges at I1, I2 and Master Set I3.



Possible applications:

- Definition of reference values by means of two pushbuttons. If one of the two buttons is pressed, the reference value is to be raised or lowered by an adjustable amount.
- Counting of (error) events. With each event, the counter counts up. The counter can trigger other functions, such as reporting errors occurring too often.

Example: P1 = 6, P2 = 4



1) Master Reset sets output O1 to zero.
2) Three counting pulses up (each 100.00%/P1 = 100.00%/6 = 16.67%)
3) One counting pulse down. (100.00%/P2 = 100.00%/4 = 25%)
4) Four counting pulses up (each 100.00%/P1 = 100.00%/6 = 16.67%)
5) Two counting pulses up, limitation to 100.00%
6) Three counting pulses down. (each 100.00%/P2 = 100.00%/4 = 25%)
7) One counting pulse up (100.00%/P1 = 100.00%/6 = 16.67%)
8) One counting pulse down. (100.00%/P2 = 100.00%/4 = 25%)
9) Two counting pulses down, limitation to zero.
10) Master Set sets output O1 to 100.00%.
11) Two counting pulses down. (each 100.00%/P2 = 100.00%/4 = 25%)

Note:
P1 and P2 are limited internally to 100.00%. If a greater value is entered, this value is replaced by 100.00%.

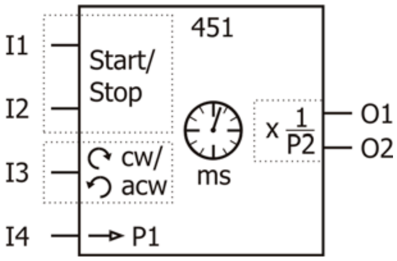
5.9.2 [451] Stopwatch with analog output

	Type	Function
I1	b	Release
I2	b	Release, inverted
I3	b	Counting direction
I4	b	Reset

	Type	Function
O1	%	(Counting value ms)/P2
O2	%	inverted output = -1
P1	%	Start value
P2	i	Divisor

Description:

- The stopwatch is running if I1 = TRUE and I2 = FALSE. In all other cases, the stopwatch is stopped.
- Input 3 determines the direction.
  I3 = TRUE: Stop watch runs forward,
  I3 = FALSE: Stopwatch runs backward.
- A positive edge at I4 sets the stopwatch (output O1) to the start value P1.
  As from the next negative edge, the stopwatch will be running (if I1 = TRUE and I2 = FALSE).
- P2 determines the divisor with which the internal value is converted in the output value.
- The output value is limited to the range 0.00% … 327.67%.



I1	I2	I3	I4	Function
1	0	1	x	Stopwatch runs forward.
1	0	0	x	Stopwatch runs backward
1	0	x	0→1	Reset to start value P1
1	0	x	1→0	Start after reset

Examples:
If I1 (release) = TRUE, I2 (release, inverted) = FALSE, I3 (counting direction) = TRUE, I4 (reset) = FALSE, the internal counter (long) is increased by one every millisecond. In order to calculate the output value, this value is divided by P2.

P2 = 1000: O1 is increased by 0.01% every second.

1) P2 = 1, time: one second (1000 ms).

Output value: $O1 = \frac{t}{P2} = \frac{1\,s}{P2} = \frac{1000\,ms}{1 \times 100\,\frac{ms}{\%}} = 10\%$

After one second, the output reaches the value 10%.

2) P2 = 1000, time: one hour (3600 s).

Output value: $O1 = \frac{t}{P2} = \frac{3600\,s}{P2} = \frac{3\,600\,000\,ms}{1000 \times 100\,\frac{ms}{\%}} = 36\%$

O1 is increased by 0.01% every second.
After one hour, the output reaches the value 36%.

5.10 Positioning functions

The positioning can be controlled directly from the PLC functions. Via the control operation mode of the positioning, the control can be handed assigned to the PlC functions. The positioning can be controlled in the settings for parameter *Configuration* **30** = "x40". In these configurations, parameter *Operation mode* **1221** must be set to "1000 - Control via function table" in order to control the positioning via the PLC functions.

Output O2|O1 (High word|Low word) outputs the actual position. In operation mode 507 - "Check state", the output indicates if a motion block is running.

Note:
The "Positioning" user manual describes the positioning functions in configurations x40.

5.10.1 [501] Start motion block as single motion

	Type	Function
I1	Pos	Target position offset
I2	%	-
I3	b	Release
I4	b	Wait until positioning is finished

	Type	Function	
O1	Pos	Actual position	Low word
O2	Pos		High word
P1	i	Number of motion block (index motion block table)	
P2	-	-	

Description:
The motion block selected with P1 is started. Repetitions and next motion blocks are not executed. If a motion block is still running, it will be stopped.

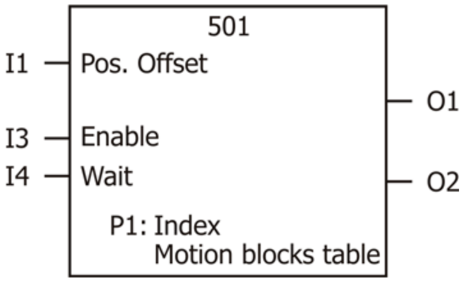
The position value set at input I1 (target position offset) is added to the target position set in the motion block.

			Configuration **30** = x40
	Instruction		Motion Block
	P1	=	Index
Target Position =	I1	+	*Target Position/Distance* **1202**

Input I1 can be combined with position values (long).

The function is only executed if input I3 (release) is set.

If input I4 (wait) is set, further instructions will only be processed when the target position has been reached. The process cannot be stopped by other instructions or resetting I3.



I3	I4	Function
1	0	Start motion block P1. Stopping by other instruction is possible. The target position can be changed by other instructions even if the target position has not been reached yet. The motion block is restarted.
1	1	Start motion block P1 and wait until positioning is finished.
0	0	The target position is not changed.
0	1	The target position can be changed by other instructions if no positioning is active.

5.10.2 [502] Start motion block in automatic mode

	Type	Function
I1	Pos	Target position offset
I2	%	-
I3	b	Release
I4	b	Wait until positioning is finished

	Type	Function	
O1	Pos	Actual position	Low word
O2	Pos		High word
P1	i	Number of motion block (index motion block table)	
P2	-	-	

Description:
The motion block selected with P1 is started. Repetitions and next motion blocks are executed. If a motion block is still running, it will be stopped.

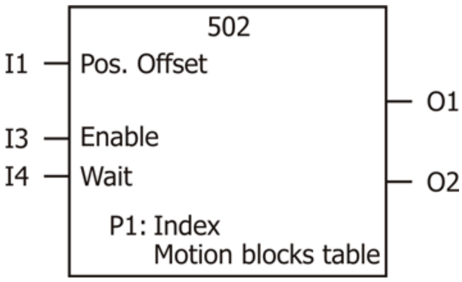
The position value set at input I1 (target position offset) is added to the target position set in the motion block.

	Instruction		*Configuration* **30** = x40 Motion Block
	P1	=	Index
Target Position =	I1	+	*Target Position/Distance* **1202**

Input I1 can be combined with position values (long).

The function is only executed if input I3 (release) is set.

If input I4 (wait) is set, further instructions will only be processed when the target position has been reached. The process cannot be stopped by other instructions or resetting I3.



I3	I4	Function
1	0	Start motion block P1 with repetitions and next motion blocks. Stopping by other instruction is possible. The target position can be changed by other instructions even if the target position has not been reached yet. The motion block is restarted.
1	1	Start motion block P1 with repetitions and next motion blocks and wait until positioning is finished.
0	0	The target position is not changed.
0	1	The target position can be changed by other instructions if no positioning is active.

5.10.3 [503] Stop motion block

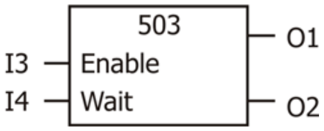
	Type	Function
I1	-	-
I2	-	-
I3	b	Release
I4	b	Wait until drive has stopped

	Type	Function	
O1	Pos	Actual position	Low word
O2	Pos		High word
P1	-	-	
P2	-	-	

Description:
The current motion block is stopped if the release at input I3 is set. The drive is stopped. If the release at I3 is reset the stopped motion block is continued and repetitions and next motion blocks are executed.

If input I4 (wait) is set, further instructions will only be processed when the drive has come to a standstill. The process cannot be stopped by other instructions or resetting I3.

The instruction is only executed if input I3 (release) is set.



I3	I4	Function
1	0	Stop motion block and stop drive
1	1	Wait until drive has stopped
1→0	0	Continue motion block

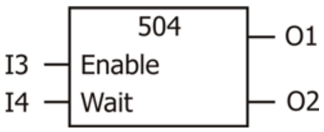
5.10.4 [504] Continue motion block

	Type	Function
I1	-	-
I2	-	-
I3	b	Release
I4	b	Wait until motion block is finished

	Type	Function	
O1	Pos	Actual position	Low word
O2	Pos		High word
P1	-	-	
P2	-	-	

Description:
Stopped motion blocks will be continued.
The function is only executed if input I3 (release) is set.

If input I4 (wait) is set, further instructions will only be processed when the motion block (including repetitions, if applicable) or automatic sequence of motion blocks is finished. The process cannot be stopped by other instructions or resetting I3.



I3	I4	Function
1	0	Continue stopped motion block
1	1	Wait until the end of the motion block or the automatic sequence

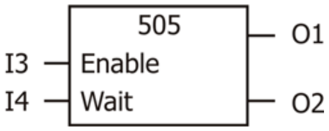
5.10.5 [505] Resume motion block

	Type	Function
I1	-	-
I2	-	-
I3	b	Release
I4	b	Wait until motion block is finished

	Type	Function	
O1	Pos	Actual position	Low word
O2	Pos		High word
P1	-	-	
P2	-	-	

Description:
Motion blocks stopped by error cut-off or mains off will be continued.
The function is only executed if input I3 (release) is set.

If input I4 (wait) is set, further instructions will only be processed when the motion block (including repetitions, if applicable) or automatic sequence of motion blocks is finished. The process cannot be stopped by other instructions or resetting I3.



I3	I4	Function
1	0	Resume Motion Block
1	1	Wait until the end of the motion block or the automatic sequence

5.10.6 [506] Start homing

	Type	Function
I1	-	-
I2	-	-
I3	b	Release
I4	b	Wait until reference position has been reached

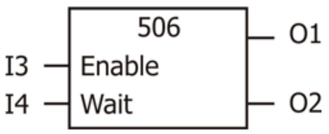
	Type	Function	
O1	Pos	Actual position	Low word
O2	Pos		High word
P1	i	Homing Mode	
P2	-	-	

Description:
The homing operation defined in P1 is started. Running motion blocks will be stopped.

		Configuration **30** = x40
Instruction		Motion Block
P1	=	*Homing Mode type* **1130**

The function is only executed if input I3 (release) is set.

If input I4 (wait) is set, further instructions will only be processed when the reference position has been reached. The process cannot be stopped by other instructions or resetting I3.



I3	I4	Function
1	0	Start homing P1.
1	1	Wait until reference position has been reached

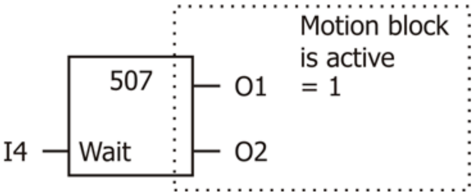
5.10.7 [507] Check state

	Type	Function
I1	-	-
I2	-	-
I3	-	-
I4	b	Wait until motion block is finished

	Type	Function
O1	b	TRUE if motion block running
O2	b	FALSE if motion block running
P1	-	-
P2	-	-

Description:
The function sets output O1 to TRUE if a motion block is running.

If input I4 (wait) is set, further instructions will only be processed when the motion block (including repetitions, if applicable) or automatic sequence of motion blocks is finished. The process cannot be stopped by other instructions or resetting I3.



Motion block running	I4	O1=
yes	0	1
no	x	0
yes	1	Wait

5.11 Bit functions for analog input values

Each individual bit of input 1 is combined with the corresponding bits of input 2 and parameter 1 (if available to the selected function). The result is saved in the corresponding bit of the output value.
For example, bit 3 of the output value depends on

- bit 3 of input value 1 and
- bit 3 of input value 2 and
- Bit 3 of parameter 1.

Parameter 2 indicates of input value I1 is to be combined with input value I2 or parameter P1:

- P2 = 1: Combination of input value I1 with input value I2
- P2 = 2: Combination of input value I1 with parameter P1
- P2 = 3: Combination of input value I1 with input value I2 and parameter P1

Master Set sets all bits of the output value (Output = 0xFFFF).
Master Reset deletes all bits of the output value (Output = 0x0000).

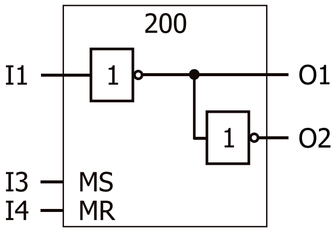
At output O2, the bitwise inverted value O1 is output.
Example: O1 = 0xFF00 → O2 = 0x00FF.

5.11.1 [200] Bit NOT operation

	Type	Function
I1	%	input value 1
I2	-	-
I3	b	Master Set
I4	b	Master Reset

	Type	Function
O1	%	$\overline{I1}$ (I1 bitwise inverted)
O2	%	inverted output (=I1)
P1	-	-
P2	-	-

Description:
At output 1 O1, the bitwise inverted value of input I1 is output (O1 = $\overline{I1}$).



Example: I1 = 0xF00F → O1 = 0x0FF0, O2 = 0xF00F

Master Set sets all bits of the output value (Output = 0xFFFF).
Master Reset deletes all bits of the output value (Output = 0x0000).

Note:
Since output I2 output the bitwise inverted value of output O1, O2 = I1.

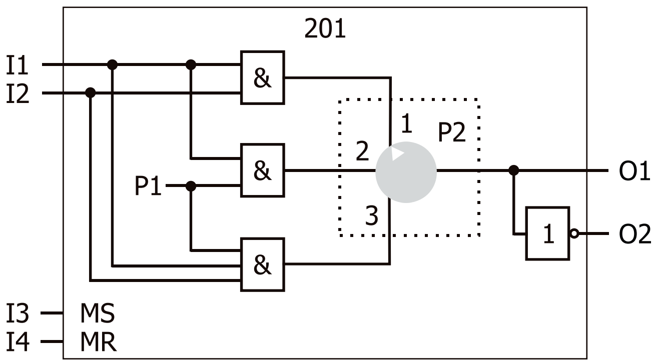
5.11.2 [201] Bit AND/NAND operation

	Type	Function
I1	%	input value 1
I2	%	input value 2
I3	b	Master Set
I4	b	Master Reset

	Type	Function
O1	%	O1=AND (I1 I2) if P2=1, O1=AND (I1 P1) if P2=2, O1=AND (I1 I2 P1) if P2=3
O2	%	inverted output = (NAND)
P1	%	Mask
P2	i	Operation mode (1, 2 or 3)

Description:
The input value at I1 is AND combined. Via P2, you can select:
- P2 = 1: I1 and I2 are AND combined.
- P2 = 2: I1 and P1 are AND combined.
- P2 = 3: I1, I2 and P1 are AND combined.

Master Set sets all bits of the output value (Output = 0xFFFF).
Master Reset deletes all bits of the output value (Output = 0x0000).



Examples:

P2	I1	I2	P1	O1	O2
1) AND (I1 I2)	0xF00F	0x0F0F	-	0x000F	0xFFF0
2) AND (I1 P1)	0xF00F	-	0x00FF	0x000F	0xFFF0
3) AND (I1 I2 P1)	0xF00F	0x0F0F	0x00FF	0x000F	0xFFF0

In example 1):

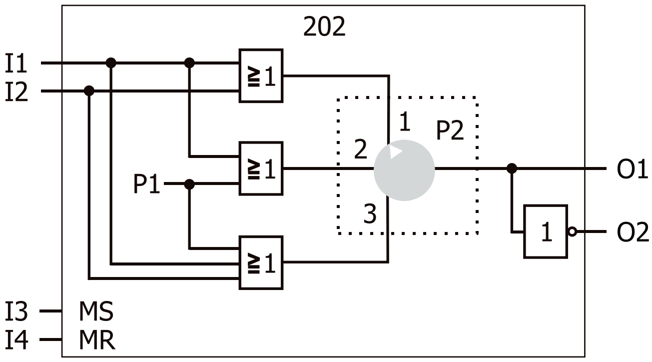
I1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	0xF00F
I2	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0x0F0F
	&	…												…		&	
O1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0x000F

5.11.3 [202] Bit OR/NOR operation

	Type	Function		Type	Function
I1	%	input value 1	O1	%	O1=OR (I1 I2) if P2=1, O1=OR (I1 P1) if P2=2, O1=OR (I1 I2 P1) if P2=3
I2	%	input value 2	O2	%	inverted output = (NOR)
I3	b	Master Set	P1	%	Mask
I4	b	Master Reset	P2	i	Operation mode (1, 2 or 3)

Description:
The input value at I1 is OR combined. Via P2, you can select:
- P2 = 1: I1, I2 are OR combined.
- P2 = 2: I1, P1 are OR combined.
- P2 = 3: I1, I2, P1 are OR combined.

Master Set sets all bits of the output value (Output = 0xFFFF).
Master Reset deletes all bits of the output value (Output = 0x0000).



Examples:

P2	I1	I2	P1	O1	O2
1) OR (I1 I2)	0xF00F	0x0F0F	-	0xFF0F	0x00F0
2) OR (I1 P1)	0xF00F	-	0x00FF	0xF0FF	0x0F00
3) OR (I1 I2 P1)	0xF00F	0x0F0F	0x00FF	0xFFFF	0x0000

Re example 1):

I1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	0xF00F
I2	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0x0F0F
	≥1	…												…		≥1	
O1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	0xFF0F

5.11.4 [203] Bit XOR/XNOR operation

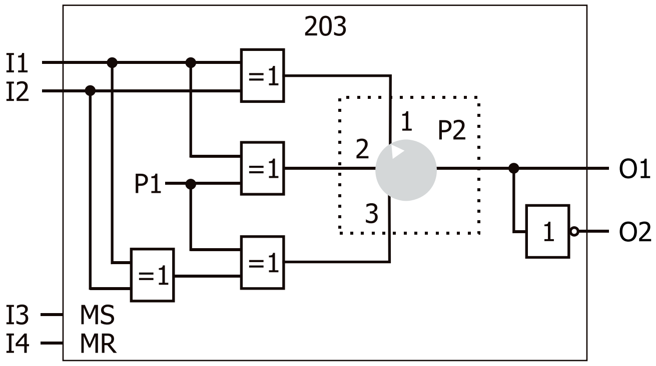
	Type	Function
I1	%	input value 1
I2	%	input value 2
I3	b	Master Set
I4	b	Master Reset

	Type	Function
O1	%	O1=XOR (I1 I2) if P2=1, O1=XOR (I1 P1) if P2=2, O1=XOR {XOR (I1 I2) P1} if P2=3
O2	%	inverted output = (XNOR)
P1	%	Mask
P2	i	Operation mode (1, 2 or 3)

Description:
The input value at I1 is Exclusive-OR combined. Via P2, you can select:

- P2 = 1: I1, I2 are Exclusive-OR combined.
- P2 = 2: I1, P1 are Exclusive-OR combined.
- P2 = 3: I1, I2, P1 are Exclusive-OR combined.

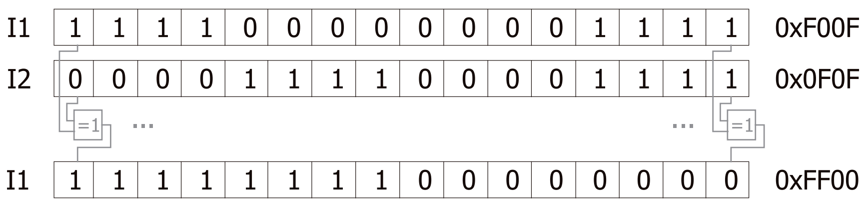
Master Set sets all bits of the output value (Output = 0xFFFF).
Master Reset deletes all bits of the output value (Output = 0x0000).



Examples:

P2	I1	I2	P1	O1	O2
1) XOR (I1 I2)	0xF00F	0x0F0F	-	0xFF00	0x00FF
2) XOR (I1 P1)	0xF00F	-	0x00FF	0xF0F0	0x0F0F
3) XOR {XOR (I1 I2) P1}	0xF00F	0x0F0F	0x00FF	0xFFFF	0x0000

Re example 1):



5.11.5 [210] Bit shift right

	Type	Function
I1	%	input value 1
I2	-	-
I3	b	Master Set
I4	b	Master Reset

	Type	Function
O1	%	I1 bitwise shifted by P2
O2	%	inverted output
P1	-	-
P2	i	Number of shifts

Description:
The input value at I1 is shifted to the right bitwise by the number of shifts (P2). Left side is filled with zeroes.

Master Set sets all bits of the output value (Output = 0xFFFF).
Master Reset deletes all bits of the output value (Output = 0x0000).

Example	P2	I1	O1	O2
1)	1: One shift	0xF00F	0x7807	0x87F8
2)	4: Four shifts	0x00FF	0x000F	0xFFF0
3)	8: Eight shifts	0xFF00	0x00FF	0xFF00

In example 1):

I1		1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1		0xF00F
1 x SHR:		↘	↘	↘	…														
O1	0→	0	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	→1	0x7807

5.11.6 [211] Bit arithmetical shift right

	Type	Function		Type	Function
I1	%	input value 1	O1	%	I1 bitwise shifted by P2, sign bit is maintained
I2	-	-	O2	%	inverted output
I3	b	Master Set	P1	-	-
I4	b	Master Reset	P2	i	Number of shifts

Description:
The input value at I1 is shifted to the right bitwise by the number of shifts (P2). The most significant bit (sign bit) is maintained.

Master Set sets all bits of the output value (Output = 0xFFFF).
Master Reset deletes all bits of the output value (Output = 0x0000).

Example	P2	I1	O1	O2
1)	1: One shift	0xF00F	0xF807	0x07F8
2)	4: Four shifts	0x00FF	0x000F	0xFFF0
3)	8: Eight shifts	0xFF00	0xFFFF	0x0000

In example 1):

I1		1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1		0xF00F
1 x SHR:		↘	↘	↘	…														
O1	0→	0	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	→1	0x7807

5.11.7 [212] Bit shift left

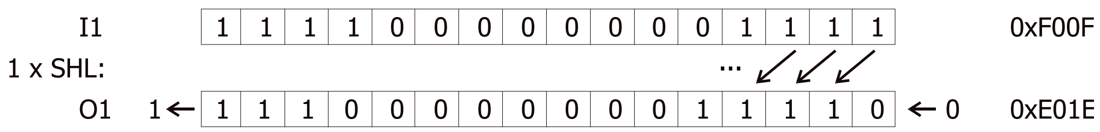
	Type	Function		Type	Function
I1	%	input value 1	O1	%	I1 bitwise shifted by P2
I2	-	-	O2	%	inverted output
I3	b	Master Set	P1	-	-
I4	b	Master Reset	P2	i	Number of shifts

Description:
The input value at I1 is shifted to the left bitwise by the number of shifts (P2). Right side is filled with zeroes.

Master Set sets all bits of the output value (Output = 0xFFFF).
Master Reset deletes all bits of the output value (Output = 0x0000).

Example	P2	I1	O1	O2
1)	1: One shift	0xF00F	0xE01E	0x1FI1
2)	4: Four shifts	0x00FF	0x0FF0	0xF00F
3)	8: Eight shifts	0xFF00	0x0000	0xFFFF

In example 1):



5.11.8 [213] Bit roll right

	Type	Function
I1	%	input value 1
I2	-	-
I3	b	Master Set
I4	b	Master Reset

	Type	Function
O1	%	I1 bitwise shifted by P2, with bits re-inserted
O2	%	inverted output
P1	-	-
P2	i	Number of shifts

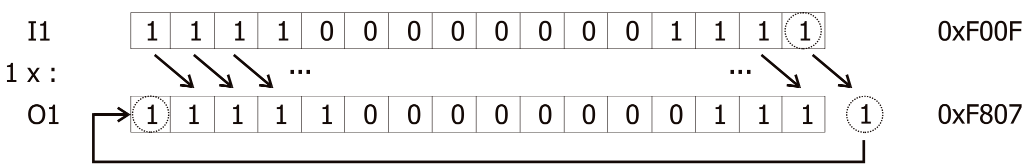
Description:
The input value at I1 is shifted to the right bitwise by the number of shifts (P2). On the left side, the bits leaving on the right side will be inserted.

Master Set sets all bits of the output value (Output = 0xFFFF).
Master Reset deletes all bits of the output value (Output = 0x0000).

Note:
Rolling by 8 bits exchanges the most significant bit and least significant byte.
Rolling by 15 bits to the right corresponds to rolling by one bit to the left.
After rolling by 16 bits, the output value at O1 is the same as the input value at I1.

Example	P2	I1	O1	O2
1)	1: One shift	0xF00F	0xF807	0x07F8
2)	4: Four shifts	0x00FF	0xF00F	0x0FF0
3)	8: Eight shifts	0xFF00	0x00FF	0xFF00

In example 1):



5.11.9 [220] Output one bit

	Type	Function
I1	%	input value 1
I2	-	-
I3	b	Master Set
I4	b	Master Reset

	Type	Function
O1	b	One bit of I1, selected via P1
O2	b	inverted output
P1	i	Number of bit (0 … 15)
P2	-	-

Description:
A selected bit of input value 1 is output at output 1. The bit is selected via P1.
P1=0: The least significant bit (LSB) is selected,
P1=15: The most significant bit (MSB) is selected.

Master Set sets all bits of the output value (Output = 0xFFFF).
Master Reset deletes all bits of the output value (Output = 0x0000).

Example	**P1**	**I1**	**O1**	**O2**
1)	1: Bit 1	0xF00F	1	0
2)	4: Bit 4	0x00FF	1	0
3)	4: Bit 4	0xFF00	0	1

In example 2):

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
I1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0x00FF

O1 1 ← P1=4

5.11.10 [221] Unite four bits to form a word

	Type	Function		Type	Function
I1	b	input value 1	O1	%	I1, I1, I3, I4 united to form a word
I2	b	input value 2	O2	%	inverted output
I3	b	input value 3	P1	i	Number of 1st bit (0 … 15)
I4	b	input value 4	P2	-	-

Description:
The state of input 1 is copied to the bit of output O1 specified via P1, the state of input 2 to the next bit, etc. All other bits of the output value are zero. If P1 > 12, bits will be lost.

Master Set sets all bits of the output value (Output = 0xFFFF).
Master Reset deletes all bits of the output value (Output = 0x0000).

Exam-ple	**P1**	**Copy**	**I4**	**I3**	**I2**	**I1**	**O1**	**O2**
1)	0	I1 to bit 0 of O1, I2 to bit 1 of O1, I3 to bit 2 of O1, I4 to bit 3 of O1	1	0	1	0	0x000A	0xFFF5
2)	5	I1 to bit 5 of O1, I2 to bit 6 of O1, I3 to bit 7 of O1, I4 to bit 8 of O1	1	0	1	0	0x0140	0xFEBF
3)	14 (P1>12)	I1 to bit 14 of O1, I2 to bit 15 of O1, I3 not copied, I4 not copied	1	0	1	0	0x4000	0xBFFF

Re example 2):

P1=5

I1 0 → bit 5
I2 1 → bit 6
I3 0 → bit 7
I4 1 → bit 8

O1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0x0140
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	

5.11.11 [222] Add two bits to a word

	Type	Function
I1	%	Input word 1
I2	b	Input Bit 1
I3	b	Input Bit 2
I4	b	Master Reset

	Type	Function
O1	%	O1=I1, Bit(P1)=I2, Bit(P2)=I3
O2	%	inverted output
P1	i	Number of 1st bit (0 … 15)
P2	i	Number of 2nd bit (0 … 15)

Description:
The states at inputs I2 and I3 are inserted in certain bits of the input value 1. The bits are defined by P1 and P2.

– The input value at I1 is copied to output O1.
– The state of input I2 is copied to the bit of output O1 specified via P1.
– The state of input I3 is copied to the bit of output O1 specified via P2.

If a bit number outside of range 0 … 15 is specified, the bit will not be written in the word.

Example	P1	P2	Copy	I1	I2	I3	O1	O2
1)	12	11	I1 to O1, I2 to bit 12 of O1, I3 to Bit 11 of O1	0xF00F	0	1	0xE80F	0x17F0
2)	4	5	I1 to O1, I2 to bit 4 of O1, I3 to Bit 5 of O1	0xF00F	1	1	0xF03F	0x0FC0
3)	0	1	I1 to O1, I2 to bit 0 of O1, I3 to Bit 1 of O1	0xF00F	0	0	0xF00C	0x0FF3

Master Set sets all bits of the output value (Output = 0xFFFF).
Master Reset deletes all bits of the output value (Output = 0x0000).

In example 1):

I2				0 (P1=12)													
I3					1 (P2=11)												
I1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	0xF00F
	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
O1	1	1	1	0	1	0	0	0	0	0	0	0	1	1	1	1	0xE80F
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	

6 Examples of combinations in the function table

The examples describe combinations of signals of the device series ACU. The combination procedure is the same in the different device series. The names of the signal sources may be different.

6.1 Write index and read index

6.1.1 Write index and read index for FT-instructions

Via the write and read indices, the index of the instruction the parameters of which are to be read or written is specified. VTable uses the parameters automatically for writing and reading. The write and read parameters are required for parameterization via the keypad of a control unit or via a bus system (e.g. PROFIBUS).

Write index and read index for parameterization and reading of FT-instructions via software VPlus

The FT-instructions can be parameterized in the user interface VPlus or in the function table VTable. In the user interface VPlus, an index of the function table can be created via parameter *FT-Write Index (FT-Table Item)* **1341**. The chosen index corresponds to a column in the function table. The settings of parameters **1343** to **1351** are applied to the selected index of the function table. Via parameter *FT-Read Index (FT-Table Item)* **1342**, the values of a selected index can be read from the function table.

Parameters		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
1341	FT write index (FT table item)	0	65	1
1342	FT read index (FT table item)	0	65	1

Settings for fixed parameterization (non-volatile):
0: all instructions in EEPROM
1 … 32: individual instructions in EEPROM

Settings for non-fixed parameterization (volatile):
33: all instructions in RAM
34 … 65: individual instructions in RAM

Note:
The settings "0" or "33" for *FT Write Index (FT table Item)* **1341** change all indices of a parameter in the EEPROM or RAM.

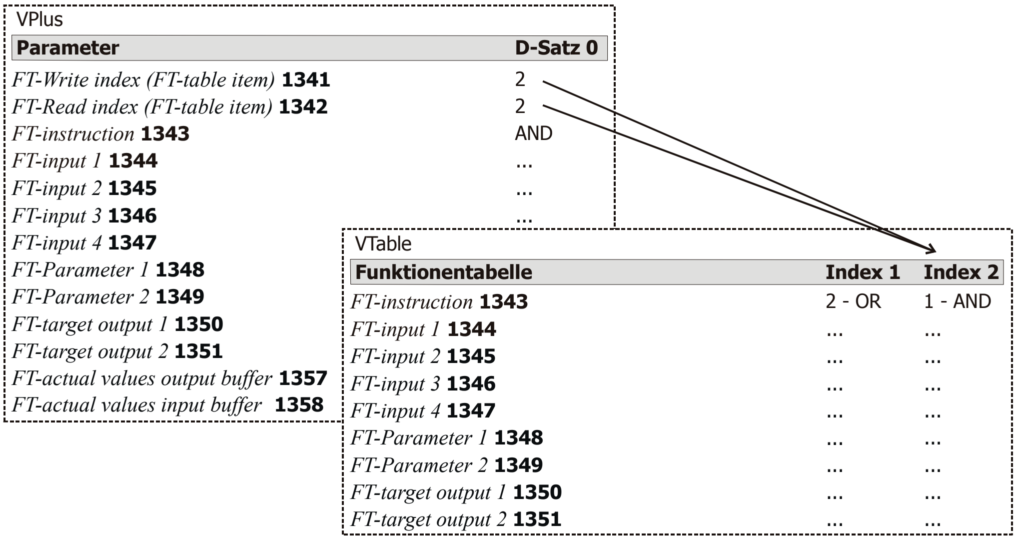
In the case of non-volatile storage (0..32), the changed values are still available when power supply is switched on again.

In the case of volatile storage (33…65), the data is only stored in RAM. If the unit is switched off, this data is lost and the data required are loaded from EEPROM.

Caution!
Writing of the EEPROM is restricted to approx. 1 million times. If this number is exceeded, the device may be damaged.

Definition:
Instruction RAM = instruction EEPROM + 33

Write index and read index for FT-instructions in function table for parameters: 1343, 1344, 1345, 1346, 1347, 1348, 1349, 1350, 1351, 1352



6.1.2 Write index and read index for the digital input buffer

Via the write and read indices, the index of the "Function table: input buffer" to be read or written is specified.

Write index and read index for parameterization and reading of "Function table: input buffer via software VPlus

The "Function table: input buffer" can be parameterized in the user interface VPlus or in the function table VTable. In the user interface VPlus, an index of the input buffer can be created via parameter *FT-Write Index (FT Input Buffer)* **1360**. The chosen index corresponds to a column in the "Function table: Input buffer" and thus an index of parameter *FT-Input Buffer* **1362**. The setting (selection of signal source or digital input) of parameter *FT-Input Buffer* **1362** is applied to the set index of "Function table: input buffer". Via parameter *FT-Read Index (FT-Input Buffer)* **1361**, the values of a selected index can be read from the "Function table: input buffer".

Parameters		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
1360	FT-Write Index (FT-input buffer)	0	33	1
1361	FT-Read Index (FT-input buffer)	0	33	1

Settings for fixed parameterization (non-volatile):
0: all input buffers in EEPROM
1 … 16: individual input buffer in EEPROM

Settings for non-fixed parameterization (volatile):
17: all input buffers in RAM
18 … 33: individual input buffer in RAM

Note:
The settings "0" or "17" for *FT Write Index (FT input buffer)* **1360** change all values of an input buffer in the EEPROM or RAM.

In the case of non-volatile storage (0..16), the changed values are still available when power supply is switched on again.

In the case of volatile storage (17…33), the data is only stored in RAM. If the unit is switched off, this data is lost and the data required are loaded from EEPROM.

Caution!
Writing of the EEPROM is restricted to approx. 1 million times. If this number is exceeded, the device may be damaged.

Definition:
Input buffer RAM = input buffer EEPROM +17

Write index and read index for the digital input buffer, example

VPlus

Parameter	Data set 0
FT-write index (FT-input buffer) **1360**	3
FT-read index (FT-input buffer) **1361**	3
FT-input buffer **1362**	75 - S6IND

VTable

Function Table: input buffer	Index 1	Index 2	Index 3
FT-input buffer **1362**	70 - Inverter Release	71 - S2IND	75 - S6IND

6.1.3 Write index and read index for the analog input buffer and FT fixed values

Via the write and read indices, the index of the "Input buffer analog" table the parameters of which are to be read or written is specified. VTable uses the parameters automatically for writing and reading. The write and read parameters are required for parameterization via the keypad of a control unit or via a bus system (e.g. PROFIBUS).

Write index and read index for parameterization and reading of "Input buffer analog" table via software VPlus

The "Input buffer analog" table can be parameterized in the user interface VPlus or in the function table VTable. In the user interface VPlus, an index of the "Input buffer analog" table can be created via parameter *FT-Write Index (FT Input analog)* **1377**. The chosen index corresponds to a column in the "Input buffer analog" table. The settings of parameters **1379** to **1397** are applied to the selected index of the "Input buffer analog" table. Via parameter *FT-Read Index (FT-Input analog)* **1378**, the values of a selected index can be read from the "Input buffer analog" table.

Parameters		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
1377	FT-Write Index (FT-input analog)	0	9	1
1378	FT-Read Index (FT-input analog)	0	9	1

Settings for fixed parameterization (non-volatile):
0: all input buffers in EEPROM
1 … 4: individual input buffer in EEPROM

Settings for non-fixed parameterization (volatile):
5: all input buffers in RAM
6 … 9: individual input buffer in RAM

Note:
The settings "0" or "5" for *FT Write Index (FT input analog)* **1377** change all values of an input buffer in the EEPROM or RAM.

In the case of non-volatile storage (0..4), the changed values are still available when power supply is switched on again.

In the case of volatile storage (5…9), the data is only stored in RAM. If the unit is switched off, this data is lost and the data required are loaded from EEPROM.

Caution!
Writing of the EEPROM is restricted to approx. 1 million times. If this number is exceeded, the device may be damaged.

Definition:
Input buffer RAM = input buffer EEPROM +5

Write index and read index for the "Input buffer analog" table

VPlus

Parameter	Data set 0
FT-write index (FT-input analog) **1377**	2
FT-read index (FT-input analog) **1378**	2
FT-input buffer frequency **1379**	62 - Reference Frequency Channel
FT-input buffer current **1380**	126 - Active Current
.	...
.	...
.	

VTable

Input buffer analog	Index 1	Index 2
FT-input buffer frequency **1379**	9 - Zero	62 - Reference Frequency Channel
FT-input buffer current **1380**	9 - Zero	126 - Active Current
.	...	...
.	...	...
.	...	...

6.2 Run/Stop

By default (factory setting) the function table is stopped and must be started by parameter *FT-RunMode* **1399**. In stop mode, no instructions are processed and there is no writing of the output buffer.

Note:
Instructions can only be edited in stop mode. If you try to make any changes while the function table is not in stop mode, an error will be displayed in VPlus. The attempted change will not be applied.

Further operation modes are available for processing individual instructions and instruction blocks. If an operation mode 11, 12, 21, 22, 31 or 32 is selected, the instruction block[1] will be processed according to the function described. Then, Run mode will be set to "0-Stop" automatically. In order to process another instruction block, the operation mode must be set to the corresponding value again.

FT-Runmode **1399**	Function
0 - Stop	The function table is stopped and no longer processed.
1 - Run	The function table is started at index 1 and processed normally.
2 - Continue	The function table is continued at the index where the processing was stopped last time, and the table is then processed normally.
11 - 12 - Single Step	One instruction is processed.
21 - 22 - Single Part	All instructions are processed until next writing of output buffer.
31 - 32 - Single Cycle	All instructions are processed until return jump. The return jump is reached when the maximum number of logic functions is processed or the next *FT-Instruction* **1343** = 0.

Note:
Two modes are available to an instruction block (1x, 2x, 3x).

[1]In this connection, an instruction block may also include a single instruction.

For control of a **PLC** it is sufficient to select a mode and set it accordingly. When the instruction block was processed, the frequency inverter resets the operation mode to "0-Stop" automatically. The same mode can be selected again.

Note:
If a diagnosis via **VPlus** is to be performed, both modes are required. Execution of the instruction block must be started by the modes alternately, because VPlus only updates parameters (on ACU) which have been changed.

Note:
If "Single Step", "Single Part" or "Single Cycle" are selected, the selected mode is maintained. The status of the function table is shown exactly in *FT-Actual Values Function* **1356** .

6.2.1 Example Run/Stop

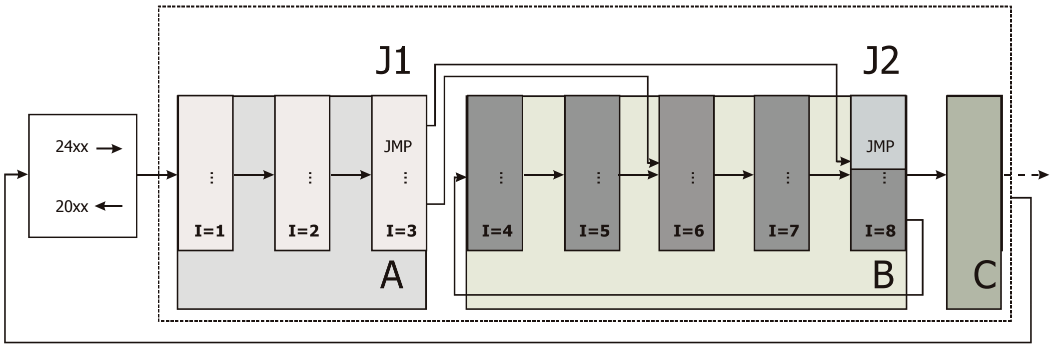
The following diagram shows a function block circuit which includes two jump functions (J1 and J2). Depending on the settings of parameter *FT-RunMode* **1399** , the procedure is as follows:

FT-Runmode **1399** = "1 – Run"
The sequence is processed continuously. Jump functions are processed according to input statuses.

FT-Runmode **1399** = "11 – Single Step", "12 – Single Step"
The sequence is interrupted after each instruction. Each time, the sequence is stopped, FT-RunMode **1399** must be restarted with "11 – Single Step" or "12 – Single Step". Jump functions are processed according to input statuses. Thus, the sequence is "I=1, Stop"; "I=2, Stop";…

FT-Runmode **1399** = "21 – Single Part", "22 – Single Part"
The sequence is processed until a jump instruction is reached which writes the output buffer. In this example, the buffer is written by both jump instructions. Thus, the sequence is "Block A, Stop"; "Block B, Stop";…

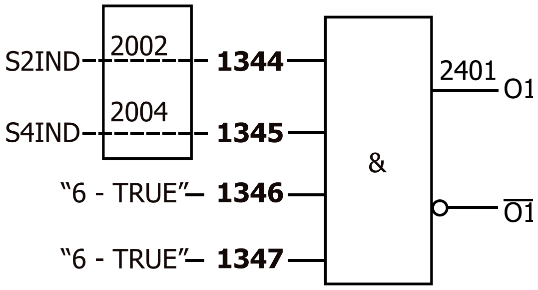
FT-Runmode **1399** = "31 – Single Cycle", "32 – Single Cycle"
The sequence is processed until the end is reached and the return jump to the start is effected (to block C). It may happen that Block B is processed repeatedly depending on the digital signals if the jump at J2 jumps to the beginning of Block B. A cycle may be, for example: "Block A, Block B, Block B, Block B, Block C, return jump, stop".



6.3 Example 1: Combining two digital outputs

Digital signals S2IND and S4IND are to control digital output S1OUT. If both signals are present, the output is TRUE. If not, the output is FALSE.

Settings in index 1 of function table:
FT Instruction **1343** = "1 - AND",
FT input 1 **1344** = "2002 - FT input buffer 2",
FT input 2 **1345** = "2004 - FT input buffer 4",
FT input 3 **1346** = "6 - TRUE",
FT input 4 **1347** = "6 - TRUE",
FT target output 1 **1350** = "2401 - FT output buffer 1".



Settings in parameter group digital outputs:
Op. Mode Digital Output 1 **530** = "80 - FT-Output Buffer 1".

6.4 Example 2: Combining several FT-instructions

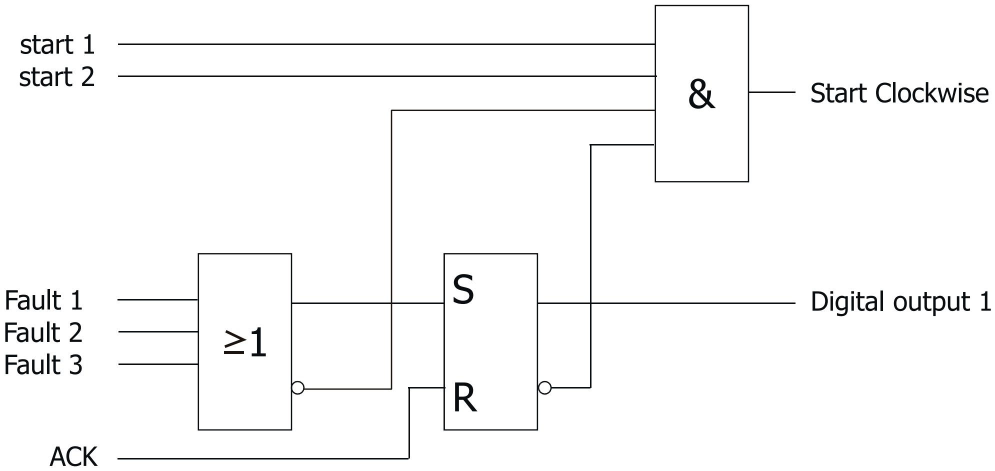
Note:
The FT-instructions will be processed column by column according to the index in the table. When designing application-specific logic links, in particular in the case of time-critical applications:

- Make sure to follow the correct order of the FT-instructions.
- Note the processing time (1 ms per FT-instruction).

Example of parameterization of instructions in a function table:

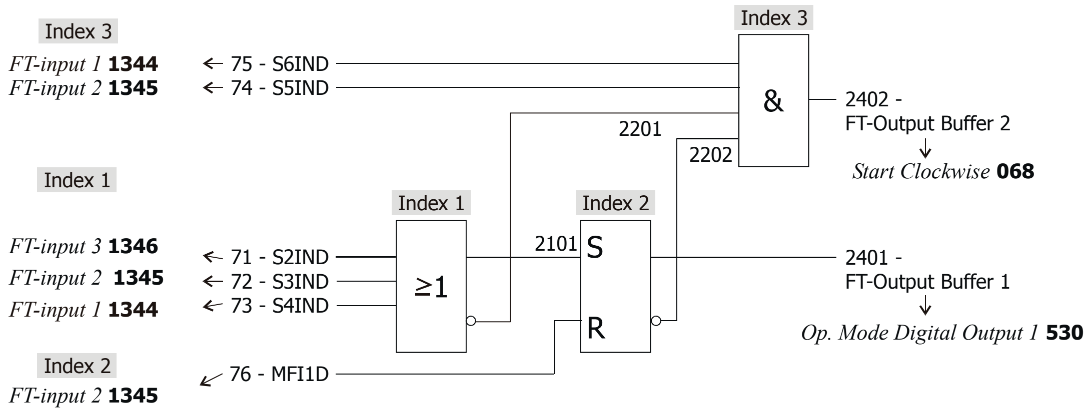
Step 1: Task
The drive may only start if both start signals (Start 1 and Start 2) are present and no error is present.
As soon as one of the two start signals (either Start 1 or Start 2) is no longer set, the drive is to be stopped.
If one of three error messages (error 1, error 2 or error 3) is present, the drive is to be stopped.
The acknow. input (Ack) is used for acknowledging the error messages.
Any error condition that may be present is to be signaled on digital output 1.

Step 2: Logic plan



Step 3: Combinations with and making entries in function table VTable

- Combine FT-instruction outputs to FT-instruction inputs in function table VTable.
- Make FT-instruction outputs generally (globally) available via signal sources "2401 - FT-Output buffer 1" to "2416 FT-Output buffer 16" and combine them with other functions (no FT-instructions)
- Output signals of FT-instructions via a digital output.



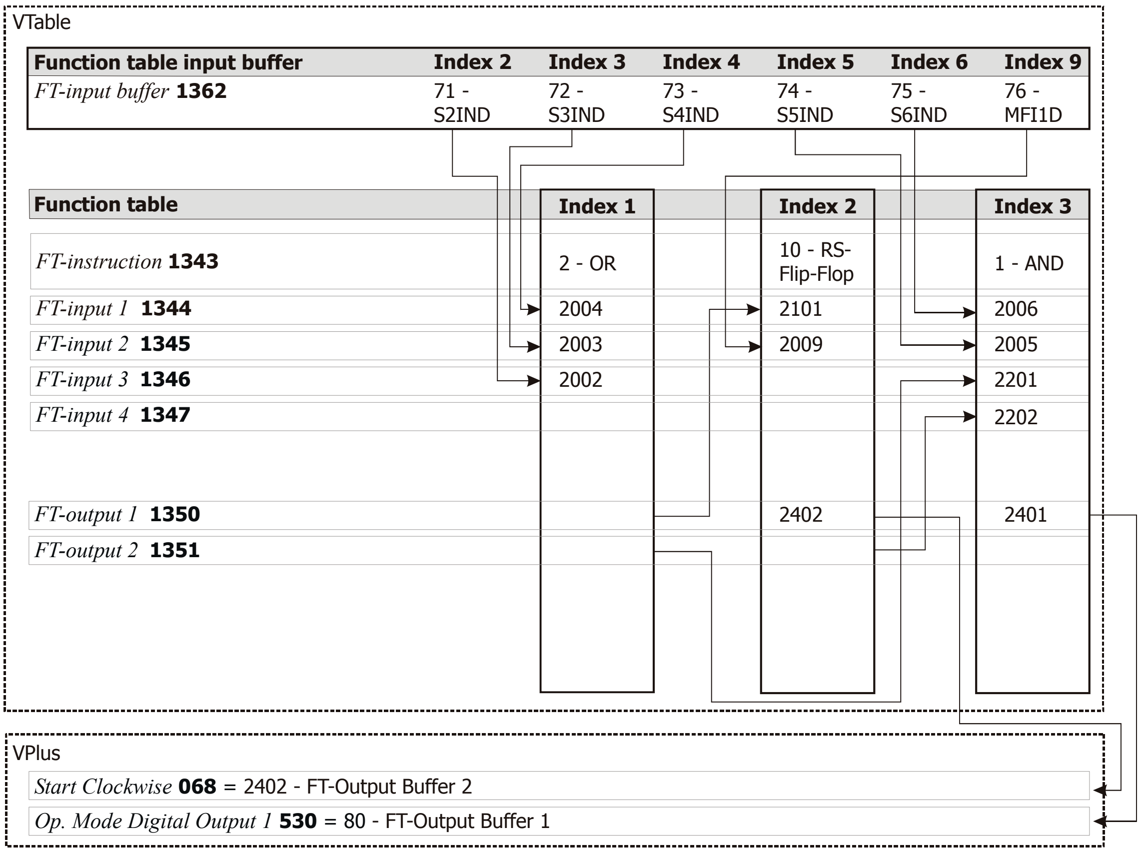


Table of functions	Index 1	Index 2	Index 3	Index 4
FT instruction **1343**	2 - OR	10 - RS Flip-Flop Superior	1 - AND	0 - Off (last table item)
FT input 1 **1344**	2004 - FT input buffer 4	2101 - Outp.1 instruction 1	2006 - FT input buffer 6	7 – FALSE
FT input 2 **1345**	2003 - FT input buffer 3	2009 - FT input buffer 9	2005 - FT input buffer 5	7 – FALSE
FT input 3 **1346**	2002 - FT input buffer 2	7 – FALSE	2201 - Outp.1 instruction 1 [1)]	7 – FALSE
FT input 4 **1347**	7 – FALSE	7 – FALSE	2202 - Outp.1 instruction 2 [2)]	7 – FALSE
FT-Target Output 1 **1350**	0 - Output not usable globally	2402 - FT-Output buffer 2	2401 - FT-Output buffer 1	0 - Output not usable globally
FT-Target Output 2 **1351**	0 - Output not usable globally	0 - Output not usable globally	0 - Output not usable globally	0 - Output not usable globally

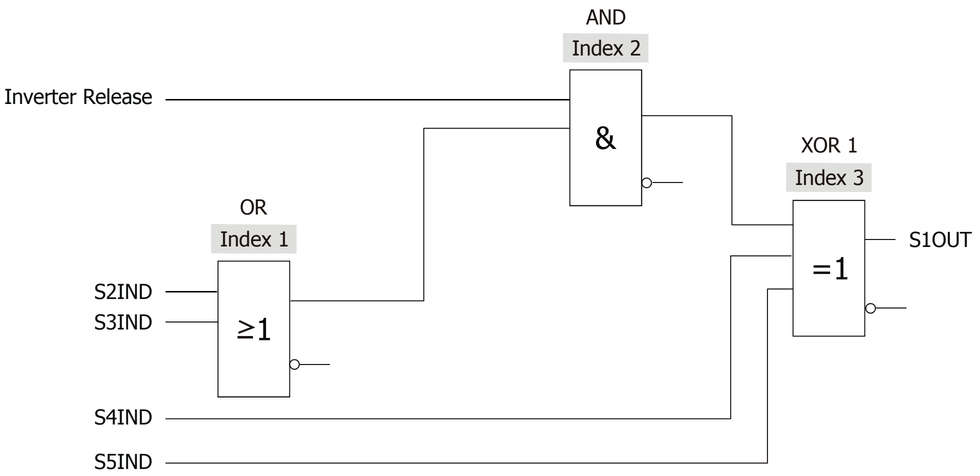
[1)] Inverted output of function 1 (in this example of OR function)
[2)] Inverted output of function 2 (in this example of RX-Flip-Flop)

The outputs of the FT-instructions are available as sources and can be linked to the inputs of other functions or output via digital outputs.

Example:

- Linking of AND function output with Start Clockwise Function, parameter *Start clockwise* **068** = "2402 - FT output buffer 2"
- Linking of RS-Flip-Flop output with digital output 1; Parameter *Operation mode digital output 1* **530** = "80 – FT-Output buffer 1"

6.5 Example 3: Parameterization of logic diagram



VTable

Function Table: Input Buffer	Index 1	Index 2	Index 3	Index 4	Index 5
FT-input buffer **1362**	70 - Inverter Release	71 - S2IND	72 - S3IND	73 - S4IND	74 - S5IND

Function Table	Index 1	Index 2	Index 3
FT-instruction **1343**	2 - OR	1 - AND	3 - XOR 1
FT-input 1 **1344**	2002	2001	2102
FT-input 2 **1345**	2003	2101	2004
FT-input 3 **1346**			2005
FT-input 4 **1347**			
FT-output 1 **1350**			2401
FT-output 1 **1351**			

VPlus

Op. Mode Digital Output 1 **530 =** 80 - FT-Output Buffer 1

7 Actual values, output signals and messages

7.1 Actual values of digital functions

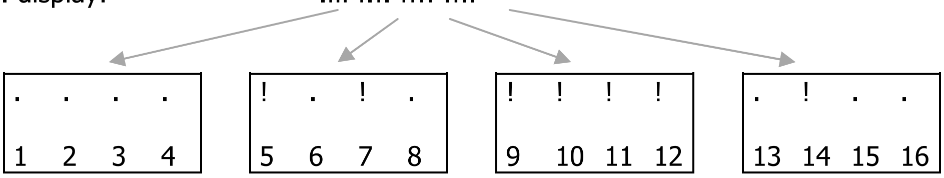
Actual values of input and output buffers

– The actual values of the global outputs 2401 to 2416 - "PLC output buffer" are indicated by parameter *PLC actual values output buffer* **1357**.

– The actual values of the global inputs 2001 to 2016 - "PLC input buffer" are indicated by parameter *PLC actual values input buffer* **1358**.

Example

e.g. display: "…. !.!. !!!! .!.."



"." = FALSE
"!" = TRUE

In the example, the following is TRUE:
2405 - PLC output buffer 5
2407 - PLC output buffer 7
2409 - PLC output buffer 9
2410 - PLC output buffer 10
2411 - PLC output buffer 11
2412 - PLC output buffer 12
2414 - PLC output buffer 14

Actual values of digital instructions

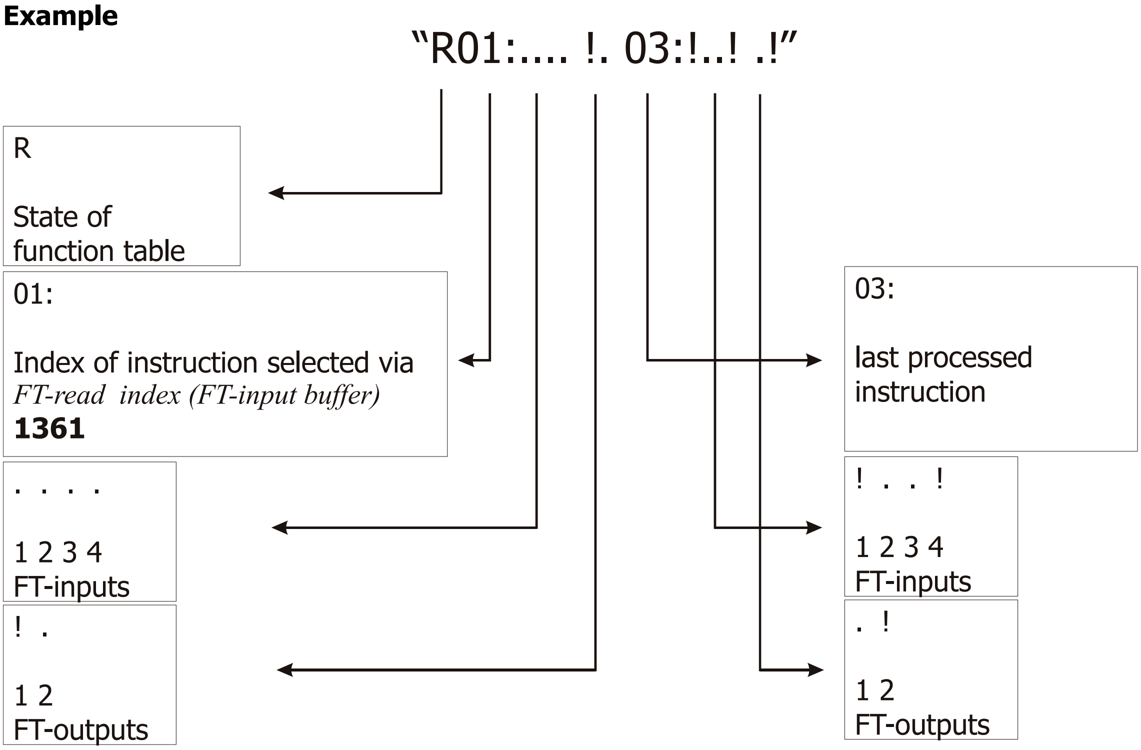
The actual values of an instruction are indicated by parameter *PLC Actual values function* **1356**. From left to right, the following is displayed:

- state of PLC or function table (e.g. started, stopped)
- Index number of selected instruction vie *PLC read index (PLC input buffer)* **1361**
- Inputs of selected instruction
- Outputs of selected instruction

- index number of last processed instruction
- Inputs of last processed instruction
- Outputs of last processed instruction

The states of the function table are:
R: Running – function table or PLC started
S: Stopped – function table or PLC stopped
U: Updating – input and output buffer are being updated
E: Empty – function table or PLC is empty
I: Initialization

Example



"." = FALSE
"!" = TRUE

Note:
For information on other actual values, refer to the operating instructions of the frequency inverter.

7.2 Actual values of analog functions

The following parameters indicate the actual values

- of the four indices of the analog input buffer.
- of the four signal sources of the analog output buffer (in the case of parameterization using the function table, the signal sources assigned to parameters *PLC target output 1* **1350** or *PLC target output 2* **1351**).

Parameters	No.
PLC actual frequency value from P.1379	**1400**
PLC actual current value from P.1380	**1401**
PLC actual percentage from P.1381	**1402**
PLC actual voltage eff. from P.1382	**1403**
PLC actual voltage sp. from P.1382	**1404**
PLC actual value general from P.1383	**1405**
PLC actual output frequency 250x	**1406**

Parameters	No.
PLC actual output current value 251x	**1407**
PLC actual output percentage 252x	**1408**
PLC actual output voltage eff. 253x	**1409**
PLC actual output voltage sp. 253x	**1410**
PLC actual output general 255x	**1411**
PLC actual value flag 256x	**1412**

Example: Actual value display, parameterization using the function table

Vtable	
Function Table Input Buffer analog	Index 2
FT-input buffer frequency **1379**	10 - Stator Frequency
Function Table	Index 1
FT-target output 1 **1350**	2504 - FT-Output Frequency 4

VPlus				
Parameter				
FT-Act. Val. Freq. from P.1379 **1400**	0.00 Hz	15.00 Hz	0.00 Hz	0.00 Hz
FT-Act. Val.Outp. Freq. 250x **1406**	0.00 Hz	0.00 Hz	0.00 Hz	5.00 Hz

The parameter names may differ from the names shown, depending on the device series. The parameter numbers are identical:

7.3 Signals for digital outputs of device

The following output signals of the can be assigned to the digital outputs of the frequency inverter.

Operation mode	Function
0 - Off	Digital output is switched off
80 - PLC output buffer 1	Digital output signal of an instruction. Signal source "2401 - PLC output buffer 1" is the output signal. This signal source contains the output value of the instruction assigned to signal source 2401.
81 - PLC output buffer 2	Digital output signal of an instruction. Signal source "2402 - PLC output buffer 2" is the output signal. This signal source contains the output value of the instruction assigned to signal source 2402.
82 - PLC output buffer 3	Digital output signal of an instruction. Signal source "2403 - PLC output buffer 3" is the output signal. This signal source contains the output value of the instruction assigned to signal source 2403.
83 - PLC output buffer 4	Digital output signal of an instruction. Signal source "2404 - PLC output buffer 4" is the output signal. This signal source contains the output value of the instruction assigned to signal source 2404.
100 to 183	Operation modes inverted (LOW active).

7.4 Signals for analog outputs of device

Via a multifunction output, the values of analog instructions can be output.
The following output signals of the function table can be assigned to the analog outputs.

Operation mode	Function
61 - Abs. value PLC outp. percent 1	Analog output signal of an instruction as an absolute value. Signal source "2521 - PLC output percent 1" is the output signal. This signal source contains the output value of the instruction assigned to signal source 2521.
62 - Abs. value PLC outp. percent 2	Analog output signal of an instruction as an absolute value. Signal source "2522 - PLC output percent 2" is the output signal. This signal source contains the output value of the instruction assigned to signal source 2522.
161 - PLC outp. percent 1	Analog output signal of an instruction. Signal source "2521 - PLC output percent 1" is the output signal. This signal source contains the output value of the instruction assigned to signal source 2521.
162 - PLC outp. percent 2	Analog output signal of an instruction. Signal source "2522 - PLC output percent 2" is the output signal. This signal source contains the output value of the instruction assigned to signal source 2522.

7.5 Signal sources for device function

Signal sources of the instructions can be assigned to the device functions for further processing. The values are updated when the output buffer is written.

Signal source
Digital
2401 … 2416 - PLC output buffer 1 … 16
Analog
2501 … 2504 - PLC outp. frequency 1 … 4
2511 … 2514 - PLC outp. current 1 … 4
2521 … 2524 - PLC outp. percent 1 … 4
2531 … 2534 - PLC outp. voltage 1 … 4
2551 … 2554 - PLC outp. user 1 … 4
2561 … 2564 - PLC flag 1 … 4

7.6 Error messages of instruction "95 - Triggering an error"

Error	Description
F3031	User error 1. In instruction "95 - Triggering of an error" shut-down behavior P1 was triggered via input I1.
F3032	User error 2. In instruction "95 - Triggering of an error" shut-down behavior P1 was triggered via input I2.
F3033	User error 3. In instruction "95 - Triggering of an error" shut-down behavior P1 was triggered via input I3.
F3034	User error 4. In instruction "95 - Triggering of an error" shut-down behavior P1 was triggered via input I4.

8 Operation as state machine

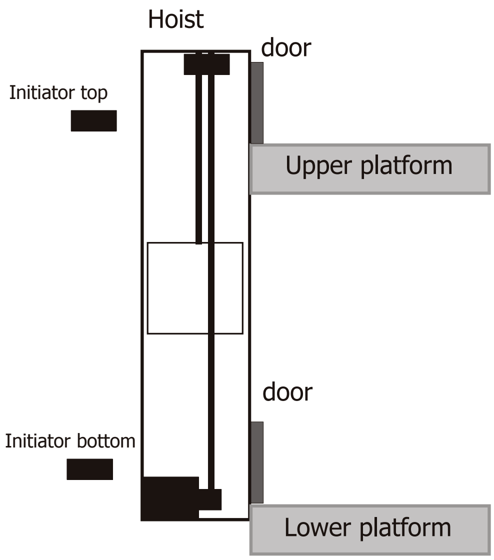
In the previous chapters, the PLC functions were introduced as a sequence of various instructions. In addition, a state machine sequence (also referred to as finite state machine) can be integrated by the specified instruction types. A state machine is often used for representing sequences schematically and for easier implementation of solutions.

In order to realize a state machine sequence, the jump functions are of particular importance. The jump functions are required for changing the state. Inputs 1 and 2 of the jump function are used for checking the condition for the transition. Inputs 3 and 4 set the input buffer and write the output buffer. In the state machine, inputs 3 and 4 are generally set to TRUE at the jump functions for this reason in order to update the changing signals for changing the state.

8.1 Example of a controller

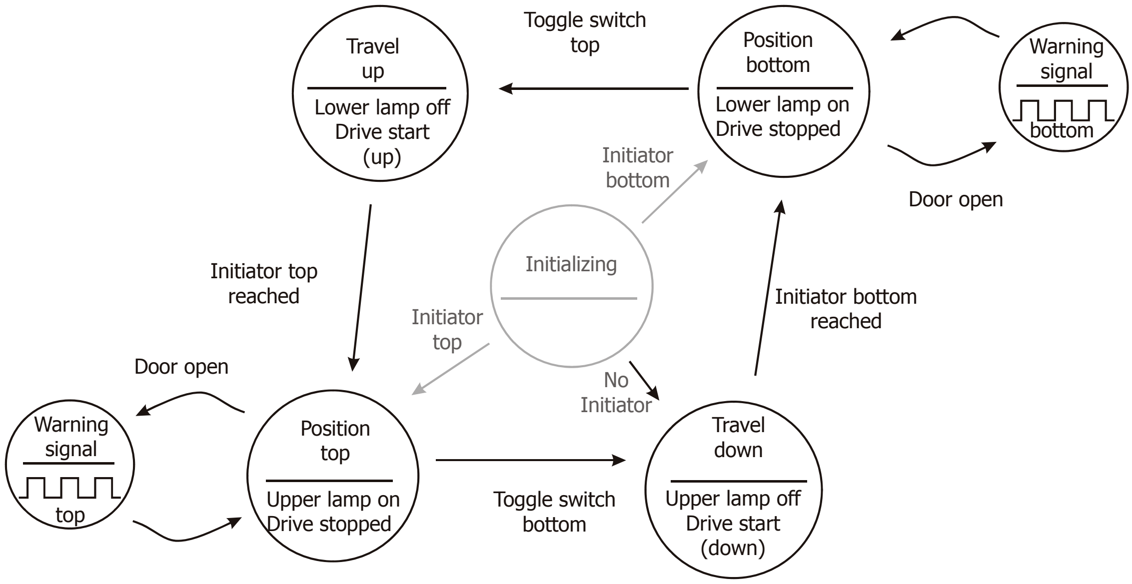
Example:
A lifting gear with two positions ("up" and "down") is to be controlled by the function table. The target position is defined via a toggle switch. Each position is equipped with an initiator which informs the frequency inverter that the target has been reached. As soon as the position is reached, the frequency inverter is to stop and the respective LED "top" or "bottom" is to be switched on. As soon as the drive starts again, the LED is turned off.

Both positions are provided with a door which can be opened manually by the user. As soon as one of the two doors is open, the warning lamp "top" or "bottom" is pulsed on and off at an interval of 100 ms. Note that the "door open" signals from the two doors are connected in series.



Representation as state machine step 1

The requirements described above are shown in the following diagram as a state machine. It must be considered that the state must be initialized first when the ACU is switched on (or in the case of a reset). In this example, initialization is performed in order to switch to the correct state. At first, the initiators are evaluated. If one of the initiators signals that the position has been reached, the corresponding state is activated. If no initiator signal is present, the lower position is approached.

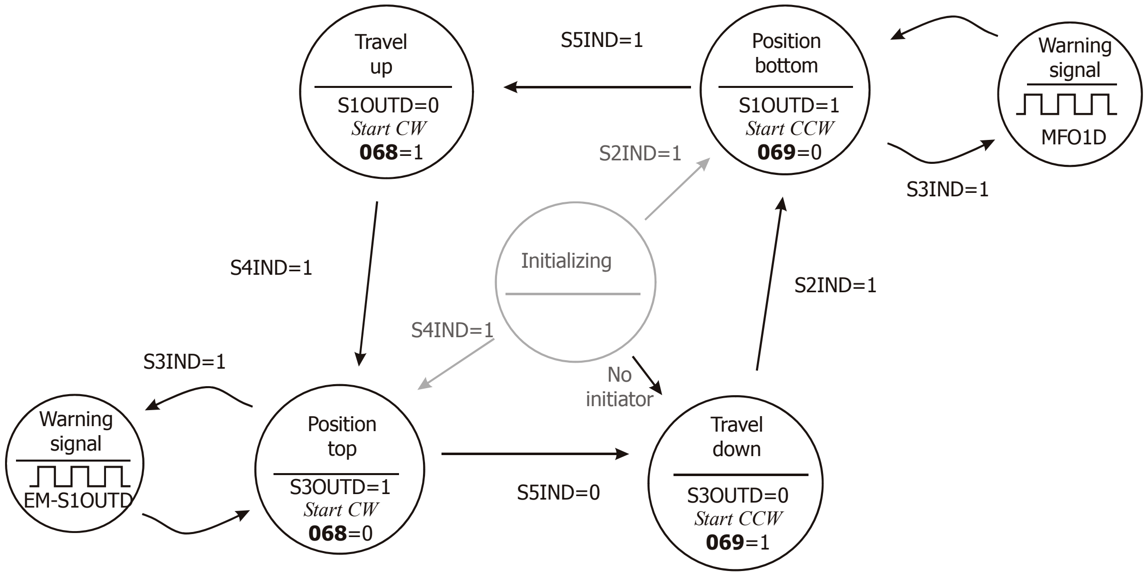


Representation as state machine step 2

The events and actions are assigned to the digital signals of the ACU. At first, the signals are linked to the input and output buffer. An EM-IO-03 extension module is available.

Function	**ACU**	**Input buffer**	**Output buffer**
toggle switch (top/bottom)	S5IND (1/0)	2005	
top position initiator (reached/not reached)	S4IND (1/0)	2004	
bottom position initiator (reached/not reached)	S2IND (1/0)	2002	
door open (open/closed)	S3IND (1/0)	2003	
bottom LED (on/off)	S1OUTD (1/0)		2401
top LED (on/off)	S3OUTD (1/0)		2402
bottom position door lamp (on/off)	MFO1D (1/0)		2403
top position door lamp (on/off)	EM-S1OUTD (1/0)		2404
start drive (up)	*Start Clockwise* **068**		2410
start drive (down)	*Start Anticlockwise* **069**		2411

With the assignment of the digital ACU signals, the following diagram is obtained:



Solution:
For assignment of the ACU signals and the input buffer of the function table, the following parameterization is required:
2002: *FT-Input Buffer* **1362**, Index 2 : "71 – S2IND"
2003: *FT-Input Buffer* **1362**, Index 3 : "72 – S3IND"
2004: *FT-Input Buffer* **1362**, Index 4 : "73 – S4IND"
2005: *FT-Input Buffer* **1362**, Index 5 : "74 – S5IND"
2006: *FT-Input Buffer* **1362**, Index 6 : "274 – S5IND inverted" (*)

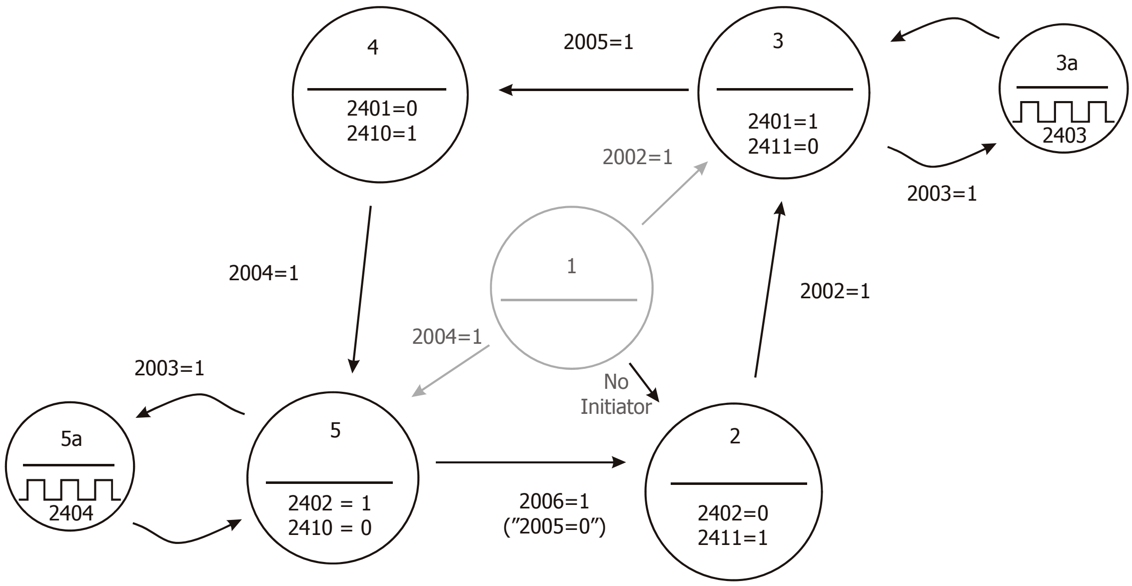
(*): Parameterization deviating from factory settings.

For assignment of the ACU signals and the output buffer of the function table, the following parameterization is required:

Operation mode digital output 1 **530**	2401 - FT-Output buffer 1
Operation mode digital output 3 **532**	2402 - FT-Output buffer 2
Op. Mode EM-S1OUTD **533**	2404 - FT-Output buffer 4
MFO1: *Operation mode* **550**	1 - Digital output
MFO1: *Digital Operation* **554**	2403 - FT-Output buffer 3
Start Clockwise **068**	2410 - FT-Output buffer 10
Start Anticlockwise **069**	2411 - FT-Output buffer 11

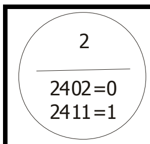
To enable easy checking of the transition "Top Position" → "Down", the inverted signal of signal S5IND in the input buffer is assigned. For easier parameterization, the names of the states used so far will be replaced by numerical values.

The following diagram is obtained for the signals of the function table:



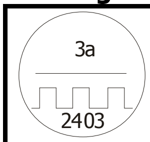
In the first step, the states and transitions are translated into instructions.

Setting state outputs:
The easiest way to set a digital signal (independent of one or several input signals) is using a Boolean operation. In this application, an OR instruction is used and an input is set to TRUE. In this way, *FT target output 1* **1350** is set to TRUE (=1) and *FT target output 2* **1351** is set to FALSE (=0).

		*FT-Instruction* **1343**	2 – OR
		FT input 1 **1344**	6 – TRUE
		FT input 2 **1345**	7 – FALSE
		FT input 3 **1346**	7 – FALSE
	→	*FT input 4* **1347**	7 – FALSE
		FT-Parameter 1 **1348**	0
		FT-Parameter 2 **1349**	0
		FT target output 1 **1350**	2411 FT-Output buffer 11
		FT target output 2 **1351**	2402 FT-Output buffer 2

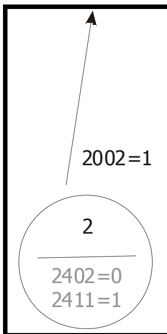
For states 3 to 5, instructions can be created in the same way.

Clock generator (state 3a)

		*FT instruction* **1343**	80 – Clock generator
		FT input 1 **1344**	2003 - Input buffer 3
		FT input 2 **1345**	7 – FALSE
		FT input 3 **1346**	7 – FALSE
		FT input 4 **1347**	7 – FALSE
	→	*FT-Parameter 1* **1348**	100
		FT-Parameter 2 **1349**	100
		FT-Target Output 1 **1350**	0
		FT-Target Output 2 **1351**	0

The clock generator of state 5a is created in the same way as 3a.

Transition from state 2 to state 3

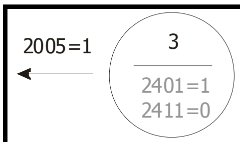


FT instruction **1343**	100 – Jump function
FT input 1 **1344**	6 – TRUE
FT input 2 **1345**	2002 - Input buffer 2
FT input 3 **1346**	6 – TRUE
→ *FT input 4* **1347**	6 – TRUE
FT-Parameter 1 **1348**	Index number$_{\text{Next state}}$
FT-Parameter 2 **1349**	Index number$_{\text{Own state}}$
FT target output 1 **1350**	0
FT target output 2 **1351**	0

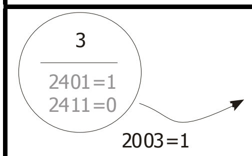
Items "Next state" and "Own state" are used as placeholders until the correct numbers of the indices can be entered. The transition from state 4 to state 5 can be performed in the same way.

Transition from state 3 to state 4

The transition from state 3 to state 4 requires a different method, as two jump events have to be checked.



FT instruction **1343**	100 – Jump function
FT input 1 **1344**	2005 - Input buffer 5
FT input 2 **1345**	6 – TRUE
FT input 3 **1346**	6 – TRUE
FT input 4 **1347**	6 – TRUE
→ *FT-Parameter 1* **1348**	next state
FT-Parameter 2 **1349**	No jump, next step
FT-Target Output 1 **1350**	0
FT-Target Output 2 **1351**	0

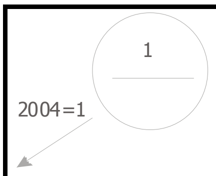


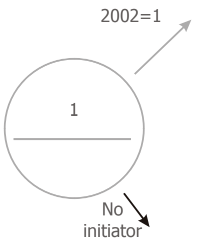
FT instruction **1343**	100 – Jump function
FT input 1 **1344**	6 – TRUE
FT input 2 **1345**	2003 - Input buffer 3
FT input 3 **1346**	6 – TRUE
FT input 4 **1347**	6 – TRUE
→ *FT-Parameter 1* **1348**	Jump target, clock generator
FT-Parameter 2 **1349**	Jump evaluation, own state
FT-Target Output 1 **1350**	0
FT-Target Output 2 **1351**	0

Items "Next state" and "Jump target, clock generator", "Jump evaluation, own state" are used as placeholders until the correct numbers of the indices can be entered. Item "No jump, next step" is a placeholder for any value. The jump function is active only if "2005 – Input buffer 2005" = TRUE is fulfilled (DI5=0). Otherwise, the next step will be executed. The transition from state 5 to state 2 can be performed again in the same way.

Initialization

Initialization is a jump function with three targets. For this reason, 2 jump functions are required. The initialization must start with index 1 because the function table always starts at index 1 after a restart.

		*FT instruction* **1343**	100 – Jump function
		FT input 1 **1344**	2004 - Input buffer 4
		FT input 2 **1345**	6 – TRUE
		FT input 3 **1346**	6 – TRUE
		FT input 4 **1347**	6 – TRUE
	→	*FT-Parameter 1* **1348**	Jump target state 5
		FT-Parameter 2 **1349**	No jump, next step
		FT-Target Output 1 **1350**	0
		FT-Target Output 2 **1351**	0

		*FT instruction* **1343**	100 – Jump function
		FT input 1 **1344**	6 – TRUE
		FT input 2 **1345**	2002 - Input buffer 2
		FT input 3 **1346**	6 – TRUE
		FT input 4 **1347**	6 – TRUE
	→	*FT-Parameter 1* **1348**	Jump target state 3
		FT-Parameter 2 **1349**	Jump target state 2
		FT-Target Output 1 **1350**	0
		FT-Target Output 2 **1351**	0

Now, all blocks are defined. These blocks are entered in the table, the placeholders are replaced by indices. The states are marked in different colors. Non-relevant items are hidden.

	Index 1	Index 2
FT instruction **1343**	100 – Jump function	100 – Jump function
FT input 1 **1344**	2004 - Input buffer 4	6 – TRUE
FT input 2 **1345**	6 – TRUE	2002 - Input buffer 2
FT input 3 **1346**	6 – TRUE	6 – TRUE
FT input 4 **1347**	6 – TRUE	6 – TRUE
FT-Parameter 1 **1348**	11	5
FT-Parameter 2 **1349**	2	3
FT-Target Output 1 **1350**	0	0
FT-Target Output 2 **1351**	0	0
FT Commentary **1352**	Init 1	Init 2

	Index 3	Index 4
FT instruction **1343**	2 – OR	100 – Jump function
FT input 1 **1344**	6 – TRUE	6 – TRUE
FT input 2 **1345**	7 – FALSE	2002 - Input buffer 2
FT input 3 **1346**	7 – FALSE	6 – TRUE
FT input 4 **1347**	7 – FALSE	6 – TRUE
FT-Parameter 1 **1348**	0	5
FT-Parameter 2 **1349**	0	4
FT-Target Output 1 **1350**	2411 FT-Output buffer 11	0
FT-Target Output 2 **1351**	2402 FT-Output buffer 2	0
FT Commentary **1352**	Z2: 2411=1	Z2 --> Z3

	Index 5	Index 6
FT instruction **1343**	2 – OR	80 – Clock generator
FT input 1 **1344**	6 – TRUE	2003 - Input buffer 3
FT input 2 **1345**	7 – FALSE	7 – FALSE
FT input 3 **1346**	7 – FALSE	7 – FALSE
FT input 4 **1347**	7 – FALSE	7 – FALSE
FT-Parameter 1 **1348**	0	100
FT-Parameter 2 **1349**	0	100
FT-Target Output 1 **1350**	2401 FT-Output buffer 1	2403 FT-Output buffer 3
FT-Target Output 2 **1351**	2411 FT-Output buffer 11	0
FT Commentary **1352**	Z3: 2401=1	Z3a: clock

	Index 7	Index 8
FT instruction **1343**	100 – Jump function	100 – Jump function
FT input 1 **1344**	2005 - Input buffer 5	6 – TRUE
FT input 2 **1345**	6 – TRUE	2003 - Input buffer 3
FT input 3 **1346**	6 – TRUE	6 – TRUE
FT input 4 **1347**	6 – TRUE	6 – TRUE
FT-Parameter 1 **1348**	9	6
FT-Parameter 2 **1349**	8	7
FT-Target Output 1 **1350**	0	0
FT-Target Output 2 **1351**	0	0
FT Commentary **1352**	Z3 --> Z4	Z3 -> Z4

	Index 9	Index 10
FT instruction **1343**	2 – OR	100 – Jump function
FT input 1 **1344**	6 – TRUE	6 – TRUE
FT input 2 **1345**	7 – FALSE	2002 - Input buffer 2
FT input 3 **1346**	7 – FALSE	6 – TRUE
FT input 4 **1347**	7 – FALSE	6 – TRUE
FT-Parameter 1 **1348**	0	11
FT-Parameter 2 **1349**	0	10
FT-Target Output 1 **1350**	2410 FT-Output buffer 10	0
FT-Target Output 2 **1351**	2401 FT-Output buffer 1	0
FT Commentary **1352**	Z4: 2410=1	Z4 --> Z5

	Index 11	Index 12
FT instruction **1343**	2 – OR	80 – Clock generator
FT input 1 **1344**	6 – TRUE	2003 - Input buffer 3
FT input 2 **1345**	7 – FALSE	7 – FALSE
FT input 3 **1346**	7 – FALSE	7 – FALSE
FT input 4 **1347**	7 – FALSE	7 – FALSE
FT-Parameter 1 **1348**	0	100
FT-Parameter 2 **1349**	0	100
FT-Target Output 1 **1350**	2401 FT-Output buffer 1	2404 FT-Output buffer 4
FT-Target Output 2 **1351**	2411 FT-Output buffer 11	0
FT Commentary **1352**	Z5: 2401=1	Z5a: clock

	Index 13	Index 14
FT instruction **1343**	100 – Jump function	100 – Jump function
FT input 1 **1344**	2006 - Input buffer 6	6 – TRUE
FT input 2 **1345**	6 – TRUE	2003 - Input buffer 3
FT input 3 **1346**	6 – TRUE	6 – TRUE
FT input 4 **1347**	6 – TRUE	6 – TRUE
FT-Parameter 1 **1348**	3	12
FT-Parameter 2 **1349**	14	13
FT-Target Output 1 **1350**	0	0
FT-Target Output 2 **1351**	0	0
FT Commentary **1352**	Z5 --> Z2	Z5 -> Z2

9 List of parameters

The parameter list is structured according to the menu branches of the control unit. The parameters are listed in ascending numerical order. A headline (shaded) can appear several times, i.e. a subject area may be listed at different places in the table. For better clarity, the parameters have been marked with pictograms:

The parameter is available in the four data sets.

The parameter value is set by the SETUP routine.

This parameter cannot be written when the frequency inverter is in operation.

This parameter can only be written in setting *FT-Runmode* **1399** = "0 - Stop".

I_{FUN}, U_{FUN}, P_{FUN}: Nominal values of frequency inverter, ü: Overload capacity of frequency inverter

Note:
In the KP500 control unit, parameter numbers > 999 are represented in hexadecimal form (999, A00 … B54 … C66 …).

9.1 Actual values

Table of functions				
No.	**Description**	**Unit**	**Display range**	**Chapter**
1356	PLC actual values function	-	X01:.... .. 01:... ..to X32:!!!! !! 32:!!!! !!	7.1
1357	PLC actual values output buffer	-	.... to !!!! !!!! !!!! !!!!	7.1
1358	PLC Actual values input buffer	-	.... to !!!! !!!! !!!! !!!!	7.1
1400	PLC actual frequency value from P.1379	Hz	0.00 … 999.99	7.2
1401	PLC actual current value from P.1380	A	0.0 … I_{max}	7.2
1402	PLC actual percentage from P.1381	%	-200 … 200	7.2
1403	PLC actual voltage eff. from P.1382	V	0.0 … U_{FUN}	7.2
1404	PLC actual voltage sp. from P.1382	V	0.0 … U_{FUN}	7.2
1405	PLC actual value general from P.1383	-	-32767 … 32767	7.2
1406	PLC actual output frequency 250x	Hz	-999.99 … 999.99	7.2
1407	PLC actual output current value 251x	A	$-I_{max}$ … I_{max}	7.2
1408	PLC actual output percentage 252x	%	-200 … 200	7.2
1409	PLC actual output voltage eff. 253x	V	0.0 … U_{FUN}	7.2
1410	PLC actual output voltage sp. 253x	V	0.0 … U_{FUN}	7.2
1411	PLC actual output general 255x	-	-32767 … 32767	7.2
1412	PLC actual value flag 256x	%	-327.67 … 327.67	7.2

9.2 Parameters of function table

The following parameters are needed only for parameterization using the function table.

No.	Description	Unit	Setting range	Factory setting	Chapter
PLC functions					
1341	PLC write index (PLC table item)	-	0 ... 65	1	6.1.1
1342	PLC read index (PLC table item)	-	0 ... 65	1	6.1.1
1343	PLC instruction	-	Selection	0 - Off (last table item)	6.3
1344	PLC input 1	-	Selection	7 – FALSE	6.3
1345	PLC input 2	-	Selection	7 – FALSE	6.3
1346	PLC input 3	-	Selection	7 – FALSE	6.3
1347	PLC input 4	-	Selection	7 – FALSE	6.3
1348	PLC parameter 1	Depending on instruction	0 ... 65535	10	4.2, 5.1
1349	PLC parameter 2		0 ... 65535	10	4.2, 5.1
1350	SPS target output 1	-	Selection	0 - Output not usable globally	6.3
1351	SPS target output 2	-	Selection	0 - Output not usable globally	6.3
1352	PLC commentary	-	16 characters	-	6.3
PLC functions input buffer					
1360	PLC write index (PLC table item)	-	0 ... 33	1	6.1.2
1361	PLC read index (PLC input buffer)	-	0 ... 33	1	6.1.2
1362	PLC input buffer	-	Selection	7 - Off	6.1.2
PLC functions input buffer analog					
1377	PLC write index (PLC input analog)	-	0 ... 9	1	6.1.3
1378	PLC read index (PLC input analog)	-	0 ... 9	1	6.1.3
1379	PLC input buffer frequency	-	Selection	9 - zero	6.1.3
1380	PLC input buffer current	-	Selection	9 - zero	6.1.3
1381	PLC input buffer percent	-	Selection	9 - zero	6.1.3
1382	PLC input buffer voltage	-	Selection	9 - zero	6.1.3
1383	SPS input buffer general source	-	0 ... 2147483647	9	6.1.3
1384	Numerator general source input 1383	%	-327.68 ... 327.67	100.00	6.1.3
1385	Denominator general source input 1383	%	0.01 ... 327.67	100.00	6.1.3
1386	Numerator general source output 2551	%	-327.68 ... 327.67	100.00	6.1.3
1387	Denominator general source output 2551	%	0.01 ... 327.67	100.00	6.1.3
1388	PLC fixed frequency value	Hz	-999.99 ... 999.99	50.00	6.1.3

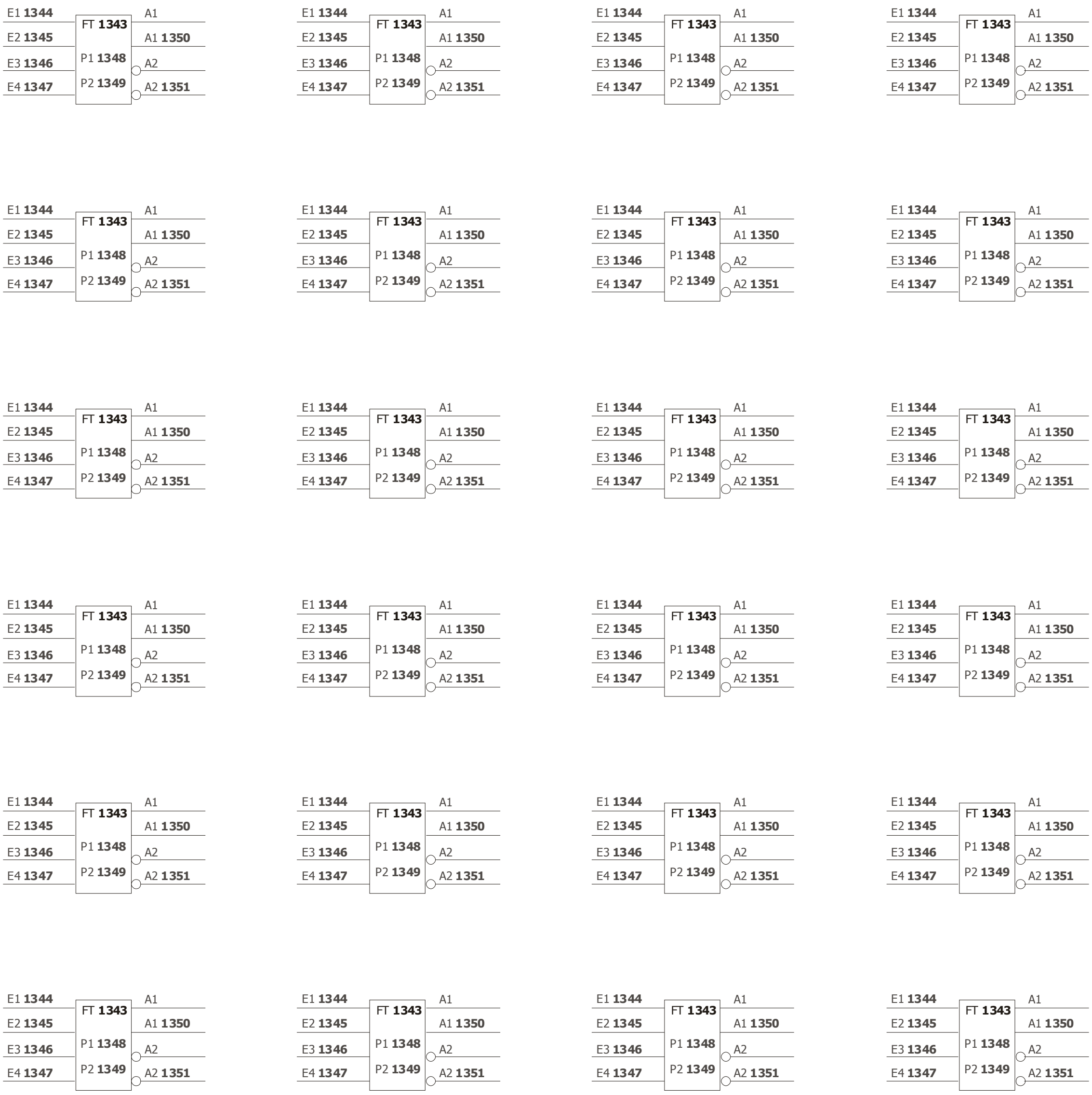
PLC functions					
No.	**Description**	**Unit**	**Setting range**	**Factory setting**	**Chap-ter**
1389	PLC fixed current value[1]	A	$-I_{max}$ … I_{max}	I_{Rated}	6.1.3
1390	PLC fixed percent value	%	-327.67 … 327.67	100.00	6.1.3
1391	PLC fixed voltage value	V	-1000.0 … 1000.0	565.7	6.1.3
1392	PLC fixed position value	units	-2 147 483 647 … 2 147 483 647	65 536	6.1.3
1393	PLC fixed speed value tab.pos.	u/s	-2 147 483 647 … 2 147 483 647	163 840	6.1.3
1394	PLC fixed ramp value tab.pos.	u/s^2	1 … 2 147 483 647	327 680	6.1.3
1395	PLC fixed general value	-	-32767 … 32767	0	6.1.3
1396	Numerator fixed general value 1395	%	-327.68 … 327.67	100	6.1.3
1397	Denominator fixed general value 1395	%	0.01 … 327.67	100	6.1.3
PLC functions					
1399	PLC RunMode	-	Selection	0 - Stop	6.2

[1] Setting range and factory settings depend on device type

10 Annex

10.1 Mask: Diagram for digital instructions of function table

FT-Eingangspuffer **1362**	Index 1	Index 2	Index 3	Index 4	Index 5	Index 6	Index 7	Index 8	Index 9	Index 10	Index 11	Index 12	Index 13	Index 14	Index 15	Index 16
Quelle:	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Werkseinstellung:	70 - FU-Freigabe	71 - S2IND	72 - S3IND	73 - S4IND	74 - S5IND	75 - S6IND	76 - MFI1D	7 - Aus	7 - Aus	7 - Aus	160 - Bereitmeldung	161 - Laufmeldung	162 - Stoermeldung	163 - Frequenzsollwert erreicht	7 - Aus	7 - Aus
Geänderte Einstellung:																



FT-Ausgangspuffer	Index 1	Index 2	Index 3	Index 4	Index 5	Index 6	Index 7	Index 8	Index 9	Index 10	Index 11	Index 12	Index 13	Index 14	Index 15	Index 16
Quelle:	2401	2402	2403	2404	2405	2406	2407	2408	2409	2410	2411	2412	2413	2414	2415	2416
Digitaler Ausgang:																

10.2 Mask: Functions settings

		1	2	3	4	5	6	7	8
FT-Instruction	1343								
FT-Input 1	1344								
FT-Input 2	1345								
FT-Input 3	1346								
FT-Input 4	1347								
FT-Parameter 1	1348								
FT-Parameter 2	1349								
FT-target output 1	1350								
FT-target output 2	1351								
FT-Commentary	1352								

		9	10	11	12	13	14	15	16
FT-Instruction	1343								
FT-Input 1	1344								
FT-Input 2	1345								
FT-Input 3	1346								
FT-Input 4	1347								
FT-Parameter 1	1348								
FT-Parameter 2	1349								
FT-target output 1	1350								
FT-target output 2	1351								
FT-Commentary	1352								

		17	18	19	20	21	22	23	24
FT-Instruction	1343								
FT-Input 1	1344								
FT-Input 2	1345								
FT-Input 3	1346								
FT-Input 4	1347								
FT-Parameter 1	1348								
FT-Parameter 2	1349								
FT-target output 1	1350								
FT-target output 2	1351								
FT-Commentary	1352								

		25	26	27	28	29	30	31	32
FT-Instruction	1343								
FT-Input 1	1344								
FT-Input 2	1345								
FT-Input 3	1346								
FT-Input 4	1347								
FT-Parameter 1	1348								
FT-Parameter 2	1349								
FT-target output 1	1350								
FT-target output 2	1351								
FT-Commentary	1352								

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