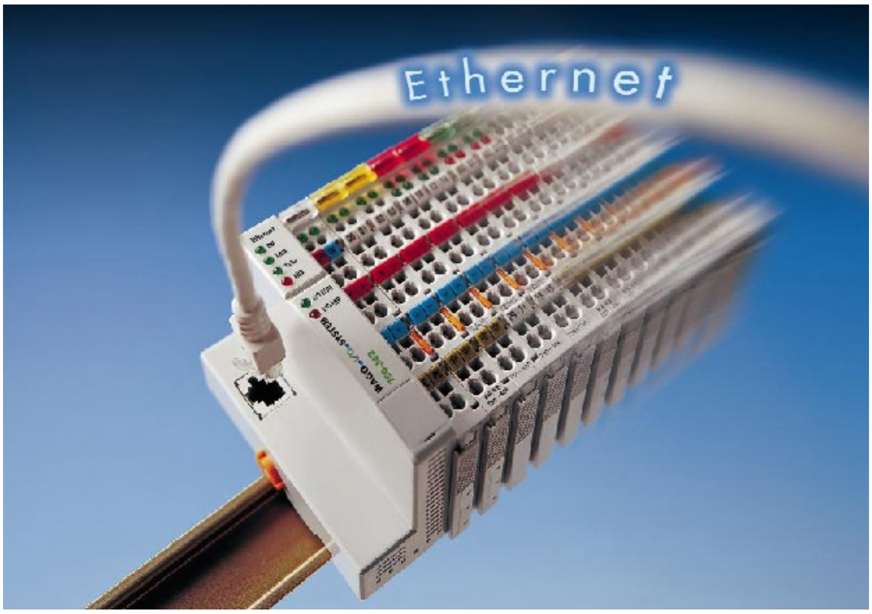
WAGO-I/O-SYSTEM 750

Modular I/O System

ETHERNET TCP/IP

750-342, 750-842



Manual

Technical description,
installation and
configuration

750-129/000-002
Version 2.0.0

WAGO
INNOVATIVE CONNECTIONS

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Every conceivable measure has been taken to ensure the correctness and completeness of this documentation. However, as errors can never be fully excluded we would appreciate any information or ideas at any time.

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1 Important comments

To ensure fast installation and start-up of the units described in this manual, we strongly recommend that the following information and explanation is carefully read and adhered to.

1.1 Legal principles

1.1.1 Copyright

This manual is copyrighted, together with all figures and illustrations contained therein. Any use of this manual which infringes the copyright provisions stipulated herein, is not permitted. Reproduction, translation and electronic and photo-technical archiving and amendments require the written consent of WAGO Kontakttechnik GmbH. Non-observance will entail the right of claims for damages.

1.1.2 Personnel qualification

The use of the product detailed in this manual is exclusively geared to specialists having qualifications in PLC programming, electrical specialists or persons instructed by electrical specialists who are also familiar with the valid standards. WAGO Kontakttechnik GmbH declines all liability resulting from improper action and damage to WAGO products and third party products due to non-observance of the information contained in this manual.

1.1.3 Intended use

For each individual application, the components supplied are to work with a dedicated hardware and software configuration. Modifications are only admitted within the framework of the possibilities documented in the manuals. All other changes to the hardware and/or software and the non-conforming use of the components entail the exclusion of liability on part of WAGO Kontakttechnik GmbH.

Please direct any requirements pertaining to a modified and/or new hardware or software configuration directly to WAGO Kontakttechnik GmbH.

1.2 Scope

This manual describes the field bus independent WAGO-I/O-SYSTEM 750 with the fieldbus coupler for ETHERNET TCP/IP along with the programmable fieldbus controller for ETHERNET TCP/IP.

Item-No.	Components
750-342	EtherNet TCP/IP 10 Mbit
750-842	Contr. EtherNet TCP/IP TCP 10 Mbit
750-4xx...6xx	I/O Modules

1.3 Symbols

Danger
Always observe this information to protect persons from injury.

Warning
Always observe this information to prevent damage to the device.

Attention
Marginal conditions must always be observed to ensure smooth operation.

ESD (Electrostatic Discharge)
Warning of damage to the components by electrostatic discharge. Observe the precautionary measure for handling components at risk.

Note
Routines or advice for efficient use of the device and software optimization.

More information
References to additional literature, manuals, data sheets and INTERNET pages.

1.4 Font conventions

Italic	Names of paths and files are marked in italic. i. e.: *C:\programs\WAGO-I/O-CHECK*
Italic	Menu items are marked in bold italic. i. e.: ***Save***
\	A backslash between two names markes a sequence of menu items. i. e.: ***File\New***
END	Keys to press are marked in bold with small capitals. i. e.: **ENTER**
< >	Keys are marked bold within angle brackets. i. e.: **<F5>**
`Courier`	Program codes are printed with the font `Courier`. i. e.: `END_VAR`

1.5 Number notation

Number code	Example	Code
Decimal	100	normal notation
Hexadecimal	0x64	C notation
Binary	'100' '0110.0100'	Within ', Nibble separated with dots

1.6 Abbreviation

AI	Analog Input
AO	Analog Output
DI	Digital Input
DO	Digital Output
I/O	Input/Output
ID	Identifier
PFC	Programmable Fieldbus Controller

2 The WAGO-I/O-SYSTEM 750

2.1 System Description

2.1.1 General

The WAGO-I/O-SYSTEM consists of various components which are capable of providing modular and application specific fieldbus nodes for various field-busses.

A fieldbus node (short: Node) consists in principle of a fieldbus coupler (short: Coupler) or a programmable fielbus controller (short: Controller) at the front end (1), a number of I/O modules (2) and an end module (3) which is placed at the other end.

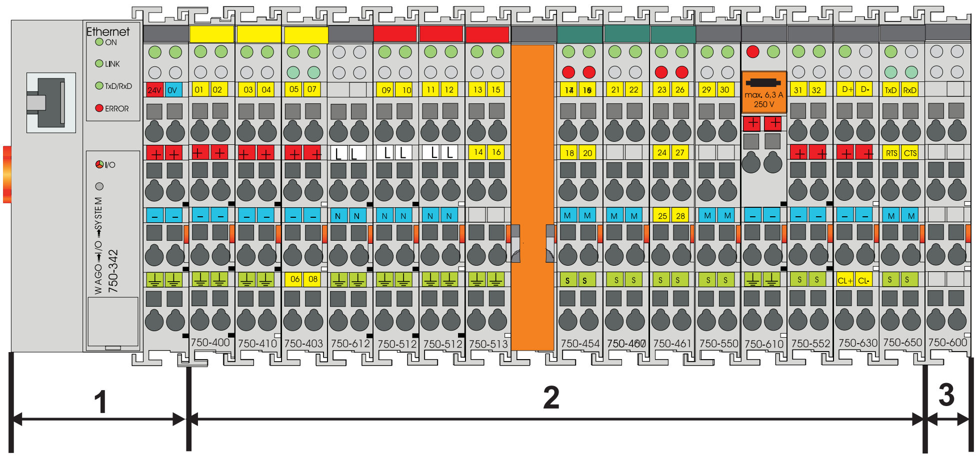


Fig. 2-1: Setting up a fieldbus node with the WAGO-I/O-SYSTEM g012900x

2.1.2 Coupler/Controller (1)

The Coupler/Controller forms the link between the fieldbus and the field devices with their I/O functions. All control functions required for the faultless operation of the I/O functions are carried out by the Coupler/Controller. The connection to different fieldbus systems is established by each of the corresponding Coupler/Controller, e.g. for PROFIBUS, INTERBUS, CAN, MODBUS etc. In this way a change of the fieldbus system is possible.

The programmable fieldbus controller 750-842 combines the ETHERNET TCP/IP functionality of the fieldbus coupler 750-342 with the functionality of a Programmable Logic Control (PLC). Programming of the application is done with WAGO-I/O-PRO in accordance with IEC 61131-3, covering all 5 programming languages. The programmer can access all fieldbus and I/O data.

Characteristics and use of the Controllers:

- The use of decentralized control can better support a PLC or PC
- Complex applications can be divided into multiple tasks
- Programmable response in the event of a fieldbus failure
- Signal pre-processing reduces fieldbus transmissions
- Peripheral equipment can be controlled directly, resulting in faster system response times
- Simple, self-sufficient control

2.1.3 I/O Modules (2)

In the I/O modules, the incoming process data is converted. Corresponding to the different requirements, special I/O modules are available for a variety of functions. There are digital and analog inputs and outputs and modules for special functions (Counter modules, Terminal blocks for encoder and resolvers and communication modules).

2.1.4 End Module (3)

An End Module is needed for faultless operation of the node. The termination module is always placed as the last module in order to obtain a termination of the fieldbus node. This module has no I/O function.

2.2 Installation

2.2.1 Safty notes

ESD (Electrostatic Discharge)
The modules are equipped with electronic components which may be destroyed by electrostatic discharge.When handling the modules, ensure that the environment (persons, workplace and packing) is well grounded. Avoid touching conductive components, e.g. gold contacts**.**

Attention
Switch off the system prior to working on bus modules!

2.2.2 Mechanical Installation

All system components can be snapped directly on a carrier rail in accordance with the European standard EN 50022 (DIN 35).

Attention
Ensure that the carrier rail is fastened with countersunk head screws or blind rivets as the snap-on foot of the I/O components extends onto the carrier rail.

The installation is simple and space saving. All modules have the same shape to minimize the project commitment.

The reliable positioning and connection of the coupler and the individual I/O modules is made using a tongue and groove system. Due to the automatic locking, the individual components are securely seated on the rail after installing.

To secure the coupler/controller against moving sideways, lock it with the orange colored locking disc on the carrier rail. To lock, insert a screwdriver into the top groove of the locking disc and press.

To pull out the fieldbus coupler, release the locking disc by pressing on the bottom groove with a screwdriver and then pull the orange colored unlocking lug.

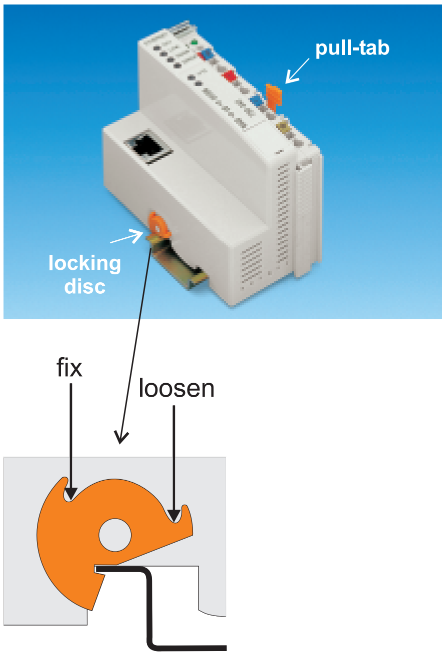


Fig. 2-2: Coupler/Controller and unlocking lug G012912d

It is also possible to release an individual I/O module from the unit by pulling the unlocking lug.

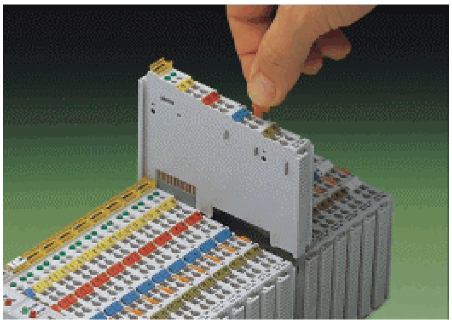


Fig. 2-3: Releasing a I/O Module p0xxx01x

Danger
Ensure that an interruption of the ground will not result in a condition which could endanger a person or equipment!

Self-cleaning power jumper contacts conduct the supply voltage for the field side. They are located on either side of the modules. The female contacts on the right-hand side of the fieldbus coupler and the bus modules are designed as spring contacts to protect against accidental contact. Male contacts are located on the left-hand side of the bus modules.

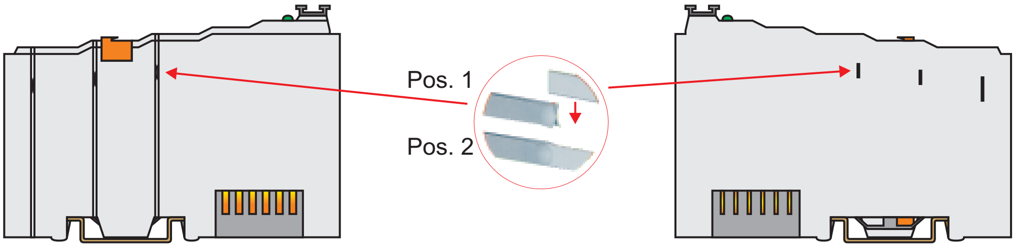


Fig. 2-4: Power Jumper Contacts g01xx00d

Danger
The power contacts have sharp-edges. Handle the module carefully to prevent injury.

Attention
Please take into consideration that some bus modules have no or only some power jumper contacts. The design of some modules does not physically allow for assembling them in rows as the grooves for the male contacts are closed at the top.

The data contacts are designed as self-cleaning gold spring contacts which automatically produce a secure connection.

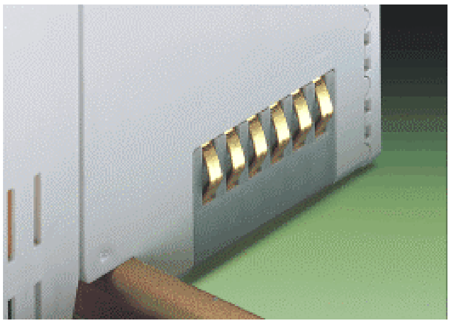


Fig. 2-5: Data contacts p0xxx07x

Warning
Do not connect the I/O module to gold spring contacts in order to avoid tarnishing or scratching!

2.3 Electrical Installation

2.3.1 Wire Connection

Conductors with a cross section of 0.08 to 2.5 mm² (AWG 28-12) can be connected using a CAGE CLAMP® connection to achieve a vibration resistant, fast and maintenance free connection. To actuate CAGE CLAMP® enter an actuation tool in the opening above the connection. Following this, enter the conductor in the corresponding opening. The conductor is clamped securely with the removal of the actuation tool.

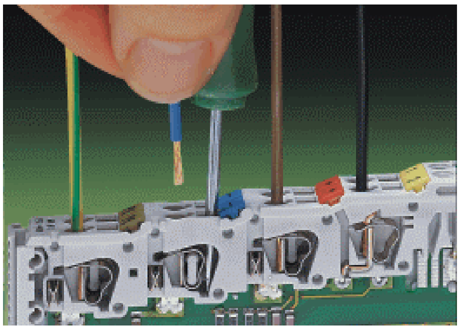


Fig. 2-6: Inserting conductor end p0xxx06x

The clamping force adjusts automatically to the cross section. The full surface of the CAGE CLAMP® pressure is applied against the conductor without damaging it. Conductor deformation is compensated for and self-loosening is avoided. The transition point between the conductor and the CAGE CLAMP® is protected against corrosive influences. The connection can be made quickly and is also maintenance free, saving the costs for a periodic checking of terminal connections.

Two carrier rail contacts responsible for the electrical contact between the grounded carrier rail and the controller are fitted underneath the coupler/controller.

Attention
Ensure a perfect contact point between carrier rail contacts and carrier rail. The carrier rail must be grounded.

2.3.2 Change fuse

Some Power supply modules of the WAGO-I/O-SYSTEM 750 are equipped with a fuse holder. To isolate the modules to the right of the power supply, the fuse can be removed from the fuse holder. For this insert a screw driver into one of the slits available on each side and lift the holder.

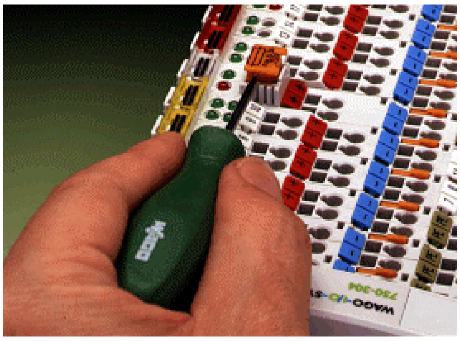


Fig. 2-7: Removing the fuse holder p0xxx05x

The fuses can be removed from or inserted into the fuse holder cover. Then push the fuse holder back into the original position.

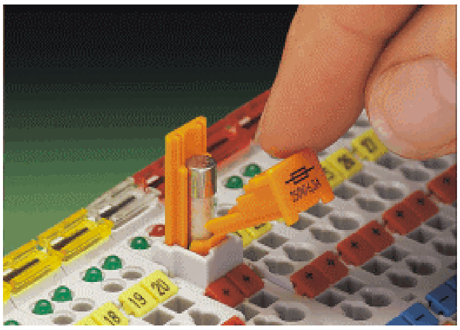


Fig. 2-8: Opening the fuse holder p0xxx03x

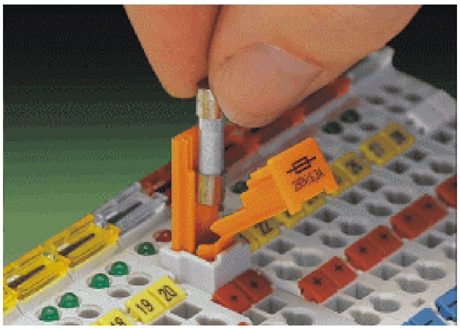


Fig. 2-9: Change fuse p0xxx04x

2.4 Power supply

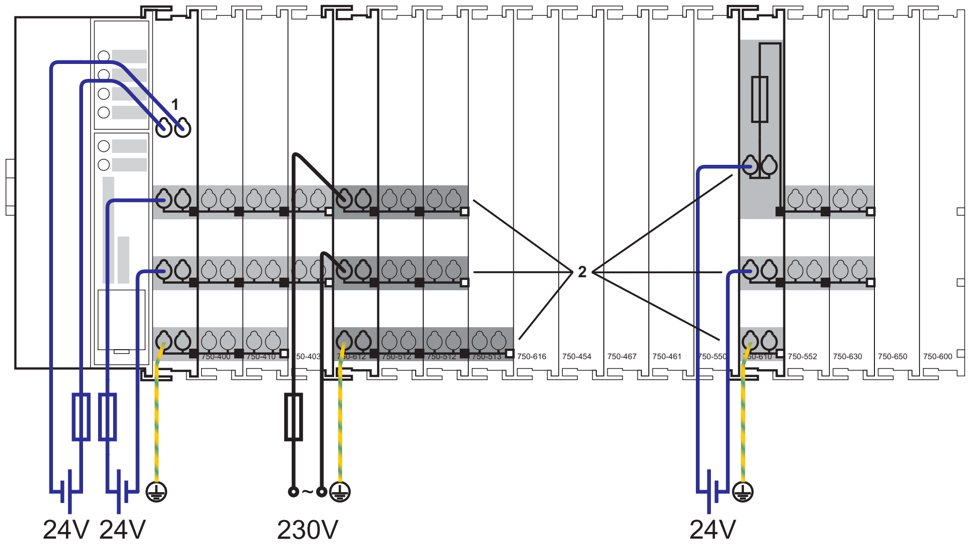


Fig. 2-10: Power supply g01xx02x

1 – Power supply System
2 – Power supply Field-side

The power supply on the field side is electrically isolated from the system supply. In this manner sensors and actuators can be supplied and fused by a separate voltage source.

If a non-regulated power supply is used for the coupler/controller electronics 24 V voltage supply, it must be filtered through a capacitor (200 µF per 1 A load current). A back-up capacitor module (Order-No. 288-824) was developed for the WAGO-I/O-SYSTEM. This module serves to regulate a noisy 24 V DC voltage supply and to keep the ripple voltage within specified limits. These fluctuations could be caused by a voltage interruption on the primary side, a secondary side overload or the switching of ”non quenched“ inductance or capacitance.

Warning
The supply module’s + and –, which are permanently integrated on the buscouplers, must be supplied with 24 V DC only.
120 V AC and 230 V AC can only be supplied via modules 750-609, 750-611 and 750-612!

Warning
The ground (earth) field side contact should be disconnected when testing the isolation. Otherwise the results could be wrong or the module could be destroyed.

2.4.1 System supply voltage

The system supply voltage (24 V DC) is filtered with a voltage regulator before powering the coupler electronics as well as to the internal bus. Electrical isolation from the external fieldbus system depends on the type of Coupler/Controller.

The internal bus includes the internal communication between the coupler/controller and the bus modules as well as the power supply for the bus modules. The power supply is limited to a maximum value. This value depends on the type of Coupler/Controller. If the sum of the internal power consumption of all bus modules exceeds this value, it is necessary to add additional internal system supply modules (Order-No. 750-613).

The control electronics in the bus modules are powered by snap-fit mounting the bus modules using the internal bus contacts. A reliable contact is assured by the gold plated, self cleaning slide contacts. The removal of a bus module will cause an interruption in communication to the following bus modules. The coupler/controller identifies the interruption point and displays a corresponding fault message.

Warning
Removing or inserting the I/O modules with the voltage applied can lead to undefined conditions. For this reason only remove the I/O modules when isolated from the power supply!

2.4.2 Supply Voltage Field Side

The voltage is automatically supplied when the I/O modules are snapped together. Self-cleaning power jumper contacts (P.J.C.s) ensure safe connections. The current capacity of the power contacts is 10 A max.

The PE contact is a preceding ground (earth) contact corresponding to the standards which can be used as a protective earth. The contact has a leakage capacity of 125 A.

Warning
Produce a low impedance connection from the carrier rail to the PE contact point in the cabinet.

Attention
Depending on the I/O function, some modules do not have P.J.C.s. It is important to note this when assembling a node. Many modules require field side power, many do not. Please review the circuit diagrams of the individual modules. An additional power supply module may be necessary.
Refer to the individual terminal/module data sheets!

When adding a power supply module, the field supply is always interrupted at the power contacts. From this point a new power supply is made, which can also include a potential change. This feature guarantees a high degree of system flexibility.

2.5 Manufacturing Number

The production number is part of the lateral marking on the component. The number contains the production date, the software version and the hardware of the component.

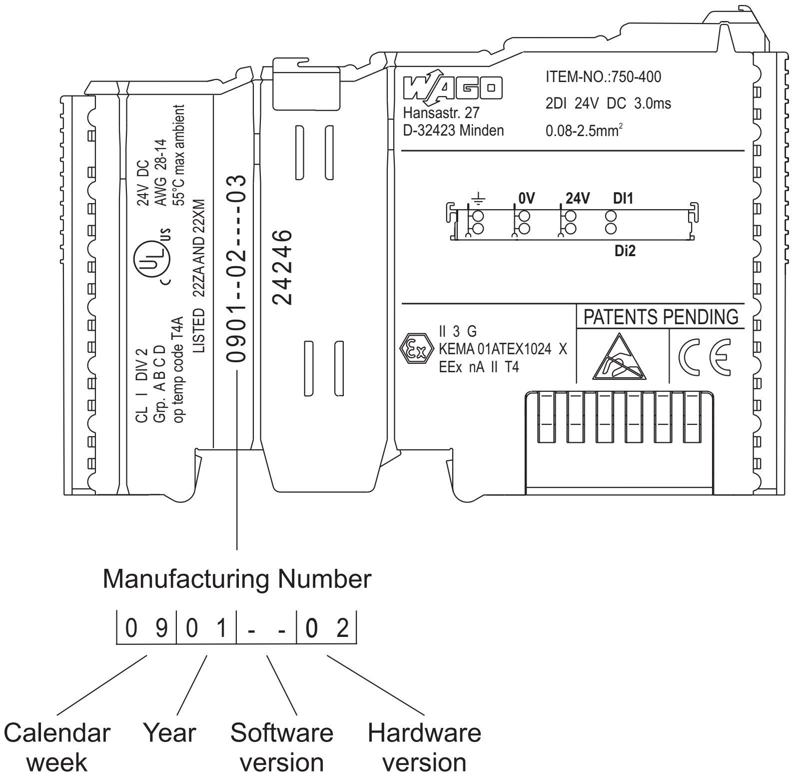


Fig. 2-11: Manufacturing Number g01xx09e

The remaining digits and characters represent internal information for WAGO Kontakttechnik GmbH.

As of calendar week 43/2000, the production number is also printed on the cover of the configuration and programming interface of the fieldbus coupler or controller.

2.6 Technical Data

Mechanic	
Material	Polycarbonate, Polyamide 6.6
Installation	on DIN 35 with interlock
modular by	double featherkey-dovetail
Mounting position	any position
Length of entire node	≤ 831 mm
Marking	marking label type 247 and 248 paper marking label 8 x 47 mm
Wire range	
Wire range	CAGE CLAMP® Connection 0,08 mm² ... 2,5 mm² AWG 28-14 8 – 9 mm Stripped length
Contacts	
Power jumpers contacts	blade/spring contact self-cleaning
Current via power contacts$_{max}$	10 A
Voltage drop at I_{max}	< 1 V/64 modules
Data contacts	slide contact, hard gold plated 1,5µ, self-cleaning
Environmental conditions	
Operating temperature	0 °C ... 55 °C
Storage temperature	-20 °C ... +85 °C
Relative humidity	95 % without condensation
Resistance to harmful substances	acc. to IEC 60068-2-42 and IEC 60068-2-43
Special conditions	Ensure that additional measures for components are taken, which are used in an environment involving: – dust, caustic vapors or gases – ionizing radiation.
Mechanical strenght	
Vibration resistance	acc. to IEC 60068-2-6
Shock resistance	acc. to IEC 60068-2-27
Free fall	acc. to IEC 60068-2-32 ≤ 1m (module in original packing)

Safe electrical isolation			
Air and creepage distance	acc. to IEC 60646-1		
Degree of protection			
Degree of protection	IP 20		
Electromagnetic compatibility*			
Directive	**Test values**	**Strength class**	**Evaluation criteria**
Immunity to interference acc. to EN 50082-2 (95)			
EN 61000-4-2	4kV/8kV	(2/4)	B
EN 61000-4-3	10V/m 80% AM	(3)	A
EN 61000-4-4	2kV	(3/4)	B
EN 61000-4-6	10V/m 80% AM	(3)	A
Emmission to interference acc. to EN 50081-2 (94)		**Measuring distance**	**Class**
EN 55011	30 dBµV/m	(30m)	A
	37 dBµV/m		

* Exception: 750-630, 750-631

Dimensions

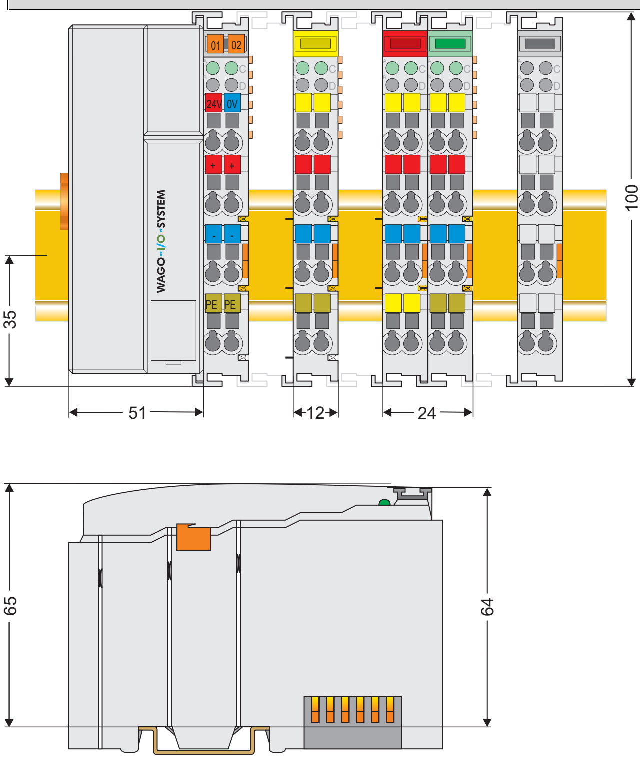


Fig. 2-12: Dimensions g01xx05d

3 Fieldbus coupler / controller

3.1 Fieldbus coupler 750-342

This chapter includes:

3.1.1 Description

The fieldbus coupler 750-342 displays the peripheral data of all I/O modules in the WAGO-I/O-SYSTEM 750 on ETHERNET.

All sensor input signals are grouped in the coupler (slave) and transferred to the higher ranking controls (master) via the fieldbus. Process data linking is performed in the higher ranking controls. The controls put out the resulting data to the actuators via the bus and the node.

To be able to transmit process data via ETHERNET, the coupler supports a series of network protocols. Process data are exchanged with the aid of the MODBUS/TCP protocol.

Once the ETHERNET TCP/IP fieldbus coupler is connected, the coupler detects all I/O modules connected to the node and creates a local process image on this basis, which can be a mixed arrangement of analog (word-by-word data exchange) and digital (bit-by-bit data exchange) modules.

The local process image is subdivided into an input and an output data area.

The data of the analog modules are mapped into the process image in the order of their position downstream of the bus coupler.

The bits of the digital modules are grouped into words and also mapped into the process image as soon as mapping of the analog modules is completed. When the number of digital I/O's exceeds 16 bits, the coupler automatically starts the next word.

Also note that all process images start at WORD 0.

Information on configuration, status and the I/O data of the fieldbus node are stored in the fieldbus coupler as HTML pages. These pages can be seen via a standard WEB browser by typing the IP address, that you assigned the coupler, into the Address field of your web browser.

3.1.2 Hardware

3.1.2.1 View

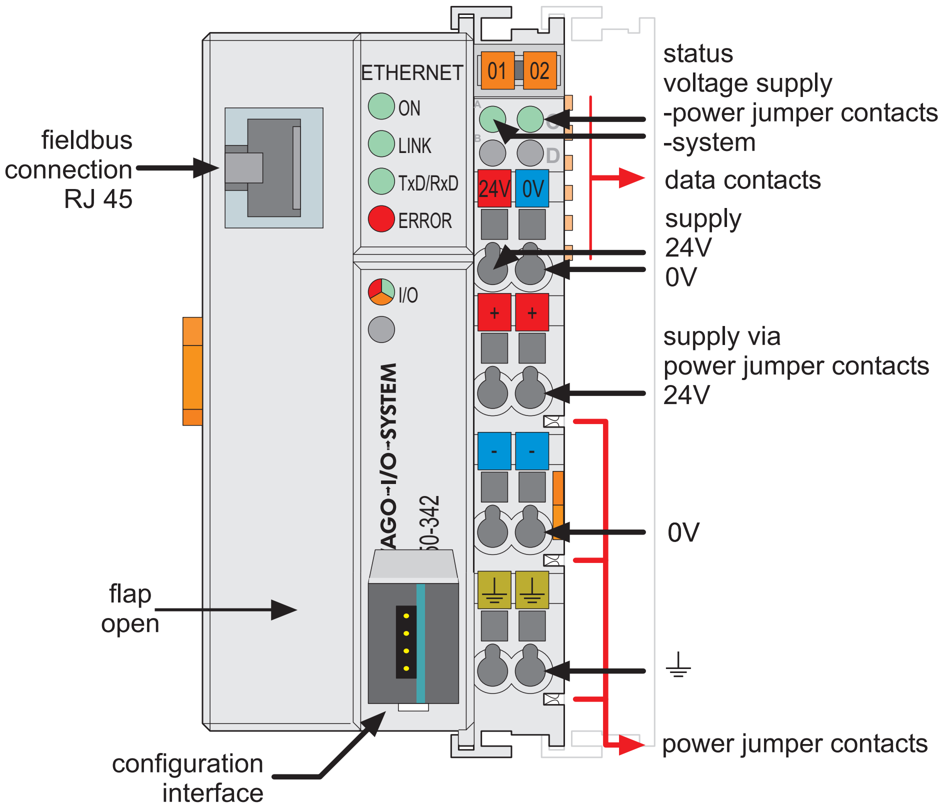


Fig. 3-1: Fieldbus coupler ETHERNET TCP/IP G034200e

The fieldbus coupler is comprised of:

- Supply module which includes the internal system supply as well as power jumper contacts for the field supply via I/O module assemblies.
- Fieldbus interface with the bus connection RJ 45
- Display elements (LED's) for status display of the operation, the bus communication, the operating voltages as well as for fault messages and diagnosis
- Configuration Interface
- Electronics for communication with the I/O modules (internal bus) and the fieldbus interface

3.1.2.2 Device supply

The supply is made via terminal bocks with CAGE CLAMP® connection. The device supply is intended both for the system and the field units.

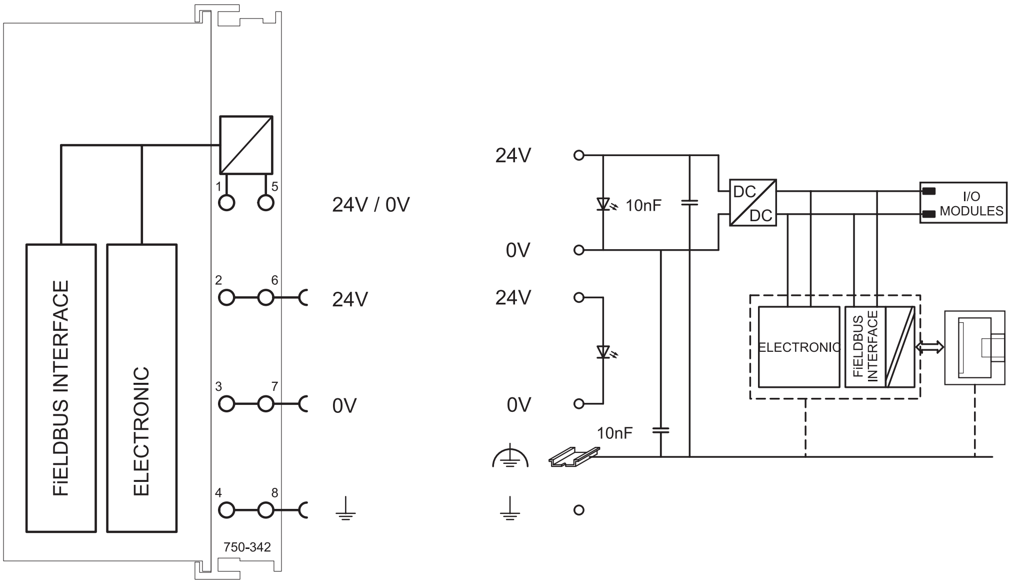
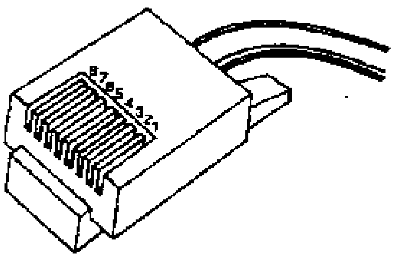


Fig. 3-2: Device supply G034201e

The integrated internal system supply module generates the necessary voltage to supply the electronics and the connected I/O modules.
The fieldbus interface is supplied with electrically isolated voltage from the internal system supply module.

3.1.2.3 Fieldbus connection

Connection to the fieldbus is by an RJ45 connector. A category 5, shielded/unshielded twisted pair cable (S-UTP) with an impedance of 100 Ohm ±15% is mandatory as a connecting line for the 10BaseT Interface.
The connection point is physically lowered for the coupler/controller to fit in an 80 mm high switch box once connected.
The electrical isolation between the fieldbus system and the electronics is achieved by means of DC/DC converters and optocouplers in the fieldbus interface.



Contact	Signal	
1	TD +	Transmit +
2	TD -	Transmit -
3	RD +	Receive +
4		free
5		free
6	RD -	Receive -
7		free
8		free

Fig. 3-3: RJ45-connector and RJ45 connector configuration

3.1.2.4 Display elements

The operating condition of the fieldbus coupler or node is signaled via light diodes (LED).

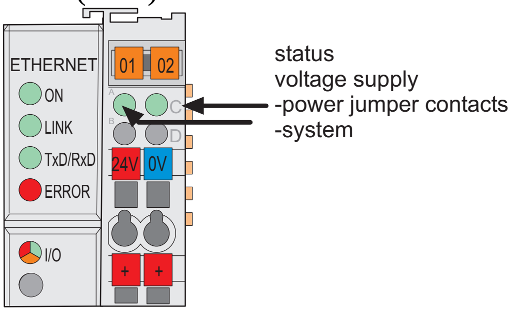


Fig. 3-4: Display elements 750-342 G012901e

LED	Color	Meaning
ON	green	Fieldbus initialization is correct
LINK	green	Link to a physical network exists
TxD/RxD	green	Data exchange taking place
ERROR	red	Error on the fieldbus
IO	red /green / orange	The 'I/O'-LED indicates the operation of the node and signals faults encountered
A	green	Status of the operating voltage – system
C	green	Status of the operating voltage – power jumper contacts

3.1.2.5 Configuration interface

The configuration interface used for the communication with WAGO-I/O-CHECK or for firmware download is located behind the cover flap.

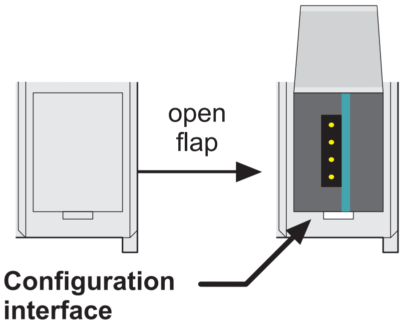


Fig. 3-5: Configuration interface g012945e

The communication cable (750-920) is connected to the 4 pole header.

3.1.2.6 Hardware address (MAC-ID)

Each WAGO ETHERNET fieldbus coupler is provided from the factory with a unique and internationally unambiguous physical ETHERNET address, also referred to as MAC-ID (Media Access Control Identity). This address is to be found on the rear of the coupler and on an adhesive tear-off label on the side of the coupler. The address has a fixed length of 6 Bytes (48 Bit) and contains the address type, the manufacturer's ID, and the serial number.

3.1.3 Operating system

Following is the configuration of the master activation and the electrical installation of the fieldbus station to start up the system.

After switching on the supply voltage, the coupler determines the I/O modules and the present configuration.

In the event of a fault, the coupler changes to the "Stop" condition. The "I/O" LED flashes red. After a fault free start up, the coupler changes to the "Fieldbus start" status and the "I/O" LED lights up green.

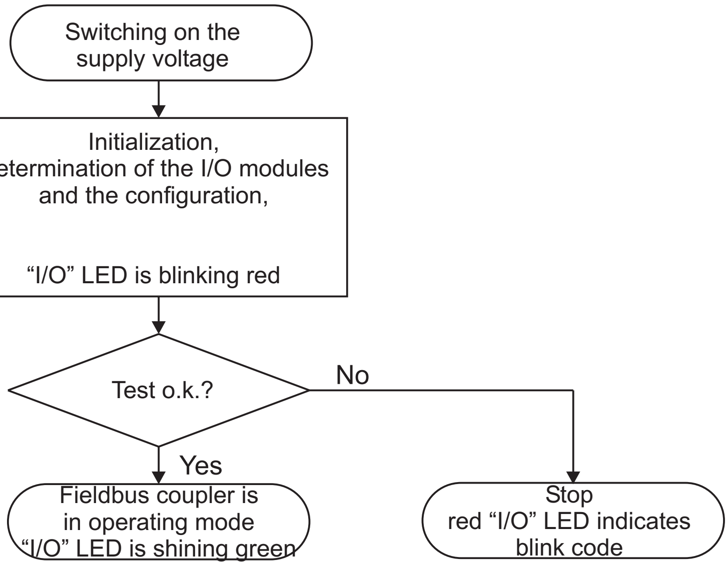


Fig. 3-6: Operating system 750-342 g012920e

3.1.4 Process image

After switching on, the coupler recognizes all I/O modules plugged into the node which supply or wait for data (data width/bit width > 0). Analog and digital I/O modules can be mixed on the same node.

Note
For the number of input and output bits or bytes of the individually activated I/O modules, please refer to the corresponding I/O module description.

The coupler produces an internal process image from the data width and the type of I/O module as well as the position of the I/O modules in the node. It is divided into an input and an output data area.

The data of the digital I/O modules is bit orientated, i.e. the data exchange is made bit for bit. The analog I/O modules are representative for all byte orientated I/O modules, i.e. those where the data exchange is made byte for byte. These I/O modules include for example the counter modules, I/O modules for angle and path measurement as well as the communication modules.

The data of the I/O modules is separate from the local input and output process image in the sequence of their position after the coupler in the individual process image.
First, all the byte oriented bus modules and then the bit oriented bus modules are stored in the process image. The bits of the digital modules are grouped to form bytes. As soon as the number of digital I/O's exceeds 8 bits, the coupler automatically starts the next byte.

Note
A process image restructuring may result if a node is changed. In this case the process data addresses also change in comparison with earlier ones. In the event of adding modules, take the process data of all previous modules into account.

The coupler provides a storage area of 256 words each (word 0 - 255) for the physical input and output data.

3.1.4.1 Example of a process input image

The following figure is an example of a process input image.
The configuration comprises of 16 digital and 8 analog inputs.
The process image thus has a data length of 8 words for the analog and 1 word for the digital inputs, i.e. 9 words in total.

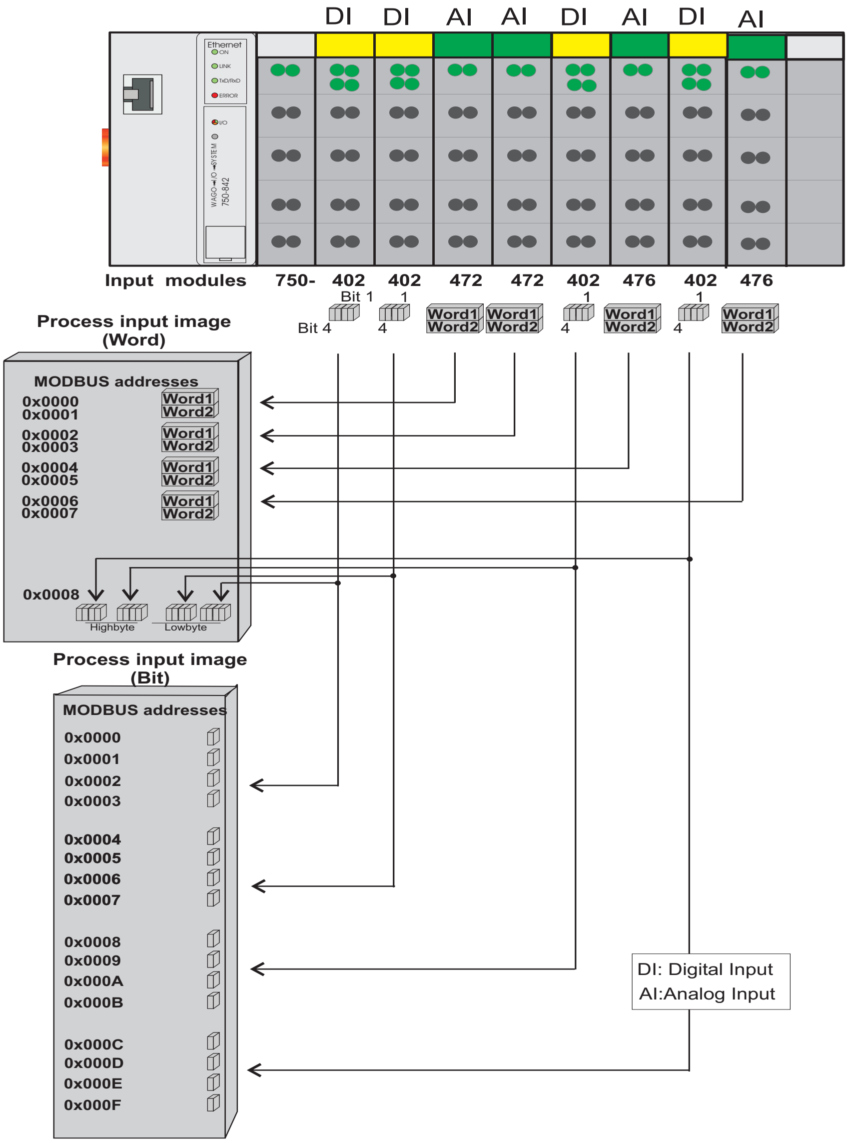


Fig. 3-7: Example of a process input image G012914e

3.1.4.2 Example of a process output image

The following example for the process output image comprises of 2 digital and 4 analog outputs.
It comprises of 4 words for the analog and 1 word for the digital outputs, , i.e. 5 words in total.

In addition, the output data can be read back by means of an offset of 200hex (0x0200) added to the MODBUS address.

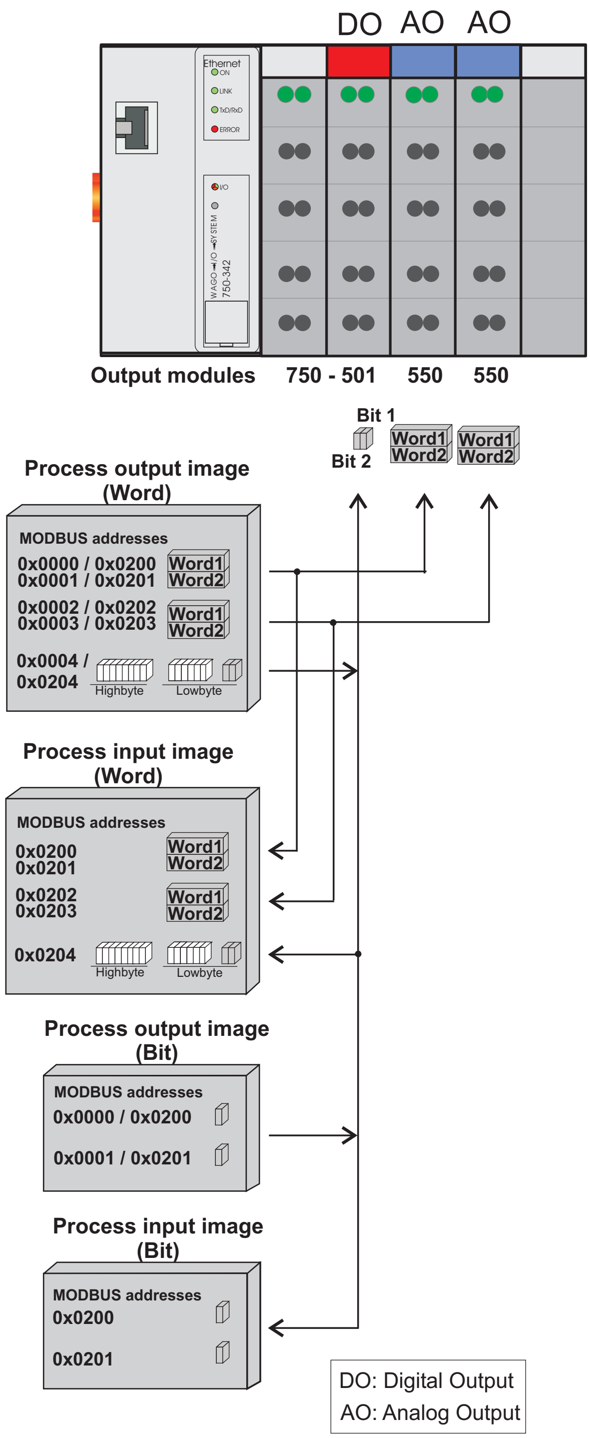


Fig. 3-8: Example of a process output image G012915e

3.1.4.3 Process data architecture for MODBUS/TCP

For some bus modules or their variations the process data architecture is specific for the fieldbus coupler used.

In the case of the ETHERNET coupler with MODBUS/TCP, the control/status byte is always masked in addition to the data bytes. This is required for the two-directional data exchange of the bus module with the higher-ranking control system. The control byte is transmitted from the control system to the module and the status byte from the module to the control system. This allows, for example, the display of overshooting or undershooting of the area.

Attention
Please refer to the respective bus module description in Chapter 4 "I/O modules" for the specific architecture of the control/status byte.

The following shows the representation of some selected modules in the process image.

In the examples, the order in which the modules are physically arranged in the node reflects the order in the image table starting with register address 0x0000. If the module is at any other position in the fieldbus node, the process data of all previous byte-wise oriented modules has to be taken into account, resulting in a basic register address for the module in the process image. The mentioned offset will be added to this basic address for addressing its process data words.

If an analog input or output module is added, it takes up 2 x 16 Bit input of output data. Therefore the first available digital point would be at word 2 keeping in mind that all process image addressing starts at WORD 0.

With the ETHERNET fieldbus coupler with MODBUS/TCP TCP, the process image is word aligned (word-alignment) and the control/status byte is always a low byte.

3.1.4.3.1 750-404, /000-00X Counter modules

This process data architecture holds true for the counter modules 750-404, 750-404/000-001, 750-404/000-002 and 750–404/000-004.

Item-No.:	Description:
750-404	Up/Down Counter
750-404/000-001	2 Channel Up Counter with enable input
750-404/000-002	Peak Time Counter
750-404/000-004	Up/Down Counter (switching outputs)

The data format of the counter modules five bytes is mapped out by the module as four data bytes and one additional control/status byte. The module supplies a 32 bit counter-output. Three words each in the process image are occupied with word-alignment.

Address	Bytes		Comment	Module
Offset	High	Low		
0		C/S	Control-/ Status byte	Module 1: **750-404,** **750-404/000-001,** **750-404/000-002,** **750-404/000-004**
1	D1	D0	Data bytes	
2	D3	D2		
3	User data	User data	Data bytes	Module 2: Analog module Channel 1
4	User data	User data	Data bytes	Module 2: Analog module Channel 2
...	...	...	...	...

The input bytes D0 to D3 form the 32 bit counter-output.
In the output bytes D0 to D3, the initial value of the counter can be set.

3.1.4.3.2 750-404/000-005 2 Channel Up Counter 16 Bit

The data format of the counter modules five bytes is mapped out by the module as four data bytes and one additional control/status byte. Three words each in the process image are occupied with word-alignment .

Address	Bytes		Comment	Module
Offset	High	Low		
0		C/S	Control/ Statusbyte	Module 1: **750-404/000-005**
1	D1	D0	Data bytes Counter 1	
2	D3	D2	Data bytes Counter 2	
3	User data	User data	Data bytes	Module 2: Analog module Channel 1
4	User data	User data	Data bytes	Module 2: Analog module Channel 2
...	...	...	...	...

The input bytes D0 and D1 form the 16 bit reading of counter 1 and the input bytes D2 and D3 form the 16 bit reading of counter 2.
When setting the counter, the load value of counter 1 is transferred in the output bytes D0 and D1. The load value of counter 2 is transferred respectively in the output bytes D2 and D3.

3.1.4.3.3 750-511, /000-002 2-Channel Digital Pulsewidth module

This process data architecture holds true for the 2 Channel Pulsewidth modules 750-511 and 750–511/000-002.

Item-No.:	**Description:**
750-511	2DO 24V DC 0.1A Pulsewidth
750-511/000-002	2DO 24V DC 0.1A Pulsewidth 100Hz

The process image of the 750-511 and 750-511/000-002 appears with 6 bytes of input and 6 bytes of output data. Four words in the process image are occupied with word-alignment .

Address Offset	**Bytes High**	**Bytes Low**	**Comment**	**Module**
0		C/S-0	Control / Status byte	Module 1 Channel 1: **750-511, 750-511/000-002**
1	D1-0	D0-0	Data bytes	
2		C/S-1	Control / Status byte	Module 1 Channel 2: **750-511, 750-511/000-002**
3	D1-1	D0-1	Data bytes	
4	User data	User data	Data bytes	Module 2: Analog Module Channel 1
5	User data	User data	Data bytes	Module 2: Analog Module Channel 2
...	...	...	...	...

3.1.4.3.4 750-630, /000-00X SSI encoder interface 24 Bit

This process data architecture holds true for the SSI encoder interface modules 750-630, 750-630/000-001 and 750–630/000-006.

Item-No.:	**Description:**
750-630	SSI encoder interface 24Bit, 125kHz Gray code, alternative Data format
750-630/000-001	SSI encoder interface 24Bit, 125kHz Binary code, alternative Data format
750-630/000-006	SSI encoder interface 24Bit, 250kHz Gray code, alternative Data format

The module is seen like an analog input with 2 x 16 Bit input data, i.e. with a total of 4 bytes user data. With word-alignment 2 words are used in the input area of the local process image.

Address	**Bytes**		**Comment**	**Module**
Offset	**High**	**Low**		
0	D1	D0	Data bytes	Module 1: **750-630,** **750-630/000-001,** **750-630/000-006**
1	D3	D2		
2	User data	User data	Data bytes	Module 2: Analog module Channel 1
3	User data	User data	Data bytes	Module 2: Analog module Channel 2
...	...	...	...	...

3.1.4.3.5 750-631, /000-001 Incremental Encoder Interface

This process data architecture holds true for the Incremental Encoder Interface modules 750-631 and 750–631/000-001.

Item-No.:	**Description:**
750-631	Incremental encoder interface, 4 times sampling
750-631/000-001	Incremental encoder interface, 1 times sampling

The bus module 750-631 and 750-631/000-001 002 appears with 6 bytes of input and 6 bytes of output data and occupying 4 words each with word-alignment.

Address	**Bytes**		**Comment**	**Module**
Offset	**High**	**Low**		
0		C/S	Control / Status byte	Module 1: **750-631,** **750-631/000-001**
1	D1	D0	ead/set counter word	
3		(D2)*)	(period)	
4	D4	D3	read latch word	
5	User data	User data	Data bytes	Module 2: Analog module Channel 1
6	User data	User data	Data bytes	Module 2: Analog module Channel 2
...	...	...	...	...

In the low byte, the control/status byte is on offset 0.
The data word D0/D1 contains the counter word (read/set), whereas the data word D3/D4 contains the latch word (read).
*) In the operating mode of permanent period measurement, the period duration is in D2 together with D3/D4.

3.1.4.3.6 750-650 RS232 Interface module, 750-651 TTY-,20 mA Current Loop, 750-653 RS485 Interface module

This process data architecture holds true for the modules 750-650, 750-651 and 750–653.

Item-No.:	Description:
750-650	RS 232 C Interface 9600,n,8,1
750-651	TTY Interface, 20 mA Current Loop
750-653	RS485 Interface

The modules appear on the bus as a combined analog input and output module with 3 x 16-bit input and output data, i.e. with a total of 4 bytes user data, occupying 2 words each with word-alignment.

Address Offset	Bytes High	Low	Comment		Module
0	D0	C/S	Data byte	Control / Status byte	Module 1: **750-650, 750-651, 750-653**
1	D2	D1	Data bytes		
2	User data	User data	Data bytes		Module 2: Analog module Channel 1
3	User data	User data	Data bytes		Module 2: Analog module Channel 2
...	...	...	...		...

3.1.4.3.7 750-650/000-001 RS232 Interface module 5 Byte

The RS232 interface module 750-650 can also be operated with a data format of 5 bytes and one Control/Status byte, i.e. a total of 6 bytes user data. For this data format, order the variation with the part number 750-650/000-001, occupying 3 words each with word-alignment in the input and output area of the process image.

Address Offset	Bytes High	Low	Comment		Module
0	D0	C/S	Data byte	Control / Status byte	Module 1: **750-650/000-001**
1	D2	D1	Data bytes		
2	D4	D3			
3	User data	User data	Data bytes		Module 2: Analog module Channel 1
4	User data	User data	Data bytes		Module 2: Analog module Channel 2
...	...	...	...		...

3.1.5 Data exchange

Process data exchange with the ETHERNET TCP/IP fieldbus coupler occurs via the MODBUS/TCP protocol.

MODBUS/TCP works according to the master/slave principle. The master is a superimposed control unit, i.e. a PC or a PLC device. The ETHERNET TCP/IP couplers of the **WAGO-I/O-SYSTEM** are slave devices.

The master makes a query for communication. Through adressing, this query can be sent to a specific node. The nodes receive the query and return a response to the master, depending on the kind of query.

A coupler can communicate with a certain number of simultaneous connections (socket connections) to other network subscribers:

- 1 connection for HTTP (reading HTML pages from coupler) and
- 3 connections via MODBUS/TCP (reading or writing input and output data from coupler).

The maximum number of simultaneous connections cannot be exceeded. If further connections are to be made, terminate existing connections beforehand.

For a data exchange, the ETHERNET TCP/IP fieldbus coupler is equipped with two interfaces:

- the interface to fieldbus (-master) and
- the interface to the bus modules.

Data exchange takes place between MODBUS master and the bus modules. The master accesses the bus module data via implemented MODBUS functions.

3.1.5.1 Memory areas

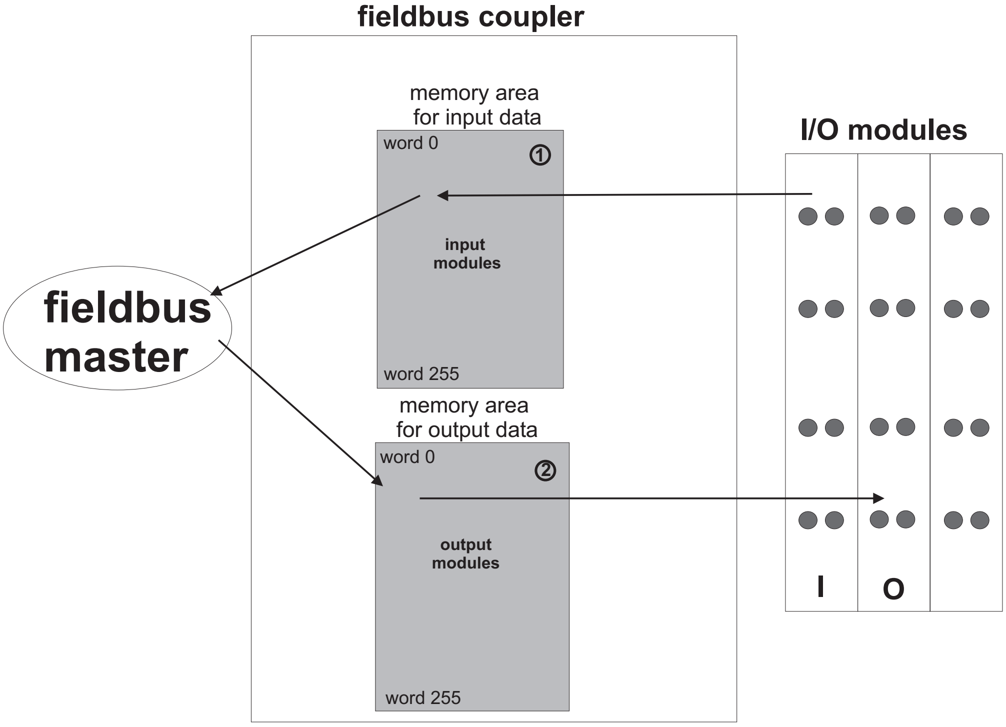


Fig. 3-9: Memory areas and data exchange for a fieldbus coupler g012939e

The coupler process image contains the physical data of the bus modules in a storage area for input data and in a storage area for output data (word 0 ... 255 each).

(1) The input module data can be read from the fieldbus side.

(2) In the same manner, writing on the output modules is possible from the fieldbus side.

In addition, all output data of the ETHERNET TCP/IP coupler are mirror imaged on a storage area with the address offset 0x0200. This allows to read output values back by adding 0x0200 to the MODBUS address.

3.1.5.2 Addressing

3.1.5.2.1 Addressing the I/O modules

The arrangement of the I/O modules in a node is optional.

When addressing, first of all the more complex modules (modules occupying 1 or more bytes) are taken into account in accordance with their physical order behind the fieldbus coupler. As such, they occupy the addresses starting with word 0.
Following this, the data of the other modules (modules occupying less than 1 byte) follow, grouped into bytes. In accordance with the physical byte-wise order this data is used to fill up the bytes. As soon as a full byte is occupied by the bit-oriented modules, the next byte is automatically started.

Note
For the number of input and output bits and/or bytes of the individual activated bus modules, please refer to the pertaining descriptions of the bus modules.

Note
Once a node is modified, a new architecture of the process image can result. As such, the address of the process data will alsochange. In the event of adding modules, the process data of all previous modules has to be taken into account.

Data width ≥ 1 Word / channel	Data width = 1 Bit / channel
Analog input modules	Digital input modules
Analog output modules	Digital output modules
Input modules for thermal elements	Digital output modules with diagnosis (2 Bit / channel)
Input modules for resistance sensors	Power supply modules with fuse holder / diagnosis
Pulse width output modules	Solid State power relay
Interface module	Relay output modules
Up/down counter	
I/O modules for angle and path measurement	

Table 3.1: I/O module data width

3.1.5.2.2 Address range

Address range for I/O module data:

Datawidth	Address								
Bit	0.0 ...	0.8... 0.15	1.0 ... 1.7	1.8... 1.15	.....	254.0 ... 254.7	254.8... 254.15	255.0 ... 255.7	255.8... 255.15
Byte	0	1	2	3	.....	508	509	510	511
Word	**0**		**1**		**.....**	**254**		**255**	

Table 3.2: Address range for the I/O module data

The register functions are to be found as from 0x1000 and can be addressed along with the implemented MODBUS function codes (read/write).

3.1.5.3 Data exchange between MODBUS master and I/O modules

The data exchange between the MODBUS master and the I/O modules is made by the implemented MODBUS functions in the coupler with reading and writing in bits or bytes.

The controller handles four different types of process data:

- Input words
- Output words
- Input bits
- Output bits

The word for word access to the digital input and output modules is made in accordance with the following table:

Digital inputs/ outputs	16.	15.	14.	13.	12.	11.	10.	9.	8.	7.	6.	5.	4.	3.	2.	1.
Process data word	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Table 3.3: Allocation of digital inputs/outputs to process data word acc. Intel format

The outputs can be read back by adding 0x0200 to the MODBUS address.

The register functions made available in the coupler, can be addressed by the MODBUS master along with the implemented MODBUS function codes (read/write). To this effect, the individual register address is entered in place of the address of a module channel.

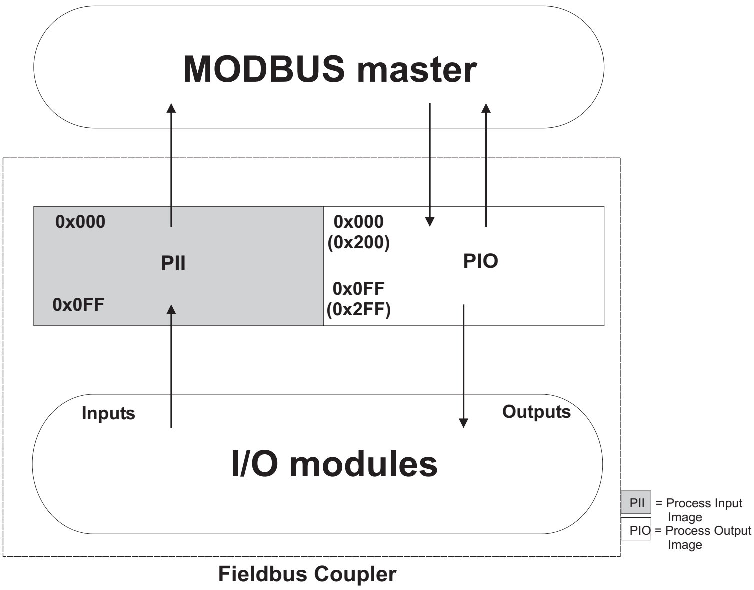


Fig. 3-10: Data exchange between the MODBUS master and I/O modules g012927e

3.1.6 Starting up ETHERNET TCP/IP fieldbus nodes

This chapter shows the step-by-step procedure for starting up a WAGO ETHERNET TCP/IP fieldbus node. The following also contains a description of how to read out the coupler-internal HTML pages.

Attention
This description is given as an example and is limited to the execution of a local startup of an individual ETHERNET fieldbus node with a computer running under windows which is not connected to a network.
Direct Internet connection should only be performed by an authorized network administrator and is, therefore, not described in this manual.

The procedure contains the following steps:

1. Noting the MAC-ID and establishing the fieldbus node
2. Connecting the PC and fieldbus node
3. Determining the IP address
4. Allocation of the IP address to the fieldbus node
5. Function of the fieldbus tests
6. Reading out information as HTML pages

3.1.6.1 Note the MAC-ID and establish the fieldbus node

Before establishing your fieldbus node, please note the hardware address (MAC-ID) of your ETHERNET fieldbus coupler.
This is located on the rear of the fieldbus coupler and on the self-adhesive tear-off label on the side of the fieldbus coupler.

MAC-ID of the fieldbus coupler will be in this format:

----- ----- ----- ----- ----- -----.

3.1.6.2 Connecting PC and fieldbus node

Connect the assembled ETHERNET TCP/IP fieldbus node via a hub or directly to the PC using a 10Base-T cable.

Attention
For a direct connection, a crossover cable is required instead of a parallel cable.

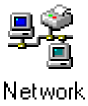
Now start the PC, functioning as master and BootP server, and switch on the voltage supply on the fieldbus coupler (DC 24 V power pack). Once the operating voltage has been switched on, the initialization starts. The fieldbus coupler determines the configuration of the bus modules and creates the process image.

During the startup the 'I/O' LED (Red) flashes at high frequency.
When the 'I/O' LED and the 'ON' LED light up green, the fieldbus coupler is ready for operation.
If an error has occurred during startup, it is indicated as an error code by the 'I/O'-LED flashing (red).

3.1.6.3 Determining IP addresses

If your PC is already connected to an ETHERNET network, it is very easy to determine the IP address of your PC. To do this, proceed as follows:

1. Go to the **Start menu** on your screen, menu item **Settings** and click on **Control Panel.**

2. Double click the icon **Network**. 

   The network dialog window will open.

3. - Under Windows NT: Select the register: **Protocols** and mark the entry *TCP/IP protocol.*
   - Under Windows 9x*:* Select the register: **Configuration** and mark the entry *TCP/IP network card*.

Attention
If the entry is missing, please install the respective TCP/IP component and restart your PC. The Windows-NT installation CD, or the installations CD for Windows 9x is required for the installation.

4. Subsequently, click the button "Properties...".
   The IP address and the subnet mask are found in the 'IP address' tab.If applicable, the gateway address of your PC is found in the 'Gateway' tab.

5. Please write down the values:

   IP address PC: ----- . ----- . ----- . -----

   Subnet mask: ----- . ----- . ----- . -----

   Gateway: ----- . ----- . ----- . -----

6. Now select a desired IP address for your fieldbus node.

Attention
When selecting your IP address, ensure that it is in the same local network in which your PC is located.

7. Please note the IP address you have chosen:
   IP address fieldbus node: ----- . ----- . ----- . -----

3.1.6.4 Allocating the IP address to the fieldbus node

The following describes how to allocate the IP address for the fieldbus node using the WAGO BootP server by way of an example. You can download a free copy from WAGO over the Internet under:
http://www.wago.com/wagoweb/usa/eng/support/downloads/index.htm.

Note
The IP address can be allocated under other operating systems (i.e. under Linux) as well as with any other BootP servers.

Attention
The IP address can be allocated in a direct connection via a crossover cable or via a parallel cable and a hub. An allocation over a switch is not possible.

BootP table

Note
Prerequisite for the following steps is the correct installation of the WAGO BootP server.

1. Go to the **Start menu**, menu item **Programs / WAGO Software / WAGO BootP Server** and click on **WAGO BootP Server configuration.**

   An editable table will appear: "bootptab.txt".
   This table displays the data basis for the BootP server. Directly following the list of all notations used in the BootP table there are two examples for the allocation of an IP address.
   "Example of entry with no gateway" and **"Example of entry with gateway".**

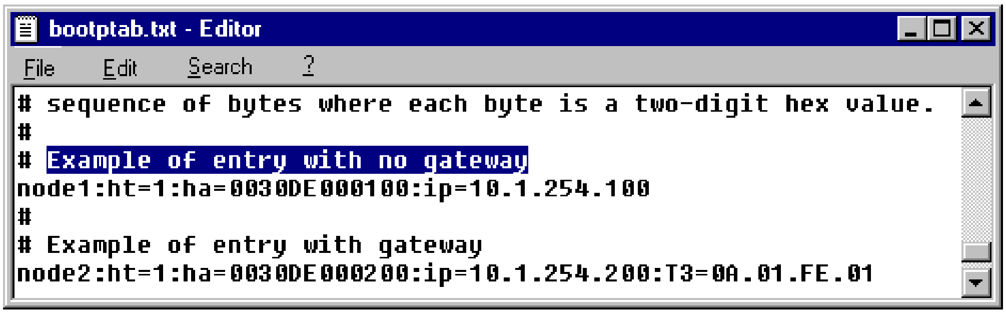


Fig. 3-11: BootP table p012908e

The examples mentioned above contain the following information:

Declaration	Meaning
node1, node2	Any name can be given for the node here.
ht=1	Specify the hardware type of the network here. The hardware type for ETHERNET is 1. (The numbers are described in *RFC1700*)
ha=0030DE000100 ha=0030DE000200	Specify the hardware address or the MAC-ID of the ETHERNET fieldbus coupler (hexadecimal).
ip= 10.1.254.100 ip= 10.1.254.200	Enter the IP address of the ETHERNET fieldbus coupler (decimal) here.
T3=0A.01.FE.01	Specify the gateway IP address here. Write the address in hexadecimal form.
sm=255.255.0.0	In addition enter the Subnet-mask of the subnet (decimal), where the ETHERNET fieldbus coupler belongs to.

No gateway is required for the local network described in this example. Therefore, the first example: **"Example of entry with no gateway"** can be used.

2. Move the mouse pointer to the text line: "node1:ht=1:ha=0030DE000100:ip=10.1.254.100" and mark the 12 character hardware address which is entered after ha=...
   Enter the MAC-ID of your own network coupler.
3. If you want to give your fieldbus node a name, delete the name "node1" and enter any name in its place.
4. To assign the coupler a desired IP address, mark the IP address specified in the example which is entered after ip=...
   Replace it with the IP address you have selected.
5. Because the second example is not necessary at present, insert a "#" in front of the text line of the second example: "**#** node2:hat=1:ha=003 0DE 0002 00:ip=10.1.254.200:T3=0A.01.FE.01", so that this line will be ignored.

Note
To address more fieldbus nodes, enter a corresponding text line showing the corresponding entries for each node.

6. Save the altered settings in this text file "bootptab.txt". To do this go to the **File** menu, menu item **Save,** and close the editor.

BootP Server

7. Now open the dialog window for the WAGO BootP server by going to the **Start menu** on your screen surface, menu item **Program / WAGO Software / WAGO BootP Server** and click on **WAGO BootP Server.**
8. Click on the "**Start**" button in the opened dialog window.
   This will activate the inquiry/response mechanism of the BootP protocol.
   A series of messages will be displayed in the BootP server. The error messages indicate that some services (i.e. port 67, port 68) in the operating system have not been defined.

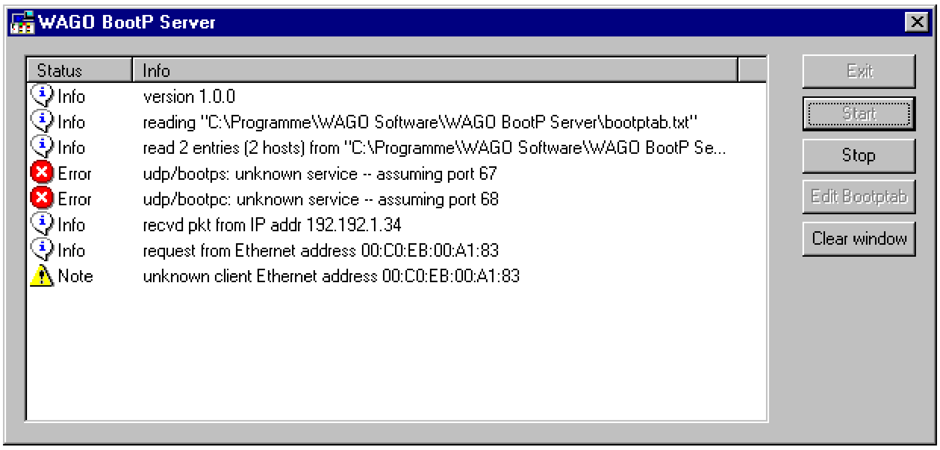


Fig. 3-12: Dialog window of the WAGO BootP server with messages g012909d

9. Now it is important to restart the coupler by resetting the hardware . This ensures that the new IP address will be accepted by the coupler.
   To do this, cycle power to the fieldbus coupler for approx. 2 seconds.

   Following this, the IP address in the coupler is permanently stored and maintained even once the coupler is removed or following a longer voltage failure.

10. Subsequently, click on the "Stop" button and then on the "Exit" button, to close the BootP Server again.

3.1.6.5 Testing the function of the fieldbus node

1. To test the communication with the coupler and the correct assignment of the IP address call up the DOS prompt under **Start menu** / **Program** / **MS-DOS Prompt**.

2. Enter the command: "**ping**" with the IP address you have assigned in the following form:
   ping [space] XXXX . XXXX . XXXX . XXXX (=IP address).
   Example: ping 10.1.254.202

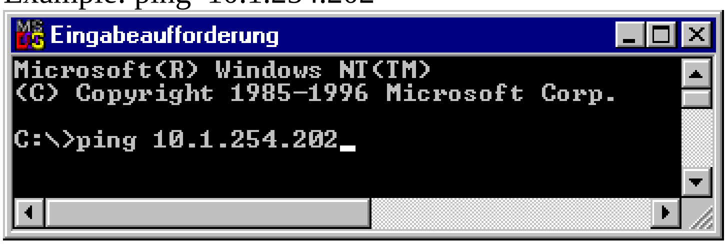


Fig. 3-13: Example for the function test of a fieldbus node P012910e

3. When the Return key has been pressed, your PC will receive a response from the coupler, which will then be displayed in the DOS prompt.
   If the error message: "Timeout" appears instead, please compare your entries again to the allocated IP address.

4. When the test has been performed successfully, you can close the DOS prompt. The network node has now been prepared for communication.

3.1.6.6 Reading out the information as HTML pages

The information saved in the fieldbus coupler can be read as an HTML page using a web browser.

- Information on the fieldbus node (Terminal Status):
  - Number of digital, analog or complex modules
  - Representation of the process image
- Information on the fieldbus coupler (Coupler and Network Details):
  - Order number
  - Firmware version
  - MAC-ID
  - IP address
  - Gateway address (if applicable)
  - Subnet mask
  - Number of transmitted and received packets
- Diagnostic information on the fieldbus coupler (Coupler Status):
  - Error code
  - Error argument
  - Error description

HTTP protocol

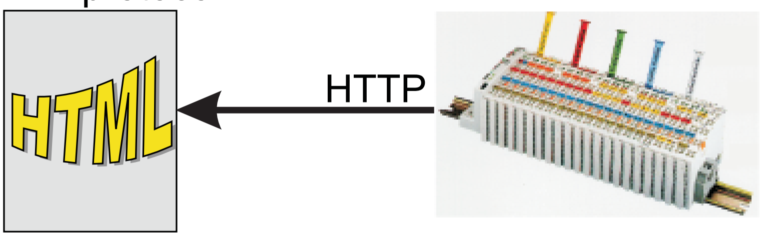


Fig. 3-14: Reading out the information via the HTTP protocol G012916d

Please proceed as follows:

1. Open a web browser such as Microsoft Internet-Explorer, Netscape Navigator, ...

2. Simply enter the IP address of your fieldbus node in the address field of the browser and press the Return key.
   The first HTML page with the information on your fieldbus coupler will be displayed in the browser window. Use the hyperlinks to find out more information.

Attention
If the pages are not displayed after local access to the fieldbus node, then define in your web browser that, as an exception, no proxyserver is to be used for the IP address of the node.

3.1.7 LED Display

The coupler possesses several LED's for displaying the coupler operating status and the complete node status.

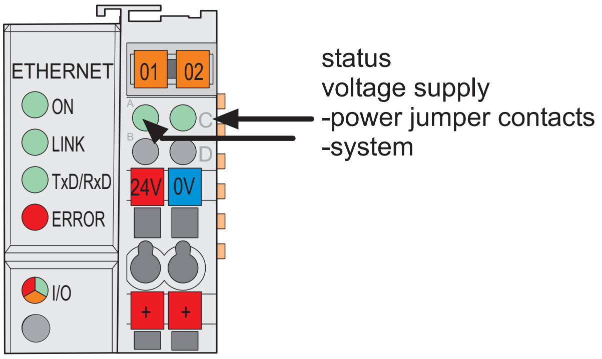


Fig. 3-15: Display elements 750-342 G012901e

A differentiation is made between the two groups of LEDs.

The first group = fieldbus contains the solid color LEDs having the designation ON (green), LINK (green), TxD/RxD (green) and ERROR (red) indicating the operating status of the communication via ETHERNET.
The second group = internal bus consists of the three-color I/O LED (red/green/orange). This LED is used to display the status of the internal bus and i. e. the status of the fieldbus node.

LEDs located on the right-hand side in the coupler feed section, show the status of the supply voltage.

3.1.7.1 Blink code

A blink code displays detailed fault messages. A fault is cyclically displayed using up to 3 different blink sequences.

- The first blink sequence (approx. 10 Hz) indicates the fault display.
- After a pause a second blink sequence appears (approx. 1 Hz). The number of blink impulses gives the **fault code**.
- The third blink sequence (approx. 1 Hz) appears following a further pause. The number of blink pulses indicates the **fault argument**.

3.1.7.2 Fieldbus status

The operating status of the communication via ETHERNET is signalled by means of the top LED group (ON, LINK, TxD/RxD and ERROR).

LED	Meaning	Trouble shooting
ON		
green	Fieldbus initialization is correct	
OFF	Fieldbus initialization is not correct, no function or self-test	Check the supply voltage (24V and 0V), check the IP configuration
LINK		
green	Link to a physical network exists	
OFF	No link to a physical network	Check the fieldbus connection.
TxD/RxD		
green	Data exchange taking place	
OFF	No data exchange	
ERROR		
red	Error on the fieldbus	
OFF	No error on the fieldbus, normal operation	

3.1.7.3 Node status

The operating status of the communication via the internal bus is signalled via the bottom I/O LED.

LED	Meaning	Trouble shooting
I/O		
Green	Fieldbus coupler operating perfectly	
Red	a) During startup of fieldbus coupler: Internal bus being initialized, Startup displayed by LED flashing fast for approx. 1-2 seconds	
Red	b) After startup of fieldbus coupler: Errors, which occur, are indicated by three consecutive flashing sequences. There is a short pause between each sequential flash.	Evaluate the fault message (fault code and fault argument).

The coupler starts up after switching on the supply voltage. The "I/O" LED blinks. The "I/O" LED has a steady light following a fault free run-up.
In the case of a fault the "I/O" LED continues blinking. The fault is cyclically displayed by the blink code.

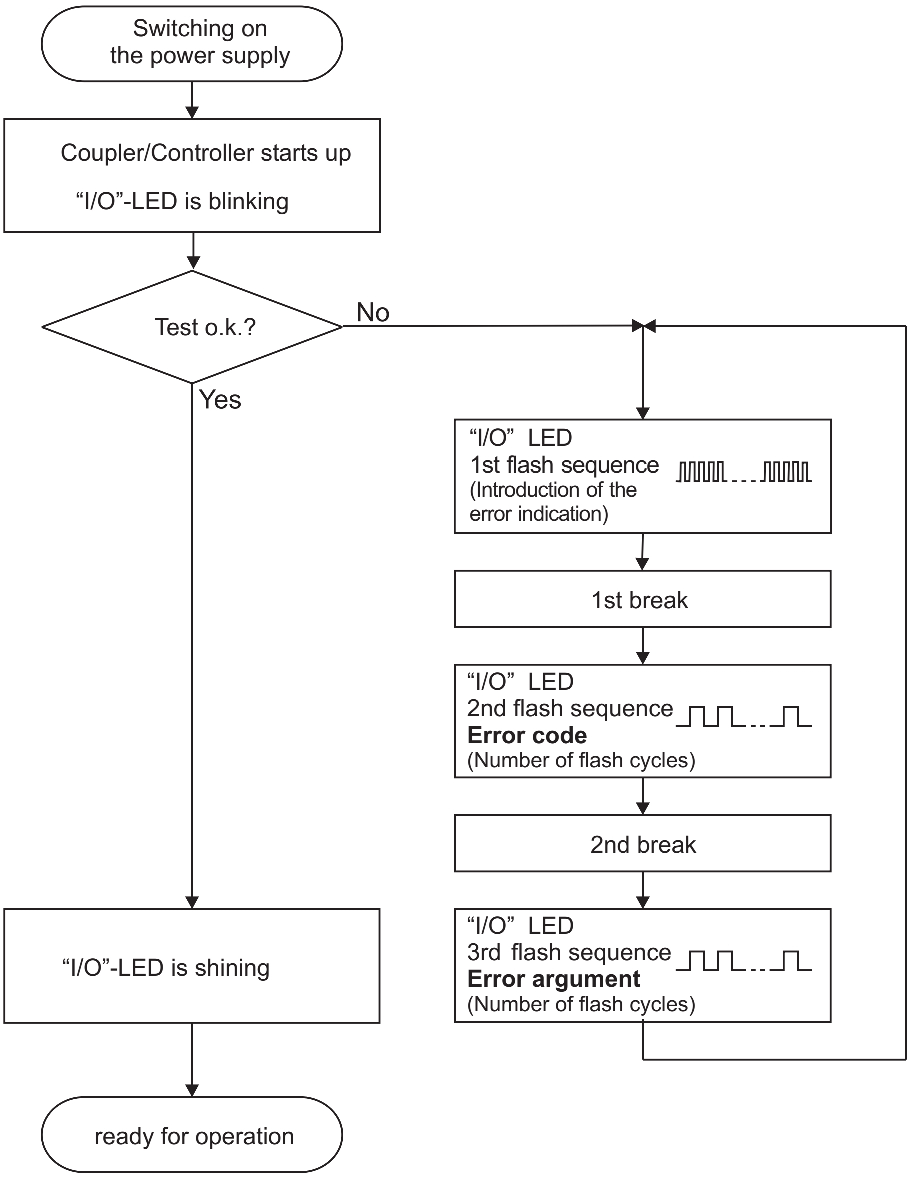


Fig. 3-16: Signalling of the LED for indication of the node status g012911e

After clearing a fault, restart the coupler by cycling the power.

3.1.7.4 Fault message via blink code from the I/O-LED

Fault argument	Fault description
Fault code 1: Hardware and Configuration fault	
0	EEPROM check sum fault / check sum fault in the parameter area of the flash memory
1	Overflow of the internal buffer memory for the inline code
2	Unknown data type
3	Module type of the flash program memory could not be determined / is incorrect
4	Fault when writing in the FLASH memory
5	Fault when deleting the FLASH memory
6	Changed I/O module configuration determined after AUTORESET
Fault code 2: Fault in programmed configuration	
0	Incorrect table entry
Fault code 3: Internal bus command fault	
0	No error argument is put out.

Fault code 4: Internal bus data fault	
0	Data fault on internal bus or Internal bus interruption on coupler
n* (n>0)	Internal bus interrupted after I/O module n
Fault code 5: Fault during register communication	
n*	Internal bus fault during register communication after I/O module n
Fault code 6: Fieldbus specific error	
1	No reply from the BootP server
2	ETHERNET controller not recognized
3	Invalid MACID
4	TCP/IP initialization error
Fault code 7: I/O module is not supported	
n*	I/O module at position n is not supported
Fault code 8: not used	
0	Fault code 8 is not used.
Fault code 9: CPU-TRAP error	
1	Illegal Opcode
2	Stack overflow
3	Stack underflow
4	NMI

* The number of blink pulses (n) indicates the position of the I/O module. I/O modules without data are not counted (i.e. supply modules without diagnostics).

Example for a fault message

Fault: The 13th I/O module has been removed.

1. The "I/O" LED starts the fault display with the first blink sequence (approx. 10 Hz).

2. The second blink phase (approx. 1 Hz) follows the first pause. The "I/O" LED blinks four times and thus signals the fault code 4 (internal bus data fault).

3. The third blink sequence follows the second pause. The "I/O ERR" LED blinks twelve times. The fault argument 12 means that the internal bus is interrupted after the 12^{th} I/O module. Supply voltage status

There are two green LED’s in the coupler supply section to display the supply voltage. The left LED (A) indicates the 24 V supply for the coupler. The right hand LED (C) signals the supply to the field side, i.e. the power jumper contacts.

LED	Meaning	Trouble shooting
A		
green	Operating voltage for the system exists.	
OFF	No operating voltage for the system.	Check the supply voltage (24V and 0V).
C		
green	Operating voltage for the power jumper contacts exists.	
OFF	No operating voltage for the the power jumper contacts.	Check the supply voltage (24V and 0V).

3.1.8 Fault behavior

3.1.8.1 Fieldbus failure

A field bus failure is given i. e. when the master cuts-out or the bus cable is interrupted. A fault in the master can also lead to a fieldbus failure.

A field bus failure is indicated when the red "ERROR"-LED is illuminated.

If the watchdog is activated, the fieldbus coupler firmware evaluates the watchdog-register in the case of fault free communication, and the coupler answers all following MODBUS TCP/IP requests with the exception code 0x0004 (Slave Device Failure).

More information
For detailed information on the Watchdog register see Chaper 6.2.12 "Watchdog (Fieldbus failure**)**".

3.1.8.2 Internal bus fault

An internal bus fault is created, for example, if an I/O module is removed. If this fault occurs during operation the output modules behave in the same manner as an I/O module stop. The "I/O" LED blinks red.
The coupler generates a fault message (fault code and fault argument).
After clearing the internal bus fault, restart the coupler by cycling the power.
The coupler starts up. The transfer of the process data is then resumed and the node outputs are correspondingly set.

3.1.9 Technical Data

System data	
Max. n. of nodes	limited by ETHERNET specification
Transmission medium	Twisted Pair S-UTP 100 Ω cat. 5
Buscoupler connection	RJ45
Max. length of fieldbus segment	100 m between hub station and 750-342; max. length of network limited by ETHERNET specification
Baud rate	10 Mbit/s
Protocols	MODBUS/TCP, HTTP, BootP
Approvals	
UL	E175199, UL508
Conformity marking	CE
Technical Data	
Max. n. of I/O modules	64
Input process image	max. 512 Byte
Output process image	max. 512 Byte
max. n. of socket connections	1 HTTP, 3 MODBUS/TCP
Voltage supply	DC 24 V (-15 % / + 20 %)
Input $current_{max}$	500 mA at 24 V
Efficiency of the power supply	87 %
Internal current consumption	200 mA at 5 V
Total current for I/O modules	1800 mA at 5 V
Isolation	500 V system/supply
Voltage via power jumper $contacts_{max}$	DC 24 V (-15 % / + 20 %)
Current via power jumper $contacts_{max}$	DC 10 A
Dimensions (mm) B x H x T	51 x 65* x 100 (*from upper edge of DIN 35 rail)
Weight	approx. 195 g
EMC Immunity to interference	acc. to EN 50082-2 (95)
EMC Emission of interference	acc. to EN 50081-2 (94)

3.2 Fieldbus controller 750-842

This chapter includes:

3.2.1 Description

The programmable fieldbus controller 750-842 (short: PFC) combines the ETHERNET TCP/IP -functions of the fieldbus coupler 750-with that of a programmable logic control (PLC).

The application program is created with **WAGO-I/O-*PRO* 32** in accordance with IEC 61131-3.

All input signals of the sensors are grouped in the controller. According to the IEC 61131-3 programming, process data treatment occurs locally in the PFC. The link results created in this manner can be put out directly to the actuators or transmitted to the higher ranking control system via the bus.

To be able to transmit process data via ETHERNET, the controller supports a number of network protocols. The process data exchange is made with the aid of the MODBUS/TCP protocol.

The programmer has the option to use function modules for programming clients and servers for all transport protocols (TCP, UDP, etc.) via a socket-API. He has access to all fieldbus and I/O data.

Once the ETHERNET TCP/IP fieldbus controller is connected, it detects all I/O modules connected to the node and produces a local process image on the basis of the detected modules. This can be a mixed arrangement of analog (word-by-word data exchange) and digital (bit-by-bit data exchange) modules. The local process image is subdivided into an input and an output data area.

The data of the analog modules is mapped into the process image in the order of their position after the bus coupler.
The bits of the digital modules are grouped to form words and also mapped into the process image once mapping of the analog modules is completed. Once the number of digital I/O's exceeds 16 bits, the coupler automatically starts another word.

Information on configuration, status and the I/O data of the fieldbus node are stored in the fieldbus controller as HTML pages. These pages can be read via a conventional WEB browser.

3.2.2 Hardware

3.2.2.1 View

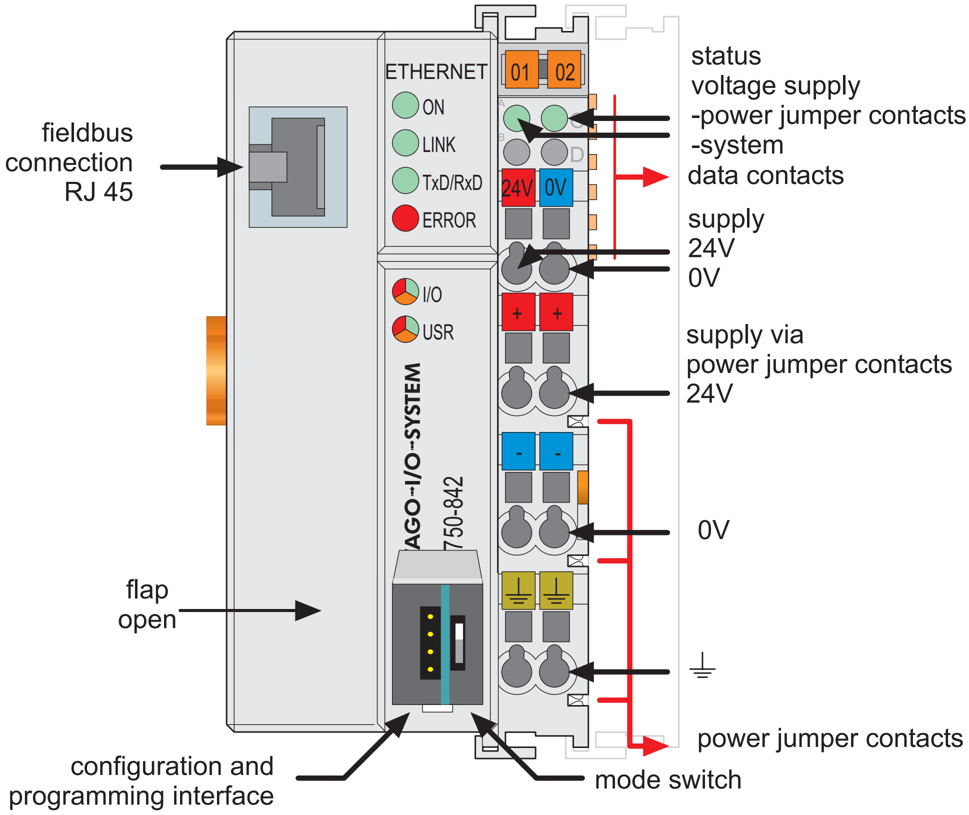


Fig. 3-17: Fieldbus controller ETHERNET TCP/IP g084200e

The fieldbus controller comprises of:

- Device supply with internal system supply module for the system supply as well as power jumper contacts for the field supply via assembled I/O modules
- Fieldbus interface with the bus connection
- Display elements (LED’s) for status display of the operation, the bus communication, the operating voltages as well as for fault messages and diagnosis
- Configuration and programming interface
- Operating mode switch
- Electronics for communication with the I/O modules (internal bus) and the fieldbus interface

3.2.2.2 Device supply

The supply is via fed in via terminal blocks with CAGE CLAMP® connection. Device supply is intended for system supply and field side supply.

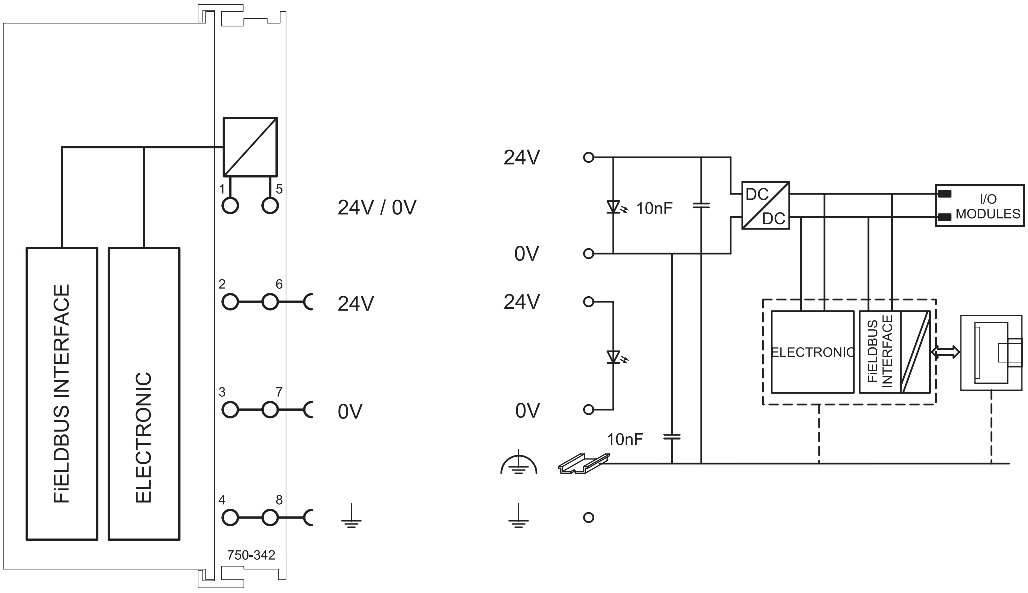


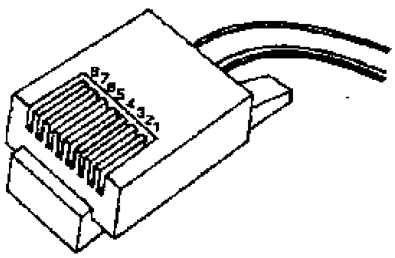
Fig. 3-18: Device supply G034201e

The integrated internal system supply module generates the necessary voltage to supply the electronics and the connected I/O modules.

The fieldbus interface is supplied with electrically isolated voltage from the internal system supply module.

3.2.2.3 Fieldbus connection

Connection to the fieldbus is by a RJ45 connector. A category 5, shielded/unshielded twisted pair cable (S-UTP) with an impedance of 100 Ohm ±15% is mandatory as a connecting line for the 10BaseT Interface.
The connection point is physically lowered for the coupler/controller to fit in an 80 mm high switch box once connected.
The electrical isolation between the fieldbus system and the electronics is achieved by means of DC/DC converters and optocouplers in the fieldbus interface.



Contact	Signal	
1	TD +	Transmit +
2	TD -	Transmit -
3	RD +	Receive +
4		free
5		free
6	RD -	Receive -
7		free
8		free

Fig. 3-19: RJ45-connector and RJ45 connector configuration

3.2.2.4 Display elements

The operating condition of the fieldbus controller or node is displayed via light diodes (LED).

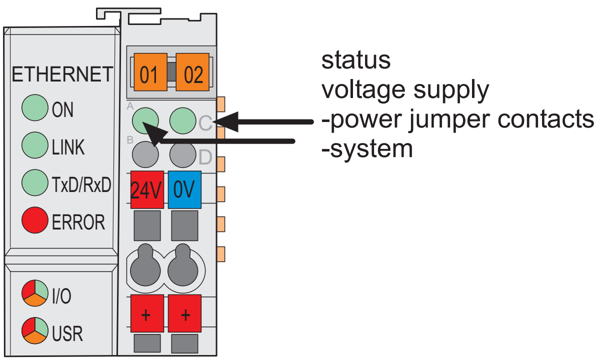


Fig. 3-20: Display elements 750-842 G012902e

LED	Color	Meaning
ON	green	Fieldbus initialization is correct
LINK	green	Link to a physical network exists
TxD/RxD	green	Data exchange taking place
ERROR	red	Error on the fieldbus
IO	red /green / orange	The 'I/O'-LED indicates the operation of the node and signals faults encountered
USR	red /green / orange	The 'USR' LED can be selected by a user program in a programmable fieldbus controller
A	green	Status of the operating voltage – system
C	green	Status of the operating voltage – power jumper contacts

3.2.2.5 Configuration and programming interface

The configuration and programming interface is located behind the cover flap. This is used to communicate with WAGO-I/O-CHECK and WAGO-I/O-*PRO* 32 as well as for firmware downloading.

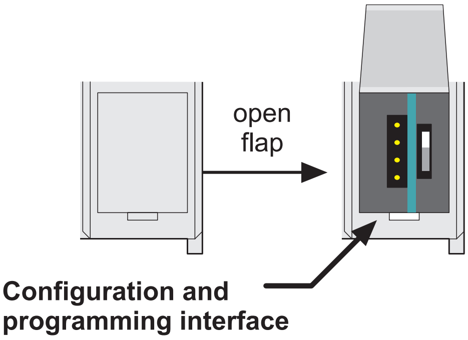


Fig. 3-21: Configuration interface g01xx06e

The communication cable (750-920) is connected to the 4 pole male header.

3.2.2.6 Operating mode switch

The operating mode switch is located behind the cover flap.

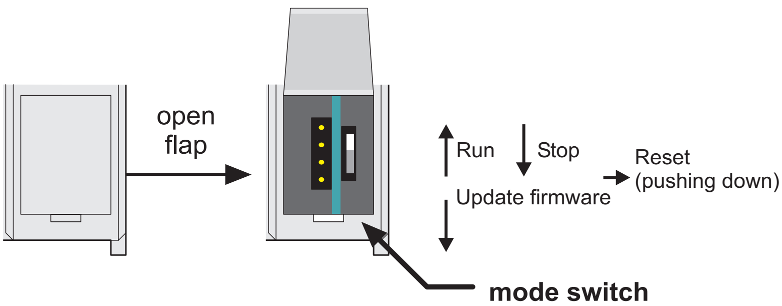


Fig. 3-22: Operating mode switch g01xx10e

The switch is a push/slide switch with 3 settings and a hold-to-run function.

Operating mode switch	Function
From middle to top position	Activate program processing (RUN)
From top to middle position	Stop program processing (STOP)
Lower position, bootstrap	For original loading of firmware, not necessary for user
Push down (i.e. with a screwdriver)	Hardware reset All outputs and flags are reset; variables are set to 0 or to FALSE or to an initial value. The hardware reset can be performed with STOP as well as RUN in any position of the operating mode switch!

An operating mode is internally changed at the end of a PLC cycle.

Attention
If outputs are set when switching from RUN to STOP mode, they remain set! Switching off the outputs on the software side i.e. by the initiators are ineffective because the program is no longer processed.

Note
With "GET_STOP_VALUE" (library "System.lib") WAGO-I/O-*PRO* 32 provides a function which recognizes the last cycle prior to a program stop giving the user the possibility to program the behavior of the controller in case of a STOP. With the aid of this function the controller outputs can be switched to a safe condition.

3.2.2.7 Hardware address (MAC-ID)

Each WAGO ETHERNET TCP/IP fieldbus controller is provided from the factory with a unique and internationally unambiguous physical ETHERNET address, also referred to as MAC-ID (Media Access Control Identity). This is located on the rear of the controller and on a self-adhesive tear-off label on the controller side. The address has a fixed length of 6 Bytes (48 Bit) and contains the address type, the manufacturer’s ID, and the serial number.

3.2.3 Operating system

3.2.3.1 Start-up

The controller starts-up after switching on the supply voltage or after a hardware reset. The PLC program in the flash memory is transferred to the RAM.

This is followed by the initialization of the system. The controller determines the I/O modules and the present configuration. The variables are set to 0 or to FALSE or to an initial value given by the PLC program. The flags retain their status . The "I/O" LED blinks red during this phase.

Following a fault free start-up the controller changes over to the "RUN" mode. The "I/O" LED lights up green.

There is not a PLC program in the flash memory when delivered. The controller start-up as described, without initialiing the system. Then it behaves as a coupler

3.2.3.2 PLC cycle

The PLC cycle starts following a fault free start-up when the operating mode switch is in the top position or by a start command from the WAGO-I/O-*PRO* 32. The input and output data of the fieldbus and the I/O modules as well as the times are read. Subsequently, the PLC program in the RAM is processed followed by the output data of the fieldbus and the I/O modules in the process image. Operating system functions, amongst others, for diagnostics and communications are performed and the times calculated at the end of the PLC cycle. The cycle starts again with the reading of the input and output data and the times.

The change of the operating mode (STOP/RUN) is made at the end of a PLC cycle.

The cycle time is the time from the start of the PLC program to the next start. If a loop is programmed within a PLC program, the PLC running time and thus the PLC cycle are extended correspondingly.

The inputs, outputs and times are not updated during the processing of the PLC program. This calculation occurs in a defined manner only at the end of the PLC program. For this reason it is not possible to wait for an event from the process or the elapse of a time within a loop.

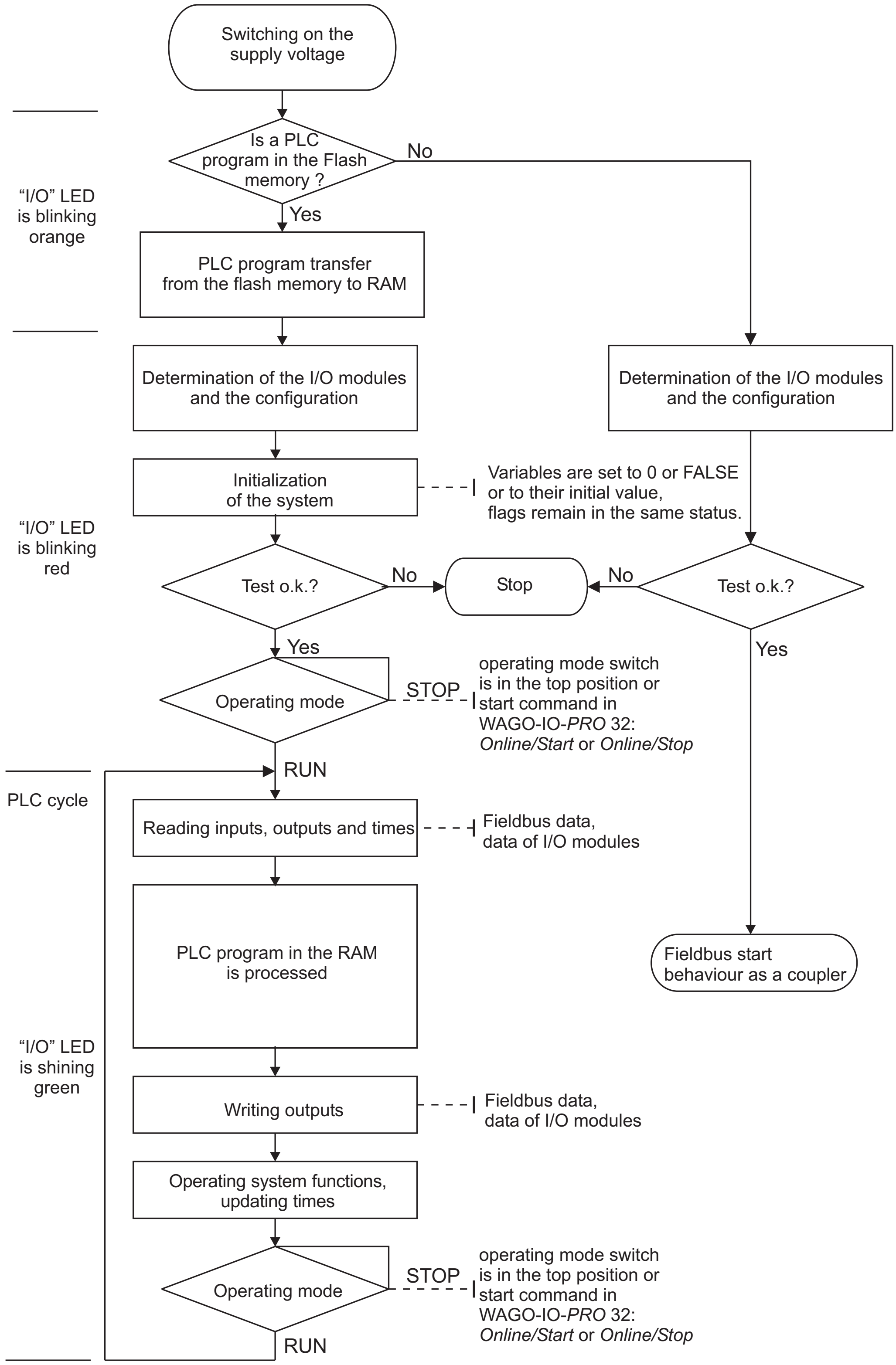


Fig. 3-23: Controller operating system g012941e

3.2.4 Process image

The powered up controller recognizes all I/O modules connected in the node, which are waiting for or transmitting data (data width/bit width > 0). In nodes analog and digital I/O modules can be intermixed.

Note
For the number of input and output bits or bytes of the individual switched on I/O modules please refer to the corresponding description of the I/O modules.

The controller generates an internal local process image from the data width and the type of I/O module as well as the position of the I/O modules in the node. This is divided into an input and an output area.

The data of the digital I/O modules are bit orientated, i.e. the data exchange is made bit by bit. The analog I/O modules are representative for all I/O modules which are byte orientated, in which the data exchange is also made byte by byte. These I/O modules also include, for example, counter modules, I/O modules for angle and path measurement as well as communication modules.

The data of the I/O modules is separated for the local input and output process image in the sequence of their position after the controller in the individual process image.
First, all the byte-oriented bus modules are filed in the process image, then the bit-oriented bus modules. The bits of the digital modules are grouped into bytes. Once the number of digital I/O's exceeds 8 bit, the coupler automatically starts another byte.

Note
If a node is changed, this may result in a new process image structure. In this case the process data addresses also changes. In the event of adding modules, the process data of all previous modules has to be taken into account.

The process image for the physical bus module data is identical with that of the WAGO ETHERNET TCP/IP fieldbus coupler. The controller uses a memory space of 256 words (word 0 ... 255) for the phyical input and output data.
The controller is assigned an additional memory space for imaging the PFC variables defined according to IEC 61131-3. This extended memory space (word 256 ... 511 each) is used to map the PFC variables behind the physical process image.

The division of the memory spaces and the access of the PLC functionality (CPU) to the process data is identical with all WAGO fieldbus controllers. Access is via an application related IEC 61131-3 program and independent on the fieldbus system.

In contrast to the above, access from the fieldbus side is fieldbus specific.
For the ETHERNET TCP/IP fieldbus controller, a MODBUS/TCP master can access the data via implemented MODBUS functions. Here, decimal and/or hexadecimal MODBUS addresses are used.

3.2.4.1 Example of a process input image

The following figure is an example of a process input image.
The configuration comprises of 16 digital and 8 analog inputs.
The process image thus has a data length of 8 words for the analog and 1 word for the digital inputs, i.e. 9 words in total.

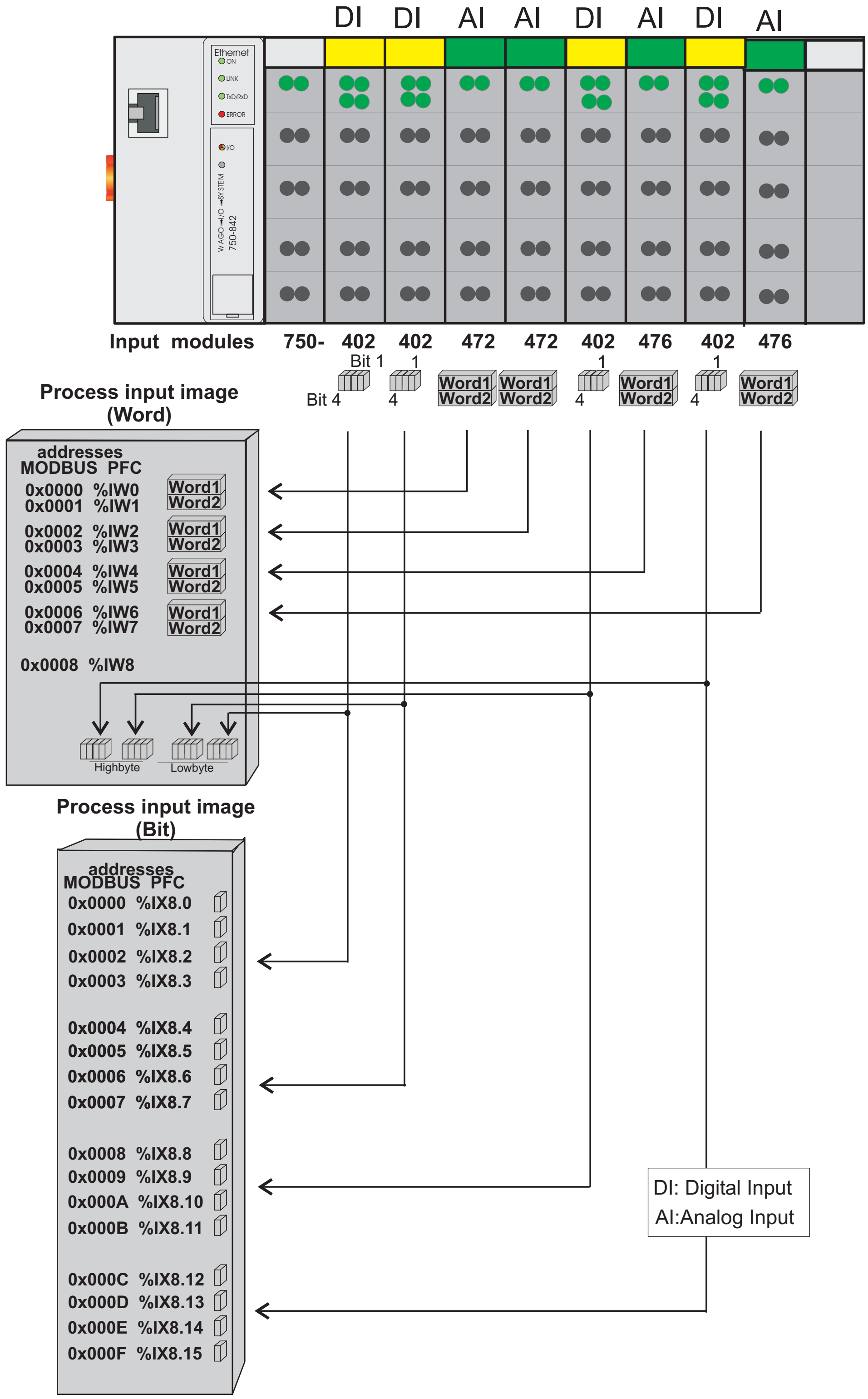


Fig. 3-24: Example of a process input image G012924e

3.2.4.2 Example of a process output image

The following example for the process output image comprises of 2 digital and 4 analog outputs.
It comprises of 4 words for the analog and 1 word for the digital outputs, , i.e. 5 words in total.

In addition, output data can be read back with an offset of 200_{hex} (0x0200) added to the MODBUS address.

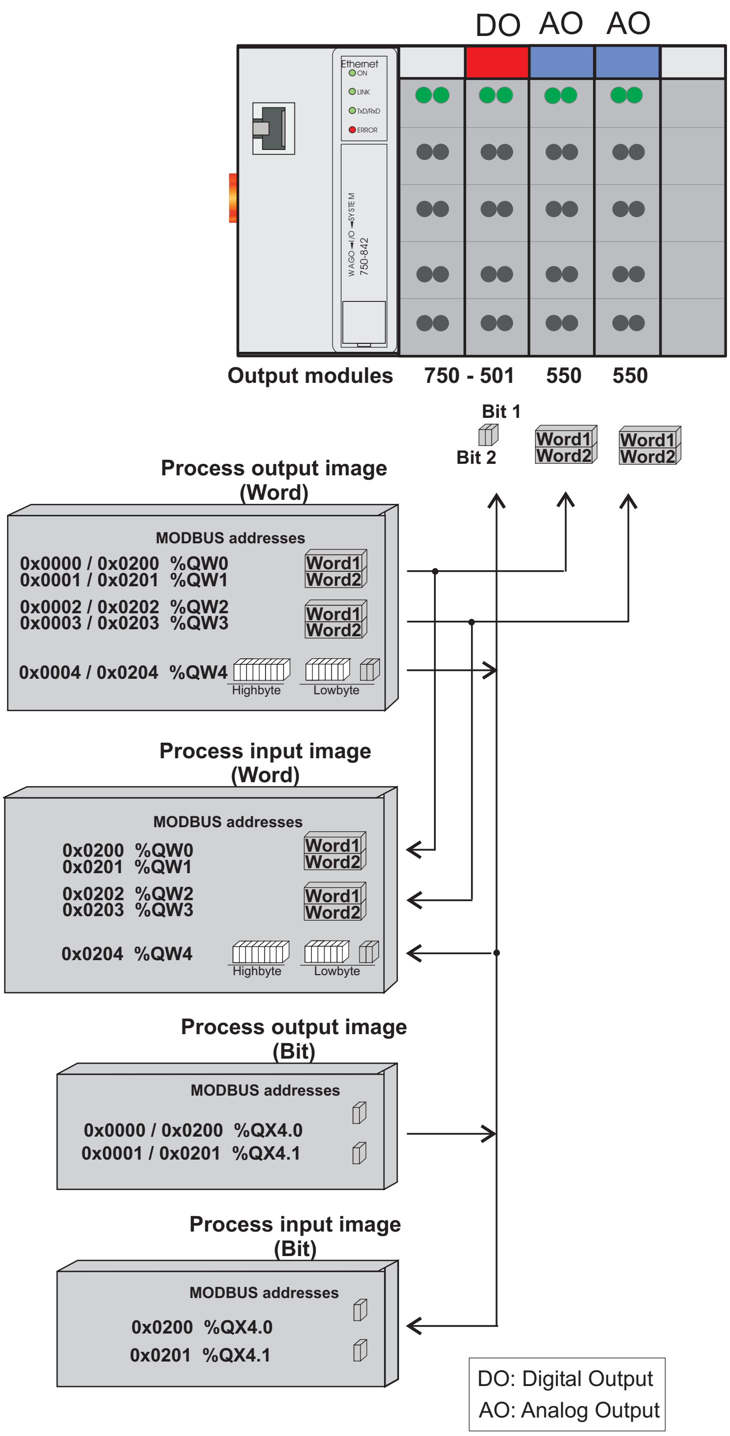


Fig. 3-25: Example of a process output image G012925e

3.2.4.3 Process data architecture for MODBUS/TCP

For some bus modules or their variations, the process data architecture is specific for the fieldbus controller used.

In the case of the ETHERNET controller with MODBUS/TCP the control/status byte is always masked in addition to the data bytes. This is required for the two-directional data exchange of the bus module with the higher-ranking control system. The control byte is transmitted from the control system to the module and the status byte from the module to the control system. This allows, for example, the display of overshooting or undershooting of the area.

Attention
Please refer to the respective bus module description in Chapter 4 "I/O modules" for the specific architecture of the respective control/status byte.

The following shows the representation of some selected modules in the process image.

In the examples, the order in which the modules are physically arranged in the node reflects the order in the image table starting with register address 0x0000. If the module is located at any other position in the fieldbus node, the process data of all previous byte-wise oriented modules have to be taken into account. In the process image, this results in a basic register address for the module. To address its process data words, the quoted offset is added to this basic address.

If an analog input or output module is added, it takes up 2 x 16 Bit input or output data.

With the ETHERNET fieldbus controller with MODBUS/TCP the process image is organized word-by-word (word-alignment) and the control/status byte is always a low byte.

3.2.4.3.1 750-404, /000-00X Counter modules

This process data architecture holds true for the counter modules 750-404, 750-404/000-001, 750-404/000-002 and 750–404/000-004.

Item number:	Description:
750-404	Up/Down Counter
750-404/000-001	2 Channel Up Counter with enable input
750-404/000-002	Peak Time Counter
750-404/000-004	Up/Down Counter (switching outputs)

The data format of the counter modules five bytes is mapped out by the module as four data bytes and one additional control/status byte. The module supplies a 32 bit counter-output, while occupying 3 words each in the process image with word-alignment.

Address	Bytes		Comment	Module
Offset	High	Low		
0		C/S	Control-/ Status byte	Module 1: **750-404, 750-404/000-001, 750-404/000-002, 750-404/000-004**
1	D1	D0	Data bytes	
2	D3	D2		
3	User data	User data	Data bytes	Module 2: Analog module Channel 1
4	User data	User data	Data bytes	Module 2: Analog module Channel 2
...	...	...	...	...

The input bytes D0 to D3 form the 32 bit counter-output.

In the output bytes D0 to D3 the initial value of the counter can be set.

3.2.4.3.2 750-404/000-005 2 Channel Up Counter 16 Bit

The data format of the counter modules five bytes is mapped out by the module as four data bytes and one additional control/status byte, while occupying 3 words each with word-alignment.

Address Offset	Bytes High	Bytes Low	Comment	Module
0		C/S	Control/ Statusbyte	Module 1: **750-404/000-005**
1	D1	D0	Data bytes Counter 1	
2	D3	D2	Data bytes Counter 2	
3	User data	User data	Data bytes	Module 2: Analog module Channel 1
4	User data	User data	Data bytes	Module 2: Analog module Channel 2
...	...	...	...	...

The input bytes D0 and D1 form the 16 bit reading of counter 1 and the input bytes D2 and D3 form the 16 bit reading of counter 2.
When setting the counter, the load value of counter 1 is transferred in the output bytes D0 and D1. The load value of counter 2 is transferred respectively in the output bytes D2 and D3.

3.2.4.3.3 750-511, /000-002 2-Channel Digital Pulsewidth module

This process data architecture holds true for the 2 Channel Pulsewidth modules 750-511 and 750–511/000-002.

Item-No.:	Description:
750-511	2DO 24V DC 0.1A Pulsewidth
750-511/000-002	2DO 24V DC 0,1A Pulsewidth 100Hz

The process image of the 750-511 and 750-511/000-002 appears with 6 bytes of input and 6 bytes of output data, while occupying 4 words each in the process image with word-alignment.

Address Offset	Bytes High	Bytes Low	Comment	Module
0		C/S-0	Control / Status byte	Module 1 Channel 1: **750-511, 750-511/000-002**
1	D1-0	D0-0	Data bytes	
2		C/S-1	Control / Status byte	Module 1 Channel 2: **750-511, 750-511/000-002**
3	D1-1	D0-1	Data bytes	
4	User data	User data	Data bytes	Module 2: Analog Module Channel 1
5	User data	User data	Data bytes	Module 2: Analog Module Channel 2
...	...	...	...	...

3.2.4.3.4 750-630, /000-00X SSI encoder interface 24 Bit

This process data architecture holds true for the SSI encoder interface modules 750-630, 750-630/000-001 and 750–630/000-006.

Item-No.:	Description:
750-630	SSI encoder interface 24Bit, 125kHz Gray code, alternative Data format
750-630/000-001	SSI encoder interface 24Bit, 125kHz Binary code, alternative Data format
750-630/000-006	SSI encoder interface 24Bit, 250kHz Gray code, alternative Data format

The module is seen like an analog input with 2 x 16 Bit input data, i.e. with a total of 4 bytes user data. Here 2 words in the input area of the local process image are occupied with word-alignment.

Address	Bytes		Comment	Module
Offset	High	Low		
0	D1	D0	Data bytes	Module 1: **750-630, 750-630/000-001, 750-630/000-006**
1	D3	D2		
2	User data	User data	Data bytes	Module 2: Analog module Channel 1
3	User data	User data	Data bytes	Module 2: Analog module Channel 2
...	...	...	...	...

3.2.4.3.5 750-631, /000-001 Incremental Encoder Interface

This process data architecture holds true for the Incremental Encoder Interface modules 750-631 and 750–631/000-001.

Item-No.:	Description:
750-631	Incremental encoder interface, 4 times sampling
750-631/000-001	Incremental encoder interface, 1 times sampling

The bus module 750-631 and 750-631/000-001 002 appears with 6 bytes of input and 6 bytes of output data and occupies 4 words each with word-alignment.

<table>
<tr><th>Address
Offset</th><th>Bytes
High</th><th>
Low</th><th>Comment</th><th>Module</th></tr>
<tr><td>0</td><td></td><td>C/S</td><td>Control / Status byte</td><td rowspan="4">Module 1:
750-631,
750-631/000-001</td></tr>
<tr><td>1</td><td>D1</td><td>D0</td><td>ead/set counter word</td></tr>
<tr><td>3</td><td></td><td>(D2)*)</td><td>(period)</td></tr>
<tr><td>4</td><td>D4</td><td>D3</td><td>read latch word</td></tr>
<tr><td>5</td><td>User data</td><td>User data</td><td>Data bytes</td><td>Module 2:
Analog module Channel 1</td></tr>
<tr><td>6</td><td>User data</td><td>User data</td><td>Data bytes</td><td>Module 2:
Analog module Channel 2</td></tr>
<tr><td>...</td><td>...</td><td>...</td><td>...</td><td>...</td></tr>
</table>

The control / status byte is in the low byte on offset 0.
The data word D0/D1 contains the counter word (read/set), whereas the data word D3/D4 contains the latch word (read).
*) In the operating mode of permanent period measurement, the period duration is in D2 together with D3/D4.

3.2.4.3.6 750-650 RS232 Interface module, 750-651 TTY-,20 mA Current Loop, 750-653 RS485 Interface module

This process data architecture holds true for the modules 750-650, 750-651 and 750–653.

Item-No.:	Description:
750-650	RS 232 C Interface 9600,n,8,1
750-651	TTY Interface, 20 mA Current Loop
750-653	RS485 Interface

The modules appear on the bus as a combined analog input and output module with 3 x 16-bit input and output data, i.e. with a total of 4 bytes user data. Here 2 words each are occupied with word-alignment.

<table>
<tr><th>Address
Offset</th><th>Bytes
High</th><th>
Low</th><th colspan="2">Comment</th><th>Module</th></tr>
<tr><td>0</td><td>D0</td><td>C/S</td><td>Data byte</td><td>Control / Status byte</td><td rowspan="2">Module 1:
750-650,
750-651,
750-653</td></tr>
<tr><td>1</td><td>D2</td><td>D1</td><td colspan="2">Data bytes</td></tr>
<tr><td>2</td><td>User data</td><td>User data</td><td colspan="2">Data bytes</td><td>Module 2:
Analog module Channel 1</td></tr>
<tr><td>3</td><td>User data</td><td>User data</td><td colspan="2">Data bytes</td><td>Module 2:
Analog module Channel 2</td></tr>
<tr><td>...</td><td>...</td><td>...</td><td colspan="2">...</td><td>...</td></tr>
</table>

3.2.4.3.7 750-650/000-001 RS232 Interface module 5 Byte

The RS232 interface module 750-650 can also be operated with a data format of 5 bytes and one Control/Status byte, i.e. a total of 6 bytes user data. For this data format, order the variation with the part number 750-650/000-001, occupying 3 words each in the input and output area of the process image with word-alignment.

Address	Bytes		Comment		Module
Offset	High	Low			
0	D0	C/S	Data byte	Control / Status byte	Module 1: **750-650/000-001**
1	D2	D1	Data bytes		
2	D4	D3			
3	User data	User data	Data bytes		Module 2: Analog module channel 1
4	User data	User data	Data bytes		Module 2: Analog module channel 2
...	...	...	...		...

3.2.5 Data exchange

With the ETHERNET TCP/IP fieldbus controller data is exchanged via the MODBUS/TCP protocol.

MODBUS/TCP works according to the master/slave principle. The master is a superimposed control unit, i.e. a PC or a PLC device.
The ETHERNET TCP/IP controller of the **WAGO-I/O-SYSTEM 750** normally are slave devices. Due to the programming with IEC 61131-3, controllers can additionally assume the master function.
The master makes a query for communication. By adressing this query can be sent to a specific node. The nodes receive the query and return a response to the master, depending on the kind of query.

A coupler is able to produce a certain number of simultaneous connections (socket connections) to other network subscribers:

- 1 connection for HTTP (read HTML pages from the controller),
- 3 connections via MODBUS/TCP (read or write input and output data from the controller),
- 2 connections via the PFC (available in the PLC functionality for IEC 61131-3 application programs) and
- 2 connections for WAGO-I/O-*PRO* (these connections are reserved for debugging the application program via ETHERNET.
  For debugging, WAGO-I/O-*PRO* requires 2 connections at the same time. However, only one programming tool can have access to the controller.

The maximum number of simultaneous connections may not be exceeded. If you wish to establish further connections, terminate existing connections first.

For a data exchange, the ETHERNET TCP/IP fieldbus controller uses three main interfaces:

- interface to the fieldbus (master),
- the PLC functionality of the PFCs (CPU) and
- the interface to the bus terminals.

Data exchange takes place between the MODBUS master and the bus modules, between the PLC functionality of the PFCs (CPU) and the bus modules as well as between the MODBUS master and the PLC functionality of the PFCs (CPU).
The master accesses the data via the MODBUS functions implemented in the controller.
PFC access to data is then made by means of an IEC 61131-3 application program, whereby data addressing is different.

3.2.5.1 Memory areas

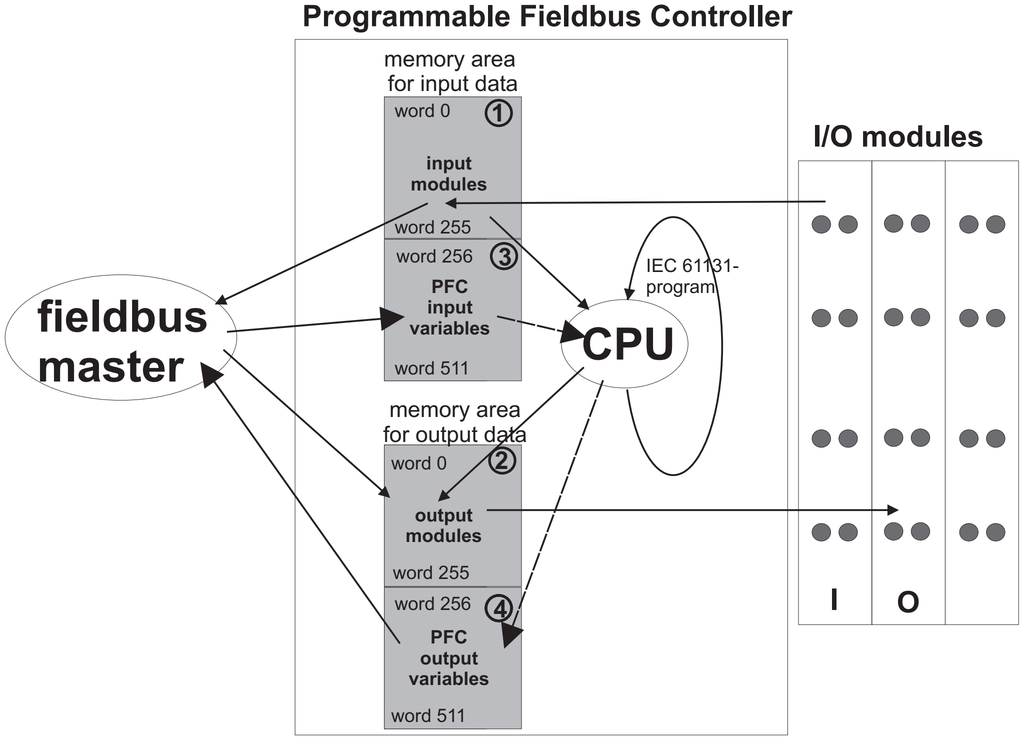


Fig. 3-26: Memory areas and data exchange for a fieldbus controller g012938e

In the memory space word 0 ... 255, the controller process image contains the physical data of the bus modules.

(1) The data of the input modules can be read by the CPU and from the field-bus side.

(2) In the same manner, writing on the output modules is possible from the CPU and from the fieldbus side. The value of the master is put out on the output while writing on an output.

The PFC variables are filed in the memory space Word 256 ... 511 of the process image.

The PFC input variables are written in the input memory space from the field-bus side and read by the CPU for further processing.

The variables processed by the CPU via the IEC 61131-3 program are filed in the output memory space and can be read out by the master.

In addition, with the ETHERNET TCP/IP controller all output data are mirror imaged on a memory space with the address offset 0x0200 which allows to read back output values by adding 0x0200 to the MODBUS address.

In addition, the controller offers further memory spaces which cannot be accessed from the fieldbus side:

RAM	The RAM memory is used to create variables not required for communication with the interfaces but for internal processing, such as for instance computation of results.
Retentive memory	The retentive memory is non volatile memory, i.e. all values are retained following a voltage failure. The memory management is automatic. In this memory area, flags for the IEC 61131-3 program are filed together with variables without memory space addressing or variables which are explicitly defined with "var retain". Note The automatic memory management can cause a data overlap. For this reason, we recommend not to use a mix of flags and retain variables.
Code memory	The IEC 61131-3 program is filed in the code memory. The code memory is a flash ROM. Once the supply voltage is applied, the program is transmitted from the flash to the RAM memory. After a successful start-up, the PFC cycle starts when the operating mode switch is turned to its upper position or by a start command from WAGO-I/O-*PRO* 32.

3.2.5.2 Addressing

3.2.5.2.1 Addressing the I/O modules

The arrangement of the I/O modules in a node is optional.
When addressing, first of all the complex modules (modules occupying 1 or more bytes) are taken into consideration in accordance with their physical order behind the fieldbus controller. As such, they occupy the addresses beginning with word 0.
Following this, the data of the other modules follow - grouped into bytes - (modules occupying less than 1 byte). These are filled byte-by-byte according to their physical order. As soon as a full byte is occupied by the bit oriented modules, the next byte starts automatically.

Note
For the number of input and output bits or bytes of the individually connected bus modules please refer to the corresponding descriptions of the bus modules.

Note
Changing a node could result into a new structure of the process image. Also the addresses of the process data will change. When adding modules, the process data of all previous modules have to be taken into account.

Data width ≥ 1 Word / channel	Data width = 1 Bit / channel
Analog input modules	Digital input modules
Analog output modules	Digital output modules
Input modules for thermal elements	Digital output modules with diagnosis (2 Bit / channel)
Input modules for resistance sensors	Power supply modules with fuse holder / diagnosis
Pulse width output modules	Solid State power relay
Interface module	Relay output modules
Up/down counter	
I/O modules for angle and path measurement	

Table 3.4: I/O module data width

3.2.5.2.2 Address range

Address range for I/O module data:

Data	Address								
Bit	0.0 ... 0.7	0.8... 0.15	1.0 ... 1.7	1.8... 1.15	.....	254.0 ... 254.7	254.8...254.15	255.0 ... 255.7	255.8... 255.15
Byte	0	1	2	3	.....	508	509	510	511
Word	**0**		**1**		**.....**	**254**		**255**	
DWord	0				.....	127			

Table 3.5: Address range for the I/O module data

Address range for fieldbus data:

Data	Address								
Bit	256.0 ... 256.7	256.8 ... 256.15	257.0 ... 257.7	257.8 ... 257.15	.....	510.0 ... 510.7	510.8 ... 510.15	511.0 ... 511.7	511.8 ... 511.15
Byte	512	513	514	515	.....	1020	1021	1022	1023
Word	**256**		**257**		**.....**	**510**		**511**	
DWord	128				.....	255			

Table 3.6: Address range for the fieldbus data

Address range for flags:

Data	Address								
Bit	0.0 ... 0.7	0.8... 0.15	1.0... 1.7	1.8... 1.15	.....	4094.0.. 4094.7	4094.8.. 4094.15	4095.0 ... 4095.7	4095.8... 4095.15
Byte	0	1	2	3	.....	8188	8189	8190	8191
Word	**0**		**1**		**.....**	**4094**		**4095**	
DWord	0				.....	2047			

Table 3.7: Address range for the flags

The register functions are located in address 0x1000 and can be addressed analog with the implemented MODBUS function codes (read/write).

3.2.5.2.3 Absolute addresses

The direct display of individual memory cells (absolute addresses) in accordance with IEC 61131-3 is made using special character strings in accordance with the following table:

Position	Character	Designation	Comments
1	**%**	Starts absolute address	
2	I Q M	Input Output Flag	
3	X* B W D	Single bit Byte (8 Bits) Word (16 Bits) Double word (32 Bits)	Data width
4		Address	
* The character 'X' for bits can be deleted			

Table 3.8: Absolute addresses

Note
Enter the absolute address character strings without blanks!

Example: Absolute addresses for input:

%IX14.	.15	.14	.13	.12	.11	.10	.9	.8	.7	.6	.5	.4	.3	.2	.1	.0
%IB29									%IB28							
%IW14																
%IDW7																
* The character 'X' for single bits can be deleted																

Table 3.9: Example for input absolute addresses

Address calculation (depending upon the word address):

Bit address: word address .0 to .15
Byte address: 1. Byte: 2 x word address
2. Byte: 2 x word address + 1

Dword address:
word address (even numbers) / 2
or word address (uneven numbers) / 2, rounded off

3.2.5.3 Data exchange between master and I/O modules

The data exchange between the MODBUS master and the I/O modules is made via the MODBUS functions implemented in the controller by reading and writing in bits or bytes.

The controller handles four different types of process data:

- Input words
- Output words
- Input bits
- Output bits

The word for word access to the digital input and output modules is made in accordance with the following table:

Digital inputs/ outputs	16.	15.	14.	13.	12.	11.	10.	9.	8.	7.	6.	5.	4.	3.	2.	1.
Prozess data word	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte	High-Byte D1								Low-Byte D0							

Table 3.10: Allocation of digital inputs/outputs to process data word acc. Intel format

Adding 0x0200 to the MODBUS address permits to read back the outputs.

The register functions addressing can be by the means of the implemented MODBUS function codes (read/write). The individual register address is referenced instead of the address of a module channel.

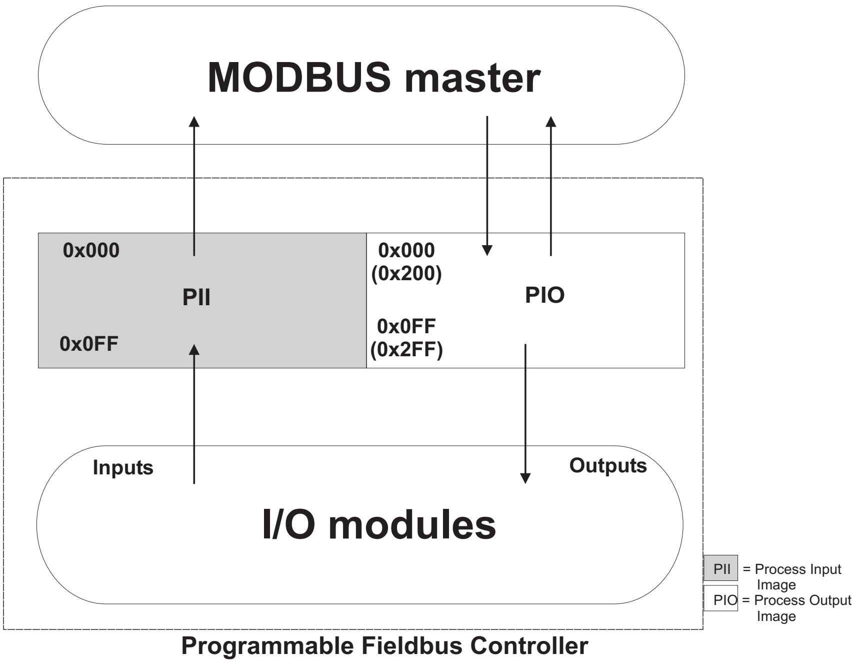


Fig. 3-27: Data exchange between MODBUS master and I/O modules g012929e

3.2.5.4 Data exchange between PLC functionality (CPU) and I/O modules

Through absolute addresses, the PLC functionality (CPU) of the PFC can directly address the bus module data.

The PFC addresses the input data with absolute addresses. The data can then be processed, internally in the controller, through the IEC 61131-3 program, whereby the flags are filed in a permanent memory area. Following this, the linking results can be directly written in the output data via absolute addressing.

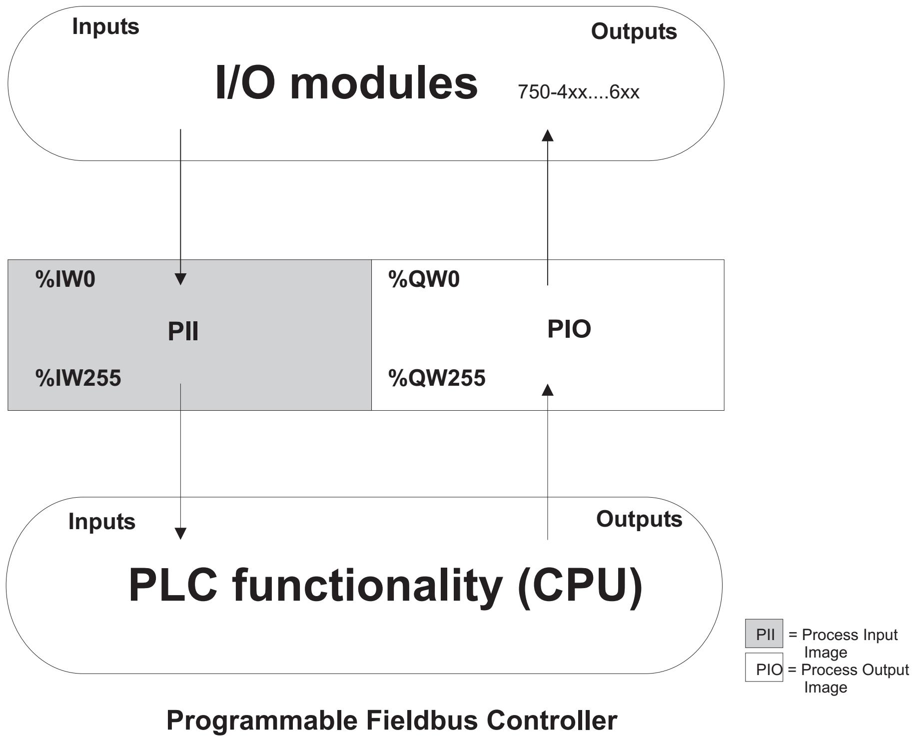


Fig. 3-28: Data exchange between PLC functionality (CPU) and I/O modules g012943e

3.2.5.5 Data exchange between master and PLC functionality (CPU)

The MODBUS master and the PLC functionality (CPU) of the PFC regard the data in a different manner.
Variables data created by the master reach the PFC as input variables and are further treated there.
Data created in the PFC is sent to the master through the fieldbus as output variables.

In the PFC the system can access the variable's data as from I/O word address 256 (double word address 128, byte address 512).

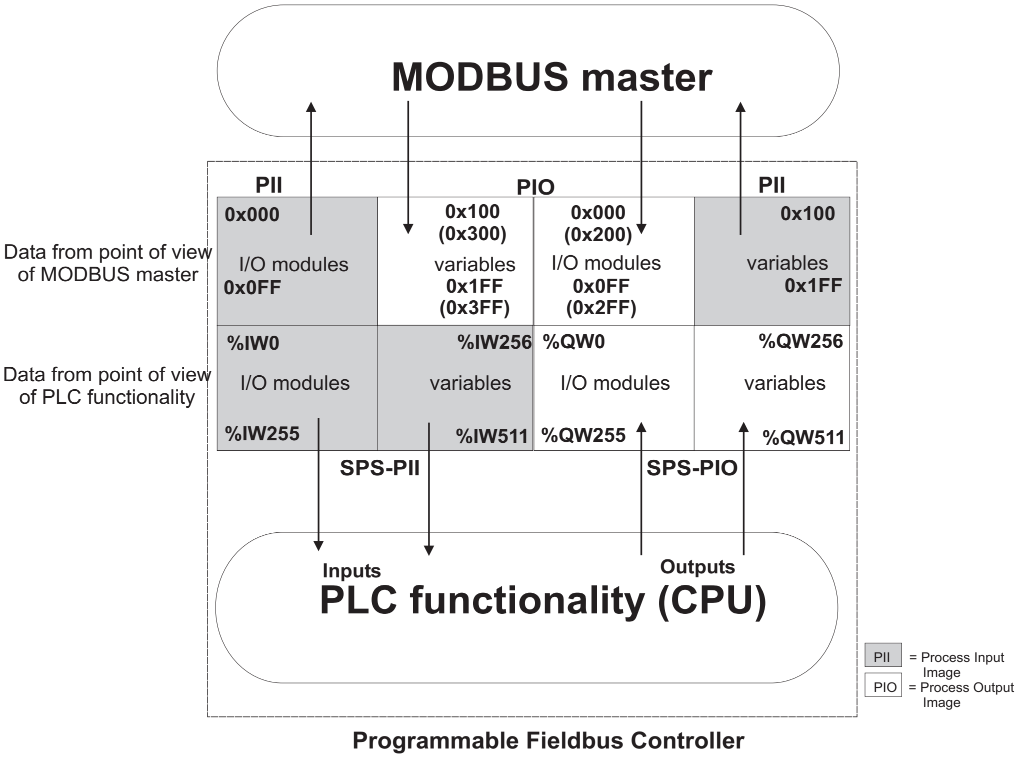


Fig. 3-29: Data exchange between MODBUS master and PLC functionality g012944e

Data access by the MODBUS master

The data can only be accessed by the MODBUS master either word by word or bit by bit.
Addressing the data from the bus modules starts with word 0 for a word-by-word access, and also with 0 in word 0 for bit 0 for a bit-by-bit access.
Addressing the data from the variables starts with word 256 for a word-by-word access, and then, with a bit-by-bit access, addressing starts from:

4096 for bit 0 in word 256
4097 for bit 1 in word 256
...
8191 for bit 15 in word 511.

The bit number can be defined using the following formula:

BitNo = (Word * 16) + Bitno_in_Word

Data access by the PLC functionality

When accessing the same data, the PLC functionality of the PFCs uses a different type of addressing.

When declaring 16 bit variables, the PLC addressing is identical to the addressing of the MODBUS master made word-by-word.

When declaring Boolean variables (1 bit) a notation different to that of the MODBUS is used.
The bit address is composed of the elements word address and bit number in the word, separated by a dot.

Example:
Bit access MODBUS to bit number 4097 => bit addressing in the PLC
<Wordno>.<Bitno> = 0.1

The PLC functionality of the PFC can also access the data byte-by-byte and double word-by-double word.
With the bytewise access, the addresses are computed according to the following formula:

High-Byte Address = Word address*2
Low-Byte Address = (Word address*2) + 1

With the access by a double word, the address is computed according to the following formula:

Double word address = High word address/2 (rounded off)
or = Low word address/2

3.2.5.6 Common access of MODBUS master and PLC functionality to outputs

The process illustration of outputs is described both by the MODBUS master as well as by the PLC functionality, so that the I/O module outputs can be set or reset from both sides. Design the user programs of the MODBUS master and the PLC functionality such that conflicting instructions for simultaneous setting or resetting of outputs is excluded.

3.2.5.7 Address review

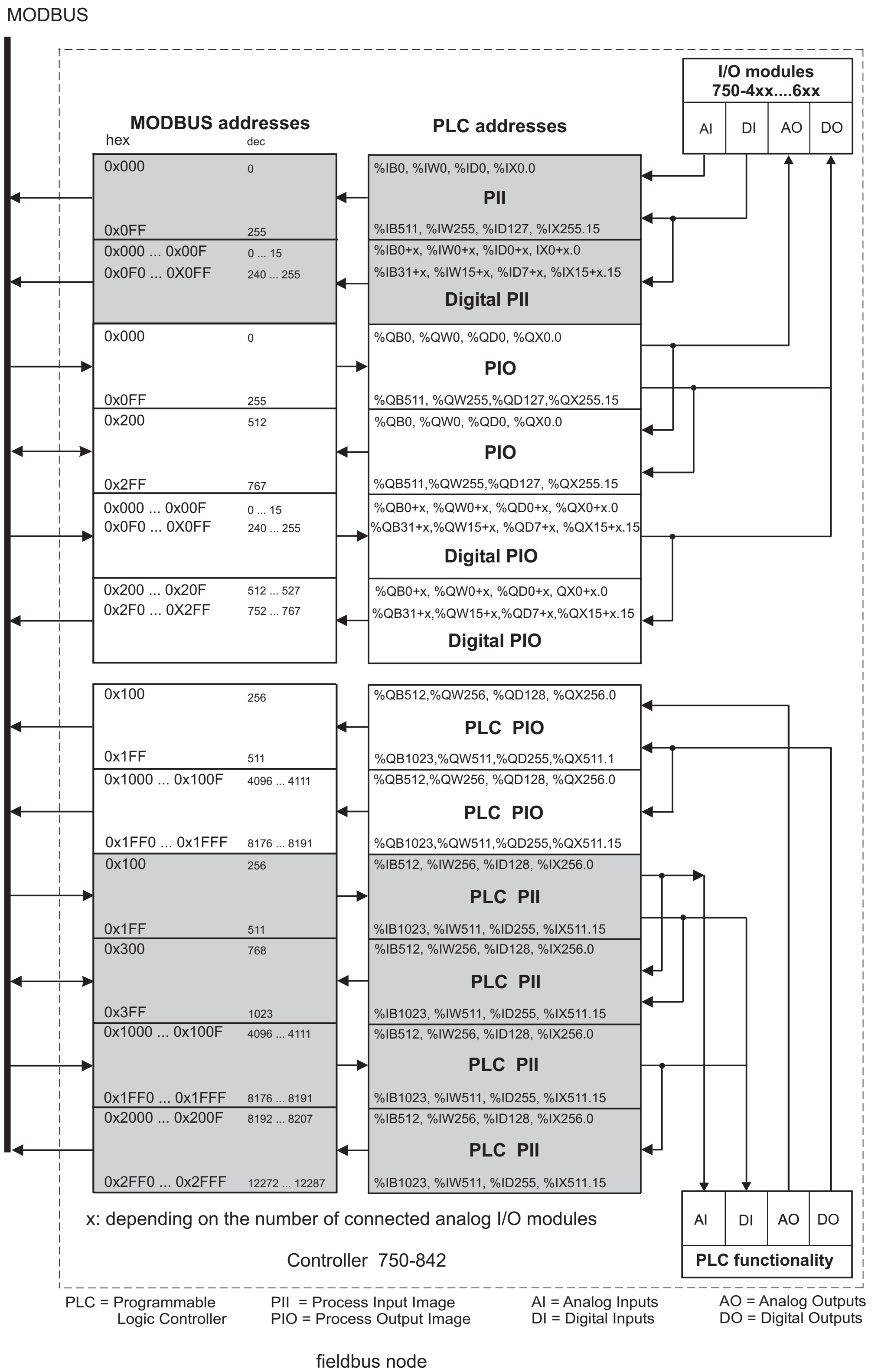


Fig. 3-30: Address review, controller

g012932e

3.2.6 Starting up ETHERNET TCP/IP fieldbus nodes

This chapter shows the step-by-step procedure for starting up a WAGO ETHERNET TCP/IP fieldbus node. The following also contains a description of how to view the controller-internal HTML pages.
Following this, information regarding PFC programming with **WAGO-I/O-*PRO* 32** are shown.

Attention
This description is given as an example and is limited to the execution of a local startup of an individual ETHERNET fieldbus node with a computer running under windows which is not connected to a network.
Direct Internet connection should only be performed by an authorized network administrator and is, therefore, not described in this manual.

The procedure contains the following steps:

1. Noting the MAC-ID and establishing the fieldbus node
2. Connecting the PC and fieldbus node
3. Determining the IP address
4. Allocation of the IP address to the fieldbus node
5. Function of the fieldbus tests
6. Viewing the HTML pages

3.2.6.1 Note the MAC-ID and establish the fieldbus node

Before establishing your fieldbus node, please note the hardware address (MAC-ID) of your ETHERNET fieldbus controller.
This is located on the rear of the fieldbus controller and on the self-adhesive tear-off label on the side of the fieldbus controller.

MAC-ID of the fieldbus controller: ----- ----- ----- ----- ----- -----.

3.2.6.2 Connecting PC and fieldbus node

Connect the assembled ETHERNET TCP/IP fieldbus node via a hub or directly to the PC using a 10Base-T cable.

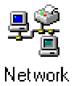
Attention
For a direct connection, a “crossover” cable is required instead of a parallel cable.

Now start the PC, functioning as master and BootP server, and apply power to the fieldbus coupler (DC 24 V power pack). Once the operating voltage has been switched on, the initialization starts. The fieldbus controller determines the configuration of the bus modules and creates the process image.
During the startup the 'I/O' LED (Red) flashes at high frequency.
When the 'I/O' LED and the 'ON' LED light up green, the fieldbus controller is ready for operation.
If an error has occurred during startup, it is indicated as an error code by the 'I/O'-LED flashing (red).

3.2.6.3 Determining IP addresses

If your PC is already connected to an ETHERNET network, it is very easy to determine the IP address of your PC. To do this, proceed as follows:

1. Go to the **Start menu** on your screen, menu item **Settings** and click on **Control Panel.**

2. Double click the icon **Network**. 

The network dialog window will open.

3. - Under Windows NT: Select the register: **Protocols** and mark the entry *TCP/IP protocol*.
   - Under Windows 9x*:* Select the register: **Configuration** and mark the entry *TCP/IP network card*.

Attention
If the entry is missing, please install the respective TCP/IP component and restart your PC. The Windows-NT installation CD, or the installations CD for Windows 9x is required for the installation.

4. Subsequently, click the button "Properties...".
The IP address and the subnet mask are found in the ‘IP address’ tab.If applicable, the gateway address of your PC is found in the ‘Gateway’ tab.

5. Please write down the values:

IP address PC:	----- . ----- . ----- . -----
Subnet mask:	----- . ----- . ----- . -----
Gateway:	----- . ----- . ----- . -----

6. Now select a desired IP address for your fieldbus node.

Attention
When selecting your IP address, ensure that it is in the same local network in which your PC is located.

7. Please note the IP address you have chosen:
IP address fieldbus node: ----- . ----- . ----- . -----

3.2.6.4 Allocating the IP address to the fieldbus node

A prerequisite for a communication with the controller is the assignment of an IP address.
The address can be transferred through BootP or a PFC program. With the PFC program, this is possible in **WAGO-I/O-*PRO* 32** using the library function "ETHERNET Set-Network-Config".

The following describes how to allocate the IP address for the fieldbus node using the WAGO BootP server by way of an example. You can download a free copy from WAGO over the Internet under:

http://www.wago.com/wagoweb/usa/eng/support/downloads/index.htm.

Note
The IP address can be allocated under other operating systems (i.e. under Linux) as well as with any other BootP servers.

Attention
The IP address can be allocated in a direct connection via a crossover cable or via a parallel cable and a hub. An allocation over a switch is not possible.

BootP table

Note
Prerequisite for the following steps is the correct installation of the WAGO BootP server.

1. Go to the **Start menu**, menu item **Programs / WAGO Software / WAGO BootP Server** and click on **WAGO BootP Server configuration. Or go to Start menu, menu item Programs/WAGO Software/WAGO BootP Server** and click on **WAGO BootP Server then click on the Edit Bootptab button located on the right hand side of the display.**
   An editable table will appear: "bootptab.txt".
   This table displays the data base for the BootP server. Directly following the list of all notations used in the BootP table there are two examples for the allocation of an IP address.
   "Example of entry with no gateway" and **"Example of entry with gateway".**

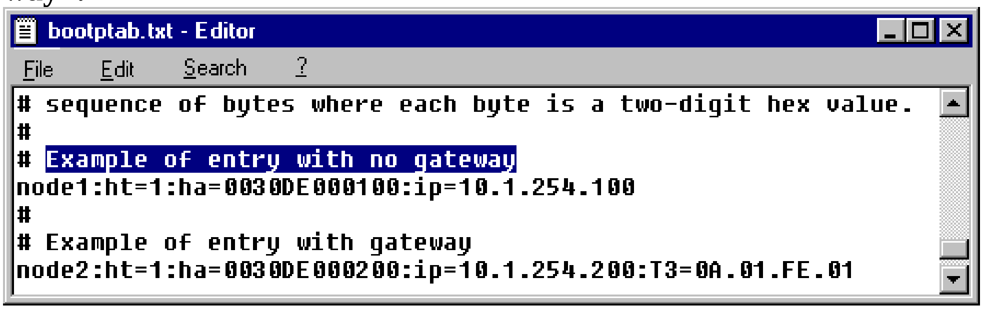


Fig. 3-31: BootP table p012908e

The examples mentioned above contain the following information:

Declaration	Meaning
node1, node2	Any name can be given for the node here.
ht=1	Specify the hardware type of the network here. The hardware type for ETHERNET is 1. (The numbers are described in *RFC1700*)
ha=0030DE000100 ha=0030DE000200	Specify the hardware address or the MAC-ID of the ETHERNET fieldbus controller (hexadecimal).
ip= 10.1.254.100 ip= 10.1.254.200	Enter the IP address of the ETHERNET fieldbus controller (decimal) here.
T3=0A.01.FE.01	Specify the gateway IP address here. Write the address in hexadecimal form.
sm=255.255.0.0	In addition enter the Subnet-mask of the subnet (decimal), where the ETHERNET fieldbus controller belongs to.

No gateway is required for the local network described in this example. Therefore, the first example: **"Example of entry with no gateway"** can be used.

2. Move the mouse pointer to the text line: "Kein-Proxy:ht=1:ha=0030DE000100:ip=10.1.254.100" and delete the 12 character hardware address which is entered after ha=...
   Enter the MAC-ID of your own network controller.
3. If you want to give your fieldbus node a name, delete the name "node1" and enter any name in its place.
4. To assign the controller a desired IP address, delete the IP address specified in the example which is entered after ip=...
   Replace it with the IP address you have selected, making sure you are separating the 3 digit numbers by a decimal.
5. Because the second example is not necessary at present, insert a "#" in front of the text line of the second example: "# hamburg:hat=1:ha=003 0DE 0002 00:ip=10.1.254.200:T3=0A.01.FE.01", so that this line will be ignored.

Note
To address more fieldbus nodes, enter a corresponding text line showing the corresponding entries for each node. Also note that the # symbol tells the BootP server to ignore any data after it, for that specific line.

6. Save the altered settings in this text file "bootptab.txt". To do this go to the **File** menu, menu item **Save,** and close the editor.

BootP Server

7. Now open the dialog window for the WAGO BootP server by going to the **Start menu** on your screen surface, menu item **Program / WAGO Software / WAGO BootP Server** and click on **WAGO BootP Server.**

8. Click on the "**Start**" button in the opened dialog window.
   This will activate the inquiry/response mechanism of the BootP protocol.
   A series of messages will be displayed in the BootP server. The error messages indicate that some services (e.g. port 67, port 68) in the operating system have not been defined. DO NOT BE ALARMED THIS IS THE CORRECT OPERATION FOR THIS EXAMPLE.

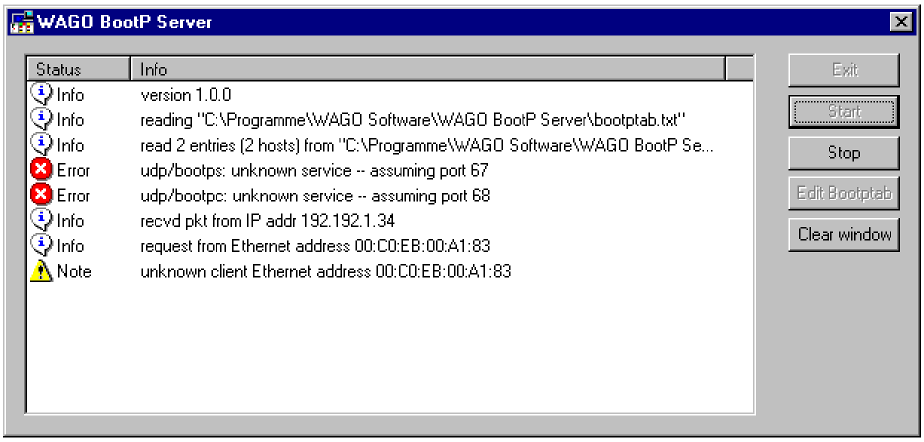


Fig. 3-32: Dialog window of the WAGO BootP server with messages P012909d

9. Now it is important to restart the controller by resetting the hardware . This ensures that the new IP address will be accepted by the controller.
   To do this, cycle power to the fieldbus controller for approximately 2 seconds or press the operating mode switch down which is located behind the configuration interface flap located on the front of the coupler.
   Following this, you should see a reply from the buscoupler stating that the IP address has been accepted (no errors). The IP address is now permanently stored in the coupler and will be retained even following the removal of the coupler or a longer voltage failure. The only way the IP address can be changed is by using the BootP software again.

10. Subsequently, click on the "**Stop**" button and then on the "**Exit**" button, to close the BootP Server .

3.2.6.5 Testing the function of the fieldbus node

1. To test the communication with the coupler and the correct assignment of the IP address call up the DOS prompt under **Start menu** / **Program** / **MS-DOS Prompt**.

2. Enter the command: "**ping"** with the IP address you have assigned in the following form:
   ping [space] XXXX **.** XXXX **.** XXXX **.** XXXX (=IP address).

Example: ping 10.1.254.202

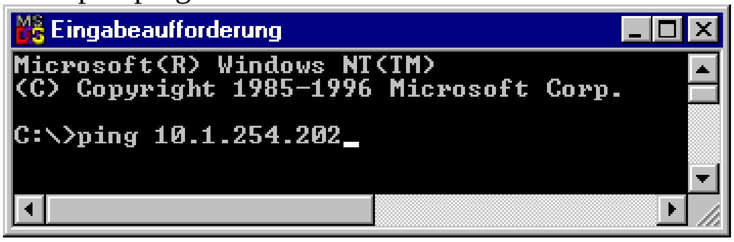


Fig. 3-33: Example for the function test of a fieldbus node P012910e

3. When the Return key has been pressed, your PC will receive a response from the controller, which will then be displayed in the DOS prompt.
   If the error message: "Timeout" appears instead, please compare your entries again to the allocated IP address and check all conections.

4. Also note that the TXD/RXD light will flash verifying each response

5. When the test has been performed successfully, you can close the DOS prompt. The network node has now been prepared for communication.

3.2.6.6 Viewing the HTML pages

The information saved in the fieldbus controller can be viewed as an HTML page using a web browser.

- Information on the fieldbus node (Terminal Status):
  - Number of digital, analog or complex modules and their model numbers
  - Representation of the process image
- Information on the fieldbus controller (Controller and Network Details):
  - Order number
  - Firmware version
  - MAC-ID
  - IP address
  - Gateway address (if applicable)
  - Subnet mask
  - Number of transmitted and received packets
- Diagnostic information on the fieldbus controller (Controller Status):
  - Error code
  - Error argument
  - Error description

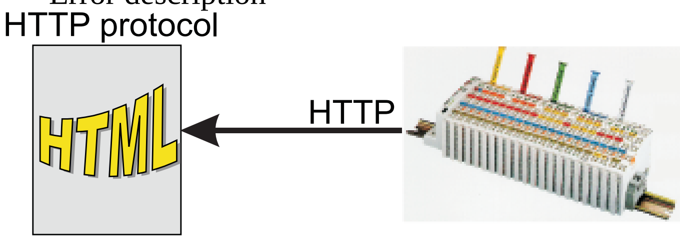


Fig. 3-34: Viewing the information through the HTTP protocol G012916d

Please proceed as follows:

1. Open a web browser such as Microsoft Internet-Explorer, Netscape Navigator, ...
2. Simply enter the IP address of your fieldbus node in the address field of the browser and press the Enter key.
   The first HTML page with the information on your fieldbus controller will be displayed in the browser window. Use the hyperlinks to find out more information.

Attention
If the pages are not displayed after local access to the fieldbus node, then define in your web browser that, as an exception, no proxyserver is to be used for the IP address of the node.

3.2.7 Programming the PFC with WAGO-I/O-*PRO* 32

Due to the IEC 61131 programming of the ETHERNET TCP/IP fieldbus controller 750-842 you have the option to use the functionality of a PLC beyond the functions of fieldbus coupler 750-342.
An application program according to IEC 61131-3 is created using the programming tool **WAGO-I/O-*PRO* 32**.

This manual, however, does not include a description of how to program with **WAGO-I/O-*PRO* 32**. In contrast, the following chapters are to describe the special modules for **WAGO-I/O-*PRO* 32** for you to utilize explicitly for programming the ETHERNET TCP/IP fieldbus controller.
The description also deals with the way of transmitting the IEC 61131-3 program into the controller and loading a suitable communication driver.

More information
For a detailed description of how to use the software, please refer to the **WAGO-I/O-*PRO* 32** manual (order No.: 759-122 / 000-001).

3.2.7.1 WAGO-I/O-*PRO* 32 library elements for ETHERNET

You are offered various libraries for different IEC 61131-3 programming applications in **WAGO-I/O-*PRO* 32**. They contain modules of universal use and can, thereby, facilitate and speed up the creation of your program. As standard, the library 'standard.lib' is available to you.

The libraries described in the following are specifically intended for ETHERNET projects with **WAGO-I/O-*PRO* 32**:

- "ETHERNET. lib"
  (contains elements for the ETHERNET fieldbus communication),
- "EtherTCPmodbus.lib"
  (contains elements for the MODBUS TCP fieldbus communication) and
- "Internal types for EtherTCPmodbus.lib"
  (contains elements for an easier access to the MODBUS/TCP requests und responses).

These libraries are loaded on the **WAGO-I/O-*PRO*** CD.
Having integrated these libraries, you have access to their POUs, data types and global variables which can be used in the same manner as those defined by yourself.

More information
For a detailed description of the POUs and the software operation, please refer to the **WAGO-I/O-*PRO* 32** manual (order No.: 759-122 / 000-001).

3.2.7.1.1 ETHERNET.lib

Element	Description
ETHERNET_CLIENT_CLOSE	Function block to close a client socket.
ETHERNET_CLIENT_OPEN	Function block to create a client socket. *)
ETHERNET_GET_NETWORK_CONFIG	Function block to get the node’s network configuration.
ETHERNET_READ	Function block to read date received from a remote system.
ETHERNET_SERVER_CLOSE	Function block to close a Server socket with all underlying connections (clients connected to the server).
ETHERNET_SERVER_OPEN	Function block to create a Server socket. It is a base for a communication to a remote system..*)
ETHERNET_SET_NETWORK_CONFIG	Function block to set the node’s network configuration.
ETHERNET_VERSION	Function to get the library’s current version.
ETHERNET_WRITE	Function block to write data to a remote system.
ETH_ERROR (Data type)	Data type defines the error codes returned by the ETHERNET function blocks.
SEL_PROTOCOL (Data type)	Data type defines the transport protocol to use. Is used by ETHERNET_CLIENT_OPEN and ETHERNET_SERVER_OPEN.
SEL_TYPE (Data type)	Data type defines the semantics of communication. Is used by ETHERNET_CLIENT_OPEN and ETHERNET_SERVER_OPEN).

*) The maximum number of connections open at a time is 2. You might have to terminate existing connections to ETHERNET_CLIENT_CLOSE or ETHERNET_SERVER_CLOSE.

3.2.7.1.2 EtherTCPmodbus.lib

Element	Description
HTONS	Function converts the value ShortNumber from Intel format to Motorola format.
RECV_MODBUS_MESSAGE	Function to receive the answer to a MODBUS/TCP request over a TCP connection.*)
SEND_MODBUS_MESSAGE	Function to send a MODBUS/TCP message over a TCP connection.*)
MODBUS_FC (Data type)	Data type, defines the function code to use. (Is used by SEND_MODBUS_MESSAGE and RECV_MODBUS_MESSAGE)

*) To prevent a complete filling of the buffer, the module SEND_MODBUS_MESSAGE should always preceed the RECV_MODBUS_MESSAGE.

3.2.7.1.3 Internal types for EtherTCPmodbus.lib

Element	Description
MODBUS_HEADER	This types are internally used by the functions SEND_MODBUS_MESSAGE and RECV_MODBUS_MESSAGE. They map the MODBUS/TCP requests and responses, so that an easier access to the message fields can be done.
MODBUS_FMC_REQUEST	
MODBUS_FMC_RESPONSE	
MODBUS_RC_REQUEST	
MODBUS_RC_RESPONSE	
MODBUS_RID_REQUEST	
MODBUS_RID_RESPONSE	
MODBUS_RIR_REQUEST	
MODBUS_RIR_RESPONSE	
MODBUS_RMR_REQUEST	
MODBUS_RMR_RESPONSE	
MODBUS_WC_REQUEST	
MODBUS_WC_RESPONSE	
MODBUS_WMR_REQUEST	
MODBUS_WMR_RESPONSE	
MODBUS_WSR_REQUEST	
MODBUS_WSR_RESPONSE	

3.2.7.2 IEC 61131-3-Program transfer

Program transfer from the PC to the controller following programming of the desired IEC 61131 application can be made in two different ways:

- via the serial interface or
- via the fieldbus.

One suitable communication driver each is required for both types.

More information
For information on the installation of the communication drivers as well as details regarding the use of the software, please refer to the **WAGO-I/O-*PRO* 32** manual (order No.: 759-122 / 000-001).

3.2.7.2.1 Transmission via the serial interface

Use the WAGO communication cable to produce a physical connection to the serial interface. This is contained in the scope of delivery of the programming tool IEC 1131-3, order No.: 759-332/000-002, or can be purchased as an accessory under order No.: 750-920.
Connect the COMX port of your PC with the communication interface of your controller using the WAGO communication cable.
A communication driver is required for serial data transmission. In **WAGO-I/O-*PRO* 32,** this driver and its parameterization are entered in the **"Communication parameters"** dialog.

1. Start the **WAGO-I/O-*PRO* 32** software by ’Start/Programs’ or by double clicking on the WAGO-I/O-PRO-32 symbol on your desk top.

2. In the **"Online"** menu click on the **"Communication parameters"** menu point.
   The dialog "Communication parameters" opens. The basic setting of this dialog does not have any entries.

3. In the selection window mark the desired driver on the right-hand dialog side (i.e. **"Serial (RS232)"**, to configure the serial connection between PC and the controller).

4. In the center window of the dialog, the following entries have to appear: -Parity: Even and -Stop bits: 1.
   If necessary, change the entries accordingly.
   You can now begin testing the controller.

Note
To be able to access the controller, ensure that the operating mode switch of the controller is set to the center or the top position.

5. Under **"Online"** click on the **"Log-on"** menu point to log into the controller.
   (The **WAGO-I/O-*PRO* 32 server** is active during online operation. The communication parameters cannot be polled.)

6. If no program is in the controller, now a window appears asking whether or not the program is to be loaded.
   Confirm with **"Yes".**
   Subsequently the current program will be loaded.

7. As soon as the program is loaded, you can start program with the **"Online"** menu, menu point **"Start"**.
   At the right-hand end of the status bar, the system signals **"ONLINE RUNNING"**.

8. To terminate the online operation, return to the **"Online"** menu and click on the **"Log-off"** menu point.

3.2.7.2.2 Transmission by the fieldbus

The PC and the controller are physically connected via the Ethernet cable. For data transmission, a suitable communication driver is required. This driver is entered in the **"Communication parameters"** dialog in **WAGO-I/O-*PRO* 32**.

1. Start the **WAGO-I/O-*PRO* 32** software by 'Start/Programs' or by double clicking on the WAGO-I/O-PRO-32 symbol on your desk top.

2. In the **"Online"** menu click on the **"Communication parameters"** menu point.
The "Communication parameters" dialog opens. The basic setting of this dialog has no entries. This is assuming that you have not used the software to configure any other couplers.

3. Select the New button on the right hand side of the Communications Parameters dialog box. Select the “Ethernet_TCP_IP” driver (it is the last entry). You can enter a name in the “Name” field located in the top-left of the dialog box. After all data has been entered click OK.

4. While the Ethernet driver is selected (click on the new driver you selected in the previous step). The following entries have to appear in the center window of the dialog: -Port No.: 2455 and –IP address: (the IP address of your controller assigned via BootP).
If necessary, change the entry accordingly.
You can now begin testing the controller.

Note
To be able to access the controller, the coupler has to have an IP address, and the operating mode switch of the controller must be in the centerre or top position.

5. Under **"Online"** click on the **"Log-on"** menu point to log into the controller.
(During online operation, the **WAGO-I/O-*PRO* 32 server** is active. The communication parameters cannot be polled.)

6. If no program is contained in the controller, a window appears asking whether or not the program is to be loaded.
Confirm with **"Yes".**
Subsequently the current program is loaded.

7. As soon as the program is loaded, you can start it by selecting **"Online"** menu, then **"Start"**.
At the right-hand end of the status bar, the system displays **"ONLINE RUNNING"**.

8. To terminate the online operation, return by the **"Online"** menu and click on the **"Log-off"** menu point.

3.2.8 LED Display

The controller possesses several LED's for on site display of the controller operating status or the complete node.

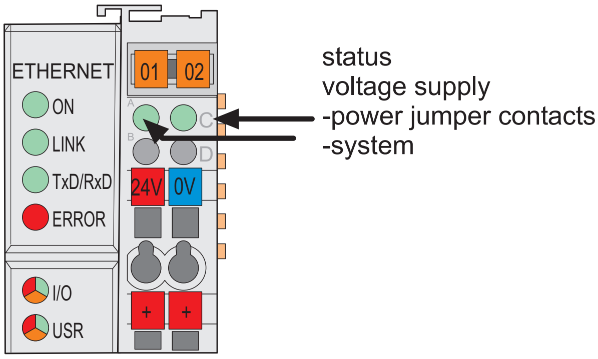


Fig. 3-35: Display elements 750-842 g012902e

A differentiation between two LED groups is made.

The first group = fieldbus contains the solid color LEDs having the designation ON (green), LINK (green), TxD/RxD (green) and ERROR (red) indicating the operating status of the communication via ETHERNET.
The second group = internal bus consists of the three-color I/O LED (red/green/orange). This LED is used to display the status of the internal bus, i. e. the status of the fieldbus node.

The three-color USR-LED can be accessed by a user program in the programmable fieldbus controller.

LEDs located on the right-hand side in the coupler power supply section show the status of the supply voltage.

3.2.8.1 Blink code

A blink code displays detailed fault messages. A fault is cyclically displayed using up to 3 different blink sequences.

- The first blink sequence (approx. 10 Hz) indicates the fault display.
- After a pause, a second blink sequence appears (approx. 1 Hz). The number of blink impulses gives the **fault code**.
- The third blink sequence (approx. 1 Hz) appears following a further pause. The number of blink pulses indicates the **fault argument (where the faulty module is physically located on the node)**.

3.2.8.2 Fieldbus status

The operating status of the communication via ETHERNET is signalled via the top LED group (ON, LINK, TxD/RxD and ERROR).

LED	Meaning	Trouble shooting
ON		
green	Fieldbus initialization is correct	
OFF	Fieldbus initialization is not correct, no function or self test	Check the supply voltage (24V and 0V), check the IP configuration
LINK		
green	Link to a physical network exists	
OFF	No link to a physical network	Check the fieldbus connection.
TxD/RxD		
green	Data exchange taking place	
OFF	No data exchange	
ERROR		
red	Error on the fieldbus	
OFF	No error on the fieldbus, normal operation	

3.2.8.3 Node status

The operating status of the communication with the internal bus is signalled by the bottom I/O-LED.

LED	Meaning	Trouble shooting
I/O		
green	Fieldbus controller operating perfectly	
red	a) During startup of fieldbus controller: Internal bus being initialized, Startup displayed by LED flashing fast for approx. 1-2 seconds	
red	b) After startup of fieldbus controller: Errors, which occur, are indicated by three consecutive flashing sequences. There is a short pause between each sequential.	Evaluate the fault message (fault code and fault argument).

The controller starts up after switching on the supply voltage. The "I/O" LED blinks. The "I/O" LED has a steady light following a fault free start-up.
In the case of a fault the "I/O" LED continues blinking. The fault is cyclically displayed by the blink code.

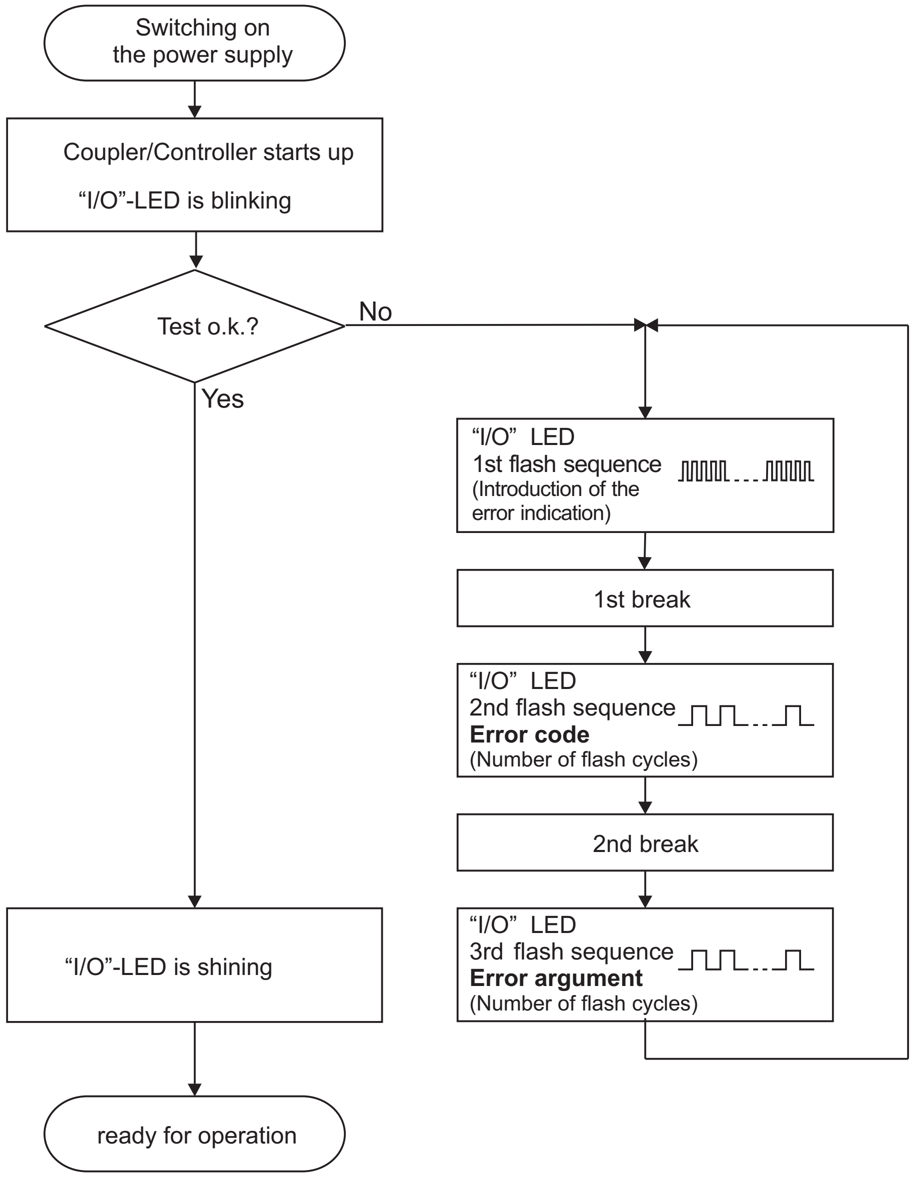


Fig. 3-36: Signalling of the LED for indication of the node status g012911e

After overcoming a fault restart the controller by cycling the power.

3.2.8.4 Fault message via blink code from the I/O-LED

Fault argument	Fault description
Fault code 1: Hardware and Configuration fault	
0	EEPROM check sum fault / check sum fault in the parameter area of the flash memory
1	Overflow of the internal buffer memory for the inline code
2	Unknown data type
3	Module type of the flash program memory could not be determined / is incorrect
4	Fault when writing in the FLASH memory
5	Fault when deleting the FLASH memory
6	Changed I/O module configuration determined after AUTORESET
Fault code 2: Fault in programmed configuration	
0	Incorrect table entry
Fault code 3: Internal bus command fault	
0	No fault argument is put out.
Fault code 4: Internal bus data fault	
0	Data fault on internal bus or Internal bus interruption on controller
n* (n>0)	Internal bus interrupted after I/O module n
Fault code 5: Fault during register communication	
n*	Internal bus fault during register communication after I/O module n
Fault code 6: Fieldbus specific errors	
1	No answer from the BootP server
2	ETHERNET controller not recognized
3	Invalid MACID
4	TCP/IP initialization error
Fault code 7: I/O module is not supported	
n*	I/O module at position n is not supported
Fault code 8: not used	
0	Fault code 8 is not used.
Fault code 9: CPU-TRAP error	
1	Illegal Opcode
2	Stack overflow
3	Stack underflow
4	NMI

* The number of blink pulses (n) indicates the position of the I/O module. I/O modules without data are not counted (i.e. supply modules without diagnostics).

Example for a fault message

Fault: The 13th I/O module has been removed.

4. The "I/O" LED starts the fault display with the first blink sequence (approx. 10 Hz).
5. The second blink phase (approx. 1 Hz) follows the first pause. The "I/O" LED blinks four times and thus signals the fault code 4 (internal bus data fault).
6. The third blink sequence follows the second pause. The "I/O ERR" LED blinks twelve times. The fault argument 12 means that the internal bus is interrupted after the 12th I/O module.

3.2.8.5 Supply voltage status

There are two green LED's in the controller supply section to display the supply voltage. The left LED (A) indicates the 24 V supply for the controller. The right hand LED (C) signals the supply to the field side, i.e. the power jumper contacts.

LED	**Meaning**	**Trouble shooting**
A		
green	Operating voltage for the system exists.	
OFF	No operating voltage for the system.	Check the supply voltage (24V and 0V).
C		
green	Operating voltage for the power jumper contacts exists.	
OFF	No operating voltage for the the power jumper contacts.	Check the supply voltage (24V and 0V).

3.2.9 Fault behavior

3.2.9.1 Fieldbus failure

A fieldbus failure is given i. e. when the master cuts-out or the bus cable is interrupted. A fault in the master can also lead to a fieldbus failure.
A fieldbus failure is indicated by illuminating the red "ERROR"-LED.
If the watchdog is activated, the watchdog-register is evaluated in the case of fault free communication.
The evaluation of the watchdog register is made using the function block 'FBUS_ERROR_INFORMATION' in the control program. The internal bus remains in function and the process illustrations are retained. The control program can be further processed independently.

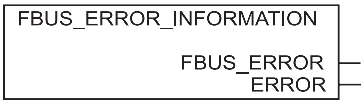


Fig. 3-37: Function block for determining a fieldbus failure g012926x

'FBUS_ERROR' (BOOL) = FALSE = no fault

= TRUE = fieldbus failure

'ERROR' (WORD) = 0 = no fault
= 1 = fieldbus failure

The nodes can set to a safe status in the case of a fieldbus failure using these outputs and a corresponding control program.

More information
For detailed information to the Watchdog register see Chaper 6.2.12 "Watchdog (Fieldbus failure)".

3.2.9.2 Internal bus fault

An internal bus fault is created, for example, if an I/O module is removed. If this fault occurs during operation, the output modules behave in the same manner as an I/O module stop.

The "I/O" LED blinks red.

The controller generates a fault message (fault code and fault argument).

Once the internal bus fault is fixed, the controller starts up following power being cycled as during a normal start-up. The transfer of the process data is then resumed and the node outputs are correspondingly set.

3.2.10 Technical Data

System data	
Max. n. of nodes	limited by ETHERNET specification
Transmission medium	Twisted Pair S-UTP 100 Ω cat. 5
Buscoupler connection	RJ45
Max. length of fieldbus segment	100 m between hub station and 750-342; max. length of network limited by ETHERNET specification
Baud rate	10 Mbit/s
Protocols	MODBUS/TCP, HTTP, BootP
Programming	WAGO-I-PRO
IEC 61131-3-3	IL, LD, FBD, ST, FC
Approvals	
UL	E175199, UL508
Conformity marking	CE
Technical Data	
Max. n. of I/O modules	64
Input process image	max. 512 Byte
Output process image	max. 512 Byte
Input variables	max. 512 Byte
Output variables	max. 512 Byte
Configuration	via function blocks
Program memory	128 Kbyte
Data memory	64 Kbyte
Non-valatile memory	8 KByte
Cycle time	< 3 ms for 1,000 statements/ 256 dig. I/O's
Max. n. of socket connections	1 HTTP, 3 MODBUS/TCP, 2 PFC, 2 WAGO-I/O-PRO
Voltage supply	DC 24 V (-15 % / + 20 %)
Input current$_{max}$	500 mA at 24 V
Efficiency of the power supply	87 %
Internal current consumption	200 mA at 5 V
Total current for I/O modules	1800 mA at 5 V
Isolation	500 V system/supply
Voltage via power jumper contacts$_{max}$	DC 24 V (-15 % / + 20 %)
Current via power jumper contacts$_{max}$	DC 10 A
Dimensions (mm) W x H x L	51 x 65* x 100 (*from upper edge of DIN 35 rail)
Weight	approx. 195 g
EMC Immunity to interference	acc. to EN 50082-2 (95)
EMC Emission of interference	acc. to EN 50081-2 (94)

4 I/O modules

All available bus modules in the WAGO-I/O-SYSTEM 750 are included in the following overview.

The following chapters contain a detailed description of each individual bus module and its variation.

Attention
The process data configuration of some bus modules or their variations are specific to the bus coupler used. For more detailed information please refer to the chapters "Process data architecture for MODBUS/TCP" in the process image description of the corresponding coupler/controller.

4.1 I/O modules-Review

Digital Inputs start on page 98

Item-No:	Name	On page
750-400	2 Channel Digital Input (filter 3.0 ms, DC 24 V)	99
750-401	2 Channel Digital Input (filter 0.2 ms, DC 24 V)	99
750-402	4 Channel Digital Input (filter 3.0 ms, DC 24 V)	101
750-403	4 Channel Digital Input (filter 0.2 ms, DC 24 V)	101
750-404	U/D Counter	103
750-405	2 Channel Digital Input (AC 230 V)	118
750-406	2 Channel Digital Input (AC 120 V)	120
750-408	4 Channel Digital Input (filter 3.0 ms, DC 24 V)	122
750-409	4 Channel Digital Input (filter 0.2 ms, DC 24 V)	122
750-410	2 Channel Digital Input (filter 3.0 ms, DC 24 V)	124
750-411	2 Channel Digital Input (filter 0.2 ms, DC 24 V)	124
750-412	2 Channel Digital Input (filter 3.0 ms, DC 48 V)	126
750-414	4 Channel Digital Input (filter 0.2 ms, DC 5 V)	128
750-415	4 Channel Digital Input (filter 0.2 ms, AC/DC 24 V)	130

Digital Outputs start on page 132

Item-No:	Name	On page
750-501	2 Channel Digital Output (0.5 A, DC 24 V)	133
750-502	2 Channel Digital Output (2A, DC 24 V)	133
750-504	4 Channel Digital Output (0.5 A, DC 24 V)	135
750-506	2 Channel Digital Output (0.5 A, DC 24 V) diag.	137
750-507	2 Channel Digital Output (2.0 A, DC 24 V) diag.	139
750-509	2 Channel Solid State Relay (2 Outputs 0,3 A, AC 230 V)	142
750-511	2 Channel Pulsewidth Output (0.1 A, DC 24 V)	142
750-512	Digital Output Relay (2 normally open contact, non-floating, AC 250 V)	144
750-513	Digital Output Relay (2 normally open contacts, isolated outputs, 2.0 A, AC 250 V)	150
750-514	Digital Output Relay (2 changeover contacts, isolated outputs, 0.5 A, AC 125 V)	153
750-516	4 Channel Digital Output (0.5 A, DC 24 V)	156
750-517	Digital Output Relay (2 changeover contacts, isolated outputs, 1.0 A, AC 230 V)	158
750-519	4 Channel Digital Output (20 mA, DC 5 V)	160

Analog Inputs

start on page 164

Item-No:	Name	On page
750-452	2 Channel Analog Input (0-20mA, Diff.)	165
750-454	2 Channel Analog Input (4-20mA, Diff.)	165
750-456	2 Channel Analog Input (±10 V, Diff.)	169
750-461	2 Channel Input PT 100 (RTD)	172
750-462	2 Channel Analog Input Thermocouple	177
750-465	2 Channel Analog Input (0-20mA single-ended)	186
750-466	2 Channel Analog Input (4-20mA single-ended)	186
750-467	2 Channel Analog Input (0-10 V single-ended)	190
750-468	4 Channel Analog Input (0-10 V single-ended)	193
750-469	2 Channel Analog Input Thermocouple (detection of broken wire)	196
750-472	2 Channel Analog Input (0-20mA single-ended) 16Bit	203
750-474	2 Channel Analog Input (4-20mA single-ended) 16Bit	203
750-476	2 Channel Analog Input (DC ±10 Vsingle-ended)	206
750-478	2 Channel Analog Input (DC 0-10 V single-ended)	206

Analog Outputs

start on page 209

Item-No:	Name	On page
750-550	2 Channel Analog Output (DC 0-10 V)	210
750-552	2 Channel Analog Output (0-20mA)	214
750-554	2 Channel Analog Output (4-20mA)	214
750-556	2 Channel Analog Output (DC ±10 V)	214

Supply and End modules start on page 217

Item-No:	Name	On page
750-600	End module	218
750-601	Supply modules with fuse holder (DC 24 V)	219
750-602	Supply modules, passive (DC 24 V)	220
750-609	Supply modules with fuse holder (AC 230 V)	219
750-610	Supply modules with fuse holder, with diagn. (DC 24 V)	221
750-611	Supply modules with fuse holder, with diagn. (AC 230 V)	221
750-612	Supply modules, passive (AC/DC 230 V)	223
750-613	Supply modules with DC-DC Converter (DC 24 V)	224
750-614	Potential multiplication modules (AC/DC 24 V-230 V)	225
750-615	Supply modules with fuse holder (AC 120 V)	219
750-616	Separation modules	226
750-622	Binary spacer modules	227

Terminal blocks for encoder and resolvers start on page 229

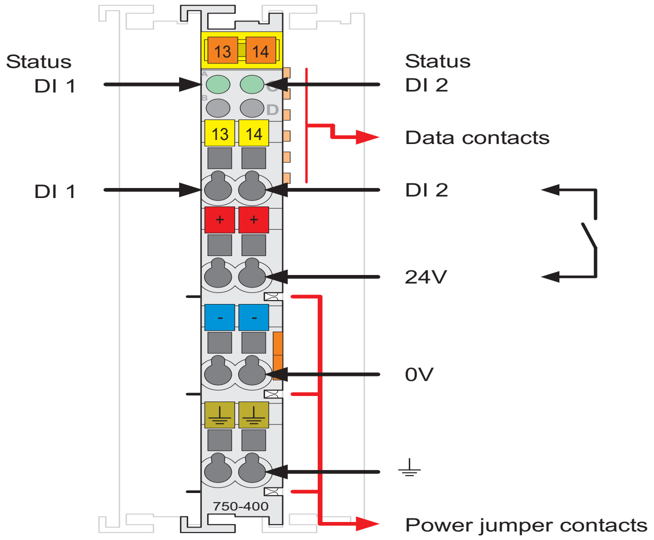
Item-No:	Name	On page
750-630	SSI transmitter interface 24Bit 125 kHz	230
750-631	Incremental encoder interface	233

Special terminal blocks start on page 238

Item-No:	Name	On page
750-650	RS232 (Full duplex)	239
750-651	TTY-, 20 mA Current Loop	245
750-653	RS485 Interface (Full duplex)	251
750-654	Data exchange module	257

4.2 Digital Inputs

4.2.1.1.1 2 Channel Digital Inputs (DC 24V, 3.0 ms / 0.2 ms) 750-400, -401



Technical description

The power supply is connected to the power jumper contacts on each I/O module for the respective operating voltage. Power connections are made automatically from module to module when snapped onto the DIN rail, with power supplied through a powerfeed module.

All 2-channel digital inputs are 4-conductor devices allowing the direct connection of 4-conductor sensors with the terminations V+, 0V, ground and signal.

The power distribution module 750-614 is available for the connection of more sensors to V+ and 0V, but does not continue the grounding contact.

RC filters are series-connected for noise rejection and relay switch debouncing. They are available with time constants of 3.0 ms and 0.2 ms.

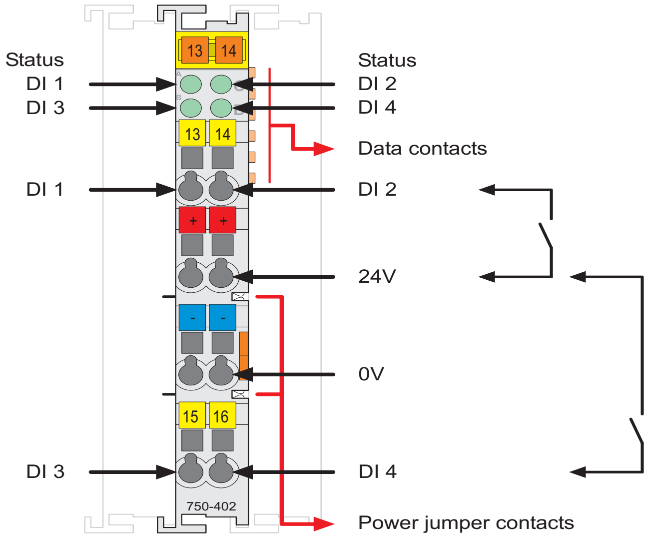
The positions of the different I/O modules in the configured node/station are selectable by the user. A block type configuration is not necessary.

These input modules can operate with all buscouplers of the WAGO-I/O-SYSTEM.

Technical Data:

Item-No.:	750-400	750-401
Number of inputs	2	
Input filter	3 ms	0.2 ms
Voltage via power jumper contacts	DC 24V (-15% / +20%)	
Signal voltage (0)	DC -3 V...+5 V (std. EN 61131 Type 1)	
Signal voltage (1)	DC 15 V...30 V (std. EN 61131 Type 1)	
Input current (internal)	2.5 mA max.	
Input current (field side)	5 mA typ.	
Isolation	500 V System/power supply	
Internal bit width	2	
Configuration	no address or configuration adjustment	
Operating temperature	0°C....+55°C	
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length	
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)	

4.2.1.1.2 4 Channel Digital Inputs (DC 24V, 3.0 ms / 0.2 ms) 750-402, -403



Technical description

The power supply is connected to the power jumper contacts on each I/O module for the respective operating voltage. Power connections are made automatically from module to module when snapped onto the DIN rail, with power supplied through a powerfeed module.

The 4-channel digital inputs are suitable for the direct connection of two 3-conductor sensors (V+, 0V, signal).

The power distribution module 750-614 is available for the connection of more sensors to V+ and 0V.

RC filters are series-connected for noise rejection and switch debouncing. They are available with time constants of 3.0 ms and 0.2 ms.

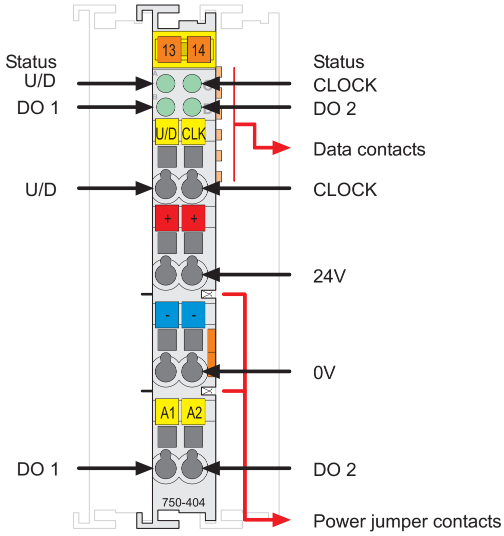
The positions of the different I/O modules in the configured node/station are selectable by the user. A block type configuration is not necessary.

These input modules can operate with all buscouplers of the WAGO-I/O-SYSTEM.

Technical Data:

Item-No.:	**750-402**	**750-403**
Number of inputs	4	
Input filter	3 ms	0.2 ms
Voltage via power jumper contacts	DC 24V (-15% / +20%)	
Signal voltage (0)	DC -3 V...+5 V (std. EN 61131 Type 1)	
Signal voltage (1)	DC 15 V...30 V (std. EN 61131 Type 1)	
Input current (internal)	5 mA max.	
Input current (field side)	5 mA typ.	
Isolation	500 V System/power supply	
Internal bit width	4	
Configuration	no address or configuration adjustment	
Operating temperature	0°C....+55°C	
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length	
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)	

4.2.1.1.3 Counter modules 750-404/000-XXX Up Down Counter100kHz 750-404



I/O modules and variations

Item-No.:	Name:
750-404	Up/Down Counter
750-404/000-001 (s. page **107**)	Counter with enable input
750-404/000-002 (s. page **108**)	Peak Time Counter
750-404/000-003 (s. page **109**)	Frequency Counter Module (0.1-10 kHz)
750-404/000-004 (s. page **114**)	Up/Down Counter (switching outputs)
750-404/000-005 (s. page **116**)	2 Channel Up Counter 16Bit

Technical description

Attention
The description that is in the I/O ring binder data pages (888-530/013-600 dated 7/96) is not correct. The bottom contacts are additional outputs.

The described configuration is counter with up/down input.

The following description is preliminary and is applicable to the factory configuration.

The counter module can operate with all WAGO-I/O-SYSTEM bus-couplers (except for the economy type).

Technical Data:

Item-No.:	750-404, 750-404/000-001, 750-404/000-004	750-404/000-002
Number of outputs	2	
Number of counters	1	
Output current	0.5 A	
Input current (internal)	70 mA	
Voltage via power jumper contacts	DC 24 V (-15 % / + 20 %)	
Signal voltage (0)	DC -3 V ... +5 V	
Signal voltage (1)	DC + 15 V ... 30 V	
Switching rate	100 kHz max	10kHz max
Input current (field side)	5 mA typ.	
Counter size	32 Bit Data	
Isolation	500V System/power supply	
Internal bit width	32 Bit Data, 8 Bit Control/Status	
Configuration	none, or via software with the consent of WAGO	
Operating temperature	0 °C ... + 55 °C	
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length	
Dimensions (mm) WxHxL	12 x 64* x 100, (*from upper edge of carrier rail)	

Organization of the input and output data:

The counter begins processing with pulses at the CLOCK input. The changes from 0 V to 24 V are counted. (The leading edge of each pulse.)

The counter counts up, if the input U/D is set at 24 V. With an open circuit input or 0 V the counter counts backwards (down).

The two bottom contacts are 24V outputs. These outputs are activated through bits in the control byte.

The high states of the input and output channels are each indicated by a LED.

Attention
For the process data configuration of these bus modules please refer to chapter "Process data architecture for MODBUS/TCP" in the process image description of the corresponding coupler/controller.

The control byte has the following bits::

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	x	Set Counter	Block Counter	Output value at output O2	Output value at output O1	x	X

The status byte has the following bits:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
x	x	Counter is set	Counter is blocked	State of signal at output O1	State of signal at output O1	24 V signal at input U/D, counter counts up	actual signal at input CLOCK

With the control and status byte the following tasks are possible:

Setting the counter:
Set Bit 5 in the control byte to "1". The desired counter value with the 32 bit value is loaded into output bytes 0-3. As long as the bits are set, the counter can stop and information is stored. The ensuing data of the counter will be conveyed to the status byte.

Blocking the counter:
Bit 4 is set into the control byte, then the count process is suppressed. Bit 4 in the status byte communicates the suppression of the counter.

Setting the outputs:
Bits 2 and 3 set the additional two outputs of the counter module.
The result of the counter is in binary. The following tasks can be handled with the control byte and the status byte:

An example:

Setting counter to a value of 100 and counting up

First of all the counter reading is set to 100 by "Setting counter", i. e. to the hexadecimal value: 0x64.

1. Enter the counter reading in the output data.
   The data bytes D0 to D3 of the output data then read as follows:

D3	D2	D1	D0
0x00	0x00	0x00	0x64

2. Validate the counter reading in the control byte with bit 5 (setting counter) to have it adopted as an output value. The control byte has the following bits:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	X	1	X	X	X	X	X

3. Wait for the feedback from the counter module in the status byte, bit 5 (counter set). The status byte has the following bits:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
X	X	1	X	X	X	X	X

4. Set bit 5 (setting counter) in the control byte in order to finish the Hand-shake. The bits in the control byte read as follows:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	X	0	X	X	X	X	X

5. The set counter reading then appears in the input data with the following data bytes D0 to D3:

D3	D2	D1	D0
0x00	0x00	0x00	0x64

Counter counting up:

Attention
For counting up, 24 V must be applied to input U/D.

6. Wait for the first and further count pulses.
   During counting, the data bytes D0 to D3 of the input data appear as follows:

D3	D2	D1	D0	Remark
0x00	0x00	0x00	0x64	no count pulse received
0x00	0x00	0x00	0x65	1st count pulse received
0x00	0x00	0x00	0x66	2nd count pulse received
....	....	....	....	
0xFF	0xFF	0xFF	0xFF	Max. counter reading reached
0x00	0x00	0x00	0x00	the next count pulse causes a number overflow
0x00	0x00	0x00	0x01	One further count pulse received
....	....	....	....	

Attention
"X" is used if the value at this position is without any significance.

4.2.1.1.4 Variation Counter with enable input 750-404/000-001

Technical description

The counter module also can be ordered as counter with enable input (750-404/000- 001).

The counter begins processing with pulses at the CLOCK input. The changes from 0 V to 24 V are counted.

The counting is enabled if the GATE (U/D)terminal is an open circuit input or 0V. To disable processing, the GATE (U/D)input is to be set to 24 V DC.

The data format of the module is 4 bytes data and a control/status byte. The module is a 32 Bit counter. The format of input and output data is the same as 750-404.

The counter module can operate with all WAGO-I/O-SYSTEM bus-couplers (except for the economy type).

4.2.1.1.5 Variation
Peak Time Counter 750-404/000-002

Technical description

The counter module also can be ordered as peak time counter with 750-404/000-002.
This description is only intended for hardware version X X X X 0 0 0 1- - - -.
The serial number can be found on the right side of the module.

The counter begins processing with pulses at the CLOCK input. The changes from 0 V to 24 V are counted.
The counter counts up if the input U/D is set at 24 V. With an open circuit input or 0 V the counter counts backwards.
The two bottom contacts each include another output. These outputs are activated through bits in the control byte.
The high states of the input and output channels are each indicated by a LED.
The counter module can operate with all WAGO-I/O-SYSTEM bus-couplers (except for the economy type).

Organization of the input and output data:

The counter begins processing with pulses at the CLOCK input and counts the pulses in a special time span. The time span is given as 10 s.

The state of the counter is stored in the process image until the next period. After the recording the counting starts again at 0.

The activation of the counting and the synchronization with the SPS is made by a handshake in the control and status byte.

The end of the counting period and thus the new process data is signaled by a toggle bit in the status byte.

The control byte has the following bits:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	Start of the periodic counting	0	Output value at output O2	Output value at output O1	0	0

The status byte has the following bits:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	Couting started	0	actual signal at output O2	Actual signal at output O1	actual signal at input V/R	Togglebit for end of the record

4.2.1.1.6 Variation Frequency Counter Module 750-404/000-003

Technical description

The counter module also can be ordered as frequency counter module with 750-404/000-003.

The counter module 750-404/000-003 measures the period of the 24 V DC input signal at the CLOCK terminal and converts it into a corresponding frequency value. The measurement is enabled if the GATE terminal is an open circuit input or 0V. To disable processing, the GATE input is to be set to 24 V DC.

The terminals O1 and O2 work as binary outputs. Each output can be activated via specific bits in the CONTROL byte.

The high states of the input and output channels are each indicated by a LED.

To recognize low frequency or near zero frequency signals, the maximum time between two data updates is parameterizable.

Technical Data:

Item-No.:	**750-404/000-003**
Number of outputs	2
Number of counters	1
Output current	0.5A (short-circuit protected)
Input current (internal)	80mA max. at DC 5V
Voltage via power jumper contacts	DC 24V (-15%/+20%)
Signal voltage (0)	DC -3V ... 5V
Signal voltage (1)	DC 15V ... 30V
Min. Pulse width	10µs
Input current	5mA typ.
Voltage drop	DC 0.6V max. at 0.5A
Internal Bit width	32 Bit Data + 8 Bit control/status
Operating temperature	0°C....+55°C
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)

Max. Frequency Range	
Integration time = 1 period	0.1 Hz - 8 kHz, Resolution 0.001Hz
Integration time = 4 periods	0.25 Hz - 32 kHz, Resolution 0.01Hz
Integration time = 16 periods	1 Hz - 100 kHz, Resolution 0.1Hz (1Hz)
Measuring Error using the max. Frequency Range	
Range 0.1 Hz - 8 kHz	< ± 1%
Range 0.25 Hz - 32 kHz	< ± 1.5 %
Range 1 Hz - 100 kHz	< ± 1.5 %

Measurements in a Lower Frequency Range*)	
Integration time = 1 period	0.1 Hz - 100 Hz, Resolution 0.001Hz
Integration time = 4 periods	1 Hz - 1 kHz, Resolution 0.01Hz
Integration time = 16 periods	10 Hz - 10 kHz, Resolution 0.1Hz (1Hz)
Measuring Error using the lower Frequency Range*)	
Range 0.1 Hz - 100 Hz	< ± 0.05%
Range 1 Hz - 1 kHz	< ± 0.05 %
Range 10 Hz - 10 kHz	< ± 0.2 %

*) For Measurements in a lower frequency range, the measuring error is lower than the measuring error using the maximum frequency range.

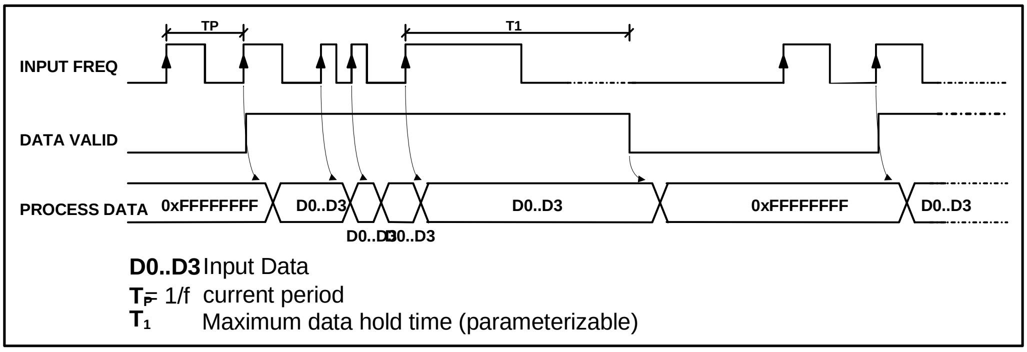
Functional description

The counter module acquires the time between one or more rising edges of the CLOCK input signal and calculates the frequency of the applied signal.

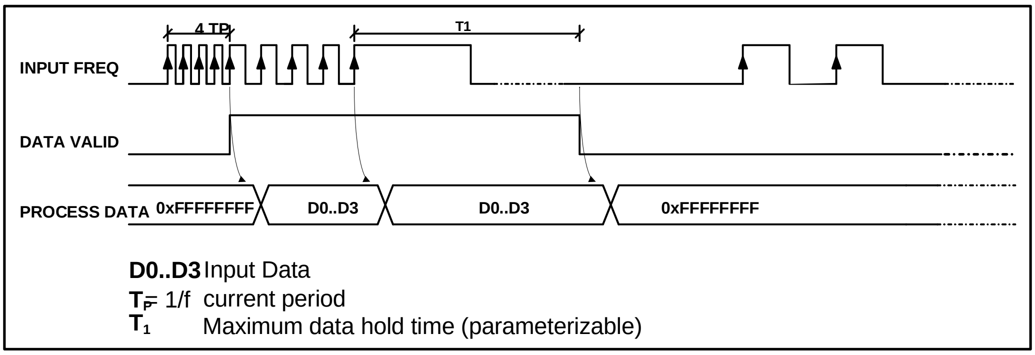
The calculation and process image update are initiated every 1st , every 4th or every 16th rising edge depending on the integration time selected via the CONTROL byte. The first detection of a rising edge starts the cyclic period measurement and cannot provide a valid frequency value. In this case the module will send 0xFFFFFFFFH for input information. The same input value is returned when a static high or static low signal is applied to the CLOCK input.

If there are no signal changes seen at the CLOCK input, the module can be forced to update the process image after defined parameterizable time spans. In this state the module will send the non valid value 0xFFFFFFFFH too.

The following figures illustrate a process data cycle.



Timing diagram for process data update sequence
(Integration time = 1 period)



Timing diagram for process data update sequence
(integration time = 4 periods)

Structure of CONTROL and STATUS byte

The control byte has the following bits:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	T_{VD} REQ	Output value at output O2	Output value at output O1	RANGE_SEL REQ1	RANGE_SEL REQ0

Bit	Description
T_{VD} REQ	Request to change the maximum time without valid data.
RANGE_SEL REQ1	Selection of the Integration time and the representation of measured frequency value.
RANGE_SEL REQ0	Selection of the Integration time and the representation of measured frequency value.

The status byte has the following bits:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	ST_ GATE	T_{VD} ACK	State of the output O2	State of the output O1	RANGE_SEL ACK1	RANGE_SEL ACK0

Bit	Description
ST_GATE	State of GATE input (0=enabled, 1=disabled)
T_{VD} ACK	Acknowledgement T_{VD} changed.
RANGE_SEL ACK1	Acknowledgement of Range Selection, Frequency values are valid.
RANGE_SEL ACK0	Acknowledgement of Range Selection, Frequency values are valid.

Structure of the Input and Output data

The input data represents the CLOCK frequency as a binary value. The representation depends on the RANGE_SEL bits in the CONTROL byte. Even the method of measuring is selected via these bits. The following table illustrates the different modes.

RANGE_SEL1	RANGE_SEL0	Method of measurement	Representation of measuring value
0	0	Integration over 1 Period	Frequency in $^{1}/_{1000}$ Hz
0	1	Integration over 4 Periods	Frequency in $^{1}/_{100}$ Hz
1	0	Integration over 16 Periods	Frequency in $^{1}/_{10}$ Hz
1	1	Integration over 16 Periods	Frequency in Hz

Attention
When a new frequency range is requested, the application has to wait for valid data until the RANGE_SEL ACK bits contain the new frequency range. The maximum delay can be calculated using the following formula.

$$T_{Dmax} = 2 \bullet \frac{\text{Number of periods to be integrated}}{\text{actual frequency}}$$

If the gate is enabled the input data contains the last valid frequency value. In this state the application cannot request a new range.

The valid frequency range stretches from 0.1 Hz (100_D) up to 10 kHz (100000_D).

To recognize static CLOCK signals, a watchdog timer is implemented. The default value for the timer is 10s. The timer resets on every Power On.

The application is able to change the watchdog time during operation by using the CONTROL byte.

This can be initiated by writing the corresponding value into the output bytes OUTPUT_DATA 1 and OUTPUT_DATA 0 before setting the T_{VD} REQ bit in the CONTROL byte.

The success of the parameter transfer is acknowledged by the module via the T_{VD} ACK bit in the STATUS information.

Attention
The range of the watchdog timer stretches from 0 to 16383ms ($0x0000_H$ to $0x3FFF_H$) in steps of 1ms per digit.
Values which raise the permitted range of the watchdog timer are masked with 0x3FFF.
If the maximum possible frequency of the different ranges is raised (see the table with maximum frequency ratings), the module will return the non valid data $0xFFFFFFFF_H$.

4.2.1.1.7 Variation Up/Down Counter with switching outputs 750-404/000-004

Technical description

The counter module also can be ordered as Counter with switching outputs with item number 750-404/000-004.

The counter module 750-404/000-004 begins processing with pulses at the CLOCK input. The changes from 0 V to 24 V are counted.

The counter counts up if the input U/D is set at 24 V. With an open circuit input or 0 V the counter counts backwards.

The terminals O1 and O2 work as binary outputs. Each output can be activated via specific bits in the CONTROL byte.

The high "on"states of the input and output channels are each indicated by a LED.

The counter module can operate with all WAGO-I/O-SYSTEM bus-couplers (except for the economy type).

Organization of the input and output data:

The control byte has the following bits

Bit 7	it 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	x	Set coun-ter	Block counter	Output value at output O2	Output value at output O1	Output O2 acti-vated depending of the counter value	Output O1 acti-vated depending of the counter value

The status byte has the following bits:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
x	x	Counter is set	Counter is blok-ked	Actual signal at output O2	Actual signal at output O1	Positive signal at input U/D, counter counting up	Actual signal at input CLOCK

With the control and status byte the following tasks are possible:

Setting the counter:
Put Bit 5 into the control byte. The counter with the 32 bit value is loaded into output bytes 0-3. As long as the bits are set, the counter can stop and information is stored. The ensuing data of the counter will be conveyed to bit 5 of status byte.

Blocking the counter:
Bit 4 is set into the control byte, then the count process is suppressed. Bit 4 in the status byte communicates the suppression of the counter.

Setting the outputs:
Bits 2 and 3 set the additional two outputs of the counter module.

Switching the outputs dependent of the counter:
The bits 0 and 1 activate the function: output dependent setting of binary outputs. If the counter reading 0x80000000 is exceeded, output A1 is activated. For the output A2 only the bottom 16 bits of the counter reading are taken into account which means that output A2 is activated as soon as the counter reading 0x8000 is exceeded. Having reached 0 again, the outputs are reset. If bits 2 or 3 are also set, they have priority, so that the corresponding output is set independent of the counter reading.
The result of the counter is in binary.

Example how to activate the digital outputs:

Set the digital output after 4.000 pulses have been counted. There are several possibilities to set an output.

If A1 is used as an automatic switching output and if the counter is to count up, set the counter to
0x80000000 - 4000 = 0x7FFFF060
and apply + 24V to the V/R input. Furthermore, activate bit 0 in the control byte. After 4000 pulses, the counter reading of 0x80000000 is reached and output A1 activated.

If you wish the counter to count down, pre-set
0x80000000 + 4000 = 0x80000FA0
and apply 0V to V/R. After 4000 pulses the counter reading 0x80000000 is reached and output A1 deactivated.

If A2 is to be used as a switching output, load the counter with
0x8000 - 4000 = 0x7060 or
0x8000 + 4000 = 0x8FA0
respectively, because only the bottom 16 bits of the counter are used for switching output A2. Instead of bit 0 now activate bit 1 in the control byte.

The binary output not involved each time can be directly addressed by the controls via bit 2 and 3.

4.2.1.1.8 Variation 2 Channel Up Counter 16 Bit 750-404/000-005

Technical description

The mode described here is a 2 channel rising edge up counter 16 bit.

In this mode, the U/D input of module 750-404 is used for the clock input of the second counter.

The following description is preliminary and is applicable to the factory configuration.

The counter module can operate with all WAGO-I/O-SYSTEM bus-couplers (except for the economy type).

Technical Data:

Item-No.:	**750-404/000-005**
Number of outputs	2
Output current	0.5 A
Number of counters	2
Input current (internal)	70 mA
Voltage via power jumper contacts	DC 24 V (-15 % / + 20 %)
Signal voltage (0)	DC -3 V ... +5 V
Signal voltage (1)	DC + 15 V ... 30 V
Switching rate	5 kHz max. (* 2 kHz when the U/D Input is dynamical switched)
Input current	5 mA typ.
Counter size	2x16 Bit Data
Isolation	500V System/power supply
Internal bit width	2x16 Bit Data; 8 Bit control/status
Configuration	none, or via software with the consent of WAGO
Operating temperature	0 °C ... + 55 °C
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64* x 100, (*from upper edge of carrier rail)

Organization of the input and output data:

Attention
For the process data configuration of these bus modules please refer to chapter "Process data architecture for MODBUS/TCP" in the process image description of the corresponding coupler/controller.

The 2 channel rising edge up counter module 750-404/000-005 counts the pulses at Clock1 and Clock2 inputs. The changes from 0 V to 24 V are counted.

The terminals O1 and O2 work as binary outputs. Each output can be activated via specific bits in the CONTROL byte.

The high states of the input and output channels are each indicated by a LED.

The control byte has the following bits:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	x	Set counter 1	Set counter 2	Output value at output O2	Output value at output O1	x	x

The status byte has the following bits:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
x	x	Counter1 is set	Counter2 is set	Actual signal at output O2	Actual signal at output O1	Actual signal at input Clock 2	Actual signal at input Clock 1

With the control and Status byte the following tasks are possible:

Setting the counter:

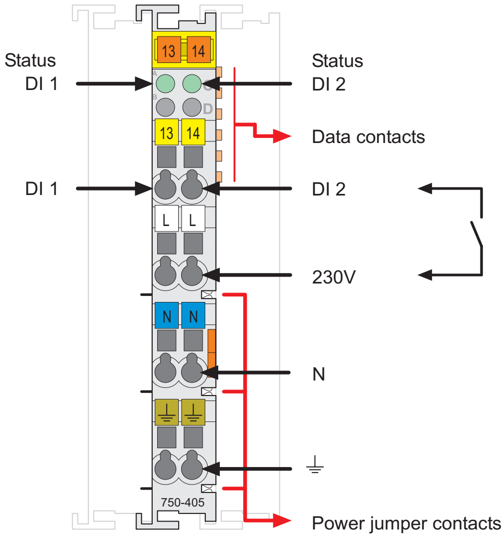
Put Bit 5/4 into the control byte. The counter1/2 with the 32 bit value is loaded into output bytes 0/1 respectively 2/3. As long as the bits are set, the counter can stop and information is stored. The ensuing data of the counter will be conveyed to bit 5/4 of status byte.

Setting the outputs:

Bits 2 and 3 set the additional two outputs of the counter module.

The result of the counter is in binary.

4.2.1.1.9 2 Channel Digital Inputs (AC 230V) 750-405



Technical description

The power supply is connected to the power jumper contacts on each I/O module for the respective operating voltage. Power connections are made automatically from module to module when snapped onto the DIN rail, with power supplied through a power feed module.

All 2-channel digital inputs are 4-conductor devices allowing the direct connection of 4-conductor sensors with the terminations V+, 0V, ground and signal.

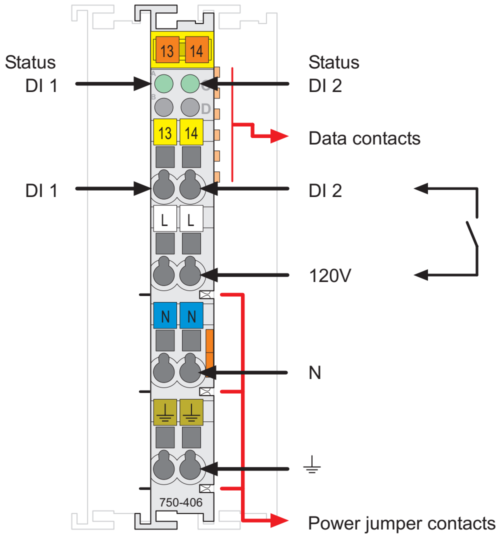
The positions of the different I/O modules in the configured node/station are selectable by the user. A block type configuration is not necessary.

These input modules can operate with all buscouplers of the WAGO-I/O-SYSTEM.

Technical Data:

Item-No.:	750-405
Number of inputs	2
Input filter	10 ms
Voltage via power jumper contacts	AC 230 V (-15%/+10%)
Signal voltage (0)	AC 0 V..40 V
Signal voltage (1)	AC 79 V... 253V
Input current (internal)	2 mA
Input current (field side)	6.5 mA typ.
Isolation	4 kV System/power supply
Internal bit width	2
Configuration	no address or configuration adjustment
Operating temperature	0°C....+55°C
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)

4.2.1.1.10 2 Channel Digital Inputs (AC 120V) 750-406



Technical description

The power supply is connected to the power jumper contacts on each I/O module for the respective operating voltage. Power connections are made automatically from module to module when snapped onto the DIN rail, with power supplied through a power feed module.

All 2-channel digital inputs are 4-conductor devices allowing the direct connection of 4-conductor sensors with the terminations V+, 0V, ground and signal.

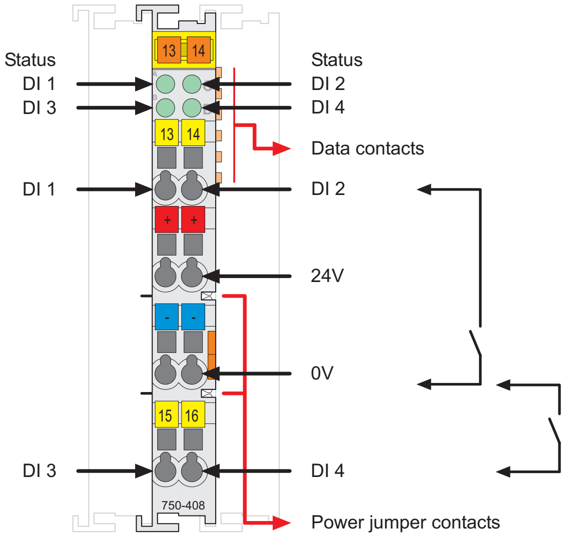
The positions of the different I/O modules in the configured node/station are selectable by the user. A block type configuration is not necessary.

These input modules can operate with all buscouplers of the WAGO-I/O-SYSTEM.

Technical Data:

Item-No.:	750-406
Number of inputs	2
Input filter	10 ms
Voltage via power jumper contacts	AC 120 V (-15%/+10%)
Signal voltage (0)	AC 0 V..20 V
Signal voltage (1)	AC 79 V...132V
Input current (internal)	2 mA
Input current (field side)	4.5 mA typ.
Isolation	4 kV System/power supply
Internal bit width	2
Configuration	no address or configuration adjustment
Operating temperature	0°C....+55°C
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)

4.2.1.1.11 4 Channel Digital Inputs (DC 24V, 3.0 ms / 0.2 ms) 750-408, -409



Technical description

The power supply is connected to the power jumper contacts on each I/O module for the respective operating voltage. Power connections are made automatically from module to module when snapped onto the DIN rail, with power supplied through a power feed module.

The 4-channel digital inputs are suitable for the direct connection of two 3-conductor sensors (V+, 0V, signal). The power distribution module 750-614 is available for the connection of more sensors to V+ and 0V.

The modules 750-408 and 750-409 are low-side switching (sinking, NPN).

RC filters are series-connected for noise rejection and switch debouncing. They are available with time constants of 3.0 ms and 0.2 ms.

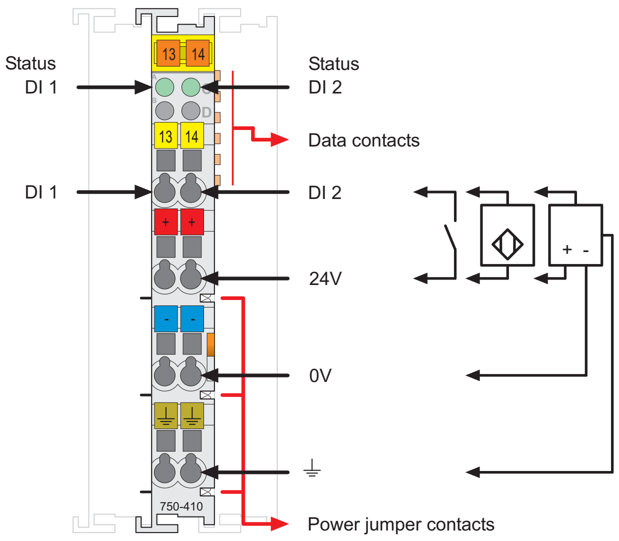
The positions of the different I/O modules in the configured node/station are selectable by the user. A block type configuration is not necessary.

These input modules can operate with all buscouplers of the WAGO-I/O-SYSTEM.

Technical Data:

Item-No.:	750-408	750-409
Number of inputs	4	
Input filter	3 ms	0.2 ms
Voltage via power jumper contacts	DC 24 V (-15% / +20%)	
Signal voltage (0)	DC 15 V...30 V	
Signal voltage (1)	DC -3 V...+5 V	
Input current (internal)	10 mA	
Input current (field side)	5 mA typ.	
Isolation	500 V System/power supply	
Internal bit width	4	
Configuration	no address or configuration adjustment	
Operating temperature	0°C....+55°C	
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length	
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)	

4.2.1.1.12 2 Channel Digital Inputs (DC 24V, 3.0 ms / 0.2 ms) 750-410, -411



Technical description

The power supply is connected to the power jumper contacts on each I/O module for the respective operating voltage. Power connections are made automatically from module to module when snapped onto the DIN rail, with power supplied through a power feed module.

All 2-channel digital inputs are 4-conductor devices allowing the direct connection of 4-conductor sensors with the terminations V+, 0V, ground and signal.

The 750-410 and 750-411 are optimized for 2 wire proximity switches.RC filters are series-connected for noise rejection and switch debouncing. They are available with time constants of 3.0 ms and 0.2 ms.

The positions of the different I/O modules in the configured node/station are selectable by the user. A block type configuration is not necessary.

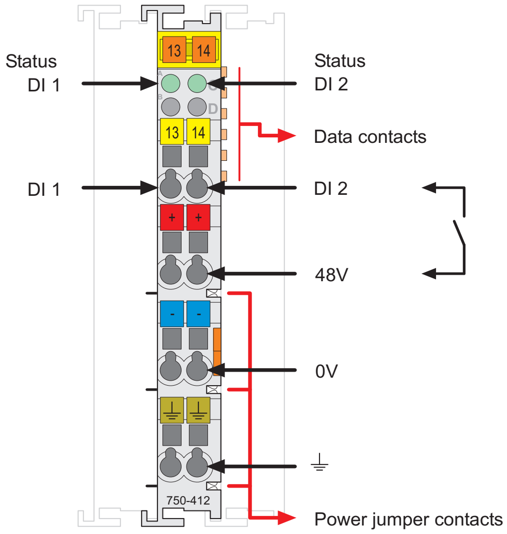
These input module can operate with all buscouplers of the WAGO-I/O-SYSTEM.

Technical Data:

Item-No.:	**750-410*)**	**750-411*)**
Number of inputs	2	
Input filter	3 ms	0.2 ms
Voltage via power jumper contacts	DC 24 V (-15% / +20%)	
Signal voltage (0)	DC -3 V...+5 V (std. EN 61131 Type 2)	
Signal voltage (1)	DC 11 V...30 V (std. EN 61131 Type 2)	
Input current (internal)	2.5 mA max.	
Input current (field side)	8 mA typ.	
Isolation	500 V System/power supply	
Internal bit width	2	
Configuration	no address or configuration adjustment	
Operating temperature	0°C....+55°C	
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length	
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)	

*) A 2-wire proximity switch can be connected, permissible closed-circuit current ≤ 2 mA

4.2.1.1.13 2 Channel Digital Inputs (DC 48 V, 3.0 ms) 750-412



I/O modules and variations

Item-No.:	Name:
750-412	2 DI 48V DC 3.0ms
750-412/000-001	2 DI 48V DC 3.0ms (without power jumper contacts)

Technical description

The power supply is connected to the power jumper contacts on each I/O module for the respective operating voltage. Power connections are made automatically from module to module when snapped onto the DIN rail, with power supplied through a power feed module.

All 2-channel digital inputs are 4-conductor devices allowing the direct connection of 4-conductor sensors with the terminations V+, 0V, ground and signal.

RC filters are series-connected for noise rejection and switch debouncing. They are available with time constants of 3.0 ms.

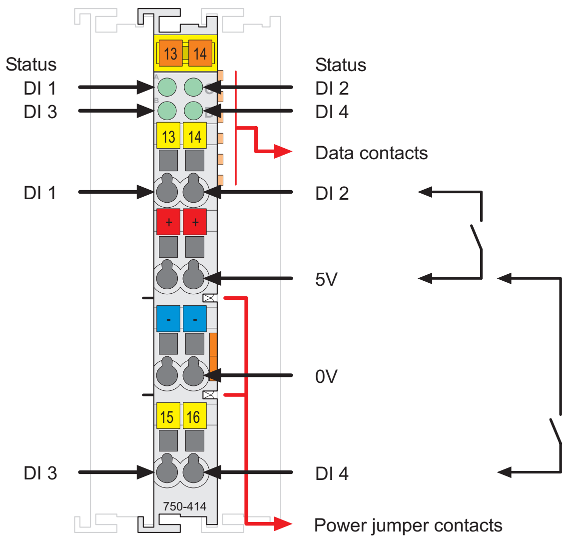
The positions of the different I/O modules in the configured node/station are selectable by the user. A block type configuration is not necessary.

These input module can operate with all buscouplers of the WAGO-I/O-SYSTEM.

Technical Data:

Item-No.:	**750-412**	**750-412/000-001**
Number of inputs	2	
Input filter	3 ms	
Voltage via power jumper contacts	DC 48 V (-15% / +20%)	-
Signal voltage (0)	DC -6 V...+10 V	
Signal voltage (1)	DC 34 V...60 V	
Input current (internal)	5 mA max.	
Input current (field side)	3.5 mA typ.	
Isolation	500 V System/power supply	
Internal bit width	2	
Configuration	no address or configuration adjustment	
Operating temperature	0°C....+55°C	
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length	
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)	

4.2.1.1.14 4 Channel Digital Inputs (DC 5 V, 0.2 ms) 750-414



Technical description

The power supply is connected to the power jumper contacts on each I/O module for the respective operating voltage. Power connections are made automatically from module to module when snapped onto the DIN rail, with power supplied through a kpower feed module.

The 4-channel digital inputs are suitable for the direct connection of two 3-conductor sensors (V+, 0V, signal). The power distribution module 750-614 is available for the connection of more sensors to V+ and 0V.

RC filters are series-connected for noise rejection and switch debouncing. They are available with time constants of 0.2 ms.

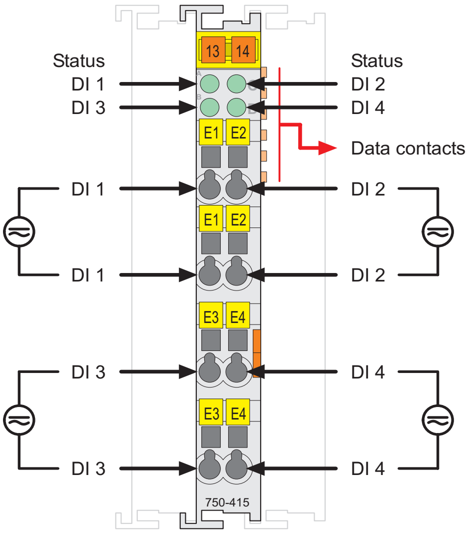
The positions of the different I/O modules in the configured node/station are selectable by the user. A block type configuration is not necessary.

These input module can operate with all buscouplers of the WAGO-I/O-SYSTEM.

Technical Data:

Item-No.:	**414**
Number of inputs	4
Input filter/Conversion time	0.2 ms
Voltage via power jumper contacts	DC 5 V
Signal voltage (0)	DC 0 V...0.8 V
Signal voltage (1)	DC 2.4...5 V
Input current (internal)	5 mA
Input current (field side)	50 µA typ.
Isolation	500 V System/power supply
Internal bit width	4
Configuration	no address or configuration adjustment
Operating temperature	0°C....+55°C
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)

4.2.1.1.15 4 Channel Digital Inputs (AC/DC 24V, 20 ms) 750-415



Technical description

The digital input module reads 24V AC/DC values from the field using the differential inputs and transmits, depending on these values, binary control signals to the higher ranking controls via the fieldbus coupler.The 4 channel digital input module is designed for a 2 conductor connection. The input signals are processed via the signal input connections E1 and E1 or E2 and E2, E3 and E3 or E4 and E4.

Warning
The module has no power contacts. For field supply to downstream I/O modules, use a supply module.

RC filters are series-connected for noise rejection and switch debouncing. They are available with time constants of 20 ms.

The positions of the different I/O modules in the configured node/station are selectable by the user. A block type configuration is not necessary.

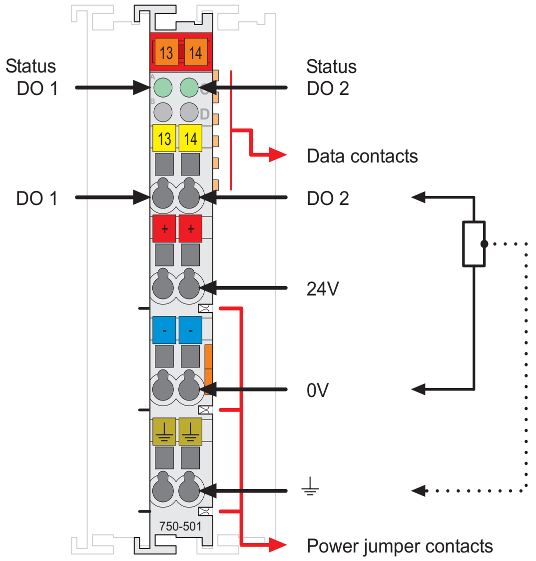
These input module can operate with all buscouplers of the WAGO-I/O-SYSTEM.

Technical Data:

Item-No.:	750-415
Number of inputs	4
Input filter/Conversion time	20 ms
Signal voltage (0)	DC -3 V...+5 V AC 0 V ... +5 V
Signal voltage (1)	DC 11 V ... 30 V AC 10 V...27 V
Input current (internal)	10 mA
Input current (field side)	DC 7.5 mA AC 9.5 mA
Isolation	500 V System/power supply 50 V Channel / Channel
Internal bit width	4
Configuration	no address or configuration adjustment
Operating temperature	0°C....+55°C
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)

4.3 Digital Outputs

4.3.1.1.1 2 Channel Digital Outputs (Standard, DC 24 V, 0.5 A / 2 A) 750-501, -502



Technical description

The power supply is connected to the power jumper contacts on each I/O module for the respective operating voltage. Power connections are made automatically from module to module when snapped onto the DIN rail, with power supplied through a power feed module.

For the digital outputs (without diagnostics) four-conductor devices (V+; 0 V; signal; ground) are standard.

In a node using both two and four channel digital modules, a two channel module must be on the left of a four channel module. The four channel modules do not have a ground connection.

All digital outputs are short-circuit protected.

Attention
In case of overloads a supply module with fuse (750-601) must be connected on the line side to protect the output modules.

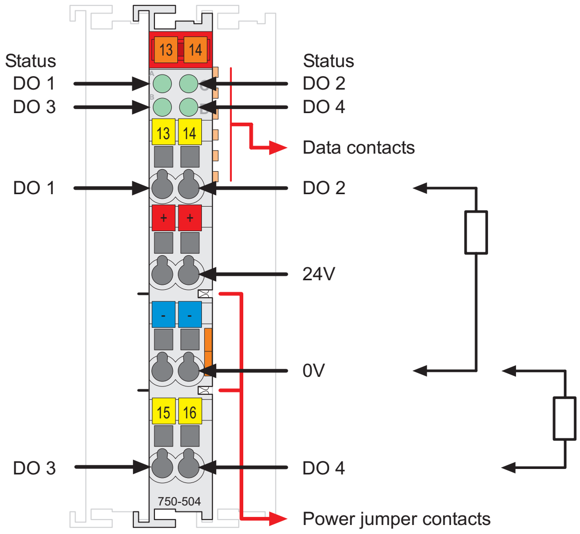
The indicated output values have been determined for 100% duty cycle.

However, in case of the 2 A versions it is possible to operate single channels at higher load currents, however always verify that the total current does not exceed 4 A per module. Example: 2x2A (standard); 1x3.5A; 1x0.5A (total current: 4 A).
The positions of the different I/O modules in the configured node/station are selectable by the user. A block type configuration is not necessary.
The output module can operate with all buscouplers of the WAGO-I/O-SYSTEM.

Technical Data:

Item-No.:	750-501	750-502
Number of outputs	2	
Kind of load	resistive, inductive, lamps	
Voltage via power jumper contacts	DC 24V (-15% / +20%)	
Output current (DC)/per channel	0.5 A	2 A
Input current (internal)	7 mA	
Input current (field side)	15 mA typ. + load	
Isolation	500 V system / power supply	
Internal bit width	2	
Configuration	no address or configuration adjustment	
Operating temperature	0°C....+55°C	
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length	
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)	

4.3.1.1.2 4 Channel Digital Outputs (Standard, DC 24 V, 0.5 A) 750-504



Technical description

The power supply is connected to the power jumper contacts on each I/O module for the respective operating voltage. Power connections are made automatically from module to module when snapped onto the DIN rail, with power supplied through a power feed module.

For the digital outputs (without diagnostics) four-conductor devices (V+; 0 V; signal; ground) are standard.

In case of 12 mm wide 4-channel digital output modules it is not possible to use 4-conductor devices. 4 signal outputs, 2xV+ and 2x0V are provided.

In a node using both two and four channel digital modules, a two channel module must be on the left of a four channel module. The four channel modules do not have a ground connection.

All digital outputs are short-circuit protected.

Attention
In case of overloads a supply module with fuse (750-601) must be connected on the line side to protect the output modules.

The indicated output values have been determined for 100% duty cycle.

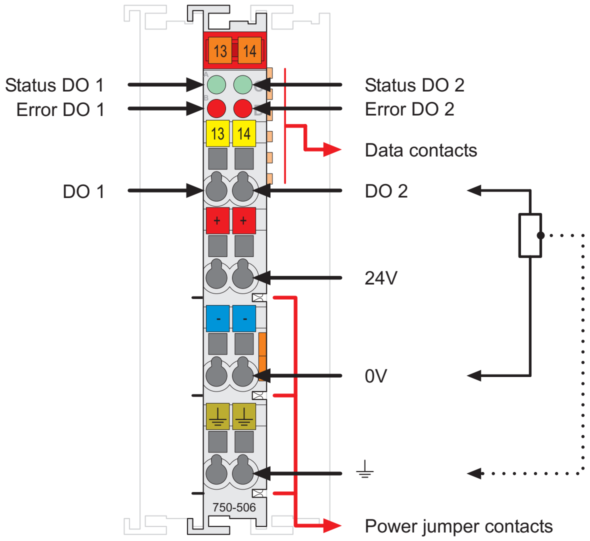
The positions of the different I/O modules in the configured node/station are selectable by the user. A block type configuration is not necessary.

The output module can operate with all buscouplers of the WAGO-I/O-SYSTEM.

Technical Data:

Item-No.:	**750-504**
Number of outputs	4
Kind of load	Resistive, inductive, lamps
Voltage via power jumper contacts	DC 24 V (-15% / +20%)
Output current (DC)/channel	0.5 A short-circuit protected
Input current (internal)	15 mA
Input current (field side)	30 mA typ. + load
Isolation	500 V system / power supply
Internal bit width	4
Configuration	no address or configuration adjustment
Operating temperature	0°C....+55°C
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)

4.3.1.1.3 2 Channel Digital Outputs (Standard with diagnostics, DC 24 V, 0.5 A) 750-506



Technical description

The power supply is connected to the power jumper contacts on each I/O module for the respective operating voltage. Power connections are made automatically from module to when snapped onto the DIN rail, with power supplies through a power feed module.

Using the digital outputs with diagnostic output bits (750-506) allows for verification of the I/O channel by the connected bus.

Example: a short-circuit at the output or an open circuit will set the appropriate error bit true indicating I/O failure. In this configuration the I/O-module includes 2 digital outputs and 2 separate digital inputs. For the digital outputs with diagnostics four-conductor devices (V+; 0V; signal; ground) are standard. All digital outputs are short-circuit protected.

Attention
In case of overloads a supply module with fuse (750-601) must be connected on the line side to protect the output modules.

The positions of the different I/O modules in the configured node/station are selectable by the user. A block type configuration is not necessary.

When using I/O modules with diagnostics, the existing inputs must be considered accordingly in the configuration of the Node/station.

The output module can operate with all buscouplers of the WAGO-I/O-SYSTEM.

Technical Data:

Item-No.:	750-506
Number of outputs	2
Input current (internal)	15 mA
Voltage via power jumper contacts	DC 24 V (- 15 % / + 20 %)
Kind of load	resistive, inductive, lamps
Output current	0.5 A short-circuit protected
Diagnostics	open circuit, overload
Isolation	500 V System/power supply
Input current (field side)	15 mA typ. + load
Internal bit width	4 in; 4 out
Configuration	without address or configuration adjustment
Operating temperature	0 °C ... + 55 °C
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)

The output bits control the state of the outputs.

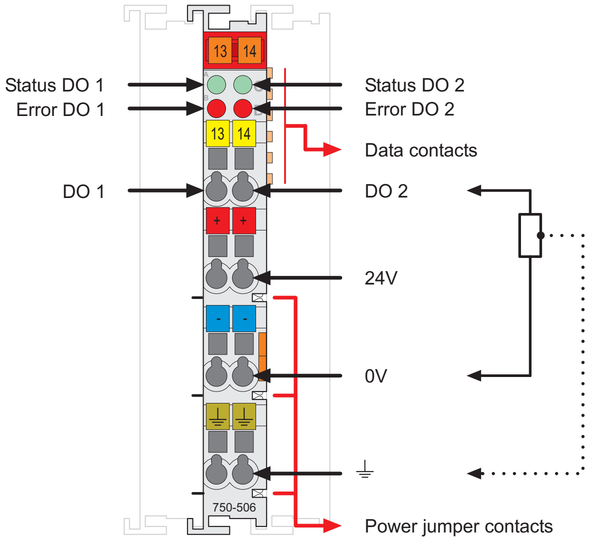
Bit:	Bit 3	Bit 2	Bit 1	Bit 0
Function:	No function	No function	Controls O2	Controls O1

The input bits show the state of the output channels.

Bit:	Bit 3	Bit 2	Bit 1	Bit 0
Function:	Diagnostics O2	Diagnostics O2	Diagnostics O1	Diagnostics O1
output follows output bit:	0	0	0	0
no load is connected:	0	1	0	1
short circuit:	1	0	1	0
power supply too low*:	1	1	1	1

*The diagnostic bits refer to a hysteresis: If the voltage of the field side is higher than 11V in the falling cycle, they are switched on. If the voltage is lower than 15.5 V in the growing cycle, they are switchedoff.

4.3.1.1.4 2 Channel Digital Outputs (Standard with diagnostics, DC 24 V, 2.0 A) 750-507



Technical description

The power supply is connected to the power jumper contacts on each I/O module for the respective operating voltage. Power connections are made automatically from module to module when snapped onto the DIN rail, with power supplies through a power feed module.

Using the digital outputs with diagnostic output bits (750-507) allows verification of the I/O channel by the connected bus.

Example: a short-circuit at the output or an open circuit will set the appropriate error bit true indicating I/O failure. In this configuration the I/O-module includes 2 digital outputs and 2 separate digital inputs. For the digital outputs with diagnostics four-conductor devices (V+; 0V; signal; ground) are standard. All digital outputs are short-circuit protected

Attention
In case of overloads a supply module with fuse (750-601) must be connected on the line side to protect the output modules.

The positions of the different I/O modules in the configured node/station are selectable by the user. A block type configuration is not necessary.

When using I/O modules with diagnostics, the existing inputs must be considered accordingly in the configuration of the Node/station.

The output module can operate with all buscouplers of the WAGO-I/O-SYSTEM.

Technical Data:

Item-No.:	**507**
Number of outputs	2
Input current (internal)	15 mA
Voltage via power jumper contacts	DC 24 V (- 15 % / + 20 %)
Kind of load	resistive, inductive, lamps
Reverse voltage protection	yes
Output current	2.0 A short-circuit protected
Short circuit limitation	$I_{(scp)}$ 42 A typ.
	$I_{(scr)}$ 33 A typ.
Open circuit detection	$I_{I(off)}$ < 30 µA typ.
GrenzFrequency	2.5 kHz
Diagnostics	Open-circuit, Overload and short circuit
Isolation	500 V System/power supply
Input current (field side)	15 mA typ. + load
Internal bit width	2 in; 2 out
Configuration	without address or configuration adjustment
Operating temperature	0 °C ... + 55 °C
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)

The possibility for diagnostics with 750-507 with each output channel:

Status from PLC to module	LED green (Output)	LED red (diagnostic)	Description
H	ON	OFF	Output O.K.
L	OFF	OFF	
H	ON	OFF	OPEN circuit*)
L	OFF	ON	
H	OFF	ON	Short circuit with GND*)
L	OFF	OFF	
H	ON	OFF	Short circuit with +24 V. *)
L	ON	ON	
H	OFF	ON	Overtemperature or Over- or Undervoltage *)
L	OFF	ON	

*) The full diagnostics is only possible with the status bit and the two LED’s on the module.

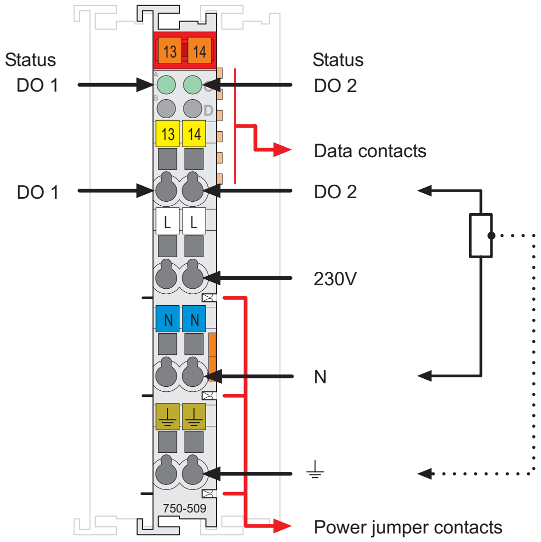
The output bits control the state of the outputs.

Bit:	Bit 1	Bit 0
Function:	controls O2	controls O1

The input bits show the state of the outputs.

Bit:	Bit 1	Bit 0
Function:	diagnostics O2	diagnostics O1
output follows output bit:	0	0
no load is connected:	0	1
short circuit:	1	0
power supply too low:	1	1

4.3.1.1.5 2 Channel Digital Outputs (Solid State Relay, AC 230 V, 0.3 A) 750-509



Technical description

The power supply for the solid state relay module is connected by a series-connected supply module for the respective operating voltage of 230 V. Power connections are made automatically from module to module via the internal P.J.C.s when snapped onto the DIN rail.

The power supply of the control side is not made via the power jumper contacts but directly from the electronics. The respective output contacts of the switching element are therefore always positioned at the field side. One termination point of these contacts must be directly connected to the power supply through a power feed module.

For the digital outputs four-conductor devices (V+; 0V; signal; ground) are standard. All digital outputs are short-circuit protected.

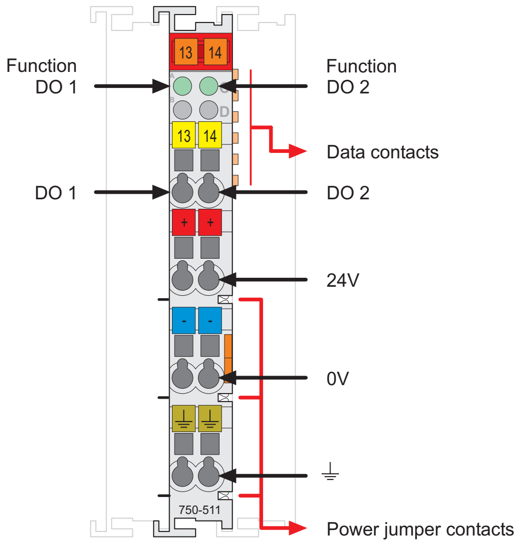
Attention
In case of overloads a supply module with fuse (750-609) must be connected on the line side to protect the output modules.

The output module can operate with all buscouplers of the WAGO-I/O-SYSTEM.

Technical Data:

Item-No.: 750-	509
Number of outputs	2
Input current (internal)	10 mA
Switching voltage	AC/DC 0 V ... 230 V
Switching current	300 mA
Speed of operation	1.65 ms typ.; 5 ms max.
Volume resistance	2.1 Ω typ.; 3.2 Ω max.
Surge current	0.5 A (20 s); 1.5 A (0.1 s)
Overvoltage protection	> ± 380 V (Varistor)
Isolation	1.5 kV System/power supply
Internal bit width	2
Configuration	without address or configuration adjustment
Operating temperature	0 °C ... + 55 °C
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)

4.3.1.1.6 2 Channel Pulsewidth Module (DC 24 V, 0.1 A) 750-511



I/O modules and variations

Item-No.:	Name:
750-511	2DO 24V DC 0.1A Pulsewidth
750-511/000-002	2DO 24V DC 0.1A Pulsewidth 2Hz – 250 HZ

Technical description

This description is for hard and software version X X X X 2 B 0 2- - - - .

The part number is displayed on the right side of the module.

The initial pre-programmed base frequency is for 250 Hz. The resolution is 10 Bits and the pulsewidth is modulated.

The following description is preliminary and is applicable to the factory configuration.

The pulsewidth output module 750-511 produces a binary modulated signal of 24 V.

The connection of the consuming device should be made between the output and 0 V (common) contacts of the module. The distribution of the 24 V DC is made via the power jumper contacts.

If galvanic isolation is desired, a new power feed via a 750-602 is required.

The PWM module can operate with all buscouplers of the WAGO-I/O-SYSTEM (except for the economy type).

Technical Data:

Item-No.:	**750-511**	**750-511/000-002**
Number of outputs	2	
Input current (internal)	70 mA	
Voltage via power jumper contacts	DC 24 V (- 15 % / + 20 %)	
Kind of load	resistive, inductive	
Output current	0.1 A short-circuit protected	
Pulse frequency	250 Hz ... 20 kHz	2 Hz ... 250 Hz
Duty cycle	0 % ... 100 % (Ton > 750 ns; Toff > 500 ns)	
Resolution	10 Bit	
Isolation	500 V System/power supply	
Input current (field side)	15 mA typ.	
Internal bit width	2 x 16 Bit Data, 2 x 8 Bit control/status	
Configuration	none, or via software with the consent of WAGO	
Operating temperature	0 °C ... + 55 °C	
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length	
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)	
Preset Frequency: Switching Frequency	250 Hz	100 Hz

Formation of on/off times

The programming of the on/off times occur with the resolution of 10 bits. The five LSB of the 16 bit value can be zeros or one. The MSB will hold the sign and is preset to the null state..

750-511, /000-002

Duty cycle %	**Increments**	**Value Binary**	**Hex.**	**Dec.**
100	1023	0111 1111 1111 1111	7F FF	32767
100	1023	0111 1111 1111 0000	7F E0	32752
50	511	0011 1111 1111 1111	3F FF	16383
25	255	0001 1111 1111 1111	1F FF	8191
12.5	127	0000 0001 0000 0000	01 00	256
0.1955	2	0000 0000 0100 0000	00 40	64
0,0977	1	0000 0000 0010 0000	00 20	32
0	0	0000 0000 0001 1111	00 1F	31
0	0	0000 0000 0000 0000	0	0

Table 4-1: Value Format

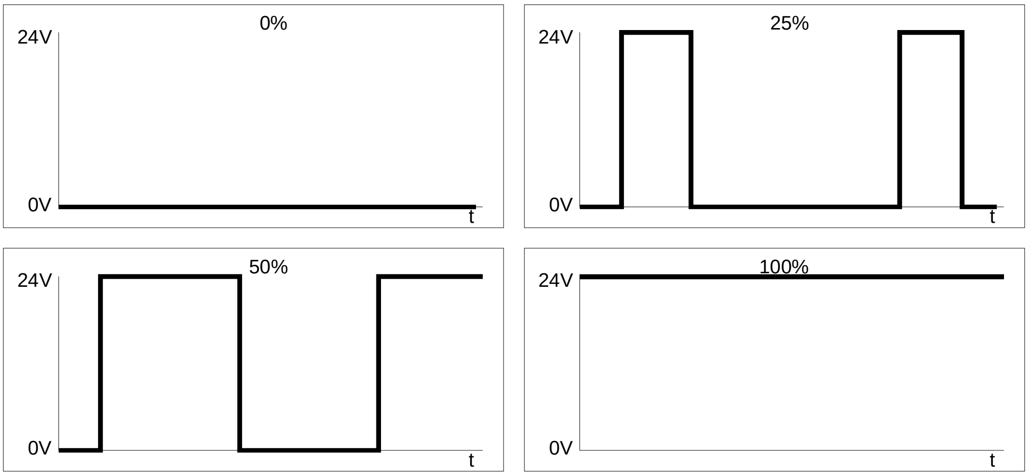


Fig.: 4-1 On/Off time relationships for Table 1.

Parameterizing the period/basic frequency

Either the period or the basic frequency can be predetermined any time by the PLC via 2 writeable registers, which are not protected against voltage loss.

Register 2: Period (16 bits)
Register 3: Basic frequency (16 bits)

As soon as the basic frequency has been input, the period is calculated automatically and entered in register 2.

The modification changes the frequency of both channels of the bus module.

The pulse width bus module loads the default values in the registers after "power-on". The PLC must take this case into account if the required values differ from the default values.

The correspondence between the digit value in the register and the period is different for each type of bus module:

Item-No.	Frequency range	Period resolution	Basic frequency resolution
750-511	250 Hz ... 20 kHz	1 µs / digit	1 Hz / digit
750-511/000-002	2 Hz ... 250 Hz	8 µs / digit	1 Hz / digit

Default Values:

Item-No.	Period	Value register 2	Basic frequency
750-511	4000 µs	4000 [0x0FA0]	250 Hz
750-511/000-002	10000 µs	1250 [0x04E2]	100 Hz

Parameterizing the registers:

The PLC can read and set the registers via the control and status byte and the output bytes in the process image.

Control byte:

Bit	B7	B6	B5	B4	B3	B2	B1	B0
Meaning	REG	W/R	0	0	0	0	A1	A0

Status byte:

Bit	B7	B6	B5	B4	B3	B2	B1	B0
Meaning	REG	0	0	0	0	0	A1	A0

REG = 0 Process data exchange
REG = 1 Access to the registers
W/R = 0 Register read mode
W/R = 1 Register write mode
A1..A0 Register address Register 2: B1=1, B0=0
Register 3: B1=1, B0=1

The output bytes of channel are used for the register values.

Examples for the pulse width bus module 750-511

The following examples illustrate the register read and write modes. The values are binary. In order to make things easier, only the process data of channel 1 is mentioned.

Register 2 read mode

The module is in process date exchange:

Control byte	Output byte 1	Output byte 0
0xxx xxxx	xxxx xxxx	xxxx xxxx

Status byte	Input byte 1	Input byte 0
0xxx xxxx	0000 0000	0000 0000

Register read access is available when bit 7 is set and the register address is entered in the control byte.

Control byte	Output byte 1	Output byte 0
1000 0010	Xxxx xxxx	xxxx xxxxx

Status byte	Input byte 1	Input byte 0	Comment
0xxx xxxx	Xxxx xxxx	xxxx xxxx	Running processing
1000 0010	0000 1111	1010 0000	Value out of register 2: 4.000 µs (250 Hz) (0x0FA0)

You can reactivate the process data exchange if you erase bit 7.

Control byte	Output byte 1	Output byte 0
0xxx xxxx	Xxxx xxxx	xxxx xxxxx

Status byte	Input byte 1	Input byte 0	Comment
1000 0010	0000 1111	1010 0000	Value out of register 2
0xxx xxxx	0000 0000	0000 0000	Process data exchange

Register 2 write mode

The module is in process data exchange mode:

Control byte	Output byte 1	Output byte 0
0xxx xxxx	xxxx xxxx	xxxx xxxx

Status byte	Input byte 1	Input byte 0
0xxx xxxx	0000 0000	0000 0000

Register write access is available by setting bit 7 and bit 6 and entering the register address in the control byte.

Control byte	Output byte 1	Output byte 0	Comment
1100 0010	0000 0100	0001 1101	Value in register 2: 1.053 µs (950 Hz) (0x041D)

Status byte	Input byte 1	Input byte 0	Comment
0xxx xxxx	xxxx xxxx	xxxx xxxx	Running processing
1000 0010	0000 0000	0000 0000	Acknowledgement

You can reactivate the process data exchange if you erase bit 7.

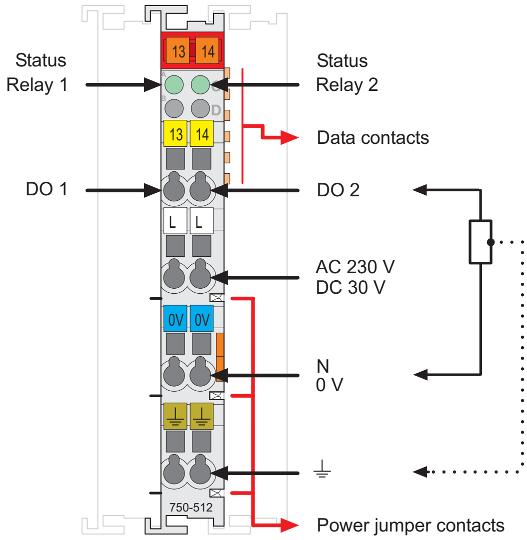
Control byte	Output byte 1	Output byte 0
0xxx xxxx	xxxx xxxx	Xxxx xxxxx

Status byte	Input byte 1	Input byte 0	Comment
1000 0010	0000 0000	0000 0000	Value out of register 2
0xxx xxxx	0000 0000	0000 0000	Process data exchange

Organization of the in- and output data:

Attention
For the process data configuration of these bus modules please refer to chapter "Process data architecture for MODBUS/TCP" in the process image description of the corresponding coupler/controller.

4.3.1.1.7 Digital Output Relay (2 normally open contacts non-floating, AC 250 V) 750-512



Technical description

The power supply for the relay coils is not made through the power jumper contacts but directly from the electronics. The respective output contacts of the switching element are therefore always positioned at the field side.

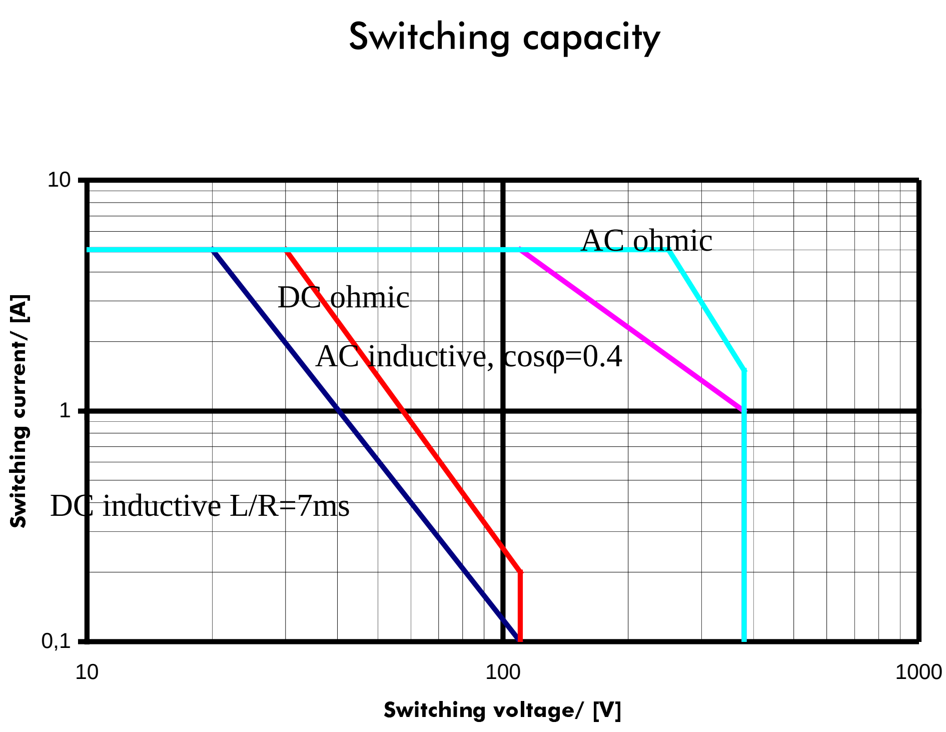
The power supply is made via a series-connected supply terminal block for the respective operating voltage. Power connections are made automatically from module to module when snapped onto the DIN rail. One termination point of these contacts must be directly connected to the power supply.

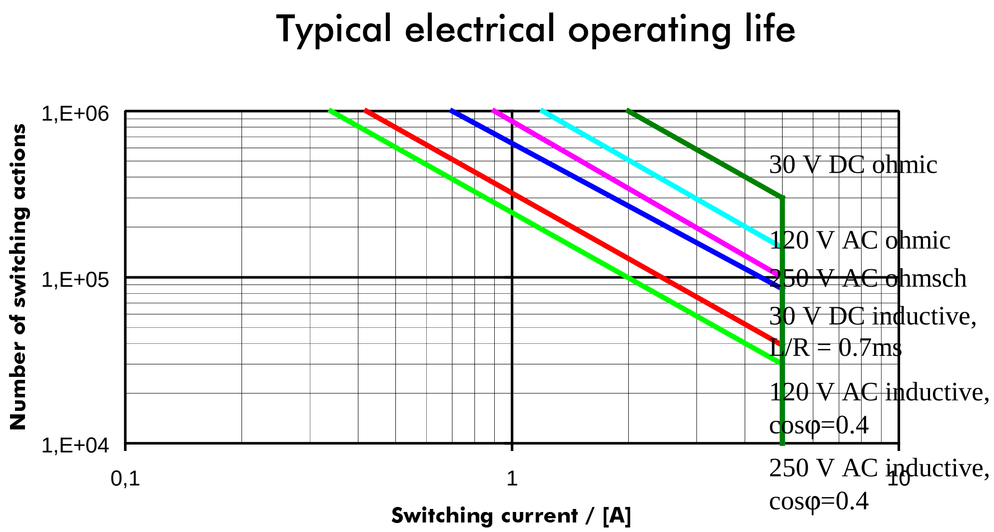
The output module can operate with all buscouplers of the WAGO-I/O-SYSTEM.

Technical Data:

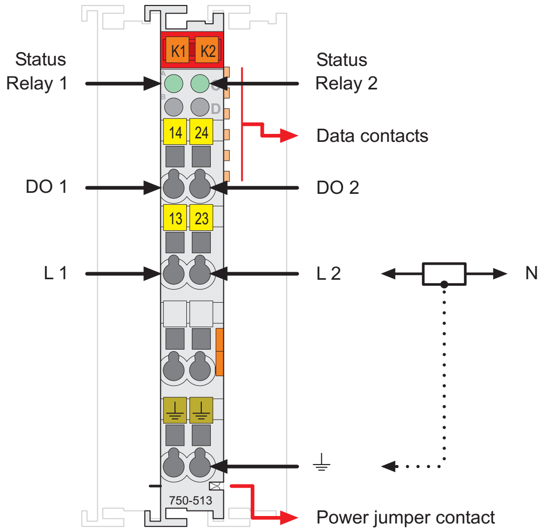
Item-No.:	**750-512**
Number of outputs	2 normally open contacts
Input current (internal)	100 mA max.
Switching voltage Relay	AC 250 V / DC 30 V
Switching power Relay	500 VA / 60 W, cos ρ_{max} =0.4, L/R_{max}=7 ms
Switching current Relay	AC/DC 2 A
Isolation	4 kV System/power supply
Internal bit width	2
Configuration	without address or configuration adjustment
Operating temperature	0 °C ... + 55 °C
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64* x 100 (from upper edge of carrier rail)

Relays in the modules 750-512





4.3.1.1.8 Digital Output Relay (2 normally open contacts isolated outputs, AC 250, 2.0 A) 750-513



Technical description

The power supply for the relay coils is not made through the power jumper contacts but directly from the electronics. The respective output contacts of the switching element are therefore always positioned at the field side.

These I/O modules are not provided with integrated power jumper contacts. Care should be taken to supply each isolated module with separate power supply connections.

A connection to ground is made through the series power jumper contact to a power feed module.

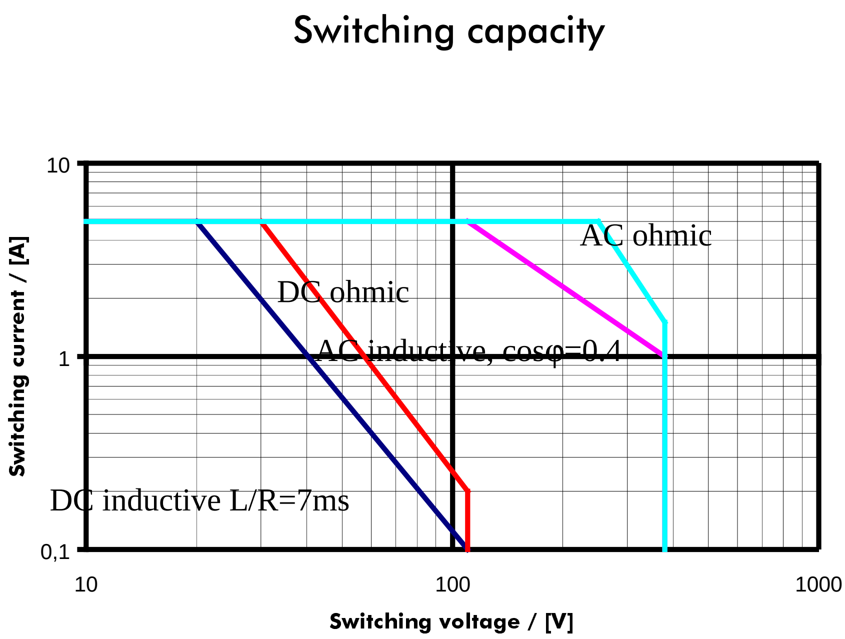
The positions of the different modulesin the configured station are the user’s choice. A block type configuration is not necessary.

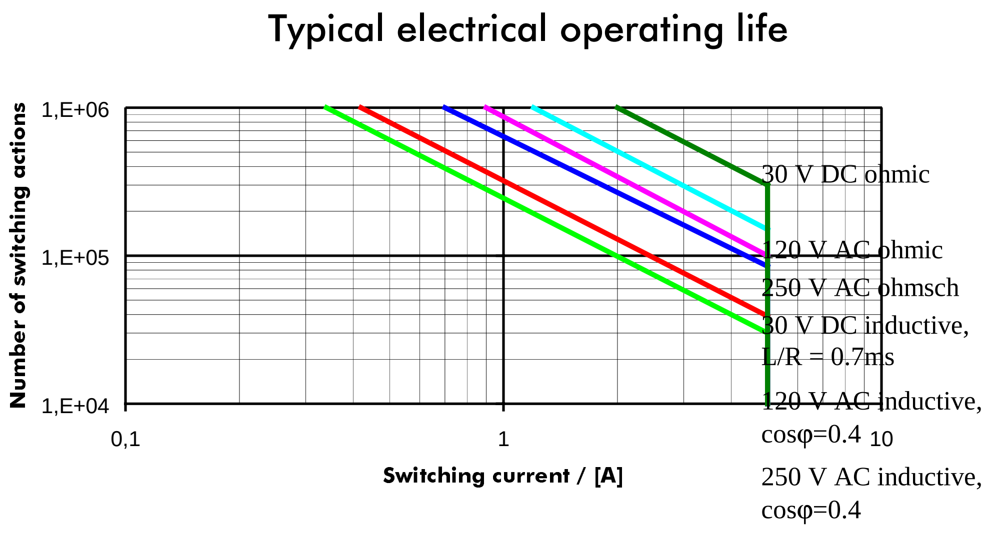
The output module can operate with all buscouplers of the WAGO-I/O-SYSTEM.

Technical Data:

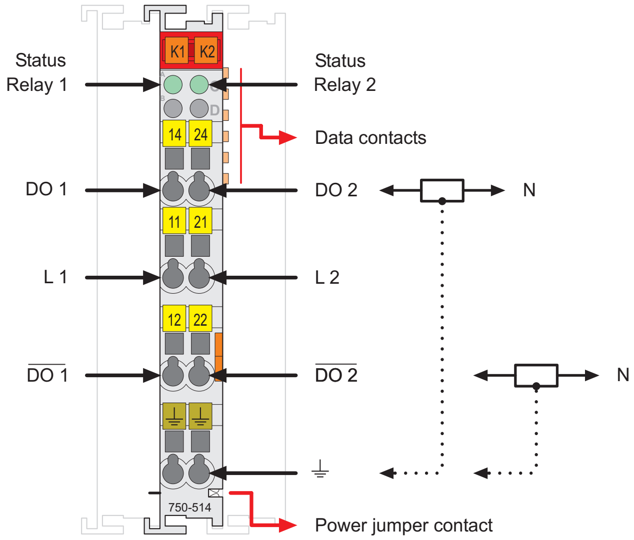
Item-No.:	750-513
Number of outputs	2 normally open contacts
Input current (internal)	100 mA max.
Switching voltage Relay	AC 250 V / DC 30 V
Switching power Relay	500 VA / 60 W, cos ρ_{max} =0.4, L/R_{max}=7 ms
Switching current Relay	AC/DC 2 A
Isolation	4 kV System/power supply
Internal bit width	2
Configuration	without address or configuration adjustment
Operating temperature	0 °C ... + 55 °C
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64* x 100 (from upper edge of carrier rail)

Relays in the modules 750-513





4.3.1.1.9 Digital Output Relay (2 changeover contacts isolated outputs, AC 125 V, 0.5 A) 750-514



Technical description

The power supply for the relay coils is not made through the power jumper contacts but directly from the electronics. The respective output contacts of the switching element are therefore always positioned at the field side.

These I/O modules are not provided with integrated power jumper contacts. Care should be taken to supply each isolated module with separate power supply connections.

A connection to ground is made through the series power jumper contact to a power feed module.

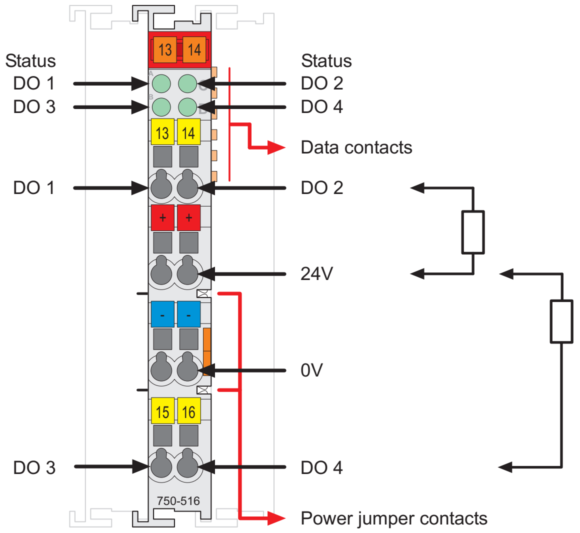
The positions of the different modules in the configured station are the user's choice. A block type configuration is not necessary.

The output module can operate with all buscouplers of the WAGO-I/O-SYSTEM.

Technical Data:

Item-No.:	**750-514**
Number of outputs	2 changeover contacts
Input current (internal)	70 mA max.
Switching voltage Relay	AC 125 V / DC 30 V
Switching power Relay	62.5 VA/ 30 W
Switching current Relay	AC 0.5 A / DC 1 A
Isolation	1.5 kV System/power supply
Internal bit width	2
Configuration	without address or configuration adjustment
Operating temperature	0 °C ... + 55 °C
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)

4.3.1.1.10 4 Channel Digital Outputs (Standard, DC 24 V, 0.5 A, sinking output) 750-516



Technical description

The power supply is connected to the power jumper contacts on each I/O module for the respective operating voltage. Power connections are made automatically from module to module when snapped onto the DIN rail, with power supplied through a power feed module.

For the digital outputs (without diagnostic) four-conductor devices (V+; 0 V; signal; ground) are standard. In case of 12 mm wide 4-channel digital output modules it is not possible to use 4-conductor devices. 4 signal outputs, 2xV+ and 2x0V are provided.

All digital outputs are short-circuit protected.

Attention
In case of overloads a supply module with fuse (750-601) must be connected on the line side to protect the output modules.

The module 750-516 is low-side switching (NPN).

The indicated output values have been determined for 100% duty cycle.

The positions of the different I/O modules in the configured node/station are selectable by the user. A block type configuration is not necessary.

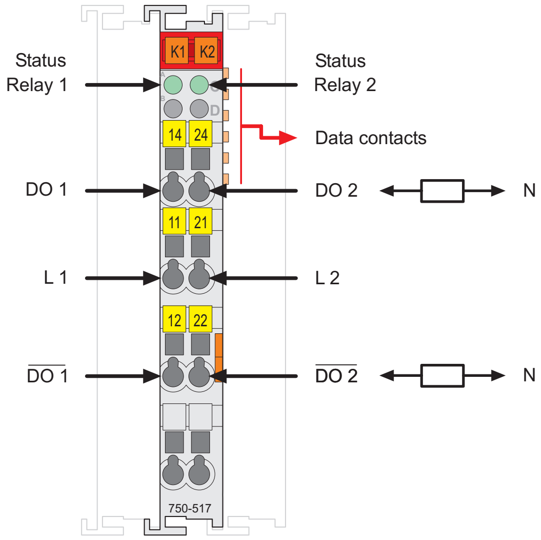
The output module can operate with all buscouplers of the WAGO-I/O-SYSTEM.

Technical Data:

Item-No.:	**750-516*)**
Number of outputs	4
Kind of load	resistive, inductive, lamps
Voltage via power jumper contacts	DC 24 V (-15% / +20%)
Output current (DC)	0.5 A short-circuit protected
Input current (internal)	15 mA
Input current (field side)	30 mA typ. + load
Isolation	500 V system / power supply
Internal bit width	4
Configuration	no address or configuration adjustment
Operating temperature	0°C....+55°C
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)

*) low-side switching

4.3.1.1.11 Digital Output Relay (2 changeover contacts isolated outputs, AC 250 V, 1 A) 750-517



Technical description

The power supply for the relay coils is not made via the power jumper contacts but directly from the electronics. The respective output contacts of the switching element are therefore always positioned at the field side.

The power supply is made via a series-connected supply terminal block for the respective operating voltage. Power connections are made automatically from module to module when snapped onto the DIN rail. One termination point of these contacts must be directly connected to the power supply.

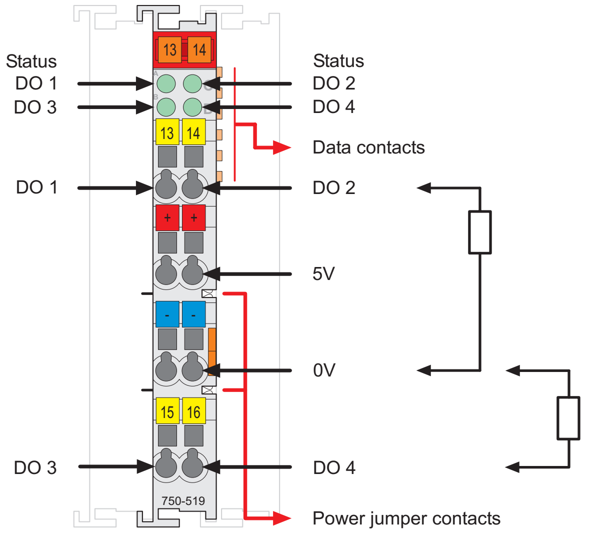
These I/O modules are not provided with integrated power jumper contacts. Care should be taken to supply each isolated module with separate power supply connections.

The output module can operate with all buscouplers of the WAGO-I/O-SYSTEM.

Technical Data:

Item-No.:	750-517
Number of outputs	2 changeover contacts
Input current (internal)	80 mA max.
Switching voltage Relay	AC 250 V
Switching power Relay	250 VA
Switching current Relay	1.0 A
Isolation	4 kV System/power supply
Internal bit width	2
Configuration	without address or configuration adjustment
Operating temperature	0 °C ... + 55 °C
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64* x 100 (from upper edge of carrier rail)

4.3.1.1.12 4 Channel Digital Outputs (DC 5 V, 20 mA) 750-519



Technical description

The power supply is provided by a series-connected supply module for the respective operating voltage. Power connections are made automatically from module to module via the internal P.J.C.s when snapped onto the DIN rail.

For the digital outputs (without diagnostics) four-conductor devices (V+; 0 V; signal; ground) are standard. In case of 12 mm wide 4-channel digital output modules it is not possible to use 4-conductor devices. 4 signal outputs, 2xV+ and 2x0V are provided.

All digital outputs are short-circuit protected.

Attention
In case of overloads a supply module with fuse (750-601) must be connected on the line side to protect the output modules.

The module 750-519 is high-side switching.

The indicated output values have been determined for 100% duty cycle.

The positions of the different I/O modules in the configured node/station are selectable by the user. A block type configuration is not necessary.

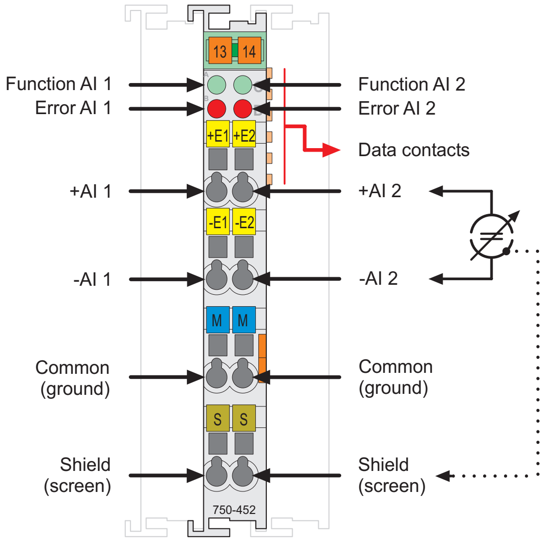
The output module can operate with all buscouplers of the WAGO-I/O-SYSTEM.

Technical Data:

Item-No.:	**750-519**
Number of outputs	4
Kind of load	Resistive, inductive, lamps
Voltage via power jumper contacts	DC 5 V
Output current (DC)	20 mA short-circuit protected
Input current (internal)	16 mA
Input current (field side)	14 mA typ.
Isolation	500 V system / power supply
Internal bit width	4
Configuration	no address or configuration adjustment
Operating temperature	0°C....+55°C
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)

4.4 Analog Inputs

4.4.1.1.1 2 Channel Analog Inputs (0-20mA / 4-20mA, Differential Inputs) 750-452, -454, (-482, -484)



I/O modules and variations

Item-No.:	Description	Name:
750-452	2 Channel Analog Input, 0-20 mA, Differential Input	2 AI 0-20mA Diff.
750-452/000-200 *formerly 750-482*	2 Channel Analog Input, 0-20 mA, Differential Input (RC Low pass) with status information within the data word	2 AI 0-20mA Diff. RC Low pass (Siemens)
750-454	2 Channel Analog Input, 4-20 mA, Differential Input	2 AI 4-20mA Diff.
750-454/000-200 *formerly 750-484*	2 Channel Analog Input, 4-20 mA, Differential Input with status information within the data word	2 AI 4-20mA Diff. (Siemens)

Technical description

This description is only intended for hardware version X X X X 2 A 0 0 - - - -. The serial number can be found on the right side of the module.
The input channels are differential inputs and they have a common ground potential.

The inputs are connected to +I and -I. The shield is connected to "S". A capacitive connection is made automatically when snapped onto the DIN rail.

These I/O modules are not provided with integrated power jumper contacts. The power supply is made by the data contacts with a DC-DC converter. The modules can work self-supporting.

The input module can operate with all buscouplers of the WAGO-I/O-SYSTEM (except for the economy type).

Technical Data:

Item-No.:	**750-452, 750-452/000-200*) (formerly 750-482)**	**750-454, 750-454/000-200*) (formerly 750-484)**
Number of inputs	2	
Nominal voltage	via system voltage	
Input current (internal)	70 mA	
Voltage	35V max.	
Signal current	0-20mA	4-20mA
Resistance	50 Ω typ.	
Resolution	12 Bit (*) 12 Bit + sign for the variations 750-452/000-200 and 750-454/000-200)	
Isolation	500V System/power supply	
Conversion time	2 ms typ.	
Bit width per channel	16Bit: Data; optional 8Bit: Control/Status	
Configuration	none, or via software with the consent of WAGO	
Operating temperature	0°C....+55°C	
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length	
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)	

Numerical format

The digitized measured value is stored in a data word (16 bit) as an input byte 0 (high) and as an input byte 1 (low). The value with a 12 bit resolution is illustrated on bit B3 ... B14. The three low value bits (B0 ... B2) are only used in the event of an error.

Some fieldbus systems process status information to the input channel using a status byte

750-452, 750-454

Input current 0-20mA	Input current 4-20mA	Value Binary	Hex.	Dec.
20	20	0111 1111 1111 1000	7F F8	32760
10	12	0100 0000 0000 0000	40 00	16384
5	8	0010 0000 0000 0000	20 00	8192
2.5	6	0001 0000 0000 0000	10 00	4096
0.156	4.125	0000 0001 0000 0000	01 00	256
0.01	4.0078	0000 0000 0001 0000	00 10	16
0.005	4.0039	0000 0000 0000 1000	00 08	8
0	4	0000 0000 0000 0111	00 07	7
0	4	0000 0000 0000 0000	0	0

Numerical format for Siemens function blocks

For fieldbus masters with the ability to evaluate the status information within the data word, i.e. Siemens format.

The status information is contained in Bit B0 .. B2.

The digitized input is placed at the position Bit B3 .. B15.

750-452/000-200, (formerly 750-482)

Input current 0-20mA	Value Binary	X E O*)	Hex.	Dec.
>20	0100 0000 0000 0	0 0 1	4001	16385
20	0100 0000 0000 0	0 0 0	4000	16384
10	0010 0000 0000 0	0 0 0	2000	8192
5	0001 0000 0000 0	0 0 0	1000	4096
2.5	0000 1000 0000 0	0 0 0	0800	2048
1.25	0000 0100 0000 0	0 0 0	0400	1024
0.625	0000 0010 0000 0	0 0 0	0200	512
0.0976	0000 0000 0000 1	0 0 0	0008	8
0	0000 0000 0000 0	0 0 0	0000	0

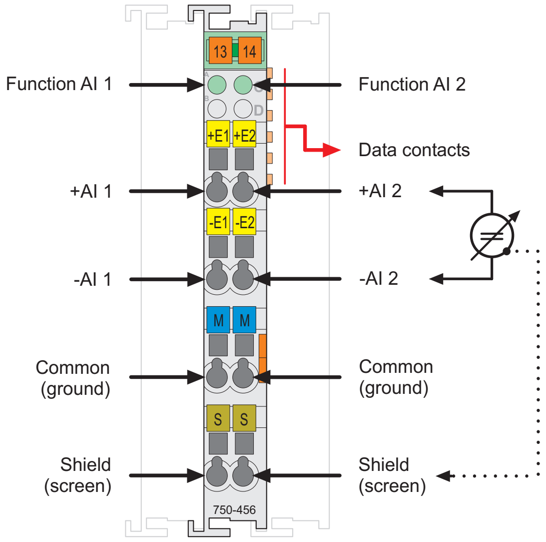
*) X : without meaning, E : short circuit or open circuit, O : overflow

750-454/000-200, (formerly 750-484)

Input current 4-20mA	Value Binary	X E O*)	Hex.	Dec.
>20	0101 0000 0000 0	0 0 1	50 01	20481
20	0101 0000 0000 0	0 0 0	50 00	20480
16	0100 0000 0000 0	0 0 0	40 00	16384
12	0011 0000 0000 0	0 0 0	30 00	12288
8	0010 0000 0000 0	0 0 0	20 00	8192
4.0078	0001 0000 0000 1	0 0 0	1008	4104
4	0001 0000 0000 0	0 0 0	1000	4096
4	0001 0000 0000 0	0 1 1	1003	4099

*) X : without meaning, E : short circuit or open circuit, O : overflow

4.4.1.1.2 2 Channel Analog Inputs (±10V Differential Inputs) 750-456



I/O modules and variations

Item-No.:	Description:	Name:
750-456	2 Channel Analog Input DC ±10V Differential Inputs	2 AI ±10V DC
750-456/000-001 *shortly 750-456/000-200*	2 Channel Analog Input DC ±10V Differential Inputs	2 AI ±10V DC (Siemens)

Technical description

This description is only intended for hardware version X X X X 2 A 0 0 - - - -.

The serial number can be found on the right side of the module.

The input channels are differential inputs and they have a common ground potential.

The inputs are connected to +I and -I. The shield is connected to "S". A capacitive connection is made automatically when snapped onto the DIN rail.

These I/O modules are not provided with integrated power jumper contacts. The power supply is made by the data contacts with a DC-DC converter. The modules can work self-supporting.

The input module can operate with all buscouplers of the WAGO-I/O-SYSTEM (except for the economy type).

Technical Data:

Item-No.:	750-456, 750-456/000-001
Number of inputs	2
Nominal voltage	via system voltage (DC DC converter)
Input current (internal)	65 mA
Overvoltage protection	35 V max.
Signal voltage	±10 V
Resistance	570 kΩ typ.
Resolution	12 Bit
Isolation	500V System/power supply
Conversion time	2 ms typ.
Bit width per channel	16Bit: Data; optional 8Bit: Control/Status
Configuration	none, or via software with the consent of WAGO
Operating temperature	0°C....+55°C
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)

Attention
The value of the input signal should be in a range of 0V to 10V or no signal.

Numerical format

All analog values will be shown in a unit numerical format. The resolution is 12 Bits and the 3 LSBs are not significant.

The following table will explain the numerical format.

750-456

Signal voltage ±10V	Value Binary	Hex.	Dec.	Status
> 10 V	0111 1111 1111 1111	7F FF	32767	42
10	0111 1111 1111 XXXX	7F FX	32760	0
5	0100 0000 0000 XXXX	40 0X	16384	0
2.5	0010 0000 0000 XXXX	20 0X	8192	0
1.25	0001 0000 0000 XXXX	10 0X	4096	0
0.0781	0000 0001 0000 XXXX	01 0X	256	0
0.0049	0000 0000 0001 XXXX	00 1X	16	0
0	0000 0000 0000 XXXX	00 0X	0	0
-2.5	1110 0000 0000 XXXX	E0 0X	57344	0
-5	1100 0000 0000 XXXX	C0 0X	49152	0
-7.5	1010 0000 0000 XXXX	A0 0X	40960	0
-10	1000 0000 0000 XXXX	80 0X	32768	0
< -10 V	1000 0000 0000 0000	80 00	32768	41

Numerical format for Siemens function blocks

For fieldbus masters with the ability to evaluate the status information within the data word, i.e. Siemens format.

The status information is contained in Bit B0 .. B2.

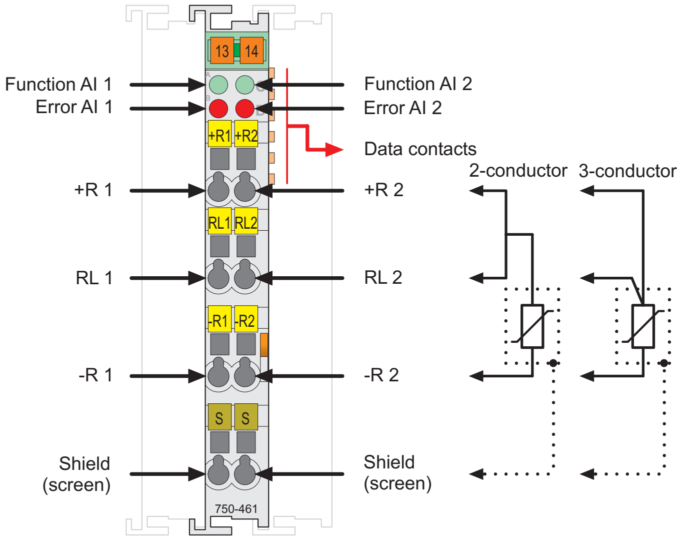
The digitized input is placed at the position Bit B3 .. B15.

750-456/ 000-001 (or /000-200)

Signal voltage ±10V	Value Binary	X E O*)	Hex.	Dec.
>10	0111 1111 1111 1	0 0 1	7F F9	32761
10	0111 1111 1111 1	0 0 0	7F F8	32760
5	0110 0000 0000 0	0 0 0	60 00	24576
2.5	0101 0000 0000 0	0 0 0	50 00	20480
1.25	0100 1000 0000 0	0 0 0	48 00	18432
0.0049	0100 0000 0000 1	0 0 0	40 08	16392
0	0100 0000 0000 0	0 0 0	40 00	16384
-2.5	0011 0000 0000 1	0 0 0	30 08	12296
-5	0010 0000 0000 0	0 0 0	20 00	8192
-7.5	0001 0000 0000 0	0 0 0	10 00	4096
-10	0000 0000 0000 1	0 0 0	00 00	8
<-10	0000 0000 0000 0	0 0 1	00 01	1

*) X : without meaning, E : short circuit or open circuit, O : overflow

4.4.1.1.3 2 Channel Input Module for resistance sensors 750-461, (-481)



I/O modules and variations

Item-No.:	Description:	Name:
750-461	2 Channel Analog Input PT 100 (RTD)	2AI PT100 (RTD)
750-461/000-002	2 Channel Analog Input Resistance test 10R-1K2	2AI Resistance test 10R-1K2
750-461/000-003	2 Channel Analog Input PT 1000 (RTD)	2AI PT1000 (RTD)
750-461/000-004	2 Channel Analog Input NI 100 (RTD)	2AI NI100 (RTD)
750-461/000-005	2 Channel Analog Input NI 1000 (RTD)	2AI NI1000 (RTD)
750-461/000-007	2 Channel Analog Input Resistance test 10R-5K	2AI Resistance test 10R-5K
750-461/000-200 *formerly 750-481*	2 Channel Analog Input PT 100 (RTD) with status information within the data word	2AI PT100 (RTD) (Siemens)

Technical description

This description is only intended for hardware version X X X X 3 A 0 2 - - - -. The serial number can be found on the right side of the module.
The described configuration is PT 100. The following description is preliminary and is applicable only to the factory configuration.

The inputs are connected to +I and -I. The shield is connected to "S". A capacitive connection is made automatically when snapped onto the DIN rail.

These I/O modules are not provided with integrated power jumper contacts. The power supply is made by the data contacts with a DC-DC converter.

The PT100 module can operate with all buscouplers of the WAGO-I/O-SYSTEM (except for the economy type).

Technical Data:

Item-No.:	**750-461**
Number of inputs	2
Input current (internal)	65 mA max.
Nominal voltage	via system voltage
Sensor types	PT 100, PT 200, PT 500, PT 1000, NI 100, NI 120, NI 1000, Resistance test
Wire connection	2-conductor, 3-conductor (presetting)
Temperature Range	200 °C ... + 850 °C (PT), - 60 °C ... + 250 °C (NI)
Resolution	0.1 °C
Isolation DC/DC	400 V System/power supply
Measuring current	0.5 mA typ.
Internal bit width	2 x 16 Bit Data, 2 x 8 Bit control/status
Configuration	None, or via software with the consent of WAGO
Presetting	3-conductor PT 100
Operating temperature	0 °C ... + 55 °C
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64 x 100 (from upper edge of carrier rail)

The function module 750-461 allows for the direct connection of PT- or NI-resistance sensors. The module is suitable for 2- or 3-wire RTDs. Connection is made according to the above wiring diagram.

Linearization is accomplished over the entire measurement range by a micro-processor.
The temperature ranges of the above listed RTD types are available to the user. The temperature ranges of the sensors are represented with a resolution of 1 bit per 0.1° C in one word (16 bits). Resulting from this, 0°C corresponds to the hexadecimal value 0000 and 100°C is 03E8 (dec.1000). Temperatures below 0° are represented in two's complement with a leading '1'.

The function module works in the defined temperature range for the PT100 sensors of -200°C to +850°C. The voltage resolution is represented with 16 bits.
An A/D converter and processor converts the voltage value to a numerical value proportional to the temperature of the selected resistance temperature sensor.

A short circuit or an interruption of the RTD wire is transmitted to the bus module and indicated by the red error LED. The green LED identifies that the module is communicating properly with the connected Buscoupler.

Operating mode:

Operating mode:	**Item-No.:**
Evaluation of resistance sensor type PT 100	750-461
Resistance test: 10 Ω to 1.2 kΩ	750-461/000-002
Evaluation of resistance sensor type PT 1000	750-461/000-003
Evaluation of resistance sensor type NI 100	750-461/000-004
Evaluation of resistance sensor type NI 1000	750-461/000-005
Resistance test: 10 Ω to 5 kΩ	750-461/000-007
Evaluation of resistance sensor type PT 100 (Siemens)	750-461/000-200

Numerical format

All temperature values will be shown in a unit numerical format. If the mode ‘DEFAULT’ is selected each bit corresponds to 0.1°C. The possible numerical range refers to the standardized temperature range of the used sensors. The following table will explain the numerical format on a preset PT100. In the third column the numerical format for PT1000 (750-461/000-003) is explained.

750-461, /000-003

Temp. °C	**Resistance (Ω) PT 100**	**Resistance (Ω) PT 1000**	**Value Binary**	**Hex.**	**Dec.*)**
850	390.481	3904.81	0010 0001 0011 0100	2134	8500
100	138.506	1385.06	0000 0011 1110 1000	03E8	1000
25.5	109.929	1099.29	0000 0000 1111 1111	00FF	255
0.1	100.039	1000.39	0000 0000 0000 0001	0001	1
0	100	1000	0000 0000 0000 0000	0000	0
-0.1	99.970	999.70	1111 1111 1111 1111	FFFF	-1
-25.5	90.389	903.89	1111 1111 0000 0001	FF01	-255
-200	18.192	181.92	1111 1000 0011 0000	F830	-2000
	<18	<180	1000 0000 0000 0001	8001	-32767

*) Temperature values under 0°C are represented as binary value in the two's complement.

750-461/000-002

Resistance (Ω)	Value Binary	Hex.	Dec.
10	0000 0000 0110 0100	00 64	100
100	0000 0011 1110 1000	03 E8	1000
200	0000 0111 1101 0000	07 D0	2000
300	0000 1011 1011 1000	0B B8	3000
400	0000 1111 1010 0000	0F A0	4000
500	0001 0011 1000 1000	13 88	5000
1000	0010 0111 0001 0000	27 10	10000
1200	0010 1110 1110 0000	2E E0	12000

750-461/000-007

Resistance (Ω)	Value Binary	Hex.	Dec.
<10	0000 0000 0110 0100	EC 00	-5120
10	0000 0011 1110 1000	00 14	20
100	0000 0111 1101 0000	00 C8	200
200	0000 1011 1011 1000	01 90	400
300	0000 1111 1010 0000	02 58	600
1000	0001 0011 1000 1000	07 D0	2000
2000	0010 0111 0001 0000	0F A0	4000
3000	0001 0111 0111 0000	17 70	6000
4000	0001 1111 0100 0000	1F 40	8000
5000	0010 0111 0001 0000	27 10	10000
>5000	0010 0111 0001 0000	27 10	10000

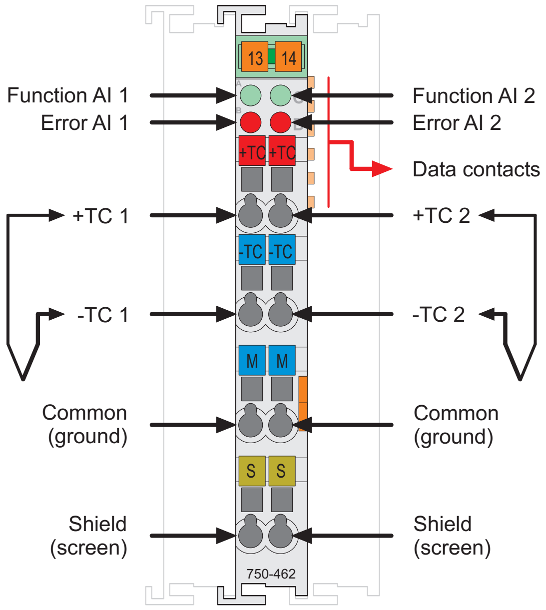
Numerical format for Siemens function blocks

750-461/000-200 (formerly 750-481)

Temp °C	Resistance (Ω)	Value Binary	X E O*)	Hex.	Dec.
> ca. 1200		0001 0000 0001 0001	0 0 1	1011	4113
	>800	not defined			
	800	1111 1111 1111 1111	0 0 0	FFFF	65535
850	390	0111 1100 1100 1101	0 0 0	7CCD	32949
560	300	0110 0000 0000 0000	0 0 0	6000	24576
266	200	0100 0000 0000 0000	0 0 0	4000	16384
0	100	0010 0000 0000 0000	0 0 0	2000	8192
-125	50	0001 0000 0000 0000	0 0 0	1000	4096
-185	25	0000 1000 0000 0000	0 0 0	0800	2048
-200	20	0000 0110 0110 0110	0 0 0	0666	1638
	10	0000 0011 0011 0011	0 0 0	0333	819
	< ca. 9	0001 0000 0001 0001	0 0 1	1011	4113

*) X : without meaning, E : short circuit or open circuit, O : overflow

4.4.1.1.4 Input for Thermocouple Modules 750-462, /000-XXX



I/O modules and variations

Item-No.:	Name:
750-462	2AI Thermo
750-462/000-001	2AI Thermo /Type S
750-462/000-002	2AI Thermo /Type T
750-462/000-003	2AI +/- 120mV
750-462/000-006	2AI Thermo /Type J
750-462/000-007	2AI Thermo /Type B
750-462/000-008	2AI Thermo /Type E
750-462/000-009	2AI Thermo /Type N
750-462/000-010	2AI Thermo /Type R
750-462/000-011	2AI Thermo /Type U
750-462/000-050	2AI Thermo /Type K without Cold junction compensation
750-462/000-061	2AI Thermo /Type U without Cold junction compensation

Technical description

This description is only intended for hardware version X X X X 2 A 0 1 - - - -.
The serial number can be found on the right side of the module.
The following description is preliminary and is applicable only to the factory configuration.
The shield is connected to "S". The connection is made automatically when snapped onto the DIN rail.
These I/O modules are not provided with integrated power jumper contacts.
The power supply is made by the data contacts with a DC-DC converter.

The thermocouple module can operate with all buscouplers of the WAGO-I/O-SYSTEM (except for the economy type).

Technical Data:

Item-No.:	**750-462**
Number of inputs	2 (Differential Input, max ± 3.5 V)
Nominal voltage	via system voltage
Sensor types	K, S, T, mV-Meter, J, B, E, N, R, U
Cold junction compensation	on each module
Resolution	0.1 °C
Isolation DC/DC	500 V System/power supply
Input current (internal)	65 mA max.
Conversion time	640 ms
Internal bit width	2 x 16 Bit Data, optional: 2 x 8 Bit control/status
Configuration	None, or via software with the consent of WAGO
Operating temperature	0 °C ... + 55 °C
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)
Presetting	- 100 °C / + 1370 °C; Type K

Attention
The 462/000-XXX modules could be replaced by the 469/000-XXX modules!

The 750-462 module permits the direct connection of thermocouple sensors.

The module is suitable for 2 or 3-wire thermocouples. For the 2-wire connection, connect the thermocouple wires between TC- and TC+ . For the 3-conductor connection, the shield is also connected. The operation of grounded sensors is provided by means of internal electrical isolation.

Attention
Both inputs are referenced to a common potential (not isolated)!

The linearization is provided over the complete range by a microprocessor. The temperature ranges of the sensors are represented with a resolution of 1 bit per 0.1°C in one word (16 Bit). Thus, 0°C corresponds to the value 0000, and 25.5°C correspond to the value 0 x 00FF. Temperatures below 0°C are represented in two’s complement.

Within the whole range of all thermocouples, the function module works like a ‘mV meter’. The voltage resolution is represented with 16 bits. A processor converts the voltage value into a numerical value proportional to the measured temperature of the selected type of thermocouple.

In order to compensate the offset voltage at the clamping point, a cold junction thermocouple compensation calculation is carried out. The circuit contains a temperature measuring sensor at the ‘CAGE CLAMP®’ connection and takes into account the temperature offset voltage when calculating the measured value.

You can find the PNs for the different sensor types for 750-462 in the following table.

Operating mode and Temperature range:

Operating mode	Temperature Range	Item-No.:
Type K	-100°C...1370°C (Standard)	750-462
Type S	0°C...+1700°C	750-462/000-001
Type T	-100°C...+400°C	750-462/000-002
mV-Meter	-120 mV...+120 mV	750-462/000-003
Type J	-100°C...+1200°C	750-462/000-006
Type B	600°C...+1800°C	750-462/000-007
Type E	-100°C...+1000°C	750-462/000-008
Type N	-100°C...+1300°C	750-462/000-009
Type R	0°C...+1700°C	750-462/000-010
Type U	-25°C...+600°C	750-462/000-011

Tab 4-1:Operating mode, Temperature range and Item number of the variations

Attention
The operating mode as mV meter in the range of -120mV to +120mV is only available with hardware version X X X X 3 A 0 2- - - - and above.
In older versions, the operating mode as mV meter is in the range of 0mV to 120mV!

LED functions:

Green LED: Function
ON: Normal
OFF: Watchdog-Timer Overflow
If the PLC does not receive data for 100 ms the green LED turns off

Red LED: Error
ON: Over- or underrange
OFF: voltage is in the measuring range

Process values

750-462, Type K

T[°C]	Value [hex]	Value [dec]	Status byte [hex]	LED
<-100.1	<FC17	<-1001	41	on
-100.1	FC17	-1001	00	off
-100.0	FC18	-1000	00	off
0.0	0000	0	00	off
200.0	07D0	2000	00	off
350.0	0DAC	3500	00	off
500.0	1388	5000	00	off
650.0	1964	6500	00	off
800.0	1F40	8000	00	off
950.0	251C	9500	00	off
1100.0	2AF8	11000	00	off
1250.0	30D4	12500	00	off
1370.0	3584	13700	00	off
1370.1	3585	13701	00	off
>1370.1	>3585	>13701	42	on
Open circuit	Room temperature		0	off

750-462/000-001, Type S

T[°C]	Value [hex]	Value [dec]	Status byte [hex]	LED
<0	<0000	<0	41	on
0.0	0000	0	00	off
100.0	03E8	1000	00	off
200.0	07D0	2000	00	off
300.0	0BB8	3000	00	off
400.0	0FA0	4000	00	off
500.0	1388	5000	00	off
1000.0	2710	10000	00	off
1500.0	3A98	15000	00	off
1700.0	4268	17000	00	off
>1700	>4268	>17000	42	on
Open circuit	Room temperature		0	off

750-462/000-002, Type T

T[°C]	Value [hex]	Value [dec]	Status byte [hex]	LED
<-100.1	<FC17	<-1001	41	on
-100.1	FC17	-1001	00	off
-100.0	FC18	-1000	00	off
-50.0	FE0C	-500	000	off
0.0	0000	0	00	off
50.0	01F4	500	00	off
100.0	03E8	1000	00	off
150.0	05DC	1500	00	off
200.0	07D0	2000	00	off
250.0	09C4	2500	00	off
300.0	0BB8	3000	00	off
350.0	0DAC	3500	00	off
400.0	0FA0	4000	42	on
>400	>0FA0	>4000	42	on
Open circuit	Room temperature		00	off

750-462/000-003, measure value ±120 mV

U[mV]	Value [hex]	Value [dec]	Status byte [hex]	LED
<-120	B000	-20480	00	off
-120.00	B6C2	-18750	00	off
-90.00	C912	-14062	00	off
-60.00	DB61	-9375	000	off
-30.00	EDB1	-4687	00	off
0.00	0000	0	00	off
30.00	1250	4688	00	off
60.00	249F	9375	00	off
90.00	36EF	14063	00	off
120.00	493E	18750	00	off
>120	7FFF	32767	00	off

One Digit correspond to 6.4 µV.

750-462/000-006, Type J

T[°C]	Value [hex]	Value [dec]	Status byte [hex]	LED
<-100	<FC18	<-1000	41	on
-100.0	FC18	-1000	00	off
0.0	0000	0	00	off
100.0	03E8	1000	00	off
200.0	07D0	2000	00	off
300.0	0BB8	3000	00	off
400.0	0FA0	4000	00	off
500.0	1388	5000	00	off
1000.0	2710	10000	00	off
1200.0	2EE0	12000	00	off
>1200	>2EE0	>12000	42	on
Open circuit	Room temperature		00	off

750-462/000-007, Type B

T[°C]	Value [hex]	Value [dec]	Status byte [hex]	LED
<-600	<1770	<6000	41	on
600.0	1770	6000	00	off
700.0	1B58	7000	00	off
800.0	1F40	8000	00	off
900.0	2328	9000	00	off
1000.0	2710	10000	00	off
1500.0	3A98	15000	00	off
1600.0	3E80	16000	00	off
1700.0	4268	17000	00	off
1800.0	4650	18000	00	off
>1800	>4650	>18000	42	on
Open circuit	Room temperature		00	off

750-462/000-008, Type E

T[°C]	Value [hex]	Value [dec]	Status byte [hex]	LED
<-100	<FC18	<-1000	41	on
0.0	0000	0	00	off
100.0	03E8	1000	00	off
200.0	07D0	2000	00	off
300.0	0BB8	3000	00	off
400.0	0FA0	4000	00	off
500.0	1388	5000	00	off
600.0	1770	6000	00	off
700.0	1B58	7000	00	off
800.0	1F40	8000	00	off
900.0	2328	9000	00	off
999.0	2706	9990	00	off
>999	>2706	>9990	42	on
Open circuit	Room temperature		00	off

750-462/000-011, Type U

T[°C]	Value [hex]	Value [dec]	Status byte [hex]	LED
<-25	<FF06	<-250	41	on
-25.0	FF06	-250	00	off
0.0	0000	0	00	off
50.0	01F4	500	00	off
100.0	03E8	1000	00	off
200.0	07D0	2000	00	off
300.0	0BB8	3000	00	off
400.0	0FA0	4000	00	off
500.0	1388	5000	00	off
590.0	170C	5900	00	off
>590	>170C	>5900	42	on
Open circuit	Room temperature		00	off

750-462/000-011, Type U -25°C -600°C

T[°C]	Value [hex]	Value [dec]	Status byte [hex]	LED
<-25	<FF06	<-250	41	on
-25.0	FF06	-250	00	off
37.5	0177	375	00	off
100.0	03E8	1000	00	off
162.5	0659	1625	00	off
225.0	08CA	2250	00	off
287.5	0B3B	2875	00	off
350.0	0DAC	3500	00	off
412.5	101D	4125	00	off
475.0	128E	4750	00	off
537.5	14FF	5375	00	off
600.0	1770	6000	00	off
>600	1770	6000	42	on
No identification of open circuit, measuring value correspond to 0°C.				

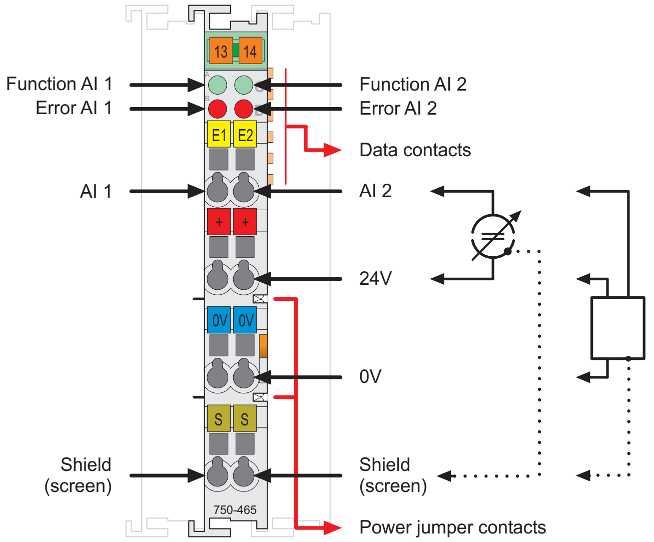
750-462/000-050, Type K without Cold junction compensation

T[°C]	Value [hex]	Value [dec]	Status byte [hex]	LED
<-100	<FC18	<-1000	41	on
-100.0	FC18	-1000	00	off
0,0	0000	0	00	off
200.0	07D0	2000	00	off
350.0	0DAC	3500	00	off
500.0	1388	5000	00	off
650.0	1964	6500	00	off
800.0	1F40	8000	00	off
950.0	251C	9500	00	off
1100.0	2AF8	11000	00	off
1250.0	30D4	12500	00	off
1370.0	3584	13700	00	off
>1370	>3584	>13700	42	on
Open circuit	0000	0	0	off

750-462/000-061, Type U without Cold junction compensation

T[°C]	Value [hex]	Value [dec]	Status byte [hex]	LED
<-25	<FF06	<-250	41	on
-25.0	FF06	-250	00	off
0.0	0000	0	00	off
50.0	01F4	500	00	off
100.0	03E8	1000	00	off
150.0	05DC	1500	00	off
200.0	07D0	2000	00	off
250.0	09C4	2500	00	off
300.0	0BB8	3000	00	off
400.0	0FA0	4000	00	off
500.0	1388	5000	00	off
600.0	1770	6000	00	off
>600	1770	6000	42	on
Open circuit	0000	0	0	off

4.4.1.1.5 2 Channel Analog Inputs (0-20mA / 4-20mA single-ended) 750-465, -466, (-486)



I/O modules and variations

Item-No.:	Description	Name
750-465	2 Channel Analog Input 0-20 mA; single-ended	2 AI 0-20 mA s.e.
750-465/000-200	2 Channel Analog Input 0-20 mA; single-ended with status infomation within the data word	2 AI 0-20 mA s.e. S5-FB

750-466	2 Channel Analog Input 4-20 mA; single-ended	2 AI 4-20 mA s.e.
750-466/000-200 (formerly 750-486)	2 Channel Analog Input 4-20 mA; single-ended with status infomation within the data word	2 AI 4-20 mA s.e. S5-FB

Technical description

This description is only intended for hardware version X X X X 2 A 0 1 - - - -. The serial number can be found on the right side of the module.

The input channels are single ended and they have a common ground potential.

The inputs are connected to +I. Via 24 V / 0 V terminals power can be provided directly to the sensor from the module. Power connections are made automatically from module to module when snapped onto the DIN rail.

The shield is connected to "S". The connection is made automatically when snapped onto the DIN rail.

The status of the input channels are indicated by the LEDs:

Function:	on	The channel function is error-free.
	off	The communication to the bus coupler is broken.
Error:	on	The input signal is out of range < 3.5 mA or > 20.5 mA.
	off	The input signal is in range.

The input module can operate with all buscouplers of the WAGO-I/O-SYSTEM (except for the economy type).

Technical Data:

Item-No.:	**750-465, 750-465/000-200*)**	**750-466, 750-466/000-200*) (formerly 750-486)**
Number of inputs	2	
Nominal voltage	via system voltage (DC / DC)	
Input current (internal)	75 mA typ.	
Input signal	0-20 mA	4-20 mA
Resistance	<150 Ω at 20 mA	
Resolution	12 Bit (*) 12 Bit + sign for the variations 750-465/000-200 and 750-466/000-200)	
Signal voltage	29 V max.	
Current limiting	< 40 mA typ. at 24 V for 1 min	
Measuring error	< ± 0,3% (from upper limit of effective range)	
Isolation	500V System/power supply	
Conversion time	2 ms typ.	
Bit width per channel	16 Bit: Data 8 Bit: Control/Status, optional	
Configuration	none, or via software with the consent of WAGO	
Operating temperature	0°C....+55°C	
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length	
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)	

Numerical format

The digitized measured value is stored in a data word (16 bit) as an input byte 0 (high) and as an input byte 1 (low). The value with a 12 bit resolution is illustrated on bit B3 ... B14. The three low value bits (B0 ... B2) are only used in the event of an error.

Some fieldbus systems process status information to the input channel using a status byte.

750-465, 750-466

Input current		Value			Status	LED
0-20 mA	4-20 mA	Binary	Hex.	Dec.		Error E (1,2)
>20.5	>20.5	0111 1111 1111 1111	0x7FFF	32767	0x42	on
20	20	0111 1111 1111 1XXX	0x7FFF	32767	0x00	off
10	12	0100 0000 0000 0XXX	0x4000	16384	0x00	off
5	8	0010 0000 0000 0XXX	0x2000	8192	0x00	off
2.5	6	0001 0000 0000 0XXX	0x1000	4096	0x00	off
0.156	4.125	0000 0001 0000 0XXX	0x0100	256	0x00	off
0.01	4.0078	0000 0000 0001 0XXX	0x0010	16	0x00	off
0.005	4.0039	0000 0000 0000 1XXX	0x0008	8	0x00	off
0	4	0000 0000 0000 0XXX	0x0000	0	0x00	off
-	3.5 - 4	0000 0000 0000 0000	0x0000	0	0x00	off
-	0 - 3.5	0000 0000 0000 0000	0x0000	0	0x41	on

Numerical format for Siemens function blocks

For fieldbus masters with the ability to evaluate the status information within the data word, i.e. Siemens format.

The status information is contained in Bit B0 .. B2.

The digitized input is placed at the position Bit B3 .. B15.

750-465/000-200 (formerly 485)

Input current 0-20 mA	Value				Status	LED Error E (1,2)
	Binary	X E O *)	Hex.	Dec.		
>20.5	0101 0000 0000 0	0 0 1	0x5001	20481	0x42	on
20	0101 0000 0000 0	0 0 0	0x5000	20480	0x00	off
10	0011 0000 0000 0	0 0 0	0x3000	12288	0x00	off
5	0010 0000 0000 0	0 0 0	0x2000	8192	0x00	off
2.5	0001 1000 0000 0	0 0 0	0x1800	6144	0x00	off
0.312	0001 0001 0000 0	0 0 0	0x1100	4608	0x00	off
0.019	0001 0000 0001 0	0 0 0	0x1010	4112	0x00	off
0.0097	0001 0000 0000 1	0 0 0	0x1008	4104	0x00	off
0	0001 0000 0000 0	0 0 0	0x1000	4096	0x00	off

*) X : without meaning, E : short circuit or open circuit, O : overflow

750-466/000-200 (formerly 750-486)

Input-current 0-20 mA	Value				Status	LED Error E (1,2)
	Binary	X E O *)	Hex.	Dec.		
>20.5	0101 0000 0000 0000	0 0 1	0x5001	20481	0x42	on
20	0101 0000 0000 0000	0 0 0	0x5000	20480	0x00	off
12	0011 0000 0000 0000	0 0 0	0x3000	12288	0x00	off
8	0010 0000 0000 0000	0 0 0	0x2000	8192	0x00	off
6	0001 1000 0000 0000	0 0 0	0x1800	6144	0x00	off
4.25	0001 0001 0000 0000	0 0 0	0x1100	4608	0x00	off
4.016	0001 0000 0001 0000	0 0 0	0x1010	4112	0x00	off
4	0001 0000 0000 0000	0 0 0	0x1000	4096	0x00	off
<3.5	0001 0000 0000 0000	0 1 1	0x1003	4099	0x41	on

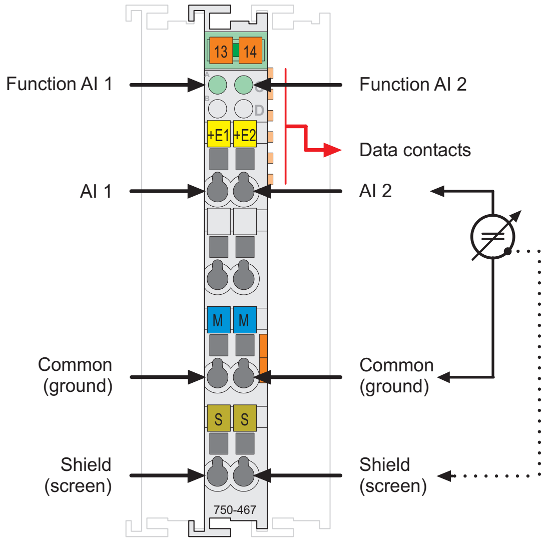
*) X : without meaning, E : short circuit or open circuit, O : overflow

Status byte

Bit	7	6	5	4	3	2	1	0
Meaning	0	ERROR	res.	res.	res.	res.	Overrange	Underrange

ERROR	Error at the input channel.
Overrange	The input signal is over the admissible measuring range, if necessary it exists a short-circuit.
Underrange	The input signal is under the admissible measuring range, if necessary it exists an open circuit (only for module 750-466).
Res.	Reserved, not currently used

4.4.1.1.6 2 Channel Analog Inputs 0-10V (single-ended)750-467, (-487)



I/O modules and variations

Item-No.:	Description:	Name
750-467	2 Channel Analog Input 0-10V single-ended	2AI 0-10V DC s.e.
750-467/000-200 *(formerly 487)*	2 Channel Analog Input 0-10V single-ended with Status information within the dataword	2AI 0-10V DC s.e. S5 FB

Technical description

This description is only intended for hardware version X X X X 2 A 0 0 - - - -.

The serial number can be found on the right side of the module.

The input channels are single ended and they have a common ground potential.

The inputs are connected to +I and ground. The shield is connected to "S". This connection in the module is made automatically when snapped onto the DIN rail.

These I/O modules are not provided with integrated power jumper contacts. The power supply is made by the data contacts with a DC-DC converter.

The input module can operate with all buscouplers of the WAGO-I/O-SYSTEM (except for the economy type).

Technical Data:

Item-No.:	**750-467, 750-467/000-200*⁾**
Number of inputs	2
Nominal voltage	via system voltage
Input current (internal)	60 mA
Overvoltage protection	35 V max.
Input signal	0-10 V
Resistance	133 kΩ typ.
Resolution	12 Bit (*⁾ 12 Bit + sign for the variations 750-467/000-200)
Isolation	500V System/power supply
Conversion time	2 ms typ.
Bit width per channel	16 Bit: Data; optional 8 Bit: Control/Status
Configuration	none, or via software with the consent of WAGO
Operating temperature	0°C....+55°C
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)

Numerical format

All analog values will be shown in a unit numerical format. The resolution is 12 Bits.

The following table will explain the numerical format. The 3 LSBs are not significant.

750-467

Input voltage 0-10V	Value Binary	Hex.	Dec.	Status
> 10	0111 1111 1111 1111	7F FF	32767	42
10	0111 1111 1111 1XXX	7F F8	32760	0
5	0100 0000 0000 0XXX	40 00	16384	0
2.5	0010 0000 0000 0XXX	20 00	8192	0
1.25	0001 0000 0000 0XXX	10 00	4096	0
0.0781	0000 0001 0000 0XXX	01 00	256	0
0.0049	0000 0000 0001 0XXX	00 10	16	0
0.0024	0000 0000 0000 1XXX	00 08	8	0
0	0000 0000 0000 0XXX	00 07	7	0
0	0000 0000 0000 0XXX	0	0	0

Numerical format for Siemens function blocks

For fieldbus masters with the ability to evaluate the status information within the data word, i.e. Siemens format

The status information is contained in Bit B0 .. B2.

The digitized input is placed at the position Bit B3 .. B15.

750-467/000-200

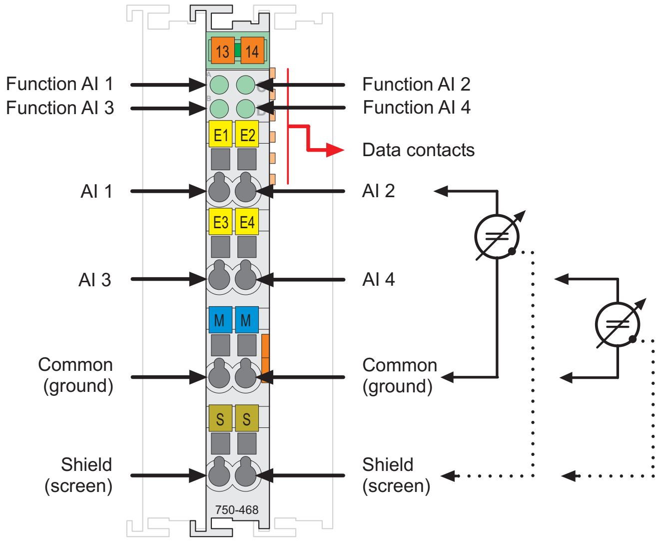
Input voltage 0-10V	Value Binary	X E O*)	Hex.	Dec.	Status
>10	0101 0000 0000 0	0 0 1	50 01	20481	42
10	0101 0000 0000 0	0 0 0	50 00	20480	0
5	0011 0000 0000 0	0 0 0	30 00	12288	0
2.5	0010 0000 0000 0	0 0 0	20 00	8192	0
1.25	0001 1000 0000 0	0 0 0	18 00	6144	0
0.0049	0001 0000 0000 1	0 0 0	10 08	4104	0
0	0001 0000 0000 0	0 0 0	10 00	4096	0

*) X : without meaning, E : short circuit or open circuit, O : overflow

Status byte

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Error	x	x	x	x	Overrange	x

4.4.1.1.7 4 Channel Analog Inputs 0-10V (single-ended)750-468, (-488)



I/O modules and variations

Item-No.:	Description:	Name
750-468	4 Channel Analog Input 0-10V single-ended	4AI 0-10V DC s.e.
750-468/000-200 *(formerly 488)*	4 Channel Analog Input 0-10V single-ended with status information within the data word	4AI 0-10V DC s.e. (Siemens)

Technical description

This description is only intended for hardware version X X X X 2 A 0 0 - - - -.

The serial number can be found on the right side of the module.

The input channels are single ended and they have a common ground potential.

The inputs are connected to +I and ground. The shield is connected to "S". The connection is made automatically when snapped onto the DIN rail.

These I/O modules are not provided with integrated power jumper contacts. The power supply is made by the data contacts with a DC-DC converter.

The input module can operate with all buscouplers of the WAGO-I/O-SYSTEM (except for the economy type).

Technical Data:

Item-No.:	**750-468**
Number of inputs	4
Nominal voltage	via system voltage (DC DC converter)
Input current (internal)	60 mA
Overvoltage protection	35 V max.
Input signal	0-10 V
Resistance	133 kΩ typ.
Resolution	12 Bit
Isolation	500V System/power supply
Conversion time	2 ms typ.
Bit width per channel	16 Bit: Data; optional 8 Bit: Control/Status
Configuration	None, or via software with the consent of WAGO
Operating temperature	0°C....+55°C
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)

Numerical format

All analog values will be shown in a unit numerical format. The resolution is 12 Bits.

The following table will explain the numerical format. (750-467, 468). The 3 LSBs are not significant.

750-468

Input voltage 0-10V	**Value Binary**	**Hex.**	**Dec.**	**Status**
> 10	0111 1111 1111 1111	7F FF	32767	42
10	0111 1111 1111 1XXX	7F F8	32760	0
5	0100 0000 0000 0XXX	40 00	16384	0
2.5	0010 0000 0000 0XXX	20 00	8192	0
1.25	0001 0000 0000 0XXX	10 00	4096	0
0.0781	0000 0001 0000 0XXX	01 00	256	0
0.0049	0000 0000 0001 0XXX	00 10	16	0
0.0024	0000 0000 0000 1XXX	00 08	8	0
0	0000 0000 0000 0XXX	00 07	7	0
0	0000 0000 0000 0XXX	0	0	0

Numerical format for Siemens function blocks

For fieldbus masters with the ability to evaluate the status information within the data word, i.e. Siemens format.

The status information is contained in Bit B0 .. B2.

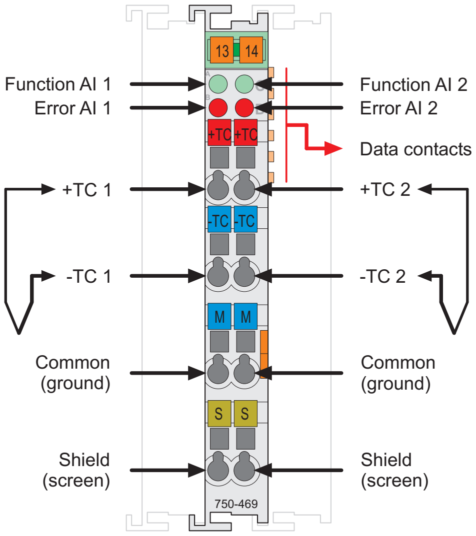
The digitized input is placed at the position Bit B3 .. B15.

750-468/000-200 (formerly 750-488)

Input voltage 0-10V	Value Binary	X E O*)	Hex.	Dec.	Status
>10	0101 0000 0000 0000	0 0 1	50 01	20481	42
10	0101 0000 0000 0000	0 0 0	50 00	20480	0
5	0011 0000 0000 0000	0 0 0	30 00	12288	0
2.5	0010 0000 0000 0000	0 0 0	20 00	8192	0
1.25	0001 1000 0000 0000	0 0 0	18 00	6144	0
0.0049	0001 0000 0000 1000	0 0 0	10 08	4104	0
0	0001 0000 0000 0000	0 0 0	10 00	4096	0

*) X : without meaning, E : short circuit or open circuit, O : overflow

4.4.1.1.8 Input for Thermocouple Modules 750-469, /000-XXX



I/O modules and variations

Item-No.:	Name:
750-469	2AI Thermo.(detection of broken wire) /Type K
750-469/000-001	2AI Thermo.(detection of broken wire) /Type S
750-469/000-002	2AI Thermo.(detection of broken wire) /Type T
750-469/000-003	2AI +/- 120mV, (detection of broken wire)
750-469/000-006	2AI Thermo.(detection of broken wire) /Type J
750-469/000-008	2AI Thermo.(detection of broken wire) /Type E
750-469/000-012	2AI Thermo.(detection of broken wire) /Type L
750-469/000-200	2AI Thermo.(detection of broken wire), Siem. Form.

Technical description

This description is only intended for hardware version X X X X 2 A 0 1 - - - -.

The serial number can be found on the right side of the module.

The following description is preliminary and is applicable only to the factory configuration.

The shield is connected to "S". The connection is made automatically when snapped onto the DIN rail.

These I/O modules are not provided with integrated power jumper contacts. The power supply is made by the data contacts with a DC-DC converter.

The thermocouple module can operate with all buscouplers of the WAGO-I/O-SYSTEM (except for the economy type).

Technical Data:

Item-No.:	**750-469**
Number of inputs	2 (Differential Input, max ± 3.5 V)
Nominal voltage	via system voltage
Sensor types	K, S, T, mV, J, E, L
Cold junction compensation	on each module
Resolution	0.1 °C
Isolation DC/DC	500 V System/power supply
Input current (internal)	65 mA max.
Conversion time	640 ms
Internal bit width	2 x 16 Bit Data, optional: 2 x 8 Bit control/status* (*detection on broken wire)
Configuration	None, or via software with the consent of WAGO
Operating temperature	0 °C ... + 55 °C
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)
Presetting	- 100 °C / + 1370 °C; Type K

The function module permits the direct connection of thermocouple sensors.

The module is suitable for 2 or 3-wire thermocouples. For the 2-wire connection, connect the thermocouple wires between TC- and TC+ . For the 3-conductor connection, the shield is also connected. The operation of grounded sensors is provided by means of internal electrical isolation.

The module 750-469 detects a broken wire. You can find the PNs for the different sensor types for 750-469 in the following table.

Attention
Both inputs are referenced to a common potential (not isolated)!

The linearization is provided over the complete range by a microprocessor. The temperature ranges of the sensors are represented with a resolution of 1 bit per 0.1°C in one word (16 Bit). Thus, 0°C corresponds to the value 0000, and 25.5°C correspond to the value 0 x 00FF. Temperatures below 0°C are represented in two's complement.

Within the whole range of all thermocouples, the function module works like a 'µV meter'. The voltage resolution is represented with 16 bits. A processor converts the voltage value into a numerical value proportional to the measured temperature of the selected type of thermocouple.

In order to compensate the offset voltage at the clamping point, a cold junction thermocouple compensation calculation is carried out. The circuit contains a temperature measuring sensor at the 'CAGE CLAMP®' connection and considers the temperature offset voltage when calculating the measured value.

Operating mode and Temperature range:

Operating mode	Temperature range	Item-No.:
Type K	-100°C...1370°C (Standard)	750-469
Type S	0°C...+1700°C	750-469/000-001
Type T	-100°C...+400°C	750-469/000-002
mV-meter	-120 mV...+120 mV	750-469/000-003
Type J	-100°C...+1200°C	750-469/000-006
Type E	-100°C...+1000°C	750-469/000-008
Type L	-25°C...+900°C	750-469/000-012

Tabel: Operating mode, Temperature range and Item number of the variations

Attention
The operating mode as mV meter in the range of -120mV to +120mV is only available for hardware version X X X X 3 A 0 2- - - - and above. In older versions, the operating mode as mV meter is in the range of 0mV to 120mV!

LED functions:

green LED: Function
ON: Normal
OFF: Watchdog-Timer Overflow
If the PLC does not receive data for 100 ms the green LED turns off.

Red LED: Error
ON: Over- or underrange or broken wire
OFF: voltage is in the measuring range

Process values

750-469, Broken wire detection ,Type K

T[°C]	Value [hex]	Value [dec]	Status byte [hex]	LED
<-100.1	<FC17	<-1001	41	on
-100.1	FC17	-1001	00	off
-100.0	FC18	-1000	00	off
47.0	01D6	470	00	off
194.0	0794	1940	00	off
341.0	0D52	3410	00	off
488.0	1310	4880	00	off
635.0	18CE	6350	00	off
782.0	1E8C	7820	00	off
929.0	144A	9290	00	off
1076.0	2A08	10760	00	off
1223.0	2FC6	12230	00	off
1370.0	3584	13700	00	off
1370.1	3585	13701	00	off
>1370.1	>3585	>13701	42	on
Open circuit	7FFF	32767	42	on

750-469/000-001, Broken wire detection ,Type S

T[°C]	Value [hex]	Value [dec]	Status byte [hex]	LED
<0	<0000	<0	41	on
0.0	0000	0	00	off
100.0	03E8	1000	00	off
200.0	07D0	2000	00	off
300.0	0BB8	3000	00	off
400.0	0FA0	4000	00	off
500.0	1388	5000	00	off
1000.0	2710	10000	00	off
1500.0	3A98	15000	00	off
1700.0	4268	17000	00	off
>1700	>4268	>17000	42	on
Open circuit	7FFF	32767	42	on

750-469/000-002, Broken wire detection ,Type T

T[°C]	Value [hex]	Value [dec]	Status byte [hex]	LED
<-100.1	<FC17	<-1001	41	on
-100.1	FC17	-1001	00	off
-100.0	FC18	-1000	00	off
-50.0	FE0C	-500	00	off
0.0	0000	0	00	off
50.0	01F4	500	00	off
100.0	03E8	1000	00	off
150.0	05DC	1500	00	off
200.0	07D0	2000	00	off
250.0	09C4	2500	00	off
300.0	0BB8	3000	00	off
350.0	0DAC	3500	00	off
400.0	0FA0	4000	42	on
>400	>0FA0	>4000	42	on
Open circuit	7FFF	32767	42	on

750-469/000-003, Measurement range ±120 mV

U[mV]	**Value [hex]**	**Value [dec]**	**Status byte [hex]**	**LED**
<-120	<B6C2	-18750	00	off
-120.00	B6C2	-18750	00	off
-90.00	C912	-14062	00	off
-60.00	DB61	-9375	000	off
-30.00	EDB1	-4687	00	off
0.00	0000	0	00	off
30.00	1250	4688	00	off
60.00	249F	9375	00	off
90.00	36EF	14063	00	off
120.00	493E	18750	00	off
>120	>493E	>18750	00	off
Open circuit	7FFF	32767	42	on

One Digit correspond to 6.4 µV

750-469/000-006, Broken wire detection,Type J

T[°C]	Value [hex]	Value [dec]	Status byte [hex]	LED
<-100	<FC18	<-1000	41	on
-100.0	FC18	-1000	00	off
0.0	0000	0	00	off
100.0	03E8	1000	00	off
200.0	07D0	2000	00	off
300.0	0BB8	3000	00	off
400.0	0FA0	4000	00	off
500.0	1388	5000	00	off
1000.0	2710	10000	00	off
1200.0	2EE0	12000	00	off
>1200.0	>2EE0	>12000	42	on
Open circuit	7FFF	32767	42	on

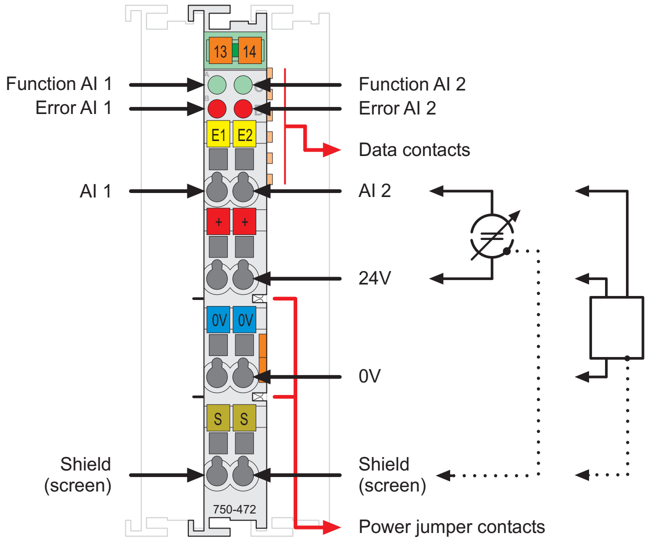
750-469/000-008, Broken wire detection,Type E

T[°C]	**Value [hex]**	**Value [dec]**	**Status byte [hex]**	**LED**
<-100.0	<FC18	<-1000	41	on
-100.0	FC18	-1000	00	off
0.0	0000	0	00	off
100.0	03E8	1000	00	off
200.0	07D0	2000	00	off
300.0	0BB8	3000	00	off
400.0	0FA0	4000	00	off
500.0	1388	5000	00	off
600.0	1770	6000	00	off
700.0	1B58	7000	00	off
900.0	2328	9000	00	off
999.0	2706	9990	00	off
>999	>2706	>9990	42	on
Open circuit	7FFF	32767	42	on

750-469/000-012, Broken wire detection,Type L

T[°C]	Value [hex]	Value [dec]	Status byte [hex]	LED
<-25	<FF06	<-1000	41	on
-25.0	FF06	-1000	00	off
0.0	0000	0	00	off
100.0	03E8	1000	00	off
200.0	07D0	2000	00	off
300.0	0BB8	3000	00	off
400.0	0FA0	4000	00	off
500.0	1388	5000	00	off
600.0	1770	6000	00	off
700.0	1B58	7000	00	off
800.0	1F40	8000	00	off
900.0	2328	9000	00	off
>900	>2328	>9000	42	on
Open circuit	7FFF	32767	42	on

4.4.1.1.9 2 Channel Analog Inputs (0-20mA / 4-20mA single-ended) 750-472, -474



I/O modules and variations

Item-No.:	Name:
750-472	2AI 0-20mA 16 Bit s.e.
750-472/000-200	2AI 0-20mA 16 Bit s.e. S5-463
750-474	2AI 4-20mA 16 Bit s.e.
750-474/000-200	2AI 4-20mA 16 Bit s.e. S5-460 /465

Technical description

This description is only intended for hardware and software version X X X X 0 2 0 2- - -- 0 5 0 3.

The serial number can be found on the right side of the module.

The input channels are single ended and they have a common ground potential.

The inputs are connected to +I. Via 24 V / 0 V power can be provided directly to the sensor from the module. Power connections are made automatically from module to module through the PJC when snapped onto the DIN rail.

The shield is connected to "S". The connection is made automatically when snapped onto the DIN rail.

The input module can operate with all buscouplers of the WAGO-I/O-SYSTEM (except for the economy type).

Technical Data:

Item-No.:	**750-472, 750-472/000-200*)**	**750-474, 750-474/000-200*)**
Number of inputs	2	
Nominal voltage	DC 24 V (-15% / +20%) via power jumper contacts	
Overvoltage protection	24 V max.	
Input current (internal)	75 mA typ.	
Input signal	0-20mA	4-20mA
Input current	< 38 mA at 24 V	
Resistance	50 Ω	
Signal voltage	non-linear/overload protection: U=DC 1.2 V +160Ω*I_{mess}	
Resolution	16 Bit internal, 15 Bit via fieldbus (*) 12 Bit + sign for the variations 750-472/000-200 and 474/000-200)	
Input filter	50 Hz	
Noise rejection at sampling frequency	< -100 dB	
Noise rejection below sampling frequency	< -40 dB	
Transition requency	13 Hz	
Isolation	500 V System/power supply	
Conversion time	80 ms typ.	
Bit width per channel	16Bit: Data; optional 8Bit: Control/Status	
Configuration	none, or via software with the consent of WAGO	
Operating temperature	0°C....+55°C	
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length	
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)	

Numerical format

The resolution of 750-472 and 750-474 are 15 Bit.

750-472, 750-474

Input current 0-20mA	Input current 4-20mA	Value Binary	Hex.	Dec.	Status	LED
>20.5	>20.5	0111 1111 1111 1111	7F FF	32767	42	on
20	20	0111 1111 1111 1111	7F FF	32767	0	off
10	12	0100 0000 0000 0000	40 00	16384	0	off
5	8	0010 0000 0000 0000	20 00	8192	0	off
2.5	6	0001 0000 0000 0000	10 00	4096	0	off
0.156	4.125	0000 0001 0000 0000	01 00	256	0	off
0.01	4.0078	0000 0000 0001 0000	00 10	16	0	off
0.005	4.0039	0000 0000 0000 1000	00 08	8	0	off
0	4	0000 0000 0000 0000	00 00	0	0	off
0	3.5 - 4	0000 0000 0000 0000	0	0	0	off
0	0 - 3.5	0000 0000 0000 0000	0	0	41 (4-20mA)	on (4-20 mA)

Numerical format for Siemens function blocks

For fieldbus masters with the ability to evaluate the status information within the data word, i.e. Siemens format.

The status information is contained in Bit B0 .. B2.

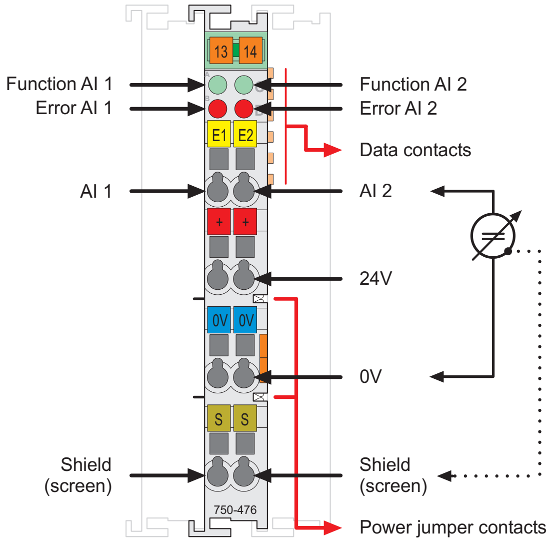
The digitized input is placed at the position Bit B3 .. B15. The numerical format for 750-472/000-200 is equivalent to S5 463 and for 750-474/000-200 to S5 460/465.

750-472/000-200, -474/000-200

Input current 4-20mA	Value Binary	X E O*)	Hex.	Dec.	Status	LED
32	0111 1111 1111 1	0 0 1	7F F9	32761	42	on
31.99	0111 1111 1111 0	0 0 0	7F F0	32752	0	on
20.5	0101 0010 0000 0	0 0 0	52 00	20992	0	on
20	0101 0000 0000 0	0 0 0	50 00	20480	0	off
16	0100 0000 0000 0	0 0 0	40 00	16384	0	off
12	0011 0000 0000 0	0 0 0	30 00	12288	0	off
8	0010 0000 0000 0	0 0 0	20 00	8192	0	off
4.0078	0001 0000 0000 1	0 0 0	10 08	4104	0	off
4	0001 0000 0000 0	0 0 0	10 00	4096	0	off
3.5	0000 1110 0000 0	0 0 0	0E 00	3584	0	on
0	0000 0000 0000 0	0 0 0	00 00	0	0	on

*) X : without meaning, E : short circuit or open circuit, O : overflow

4.4.1.1.10 2 Channel Analog Inputs (± 10 V / 0-10 V, 16 Bit, single-ended) 750-476, -478



I/O modules and variations

Item-No.:	Description	Name
750-476	2 Channel Analog Input ± 10 V, single-ended	2 AI ± 10 V DC 16 Bit s.e.
750-478	2 Channel Analog Input 0-10 V, single-ended	2 AI 0-10 V DC 16 Bit s.e.

Technical description

This description is only intended for hardware and software version X X X X 0 4 0 2 - - - - .

The serial number can be found on the right side of the module.
The input channels are single ended and they have a common ground potential.

The inputs are connected to I and 0V.

The shield is connected to "S". The connection is made automatically when snapped onto the DIN rail.

The input module can operate with all buscouplers of the WAGO-I/O-SYSTEM (except for the economy type).

Technical Data:

Item-No.:	**750-476**	**750-478**
Number of inputs	2	
Nominal voltage	via system voltage	
Overvoltage protection	24 V max.	
Input current (internal)	75 mA typ.	
Input signal	+/- 10 V	0 - 10 V
Resistance	130 kΩ typ.	
Resolution	15 Bit + Sign	
Isolation	500 V System/power supply	
Noise rejection at sampling frequency	< -100 dB	
Noise rejection below sampling frequency	< -40 dB	
Transition Frequency	13 Hz	
Input filter	50 Hz	
Conversion time	80 ms	
Bit width per channel	16Bit: Data; optional 8Bit: Control/Status	
Configuration	none, or via software with the consent of WAGO	
Operating temperature	0°C....+55°C	
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length	
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)	

Numerical format

All analog values will be shown in a unit numerical format. The resolution for 750-476 and 750-478 is 15 Bit plus sign.

750-476, 750-478

Input voltage		Value			Status	LED
0-10V	±10V	Binary	Hex.	Dec.	(hex)	Error E (1,2)
>11	>11	0111 1111 1111 1111	0x7FFF	32767	0x42	on
>10.5	>10.5	0111 1111 1111 1111	0x7FFF	32767	0x42	off
10	10	0111 1111 1111 1111	0x7FFF	32767	0x00	off
5	5	0100 0000 0000 0000	0x4000	16384	0x00	off
2.5	2.5	0010 0000 0000 0000	0x2000	8192	0x00	off
1.25	1.25	0001 0000 0000 0000	0x1000	4096	0x00	off
0.0781	0.0781	0000 0001 0000 0000	0x0100	256	0x00	off
0.049	0.049	0000 0000 0001 0000	0x0010	16	0x00	off
0.0003	0.0003	0000 0000 0000 0001	0x0001	1	0x00	off
0	0	0000 0000 0000 0000	0x0000	0	0x00	off
<-0.5		0000 0000 0000 0000	0x0000	0	0x41	off
<-1		0000 0000 0000 0000	0x0000	0	0x41	on
	-5	1100 0000 0000 0000	0xC000	49152	0x00	off
	-10	1000 0000 0000 0000	0x8000	32768	0x00	off
	<-10.5	1000 0000 0000 0000	0x8000	32768	0x41	off
	<-11	1000 0000 0000 0000	0x8000	32768	0x41	on

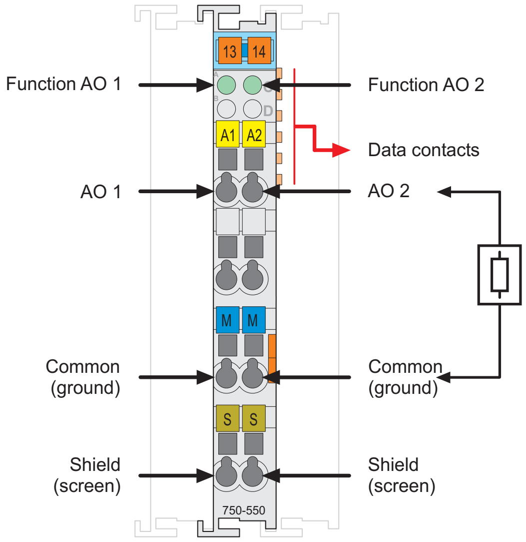
Status byte

Bit	7	6	5	4	3	2	1	0
Meaning	0	ERROR	res.	res.	res.	res.	Overrange	Underrange

ERROR	Error on input channel.
Overrange	The input signal is over the admissible measuring range.
Underrange	The input signal is under the admissible measuring range.
res.	Reserved, not currently used

4.5 Analog Outputs

4.5.1.1.1 2 Channel Analog Outputs (DC 0-10V / ±10V) 750-550, -556, (-580)



I/O modules and variations

Item-No.:	Description	Name
750-550	2 Channel Analog Output, 0-10V	2AO 0-10V DC
750-550/000-200 *formerly 750-580*	2 Channel Analog Output, 0-10V with status infomation within the data word	2AO 0-10V DC Siemens Format

750-556	2 Channel Analog Output, ±10V	2AO ±10V DC
750-556/000-200	2 Channel Analog Output, ±10V with status infomation within the data word	2AO ±10V DC Siemens Format

Technical description

This description is only intended for hardware version X X X X 2 A 0 1 - - - -. The serial number can be found on the right side of the module.

The output signal of 750-550 is a 0-10 V signal, the output signal of 750-556 is a ±10 V signal.
Sensors should be connected to "O" and to the common ground.
The shield is connected to "S". The connection is made automatically when snapped onto the DIN rail.

These I/O modules are not provided with integrated power jumper contacts. The power supply is made by the data contacts with a DC-DC converter.

The output module can operate with all buscouplers of the WAGO-I/O-SYSTEM (except for the economy type).

Technical Data:

Item-No.:	750-550, 750-550/000-200 (formerly 750-580)	750-556, 750-556/000-200
Number of outputs	2	
Input current (internal)	65 mA	
Nominal voltage	via system voltage	
Signal voltage	0 - 10 V	±10 V
Resistance	> 5 kΩ	
Resolution	12 Bit	
Isolation	500 V System/power supply	
Internal bit width per Channel	1 x 16 Bit Data	
Configuration	none, or via software with the consent of WAGO	
Operating temperature	0 °C ... + 55 °C	
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length	
Dimensions (mm) WxHxL	12 x 64* x 100, (*from upper edge of carrier rail)	

Numerical format

All analog values will be shown in a numerical format. The resolution is 12 Bits.
The 3 LSBs are not significant. The following tables will explain the numerical format. The data format is signed 16 bit, although lowest 3 bits are ignored.

750-550

Output voltage 0-10V	Value Binary	Hex.	Dec.
10	0111 1111 1111 1111	7F FF	32767
5	0100 0000 0000 0000	40 00	16384
2.5	0010 0000 0000 0000	20 00	8192
1.25	0001 0000 0000 0000	10 00	4096
0.0781	0000 0001 0000 0000	01 00	256
0.0049	0000 0000 0001 0000	00 10	16
0.0024	0000 0000 0000 1000	00 08	8
0	0000 0000 0000 0111	00 07	7
0	0000 0000 0000 0000	00 00	0

750-556

Output voltage ±10V	Value Binary	Hex.	Dec.
10	0111 1111 1111 1111	7F FF	32767
5	0100 0000 0000 0000	40 00	16384
2.5	0010 0000 0000 0000	20 00	8192
1.25	0001 0000 0000 0000	10 00	4096
0.0781	0000 0001 0000 0000	01 00	256
0.0049	0000 0000 0001 0000	00 10	16
0	0000 0000 0000 1111	00 0F	15
0	0000 0000 0000 0000	00 00	0
-2.5	1110 0000 0000 0000	E0 00	57344
-5	1100 0000 0000 0000	C0 00	49152
-7.5	1010 0000 0000 0000	A0 00	40960
-10	1000 0000 0000 0000	80 00	32768

Numerical format for Siemens function blocks

For fieldbus masters with the ability to evaluate the status information within the data word, i.e. Siemens format.

The status information is contained in Bit B2 .. B0.

The digitized input is placed at the position Bit B3 .. B15.

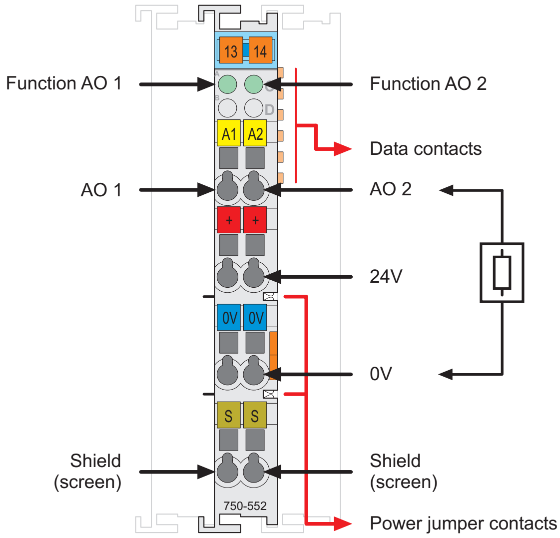
750-550/000-200

Output voltage 0-10V	**Value Binary**	**Hex.**	**Dec.**
>10	>0100 0000 0000 XXXX	>40 00	>16384
10	0100 0000 0000 XXXX	40 00	16384
7.5	0011 0000 0000 XXXX	30 00	12288
5	0010 0000 0000 XXXX	20 00	8192
2.5	0001 0000 0000 XXXX	10 00	4096
1.25	0000 1000 0000 XXXX	08 00	2048
0	0000 0000 0000 XXXX	00 00	0

750-556/000-200

Output oltage ±10V	**Value Binary**	**Hex.**	**Dec.**
-10	<1100 0000 0000 XXXX	<C0 00	<-16384
-10	1100 0000 0000 XXXX	C0 00	-16384
-7.5	1101 0000 0000 XXXX	D0 00	-12288
-5	1110 0000 0000 XXXX	E0 00	-8192
-2.5	1111 0000 0000 XXXX	F0 00	-4096
0	0000 0000 0000 XXXX	00 00	0
2.5	0001 0000 0000 XXXX	10 00	4096
5	0010 0000 0000 XXXX	20 00	8192
7.5	0011 0000 0000 XXXX	30 00	12288
10	0100 0000 0000 XXXX	40 00	16384
>10	>0100 0000 0000 XXXX	>40 00	>16384

4.5.1.1.2 2 Channel Analog Outputs (0-20mA / 4-20mA) 750-552, -554, (-584)



I/O modules and variations

Item-No.:	Description	Name
750-552	2 Channel Analog Output, 0-20 mA	2AO 0-20mA
750-552/000-200	2 Channel Analog Output, 0-20 mA with status infomation within the data word	2AO 0-20mA (Siemens Format)

750-554	2 Channel Analog Output, 4-20 mA	2AO 4-20mA
750-554/000-200 *formerly 750-584*	2 Channel Analog Output, 4-20 mA with status infomation within the data word	2AO 4-20mA (Siemens Format)

Technical description

This description is only intended for hardware version X X X X 2 A 0 1 - - - -. The serial number can be found on the right side of the module.

The output signal of 750-552 and 750-554 is a 0-20 mA or 4-20 mA signal. Sensors may be connected to "O" and to the common ground (0V).
The shield is connected to "S". The connection is made automatically when snapped onto the DIN rail.

Power connections are made from module to module via power jumper contacts when snapped onto the DIN rail.

For a self-supporting function, the power supply has to be connected by an input module (i.e. 750-602).

The output module can operate with all buscouplers of the WAGO-I/O-SYSTEM (except for the economy type).

Technical Data:

Item-No.:	750-552, 750-552/000-200*)	750-554, 750-554/000-200*) (formerly 750-584)
Number of outputs	2	
Input current (internal)	60 mA max.	
Nominal voltage	DC 24 V (-15% / +20%) via power jumper contacts	
Signal current	0-20 mA	4-20 mA
Resistance	< 500 Ω	
Linearity	±2 LSB (last Significant Bit)	
Resolution	12 Bit (*) 12 Bit + sign for the variations 750-552/000-200 and 750-554/000-200)	
Isolation	500V System/power supply	
Bit width per channel	16Bit: Data	
Configuration	none, or via software with the consent of WAGO	
Operating temperature	0°C....+55°C	
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length	
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)	

Numerical format

All analog values will be shown in a numerical format. The following table will explain the numerical format. (750-552/554). The 3 LSBs are not significant.

750-552, 750-554

Output current 0-20 mA	Output current 4-20 mA	Value Binary	Hex.	Dec.
20	20	0111 1111 1111 1111	7F FF	32767
10	12	0100 0000 0000 0000	40 00	16384
5	8	0010 0000 0000 0000	20 00	8192
2.5	6	0001 0000 0000 0000	10 00	4096
0.156	4.125	0000 0001 0000 0000	01 00	256
0.01	4.0078	0000 0000 0001 0000	00 10	16
0.005	4.0039	0000 0000 0000 1000	00 08	8
0	4	0000 0000 0000 0111	00 07	7
0	4	0000 0000 0000 0000	0	0

Numerical format for Siemens function blocks

For fieldbus masters with the ability to evaluate the status information within the data word, i.e. Siemens format.

The status information is contained in Bit B2 .. B0.

The digitized input is placed at the position Bit B3 .. B15.

750-552/000-200

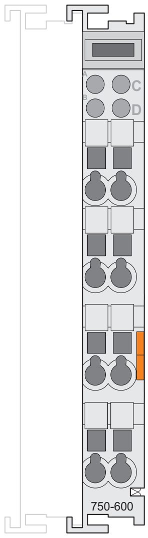
Output current 0-20 mA	Value Binary	Hex.	Dec.
20	0100 0000 0000 0000	40 00	16384
17.5	0011 1000 0000 0000	38 00	14336
15	0011 0000 0000 0000	30 00	12288
12.5	0010 1000 0000 0000	28 00	10240
10	0010 0000 0000 0000	20 00	8192
7.5	0001 1000 0000 0000	18 00	6144
5	0001 0000 0000 0000	10 00	4096
2.5	0000 1000 0000 0000	08 00	2048
0	0000 0000 0000 0000	00 00	0

750-554/000-200

Output current 4-20 mA	Value Binary	Hex.	Dec.
20	0100 0000 0000 0000	40 00	16384
16	0011 0000 0000 0000	30 00	12288
12	0010 0000 0000 0000	20 00	8192
8	0001 0000 0000 0000	10 00	4096
4.015	0000 0000 0001 0000	0010	16
4	0000 0000 0000 0000	0000	0

4.6 Supply and End modules

4.6.1.1.1 End module 750-600



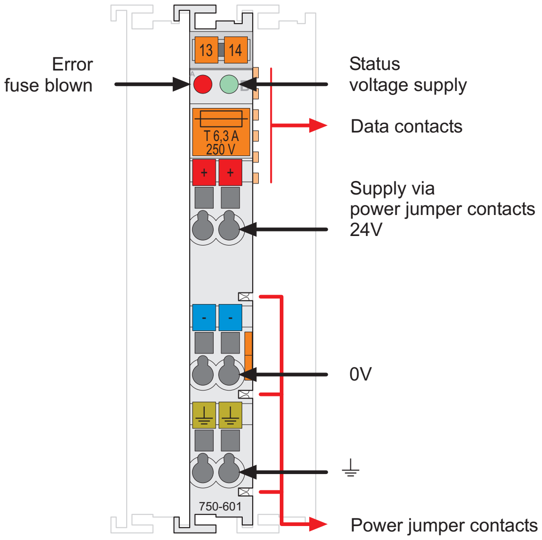
Technical description

After the fieldbus node is assembled with the correct buscoupler and selected I/O modules, the end module is snapped onto the assembly. It completes the internal data circuit and ensures correct data flow. This module is a necessary component to all WAGO fieldbus nodes.

Technical Data:

Item-No.:	750-600
Voltage	-
Current via contacts	-
Operating temperature	0 °C ... + 55 °C
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64 x 100, (from upper edge of carrier rail)

4.6.1.1.2 Supply modules (DC 24V / AC 230V / AC 120V) 750-601, -609, -615



Technical description

The supply module feeds field power through the power jumper contacts. Maximum current supply to the modules with fuse holder is 6.3 A. Should more current be needed, additional supply modules may be added in the assembly.

The modules 750-601, 609 and 615 are additionally equipped with a fuse. Changing the fuse is accomplished by pulling out the fuse holder and removing the fuse.

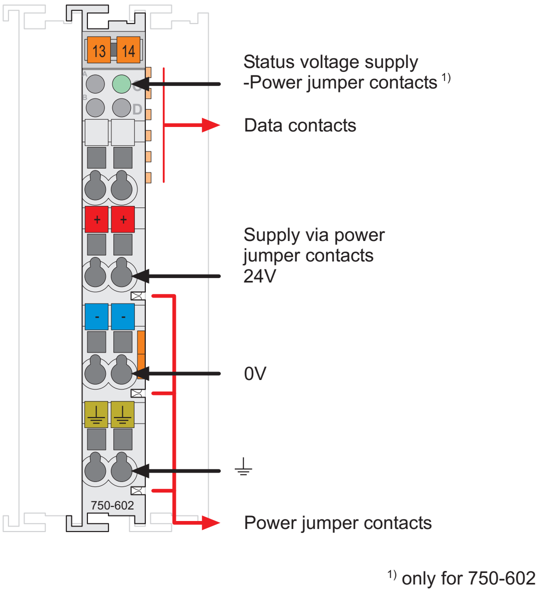
A blown fuse is indicated by a red LED.

Make sure the proper voltage is applied to the supply module. Use caution when changing voltage potential within a node. All modules following the supply module will be powered at the new potential. The following table shows the voltage ratings for the supply modules.

Technical Data:

Item-No.:	**750-601**	**750-609**	**750-615**
Voltage	DC 24 V	AC 230 V	AC 120 V
Current via contacts	max. 6.3 A		
Fuse	5 x 20, 6.3 A		
Operating temperature	0 °C ... + 55 °C		
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length		
Dimensions (mm) WxHxL	12 x 64 x 100, (from upper edge of carrier rail)		

4.6.1.1.3 Supply modules (DC 24V, passive) 750-602



Technical description

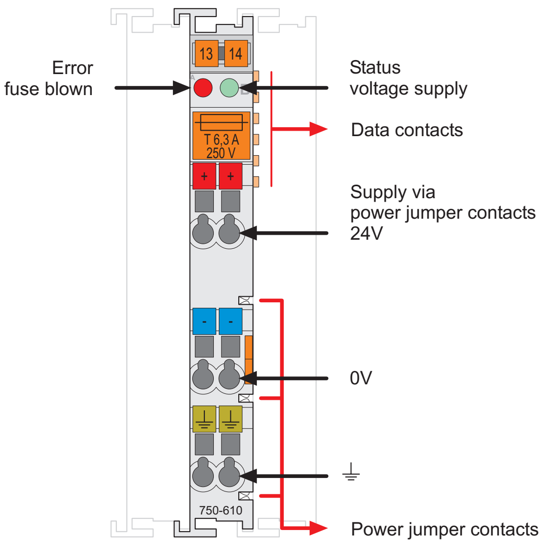
The supply module feeds field power through the power jumper contacts. Maximum current supply to all connected modules is 10 A. Should more current be needed, additional supply modules may be added in the assembly.

Make sure the proper voltage is applied to the supply module. Use caution when changing voltage potential within a node. All modules following will be powered at the new potential.

Technical Data:

Item-No.:	750-602
Voltage	DC 24 V
Current via contacts	Max. DC 10 A
Operating temperature	0 °C ... + 55 °C
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64 x 100, (from upper edge of carrier rail)

4.6.1.1.4 Supply modules (DC 24V / AC 230V) 750-610, -611



Technical description

The supply module feeds field power through the power jumper contacts. Maximum current supply to the modules with fuse holder is 6.3 A. Should more current be needed, additional supply modules may be added in the assembly.

Changing the fuse is accomplished by pulling out the fuse holder and removing the fuse. A blown fuse is indicated by a LED.

The 750-610 and 611 modules send information about the status of the supply module to the fieldbus coupler through two digital input bits.

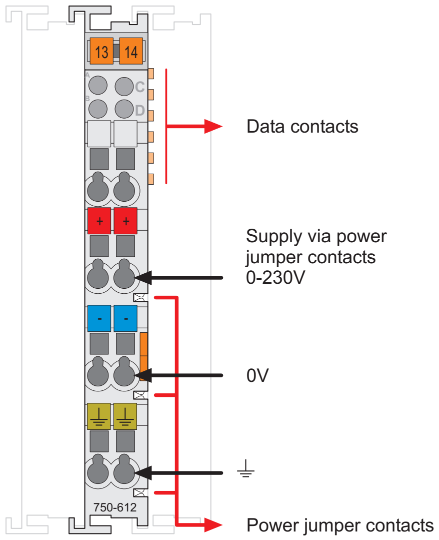
Bit 1	Bit 2	Description	750-610	750-611
0	0	Voltage under:	DC 5 V	AC 40 V
1	0	Fuse blown		
0	1	Fuse o.k., Voltage over:	DC 15 V	AC 164 V

Make sure the proper voltage is applied to the supply module. Use caution when changing potential within the node. All modules following the supply module will be powered at the new potential. The following table shows the voltage ratings for the supply modules.

Technical Data:

Item-No.:	750-610	750-611
Number of inputs	2	
Current consumption	5 mA	
Internal bit width	2	
Voltage	DC 24 V	AC 230 V
Current via contacts	max. 6.3 A	
Fuse	5 x 20, 6.3 A	
Operating temperature	0 °C ... + 55 °C	
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length	
Dimensions (mm) WxHxL	12 x 64 x 100, (from upper edge of carrier rail)	

4.6.1.1.5 Supply modules (AC/DC 230V passive) 750-612



Technical description

The supply module feeds field power through the power jumper contacts.

Maximum current supply to all connected modules is 10 A.

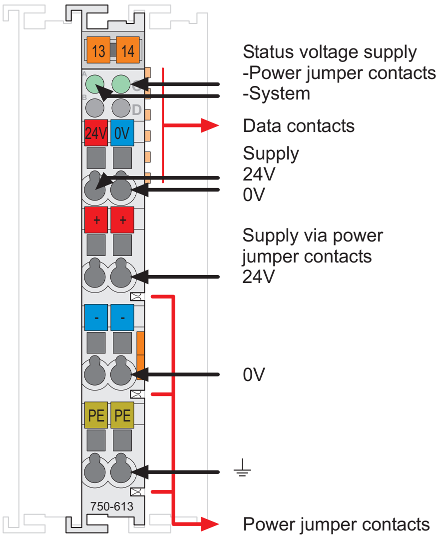
Should more current be needed,additional supply modules may be added in the assembly.

Make sure the proper voltage is applied to the supply module. Use caution when changing voltage potential within a node. All modules following the supply module will be powered at the new potential. The following table shows the voltage rating for the supply module.

Technical Data:

Item-No.:	**750-612**
Voltage	AC/DC 0 - 230 V
Current via contacts	max. DC 10 A
Operating temperature	0 °C ... + 55 °C
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64 x 100, (from upper edge of carrier rail)

4.6.1.1.6 Supply modules (DC 24V with DC-DC converter) 750-613



Technical description

The supply module feeds field power through the power jumper contacts.

Maximum current supply to all connected modules is 10 A.

Should more current be needed, additional supply modules may be added in the assembly.

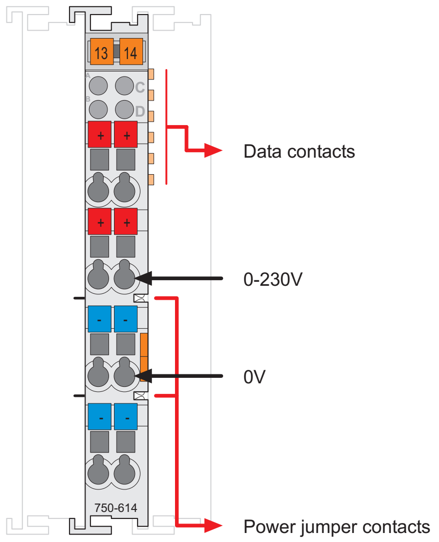
The 750-613 supplies voltage to the field side and the internal data bus. It can supply 2A max to the internal data bus. If the sum of the internal data bus current consumption exceeds 2 A, an additional supply module must be added.

Make sure the proper voltage is applied to the supply module. The following table shows the voltage rating for the supply module.

Technical Data:

Item-No.:	**750-613**
Voltage	DC 24 V (-15%/+20%)
Current via contacts	max. DC 10 A
Current via internal data bus	max. 2 A
Operating temperature	0 °C ... + 55 °C
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64* x 100, (*from upper edge of carrier rail)

4.6.1.1.7 Potential multiplication modules 750-614



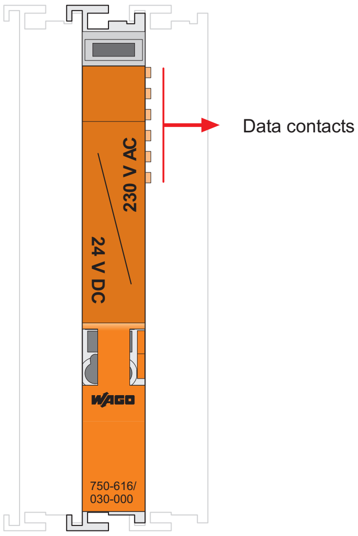
Technical description

The potential multiplication module allows additional + and - voltage connection points (up to 4 additional). This eliminates the need for external terminal blocks.

Technical Data:

Item-No.:	**750-614**
Voltage	AC/DC 24 V - 230 V
Current via contacts	max. 10 A
Operating temperature	0 °C ... + 55 °C
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64 x 100, (from upper edge of carrier rail)

4.6.1.1.8 Separation modules 750-616



I/O modules and variations

Item-No.:	Description	Name
750-616	Separation modules	Separation modules
750-616/030-000	Separation modules "24 V DC/230 V AC"	Separation modules "24 V DC /230 V AC"

Technical description

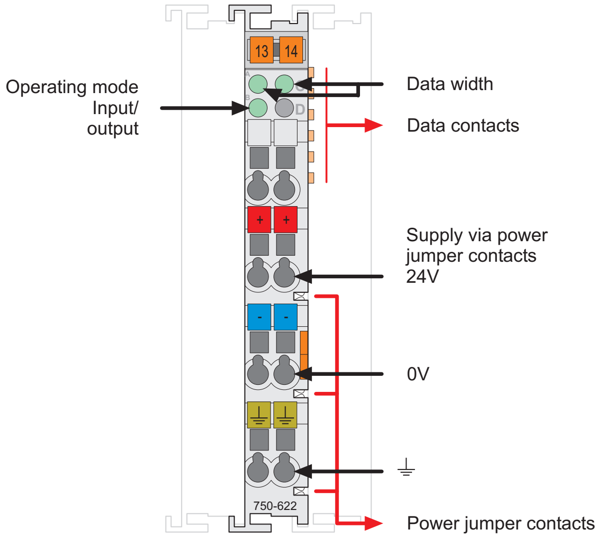
This module allows increased air- and creepage distances between different field voltages within a node.

There are two different separation modules. The 750-616 module does not have printing. The 750-616/030-000 has "24 V DC /230 V AC" printed on the front.

Technical Data:

Item-No.:	750-616, 616/030-000
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)

4.6.1.1.9 Binary spacer modules 750-622



Technical description

The binary spacer module reserves digital addresses in the WAGO buscoupler.

The number of inputs or outputs can be selected by two DIP switches. 2, 4, 6 or 8 bits are possible (1, 2, 3 or 4-channel modules). A third DIP Switch selects inputs or outputs.

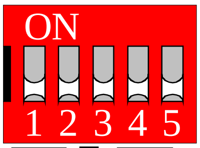
The configuration is indicated by means of 3 LEDs, which are lit, even if there is no voltage applied.

The binary spacer module also works as a 24 V supply module. Power must be connected to supply the modules following the binary spacer.

Technical Data:

Item-No.:	**750-622**
Number of in- or outputs	2, 4, 6 or 8
Nominal voltage	DC 5 V internal
Input current (internal)	10 mA max.
Voltage (field side)	DC 24 V (-15%/+20%)
Current via power jumper con-tacts	10 A max.
Input current (field side)	-
Isolation	500 V System/power supply
Internal Bit width	2, 4, 6 or 8
Configuration	none, or via software with the consent of WAGO
Operating temperature	0°C....+55°C
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)

The DIP switches and LEDs are used as follows. When the switch is OFF the LED is also OFF (dark LED symbol). When the switch is ON the LED lightens (light LED symbol).

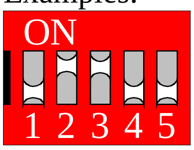


X	X	Don't care	

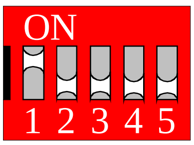
OFF	Inputs	B D
ON	Outputs	B D

OFF	OFF	2 Bit (1x 2 Bit)	A C
ON	OFF	4 Bit (2x 2 Bit)	A C
OFF	ON	6 Bit (3x 2 Bit)	A C
ON	ON	8 Bit (4x 2 Bit)	A C

Examples:



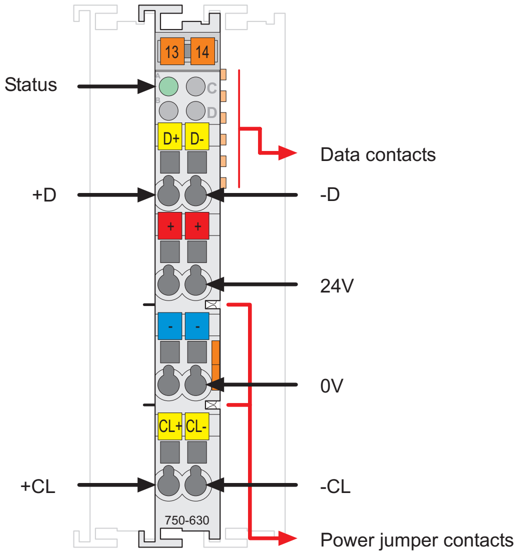
6 Binary Outputs (3x 2 Channel output modules)



4 Binary Inputs (2x 2 Channel input modules)

4.7 Terminal blocks for encoder and resolvers

4.7.1.1.1 SSI transmitter interface 750-630



I/O modules and variations

Item-No.:	Description	Name
750-630	SSI transmitter interface 24Bit, 125kHz Gray code, alternative data format	SSI/ 24BIT/ 125KHZ/ GRAY CODE
750-630/000-001	SSI transmitter interface 24Bit, 125kHz Binary code, alternative data format	SSI/ 24BIT/ 125KHZ/ BIN
750-630/000-006	SSI transmitter interface 24Bit, 250kHz Gray code, alternative data format	SSI/ 24BIT/ 250KHZ/ GRAY CODE

Technical description

This technical description is only valid for hardware and software versions X X X X 2 B 0 2----. The product series number is printed on the right side of the module.

The operational mode of the module is factory preset to a 24 bit absolute encoder Gray code signal transmitted at 125kHz.

The following description is preliminary and is applicable to the factory configuration.

The SSI Interface can operate with all WAGO-I/O-SYSTEM bus-couplers (except for the economy type).

Technical Data:

Item-No.:	**750-630**	**750-630/000-001**	**750-630/000-006**
Encoder connections	Data Input: D+; D-; Clock output: CI+; CI-		
current consumption (internal)	85 mA typ.		
Power supply	DC 24 V (-15%/+20%)		
Sensor power supply	DC 24 V via power jumper contacts		
Baud rate	max. 1 MHz		
Data field width	32 Bit		
Signal output (clock)	Differential signal (RS 422)		
Signal input (positional)	Differential signal (RS 422)		
Output data format	Gray code / Dual code		
Internal bit width	1 x 32 Bit Data, 1 x 8 Bit control/status		
Configuration	none, or via software with the consent of WAGO		
Isolation	500 V system / power supply		
Operating temperature	0°C....+55°C		
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length		
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)		
Presetting	125 kHz Gray code 24 Bit Data	125 kHz Binary 24 Bit Data	250 kHz Gray code 24 Bit Data

Terminal Configuration:

Input	**Type**	**Function**
Signal D+ and Signal D-	Input, RS422	Positional data from encoder, Gray code
Signal Cl+ and Signal CL-	Output, RS422	Clock signal output for communications interface
+24V	Input	24 V DC supply voltage to module, field connection.
0V	Input	0 V DC supply voltage return to module, field connection.

The use of this module in conjunction with a SSI encoder provides direct positional information rather than the type of data resulting from incremental type encoders.

Absolute encoders are comprised of several data disks to generate a data word which is unique through out the 360 degrees of rotation. The data format is a modified binary pattern in either Gray code or Dualcode.

The resolution of the sensor depends upon the configuration of the sensor and the physical number of revolutions in the motion profile. Since the basis of the encoder is to provide absolute positional information, which is based upon a mechanical configuration limited to one revolution or less, the maximum resolution of this module is 24 bit.

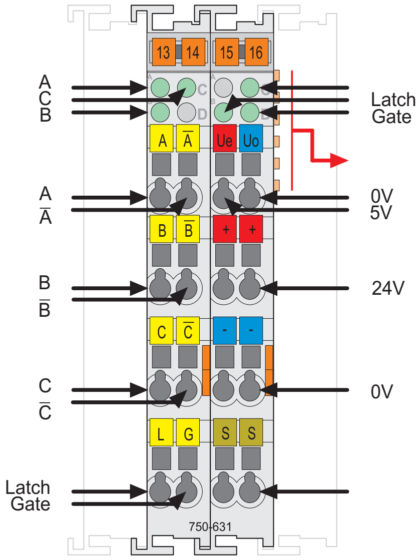
The frequency of the data signal input to the SSI module is maintained at 125 kHz.

Listed below are the recommended cable lengths for the various clock signal Baud rates

Baud rate	max. Cable length
100 kHz	400 m
125 kHz	300 m
200 kHz	200 m
300 kHz	100 m
400 kHz	50 m

Attention
For the process data configuration of these bus modules please refer to chapter "Process data architecture for MODBUS/TCP" in the process image description of the corresponding coupler/controller.

4.7.1.1.2 Incremental encoder interface 750-631



I/O modules and variations

Item-No.:	Description	Name
750-631	Incremental encoder-interface 4 times sampling	Increment. Enc.
750-631/000-001	Incremental encoder-interface 1 time sampling	Increment. Enc./Single Interpret.

Technical description

Attention
The description that is in the I/O ring binder data pages (888-543/020-101 dated 4/96) is not correct.

This technical description is only valid for hardware and software versions X X X X 2 B

0 1----. The product series number is printed on the right side of the module.

The described operational mode is 4 times or quadrature sampling.

The following description is preliminary and is applicable to the factory confi-guration.

The Quadrature Encoder Interface can operate with all WAGO-I/O-SYSTEM buscouplers (except for the economy type).

Technical Data:

Item-No.:	**750-631**	**750-631/000-001**
Encoder connections	A, A (inv), B, B (inv), C, C (inv)	
current consumption (internal)	25 mA	
Sensor supply Voltage	DC 5 V	
Data word	16 Bit Binary	
Maximum Frequency	1 MHz	
Quadraturdecoder	1-2-4 times sampling	
Data Latch word	16 Bit	
Commands	read, reset, start	
Supply Voltage	DC 24 V (- 15 % / + 20 %)	
Input current (internal)	85 mA typ. without sensor	
Sensor output current	300 mA max.	
Internal bit width	1 x 32 Bit Data, 1 x 8 Bit control/status	
Configuration	none, or via software with the consent of WAGO	
Operating temperature	0 °C ... + 55 °C	
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length	
Dimensions (mm) WxHxL	24 x 64* x 100 (*from upper edge of carrier rail)	
Default configuration	4 times sampling	1 times sampling

Operational Characteristics:

The quadrature encoder interface accepts up to two input signals for the counting increment. The index pulse may also be considered should the control configuration require it. There is also a Latch and Gate input available on the module for added functionality.

The quadrature encoder provides two signals that are shifted 90 degrees from each other, signals A and B. In order to achieve a better common mode noise rejection ratio, the output signals from the encoder are transmitted via a differential signal. Their complement signals, A(inv.) and B(inv.) are also transmitted. A directional determination may be made by which signal leads. If the A signal leads, the direction is considered to be forward. If the B signal leads, the direction is considered to be reverse.

By exchanging the A and A(inv.) the phase relationship will be changed by 180 degrees, thus allowing the direction to be preset via the wiring configuration.

Most quadrature encoders have an Index signal, or Z rev, as well as the incremental signal. This signal provides one pulse per revolution with a duration equal to an incremental pulse.

The inputs to the quadrature encoder module must be supplied from an encoder with Line Driver Outputs for proper operation. The 5 Volt DC output may be used to power the encoder. The 24 Volt DC input supply must be provided from an external power supply.

The Gate and Latch inputs are 24 Volt DC.

Module Inputs and Outputs:

Input	Type	Function
Signal A and Signal -A	Input, TTL	Incremental pulse signals for channel A
Signal B and Signal -B	Input, TTL	Incremental pulse signals for channel B
Signal C and Signal -C	Input, TTL	Index pulse signals
Shield	Input	Shield connection for encoder wiring
Sensor 0V	Output	Supply return for encoder supply
Sensor +5V	Output	5 Volt DC supply for encoder
+24V	Input	24 Volt DC supply, field connection
0V	Input	Supply return, field connection
Gate	Input, 24V	24 Volt DC input for gate signal
Latch	Input, 24V	24 Volt DC input for Latch signal

The Input Gate stops the counter. Only 0 V or an open connection will initialize the counter.

24 V stops the counting process.

The input Latch controls the writing of the actual counter value into the Latch register. This input is activated by the control bit EN_LATEXT ("1"). EN_LACT has to be deactivated ("0"). The first change from 0 V to 24 V at the Latch input writes the actual counter value into the Latch register.

The control byte has the following bits:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	x	CFAST_M	x	x	CNT_SET	EN_LATEXT	EN_LATC
0	x	Operating mode	x	x	Counter set	Release Latch	Release Index Pulse

Please note **Bit 7** is a reserved bit and must always be set to 0. It is responsible for register communication which is not described in this chapter.

Bit	Function
CFAST_M	Fast mode operation. Only the counter module function will be operable. All other control bits will be ignored.
CNT_SET	The counter module will be preset to a count value with a rising edge.
EN_LATEXT	0 =The external latch input is deactivated. 0 to 1=The module will latch in the counter data on the first rising edge. Other changes have no effect.
EN_LACT	0 =Latching data with the Index pulse is deactivated. 0 to 1=The Index pulse will latch in the counter data on the first rising edge. Other changes have no effect.

The status byte contains the information as listed below.

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
0	x	x	OVER-FLOW	UNDER-FLOW	CNTSET_ACC	LATEXT_VAL	LATC_VAL
0	x	x	Counter Overflow	Counter Underflow	Counter Set Acknowledge	External Latch Acknowledge	Latch Data Set

Bit	Function
OVERFLOW	The Overflow bit will be set if the counter value rolls over from 65535 to 0. This bit will automatically be reset if the counter passes through more than one third of the count range, 21845 to 21846, or if an Underflow occurs.
UNDERFLOW	The Underflow bit will be set if the counter value rolls back from 65535 to 0. This bit will automatically be reset if the counter passes through more than two thirds of the count range, 43690 to 43689, or if an Overflow occurs.
CNTSET_ACC	The Counter Set Acknowledge bit is set when a valid counter value is preset to the module.
LATEXT_VAL	The Latch External Valid Acknowledge bit is set when a counter value is latched into the module via the Latch input.
LACT_VAL	The Latch Index Pulse Valid Acknowledge bit is set when a counter value is latched into the module via the Index pulse.

It is possible to process and/or check the actions listed below via the control and status bits

Extending the 16 bit counting range:

The internal counting range is 16 bits or a maximum value of 65535. Should the application require an extended count range the location-difference-integration method may be employed. This method uses the control system to store the encoder module value. Any new encoder value will have the previously stored encoder value subtracted from it. This value will then be added to an accumulated register value. It is assumed that the encoder value difference of the two encoder values is smaller than 16 bits therefore overflows need not be considered.
Another method calculates the extended encoder range via the underflow and overflow status bits. The encoder value is either added or subtracted to the ac-

cumulation register depending upon the status of the overflow or underflow bits.

Setting Counter Position:

The counter can be preset with the CNT_SET bit.

The desired preset is loaded into the data register and the CNT_SET bit is set from 0 to 1. The CNTSET_ACC bit will be set to 1 when the preset value is loaded into the count register.

Maintaining the Present Counter Position:

The encoder present value may be maintained or latched via the external Latch input. First the external latch must be enabled via the EN_LATEXT bit. Once the input is enabled, the data will be latched into the counter module upon a 0 to 1 transition. Upon completion of the latch process the external latch valid bit LATEXT_VAL will be set to 1.

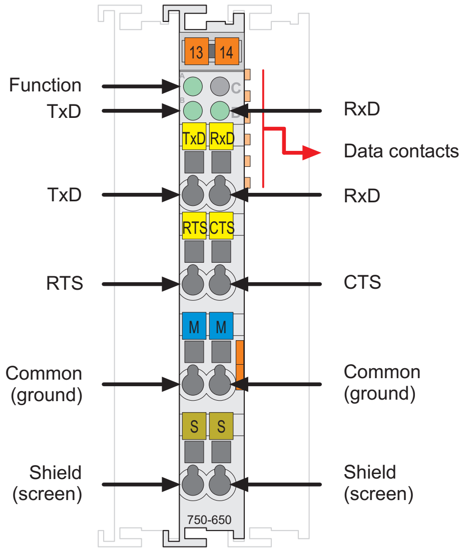
Maintaining a Reference Point:

The storage of a present counter value may also accomplished via the Index pulse from the encoder. First the index latch enable bit must be set, EN_LACT, to a value 1. The encoder present value will be latched upon the low to high transition of the Index input. Upon completion of the data latch process the Index Latch Valid bit, LACT_VAL will be set to 1.

Attention
For the process data configuration of these bus modules please refer to chapter "Process data architecture for MODBUS/TCP" in the process image description of the corresponding coupler/controller.

4.8 Special terminal blocks

4.8.1.1.1 RS232C Interface 750-650



I/O modules and variations

Item-No.:	Description	Name
750-650	RS 232 C Interface 9600,n,8,1	RS 232 C/ 9600/ N/ 8/ 1
750-650/000-001	RS 232 C Interface 9600,n,8,1 5 Byte	RS 232 C/ 9600/ N/ 8/ 1/ 5BYTE

Technical description

This technical description is only valid for hardware and software versions X X X X 2 C 0 3----. The product series number is printed on the right side of the module.

The following description is preliminary and is applicable to the factory preset configuration.

Many other operational modes are possible (please contact WAGO for the corresponding settings).

The interface module can operate with all WAGO-I/O-SYSTEM buscouplers (except for the economy type).

Technical Data:

Item-No.:	750-650, 750-650/000-001
Transmission channel	2 (1/1), T x D and R x D, full duplex
Transmission rate	1200 - 19200 Baud
Bit skew	< 3 %
Bit transmission	-
Resistance	-
Current consumption (internal)	50 mA max.
Transmission length	max. 15 m RS 232 cable
Input buffer	128 Byte
Output buffer	16 Byte
Voltage supply	via internal system supply
Isolation	500 V System/power supply
Internal bit width	1 x 40 Bit, 1 x 8 Bit control/status
Configuration	none, or via software with the consent of WAGO
Operating temperature	0 °C ... + 55 °C
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)
Presetting: Baud rate Internal bit width	 9600 Baud 1 x 24 Bit in/out, 1 x 8 Bit Control/Status

Description of RS 232:

The interface module is designed to operate with all WAGO I/O fieldbus couplers. The serial interface module allows the connection of RS 232-Interface devices to the WAGO I/O SYSTEM. The RS 232 Interface module can provide gateways within the fieldbus protocol. This allows serial equipment such as printers, barcode readers, and links to local operator interfaces to communicate directly by the fieldbus protocol with the PLC or PC Master.

This module does not support a higher level protocol. Communication is made completely transparent to the fieldbus allowing flexibility in further applications of the serial interface module. The communication protocols are configured at the Master PLC or PC.
The 128 byte input buffer provides for high rates of data transmission. When using slower transmission speeds, you can collect the received data with lower priority without loosing data.
The 16 byte output buffer provides for faster transmission of larger data strings.

Attention
The data transmission takes place at 9,600 baud (default value). 1 start bit, 8 data bits and 1 stop bit will be transmitted. No parity is available. The user controls data via the RTS and CTS signals. These signals are generated in the module depending on the loading status of the buffers. These controls can be deactivated by means of an external jumper. RTS and CTS are to be connected.

Attention
For testing purposes the Windows terminal emulation Terminal can be used. A cable with a 9- pole sub-D socket is required. Pin 5 is connected to input "common". Pin 2 is connected to TxD and Pin 3 to RxD. RTS and CTS of the module are connected. A hardwarehandshake between the terminal emulation and the PLC is not possible.

Organization of the in- and output data:

The module is a combined analog input and output module with 2 x 16 bit input and output data. The transfer of the data to be transmitted and the received data is made via 3 output and 3 input bytes. One control byte and one status byte are used to control the floating data.

Requests are indicated by a change of a bit. An assigned bit indicates execution by adopting the value of the request bit.

Up to 3 characters which have been received via interface can be stored in the input bytes 0 to 2. The output bytes will contain the characters to be sent.

The control byte consists of the following bits:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	OL 2	OL1	OL0	0	IR	RA	TR
Constant value should always be 0.	Frames available in output area OL2 is always 0, i.e. OL2, OL1, OL0 = 0,1,1 3 characters should be sent and put into the output.			Constant value should always be 0.	Initialization request	Receive acknow-ledge	Transmit request

The status byte has the following bits:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	IL2	IL1	Il0	BUF_F	IA	RR	TA
Constant value should always be 0.	Frames available in input area IL2 is always 0. i.e. IL2, IL1, IL0 = 0,1,0 2 characters were received and reside in input 0 and input 1.			Input buffer is full.	Initialization acknowledge	Receive request	Transmit acknow-ledge

The PLC/PC is able to control transmission and reception of data by means of the control byte and the status byte.

Initialization of the module:

- set IR bit in the control byte to "1"
- transmit/receive functions are blocked
- output/input buffers are erased
- serial interface module will load its configuration data

Transmitting data:

- TR≠TA: put characters into output bytes 0 to 2
- amount of characters is specified in OL0 to OL2
- TR is inverted and read out
- characters are put into output buffer if TR=TA

Receiving data:

- RR≠RA: data in input bytes 0 to 2 characters are available
- amount of characters is specified in IL0 to IL2
- characters in IL0 to IL2 are read out
- RA is inverted and read out
- all characters are read when RR=RA

The transmitting and receiving of data can be done simultaneously. The initialization request has priority and will stop transmitting and receiving of data immediately.

Attention
Resetting the initialization bit can be performed with the following message.

Message: input buffer full (Bit 3)
Input buffer is full. Data which is being currently received is now lost.

An example:

The module is initialized.

- The initialization bit in the control byte is set.

Output byte 0	Control byte	Output byte 2	Output byte 1
0x00	0000.0100	0x00	0x00

- After the initialization has been executed, the status byte will give back 000.0100.

Input byte 0	Status byte	Input Byte 2	Input byte 1	
XX	0XXX.X0XX	XX	XX	Module is still being reset.
XX	0XXX.X1XX	XX	XX	Initialization completed.

Sending of the data string "Hello" in ASCII code:

-The first 3 characters and the buffer length of 3 are transmitted.

Output byte 0	Control byte	Output byte 2	Output byte 1	
'H' (0 x 48)	0011.0000	'l' (0 x 6C)	'e' (0 x 60)	Entering data to module

-The transmission request bit (TR) is inverted.

Output byte 0	Control byte	Output byte 2	Output byte 1	
'H'	0011.0001	'l'	'e'	Send Data

-As soon as TR=TA, the rest of the data can be sent.

Input byte 0	Status byte	Input Byte 2	Input byte 1	
XX	0XXX.XXX0	XX	XX	The data is still being transferred.
XX	0XXX.XXX1	XX	XX	Data transfer completed.

-The last 2 characters and the buffer length of 2 are transmitted.

Output byte 0	Control byte	Output byte 2	Output byte 1
'l'	0010.0001	XX	'o' (0 x 6F)

-The transmission request bit (TR) is inverted.

Output byte 0	Control byte	Output byte 2	Output byte 1
'l'	0010.0000	XX	'o'

- As soon as TA = TR, the data has been transferred to the output buffer.

Input byte0	Status byte	Input byte2	Input byte1	
XX	0XXX.XXX1	XX	XX	The data is still being transferred.
XX	0XXX.XXX0	XX	XX	Data transfer completed.

Receiving the character chain "WAGO”

-As soon as RA≠RR, the input bytes contain data.

Output byte 0	Control byte	Output byte 2	Output byte 1
XX	0XXX.000X	XX	XX

Input byte0	Status byte	Input byte2	Input byte1	
XX	0XXX.0X0X	XX	XX	No received data available.
‘W’	0011.0X1X	‘G’	‘A’	The information is in the input bytes.

-After the 3 characters have been processed, RA is inverted.

Output byte 0	Control byte	Output byte 2	Output byte 1	
XX	0XXX.001X	XX	XX	Command to read from input buffer

-If RA≠RR, the receiving of additional characters will continue.

Input byte 0	Status byte	Input byte 2	Input byte 1	
XX	0XXX.0X1X	XX	XX	No received data available.
‘O’	0001.0X0X	XX	XX	The information is in the input bytes.

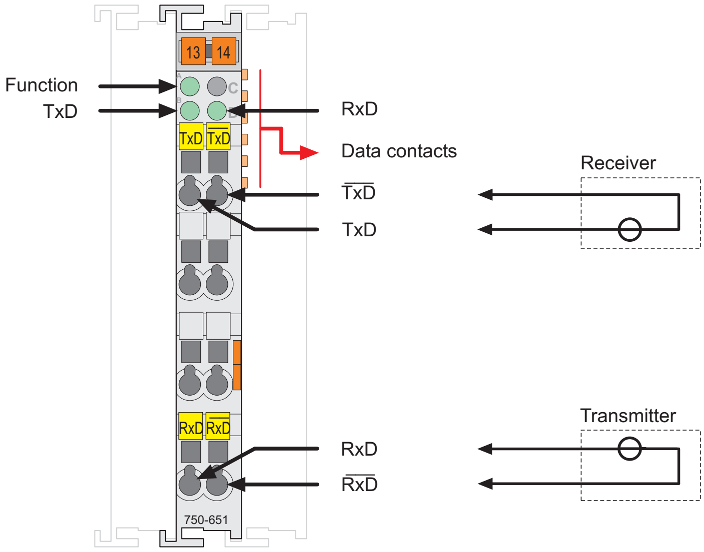
-After the characters have been processed, RA is inverted.

Output byte 0	Control byte	Output byte2	Output byte1
XX	0XXX.000X	XX	XX

Attention
0 x 23 is a hexadecimal value
0101.1001 is a binary value
An X indicates that this particular value has no importance.
XX indicates that the whole value has no importance.

Attention
For the process data configuration of these bus modules please refer to chapter "Process data architecture for MODBUS/TCP" in the process image description of the corresponding coupler/controller.

4.8.1.1.2 TTY Interface - 20mA Current Loop 750-651



Technical description

This technical description is only valid for hardware and software versions X X X X 2 C 0 3----. The product series number is printed on the right side of the module.

The following description is preliminary and is applicable to the factory preset configuration.
Many other operational modes are possible (please contact WAGO for the corresponding settings).

The interface module can operate with all WAGO-I/O-SYSTEM buscouplers (except for the economy type).

Technical Data:

Item-No.:	**750-651**
Transmission channel	2 (1/1), T x D and R x D, full duplex
Transmission rate	1200 - 19200 Baud
Bit skew	-
Bit transmission	2 x 20 mA passive
Resistance	< 500 Ω
Current consumption (internal)	50 mA max.
Transmission length	max. 1000 m twisted pair
Input buffer	128 Byte
Output buffer	16 Byte
Voltage supply	via internal system supply
Isolation	500 V System/power supply
Internal bit width	1 x 40 Bit, 1 x 8 Bit control/status
Configuration	none, or via software with the consent of WAGO
Operating temperature	0 °C ... + 55 °C
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)
Presetting: Baud rate Internal bit width	 9600 Baud 1 x 24 Bit in/out, 1 x 8 Bit control/status

Description TTY:

The TTY interface module allows the connection of TTY-Interface devices to the WAGO I/O SYSTEM. The TTY Interface module can provide gateways within the fieldbus protocol. This allows serial equipment such as printers, barcode readers, and links to local operator interfaces to communicate directly by the fieldbus protocol with the PLC or PC Master.

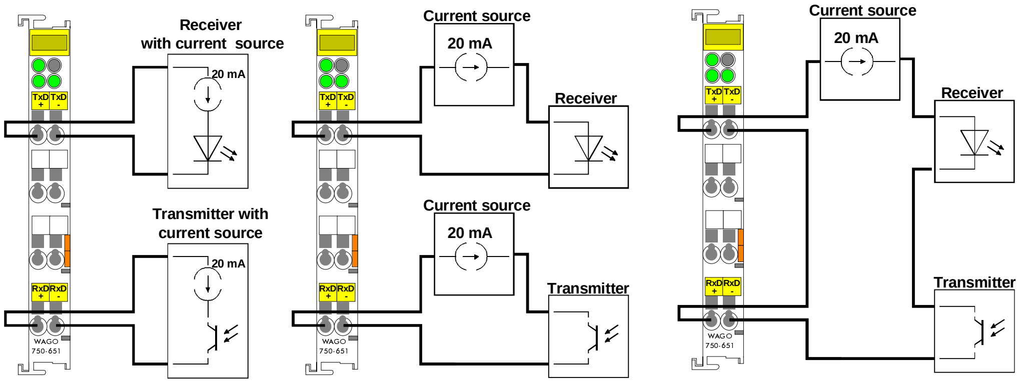
This module does not support a higher level protocol. Communication is made completely transparent to the fieldbus allowing flexibility in further applications of the serial interface module. The communication protocols are configured at the Master PLC or PC.

The 128 byte input buffer provides for high rates of data transmission. When using slower transmission speeds, you can collect the received data with lower priority without loosing data.

The 16 byte output buffer provides for faster transmission of larger data strings.

Attention
The data transmission takes place at 9600 baud (default value). 1 start bit, 8 data bits and 1 stop bit will be transmitted. No parity is available. The drivers are high impedence. The control of data is made by the user software.

Attention
The TTY Interface is passive in sending and receiving, thus having no current sources. For data conversion, an active partner is needed or an additional current source has to be connected.



Point to point connection with active subscribers

Point to point connection with passive subscriber and additional current sources

Bus connection with a current source and a passive subscriber

Organization of the input and output data:

The module is a combination of an analog input and output module with 2 x 16 bit input and output data. The transfer of the data to be transmitted and the received data is made via 3 output and 3 input bytes. One control byte and one status byte are used to control the floating data.

Requests are indicated by a bit change of state. An assigned bit indicates execution by adopting the value of the request bit.

Up to 3 characters which have been received via interface can be stored in the input bytes 0 to 2. The output bytes will contain the characters to be sent.

The control byte consists of the following bits:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	OL 2	OL1	OL0	0	IR	RA	TR
Constant value should always be 0.	Frames available in output area OL2 is always 0, i.e. OL2, OL1, OL0 = 0,1,1 3 characters should be sent and put into the output.			Constant value should always be 0.	Initialization request	Receive acknow-ledge	Transmit request

The status byte consists of the following bits:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	IL2	IL1	Il0	BUF_F	IA	RR	TA
Constant value should always be 0.	rames available in input area IL2 is always 0. i.e. IL2, IL1, IL0 = 0,1,0 2 characters were received and reside in input 0 and input 1.			Input buffer is full.	Initialization acknow-ledge	Receive request	Transmit acknow-ledge

The PLC is able to control transmission and reception of data by means of the control byte and the status byte.

Initialization of the module:

- set IR bit in the control byte to "1"
- transmit/receive functions are blocked
- output/input buffers are erased
- serial interface module will load its configuration data

Transmitting data:

- TR≠TA: put characters into output bytes 0 to 2
- amount of characters is specified in OL0 to OL2
- TR is inverted and read out
- characters are put into output buffer if TR=TA

Receiving data:

- RR≠RA: input bytes 0 to 2 characters are available
- amount of characters is specified in IL0 to IL2
- characters in IL0 to IL2 are read out
- RA is inverted and read out
- all characters are read when RR=RA

The transmitting and receiving of data can be done simultaneously. The initialization request has prioirity and will stop the transmitting and receiving of data immediately.

Attention
Resetting the initialization bit can be performed with the following message.

Message: input buffer full (Bit 3)
Input buffer is full. Data which is being currently received is now lost.

An example:

The module is initialized.

- The initialization bit in the control byte is set.

Output byte 0	Control byte	Output byte 2	Output byte 1
0x00	0000.0100	0x00	0x00

- After the initialization has been executed, the status byte will give back 000.0100.

Input byte 0	Status byte	Input byte 2	Input byte 1	
XX	0XXX.X0XX	XX	XX	Module is still being reset.
XX	0XXX.X1XX	XX	XX	Initialization completed.

Sending of the data string "Hello” in ASCII code:

-The first 3 characters and the buffer length of 3 are transmitted.

Output byte 0	Control byte	Output byte 2	Output byte 1	
‘H’ (0 x	0011.0000	‘l’ (0 x 6C)	‘e’ (0 x 60)	Entering data to module

-The transmission request bit (TR) is inverted.

Output byte 0	Control byte	Output byte 2	Output byte 1	
‘H’	0011.0001	‘l’	‘e’	Send Data

-As soon as TR=TA, the rest of the data can be sent

Input byte 0	Status byte	Input byte 2	Input byte 1	
XX	0XXX.XXX0	XX	XX	The data is still being transferred.
XX	0XXX.XXX1	XX	XX	Data transfer completed.

-The last 2 characters and the buffer length of 2 are transmitted.

Output byte 0	Control byte	Output byte 2	Output byte 1
‘l’	0010.0001	XX	‘o’ (0 x 6F)

-The transmission request bit (TR) is inverted.

Output byte 0	Control byte	Output byte 2	Output byte 1
‘l’	0010.0000	XX	‘o’

- As soon as TA = TR, the data has been transferred to the output buffer.

Input byte0	Status byte	Input byte2	Input byte1	
XX	0XXX.XXX1	XX	XX	The data is still being transferred.
XX	0XXX.XXX0	XX	XX	Data transfer completed.

Receiving the character chain "WAGO”

-As soon as RA≠RR, the input bytes contain data.

Output byte 0	Control byte	Output byte 2	Output byte 1
XX	0XXX.000X	XX	XX

Input byte0	Status byte	Input byte2	Input byte1	
XX	0XXX.0X0X	XX	XX	No received data available.
‘W’	0011.0X1X	‘G’	‘A’	The information is in the input bytes.

-After the 3 characters have been processed, RA is inverted.

Output byte 0	Control byte	Output byte 2	Output byte 1	
XX	0XXX.001X	XX	XX	Command to read from input buffer

-If RA≠RR, the receiving of additional characters will continue.

Input byte 0	Status byte	Input byte 2	Input byte 1	
XX	0XXX.0X1X	XX	XX	No received data available.
‘O’	0001.0X0X	XX	XX	The information is in the input bytes.

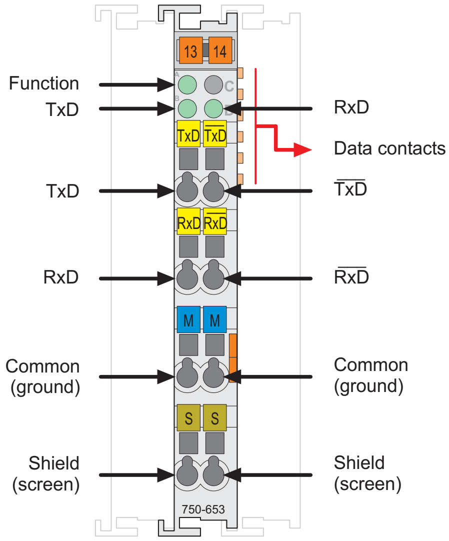
-After the characters have been processed, RA is inverted.

Output byte 0	Control byte	Output byte2	Output byte1
XX	0XXX.000X	XX	XX

Attention
0 x 23 is a hexadecimal value
0101.1001 is a binary value
An X indicates that this particular value has no importance.
XX indicates that the whole value has no importance.

Attention
For the process data configuration of these bus modules please refer to chapter "Process data architecture for MODBUS/TCP" in the process image description of the corresponding coupler/controller.

4.8.1.1.3 RS485C Interface 750-653



Technical description

This technical description is only valid for hardware and software versions X X X X 2 C 0 3----. The product series number is printed on the right side of the module.

The following description is preliminary and is applicable to the factory preset configuration.

Many other operational modes are possible (please contact WAGO for the corresponding settings).

The interface module can operate with all WAGO-I/O-SYSTEM buscouplers (except for the economy type).

Technical Data:

Item-No.:	**750-653**
Transmission channel	1 TxD / 1 RxD, full/ half duplex
Transmission rate	1200 - 19200 Baud
Bit skew	-
Bit transmission	Acc. to ISO 8482/ DIN 66259 T 4
Resistance	-
Input current (internal)	50 mA max.
Transmission length	max. 500 m twisted pair
Input buffer	128 Byte
Output buffer	16 Byte
Voltage supply	via internal system supply
Isolation	500 V System/power supply
Internal bit width	1 x 40 Bit, 1 x 8 Bit control/status
Configuration	none, or via software with the consent of WAGO
Operating temperature	0 °C ... + 55 °C
Wire connection	CAGE CLAMP®; 0.08 mm^2 - 2.5 mm^2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)
Presetting: Baud rate Internal bit width	 9600 Baud 1 x 24 Bit in/out, 1 x 8 Bit control/status

Description RS 485:

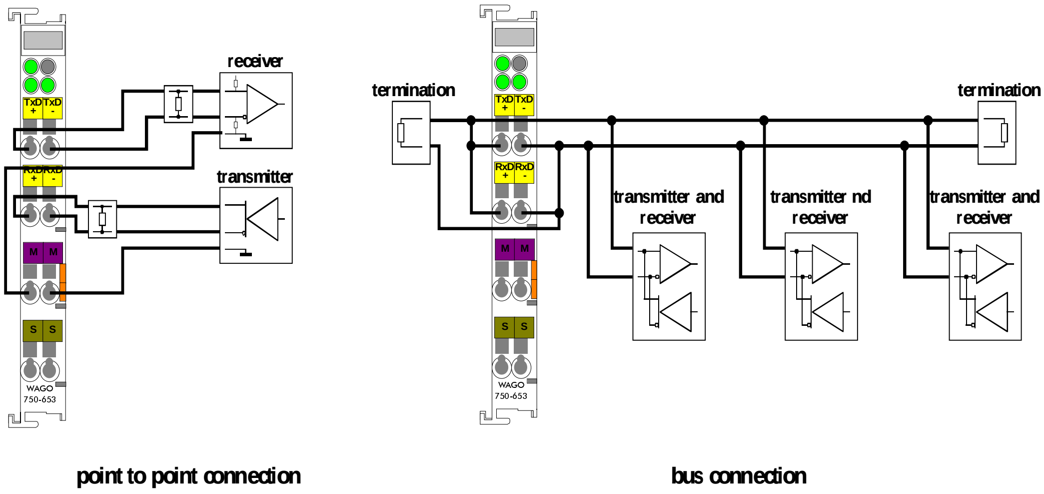
The interface module is designed to operate with all WAGO I/O fieldbus couplers. The serial interface module allows the connection of RS485 or RS488-Interface devices to the WAGO I/O SYSTEM. The RS485/RS488 Interface module can provide gateways within the fieldbus protocol. This allows serial equipment such as printers, barcode readers, and links to local operator interfaces to communicate directly by the fieldbus protocol with the PLC or PC Master.

This module does not support a higher level protocol. Communication is made completely transparent to the fieldbus allowing flexibility in further applications of the serial interface module. The communication protocols are configured at the Master PLC or PC.
The 128 byte input buffer provides for high rates of data transmission. When using slower transmission speeds, you can collect the received data with less priority without loosing data.

The 16 byte output buffer provides for faster transmission of larger data strings.

Attention
The data transmission takes place at 9,600 baud (default value). 1 start bit, 8 data bits and 1 stop bit will be transmitted. No parity is available. The drivers are high impedence. The control of data is made by the user software.

Attention
The interface module can be used for bus connections as well as for point to point connections. With bus connections, *modules that are not connected to the power supply* can also be wired. They do not disturb the bus connection.



Organization of the input and output data:

The module is a combination of analog input and output module with 2 x 16 bit input and output data. The transfer of the data to be transmitted and the received data is made via 3 output and 3 input bytes. One control byte and one status byte are used to control the floating data.

Requests are indicated by a bit change of state. An assigned bit indicates execution by adopting the value of the request bit.

Up to 3 characters which have been received via interface can be stored in the input bytes 0 to 2. The output bytes will contain the characters to be sent.

The control byte consists of the following bits:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	OL 2	OL1	OL0	0	IR	RA	TR
Constant value should lways be 0.	Frames available in output area OL2 is always 0, i.e. OL2, OL1, OL0 = 0,1,1 3 characters should be sent and put into the output.			Constant value should always be 0.	Initialization request	Receive acknow-ledge	Transmit request

The status byte consists of the following bits:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	IL2	IL1	Il0	BUF_F	IA	RR	TA
Constant value should always be 0.	Frames available in input area IL2 is always 0. i.e. IL2, IL1, IL0 = 0,1,0 2 characters were received and reside in input 0 and input 1.			Inpput buffer is full.	Initialization acknow-ledge	Receive request	Transmit acknow-ledge

The PLC is able to control transmission and reception of data by means of the control byte and the status byte.

Initialization of the module:

- set IR bit in the control byte to "1"
- transmit/receive functions are blocked
- output/input buffers are erased
- serial interface module will load its configuration data

Transmitting data:

- TR≠TA: put characters into output bytes 0 to 2
- amount of characters is specified in OL0 to OL2
- TR is inverted and read out
- characters are put into output buffer if TR=TA

Receiving data:

- RR≠RA: input bytes 0 to 2 characters are available
- amount of characters is specified in IL0 to IL2
- characters in IL0 to IL2 are read out
- RA is inverted and read out
- all characters are read when RR=RA

The transmitting and receiving of data can be done simultaneously. The initialization request has prioirity and will stop transmitting and receiving of data immediately.

Attention
Resetting the initialization bit can be performed with the following message.

Message: input buffer full (Bit 3)
Input buffer is full. Data which is being currently received is now lost.

An example:

The module is initialized.

- The initialization bit in the control byte is set.

Output byte 0	Control byte	Output byte 2	Output byte 1
0x00	0000.0100	0x00	0x00

- After the initialization has been executed, the status byte will give back 000.0100.

Input byte 0	Status byte	Input byte 2	Input byte 1	
XX	0XXX.X0XX	XX	XX	Module is still being reset.
XX	0XXX.X1XX	XX	XX	Initialization completed.

Sending of the data string "Hello” in ASCII code:

-The first 3 characters and the buffer length of 3 are transmitted.

Out-put byte 0	Control byte	Output byte 2	Output byte 1	
‘H’ (0 x	0011.0000	‘l’ (0 x 6C)	‘e’ (0 x	Entering data to module

-The transmission request bit (TR) is inverted.

Out-put byte 0	Control byte	Output byte 2	Output byte 1	
‘H’	0011.0001	‘l’	‘e’	Send Data

-As soon as TR=TA, the rest of the data can be sent.

Input byte 0	Status byte	Input byte 2	Input byte 1	
XX	0XXX.XXX0	XX	XX	The data is still being transferred
XX	0XXX.XXX1	XX	XX	Data transfer completed.

-The last 2 characters and the buffer length of 2 are transmitted.

Output byte 0	Control byte	Output byte 2	Output byte 1
‘l’	0010.0001	XX	‘o’ (0 x 6F)

-The transmission request bit (TR) is inverted.

Output byte 0	Control byte	Output byte 2	Output byte 1
‘l’	0010.0000	XX	‘o’

- As soon as TA = TR, the data has been transferred to the output buffer..

Input byte0	Status byte	Input byte2	Input byte1	
XX	0XXX.XXX1	XX	XX	The data is still being transferred.
XX	0XXX.XXX0	XX	XX	Data transfer completed.

Receiving the character chain "WAGO”

-As soon as RA≠RR, the input bytes contain data.

Output byte 0	Control byte	Output byte 2	Output byte 1
XX	0XXX.000X	XX	XX

Input byte0	Status byte	Input byte2	Input byte1	
XX	0XXX.0X0X	XX	XX	No received data available.
‘W’	0011.0X1X	‘G’	‘A’	The information is in the input bytes.

-After the 3 characters have been processed, RA is inverted.

Out-put byte 0	Control byte	Output byte 2	Output byte 1	
XX	0XXX.001X	XX	XX	Command to read from input buffer

-If RA≠RR, the receiving of additional characters will continue.

Input byte 0	Status byte	Input byte 2	Input byte 1	
XX	0XXX.0X1X	XX	XX	No received data available.
‘O’	0001.0X0X	XX	XX	The information is in the input bytes.

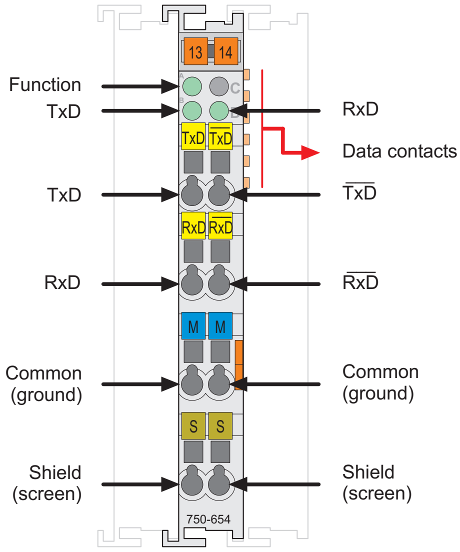
-After the characters have been processed, RA is inverted.

Output byte 0	Control byte	Output byte2	Output byte1
XX	0XXX.000X	XX	XX

Attention
0 x 23 is a hexadecimal value
0101.1001 is a binary value
An X indicates that this particular value has no importance.
XX indicates that the whole value has no importance.

Attention
For the process data configuration of these bus modules please refer to chapter "Process data architecture for MODBUS/TCP" in the process image description of the corresponding coupler/controller.

4.8.1.1.4 Data exchange module 750-654



Technical description

This technical description is only valid for hardware and software version X X X X 2 C 0 0 - - - -. The product series number is printed on the right side of the module.

The data exchange module allows the exchange of data between different fieldbus systems.

Two modules are a communication pair that is connected by means of two twisted wire pairs. Each module is part of a fieldbus node.

The data exchange is done in full duplex operation, independent of the fieldbus system used. The data of the output process image of the fieldbus coupler is transmitted to the communication partner. This module then transmits the data to the input process image of its fieldbus coupler and vice versa.

Factory preset transmission is 32 bits of input data and 32 bits of output data. Data transfer time for 32 bits of I/O is about 5 ms.

The LED “Function“ indicates a data exchange with the buscoupler. The status of the data transmission is indicated by the TxD and RxD LEDs.

The data exchange module can operate with all WAGO-I/O-SYSTEM buscouplers (except for the economy type).

Technical Data:

Item-No.:	**750-654**
Transmission channel	TxD and RxD, full duplex, 2 channels
Transmission rate	62500 Baud
Bit transmission	via 2 twisted pair with differential signals
Resistance of cable	120 Ω
Input current (internal)	65 mA max.
Transmission length	max. 100 m twisted pair
Voltage supply	via internal system
Isolation	500 V System/power supply
Internal bit width	1 x 40 Bit in-/output data, 1 x 8 Bit Control/Status
Configuration	none, or via software with the consent of WAGO
Operating temperature	0 °C ... + 55 °C
Wire connection	CAGE CLAMP®; 0.08 mm2 - 2.5 mm2, AWG 28 – 14, 8 – 9 mm Stripped length
Dimensions (mm) WxHxL	12 x 64* x 100 (*from upper edge of carrier rail)
Presetting: Internal bit width	1 x 32 Bit in/out, 1 x 8 Bit control/status

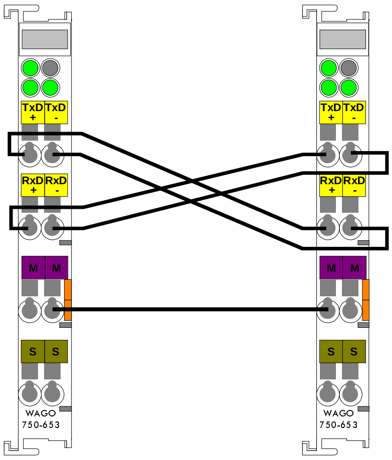
Description of data exchange module:

The data exchange module allows for the exchange of 4 (5) bytes between different fieldbus systems via multiplexing of a serial connection. The delay which is caused by the multiplexor is < 5ms. The integrated watchdog function switches all outputs to zero if there is no valid information for more than 200 ms via the multiplex connection.

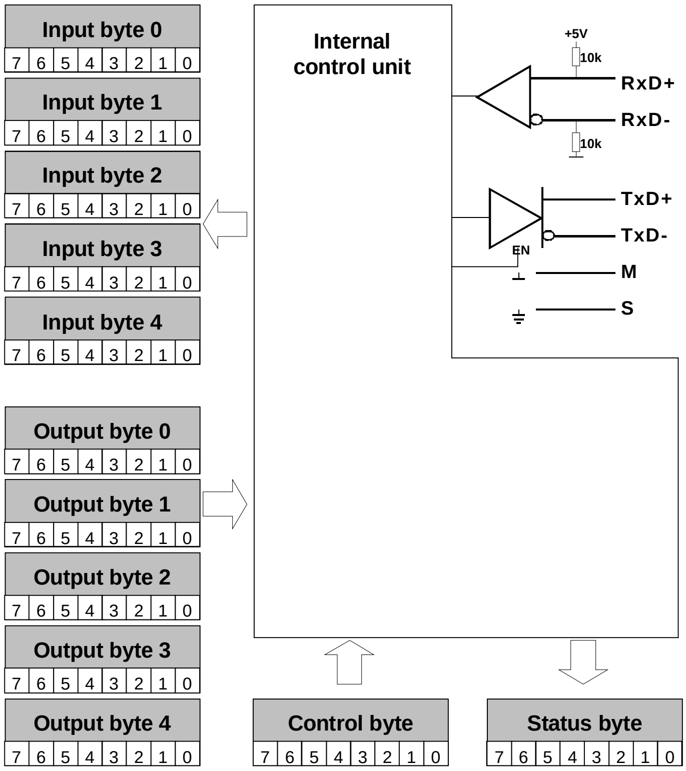
The 128 bytes input buffer provides for high rates of data transmission. When using slower speeds, you can collect the received data with lower priority without loosing data.

The 16 byte output buffer provides for faster transmission of larger data strings.

The data exchange module is connected peer-to-peer. For the wiring of the serial multiplex connection the RxD and TxD cables are crossed. The following illustrations show the peer-to-peer connection and the internal structure of the data exchange module.



Point to point connection



Organization of the input and output data:

The module is a combination of a special function input and output module with 1 x 32 (40) Bit input and output data. The transfer of the data to be transmitted and the received data is made via 5 input and 5 output Bytes. One control byte and one status byte are used to control the floating data.

The control byte consists of the following bits:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	X	X	X	X	X	X	X
Constant value always should be 0.	Not used						

The status byte consists of the following bits:

Bit7	Bit 6	Bit 5	Bit4	Bit3	Bit2	Bit1	Bit0
0	X	X	RCVT1	RCVT2	CHK	OVR	PAR
Constant value always should be 0.			Module is in timeout. All output bits are set to 0 (watchdog).	The recei-ver is in timeout.	Checksum error.	Buffer overflow	Parity error or wrong data in a frame.

The PLC is able to control transmission and reception of data by means of the control byte and the status byte.

Control of the multiplex connection:

In the process image of the transmitting buscoupler, one Bit is set to "1" for the whole time. As long as this Bit is "1" in the receiving coupler, further input Bits can be evaluated. If the Bit is "0" the multiplex connection has been disrupted. The further Bits are also 0 because of the watchdog.

Control of the multiplex connection with acknowledge:

If the transmitting buscoupler gets an acknowledge from the receiving buscoupler, the received bit must be transfered as an output bit to the process image. The transmission is successful as long as the Bit is "1".

Handshake:

If a serial data exchange should be made with the data exchange module, the handshake can be made via "Toggle Bits". Therefore an input bit and an output bit are reserved. As soon as those bits are different from each other, a request from the opposite module is made. As soon as the request is executed the output bit is toggled

5 ETHERNET

ETHERNET is a technology, which has been proven and established as an effective means of data transmission in the field of information technology and office communication. Within a short time ETHERNET has also made a successful breakthrough in the area of private PC networks throughout the world.

This technology was developed in 1972 by Dr. Robert M. Metcalfe, David R. Boggs, Charles Thacker, Butler W. Lampson, and Xerox (Stanford, Ct.). Standardization (IEEE 802.3) took place in 1983.

ETHERNET predominantly uses coaxial cables or twisted pair cables as a transmission medium. Connection to ethernet, often already existing in networks, (LAN, Internet) is easy and the data exchange at a transmission rate of 10 Mbit/s is very fast.

ETHERNET has been equipped with higher level communication software in addition to standard IEEE 802.3, i.e. TCP/IP (Transmission Control Protocol / Internet Protocol) to allow communication between different systems. The TCP/IP protocol stack offers a high degree of reliability for the transmission of information.

In the ETHERNET TCP/IP fieldbus coupler developed by WAGO, the following application protocols have been implemented on the basis of the TCP/IP stack:

- a MODBUS/TCP server,
- a BootP client and
- an HTTP server.

These protocols allow the user to create applications (master applications) with standardized interfaces and transmit process data via an ETHERNET interface.

Information such as the fieldbus node architecture, network statistics and diagnostic information is stored in the fieldbus coupler and can be viewed as HTML pages via a web browser being served from the HTTP server in the buscoupler (Microsoft Internet-Explorer, Netscape Navigator,...). Through the WAGO IO Pro 32 software it is possible to create your own webpages and store them in the coupler for control of the PFC program (this is for the 750-842 PFC only.)

The WAGO ETHERNET TCP/IP fieldbus coupler does not require any additional master components other than a PC with a network card. The fieldbus coupler can be easily connected to local or global networks using the RJ45 connector. Other networking components such as hubs, switches or repeaters can also be used. However, to establish the greatest amount of "determinism" a switch is recommended.

The use of ETHERNET as a fieldbus allows continuous data transmission between the plant floor and the office. Connection of the ETHERNET TCP/IP fieldbus coupler to the Internet even enables industrial processing data for all types of applications to be called up world-wide. This makes site independent monitoring, visualization, remote maintenance and control of processes possible.WAGO Kontakttechnik GmbH is a member of IAONA Europe, an organization with the purpose of establishing ETHERNET in automation technology.

5.1 Network architecture – Principles and Regulations

A simple ETHERNET network is designed on the basis of one PC with a network card (NI), one connection cable, one ETHERNET fieldbus node and one 24 V DC power supply for the coupler voltage source.

Each fieldbus node consists of an ETHERNET TCP/IP fieldbus coupler/controller, I/O modules and an end module. The individual bus modules are connected to the ETHERNET TCP/IP fieldbus coupler/controller via an internal bus when they are snapped onto the carrier rail.

It is possible to connect 64 I/O modules to an ETHERNET TCP/IP fieldbus coupler/controller.

Sensors and actuators are connected to the digital or analog I/O modules on the field side. These are used for process signal acquisition or signal output to the process, respectively.

The fieldbus coupler/controller detects all connected I/O modules, creating a local process image of them. This can consist of a mixed arrangement of analog (data exchange of words) and digital (data exchange of bits) bus modules.

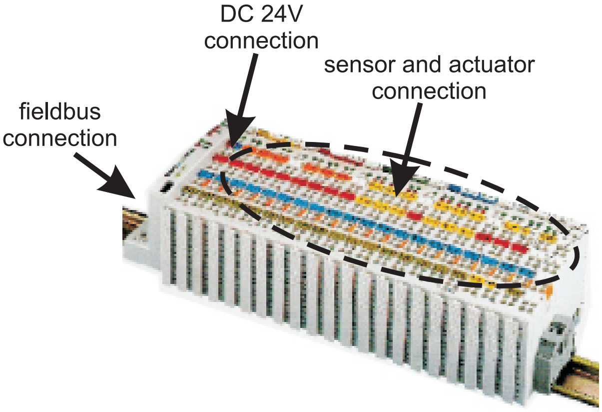


Fig. 5-1. Connection principle of a fieldbus node for a network architecture

Fieldbus communication between the master application and the fieldbus coupler/controller takes place via the MODBUS/TCP protocol over ethernet.

MODBUS/TCP maps creates an image of the distributed MODBUS protocol on ETHERNET TCP/IP. The process data can be read and written via ETHERNET . There are numerous applications available which already use this, such as HMI, SCADA, PLC, Soft PLC.

5.1.1 Transmission media

General ETHERNET transmission standards

For transmitting data the ETHERNET standard supports numerous technologies with various parameters of which differ from each other such as i.e. transmission speed, medium, segment length and type of transmission.

10Base5	Uses a 10 mm 50 Ohm coaxial cable for a 10Mbps baseband signal for distances of up to 500 m in a physical bus topology (often referred to as Thick ETHERNET).
10Base2	Uses a 5 mm 50 Ohm coaxial cable for a 10Mbps baseband signal for distances of up to 185 m in a physical bus topology (often referred to as Thin ETHERNET or ThinNet).
10Base-T	Uses a 24 AWG UTP or STP/UTP (twisted pair cable) for a 10Mbps baseband signal for distances up to 100 m in a physical star topology.
10Base-F	Uses a fiber-optic cable for a 10Mbps baseband signal for distances of up to 4 km in a physical star topology. (There are three subspecifications: 10Base-FL for fiber-optic link, 10Base-FB for fiber-optic backbone and 10Base-FP for fiber-optic passive).

Tab. 5-1: ETHERNET transmission standards

The four media types are shown with their IEEE shorthand identifiers. The IEEE identifiers include three pieces of information. The first item, “10”, stands for the media.

The third part of the identifier provides a rough indication of segment type or length. For thick coaxial cable, the “5” indicates a 500 meter maximum length allowed for individual thick coaxial segments. For thin coaxial cable, the “2” is rounded up from the 185 meter maximum length for individual thin coaxial segments. The “T” and “F” stand for ‘twisted pair’ and ‘fiber optic’, and simply indicate the cable type.

10Base-T

10Base-T Standard is used for the WAGO ETHERNET fieldbus coupler. This allows for simple and economical network architecture using STP/UTP cable as the transmission medium.

STP is shielded twisted pair category 5 cables (CAT 5). UTP is twisted pair without shielding implemented.

Parameter	10BaseT
Medium	Twisted-Pair
Signaling technology	Baseband
Signaling code	Manchester encoding
Bit rate (Mbit / s)	10
Topology	Star
Max. segment length (m)	100
Max. packet size (Byte)	1512
Min. packet size (Byte)	64

Tab. 5-2: Important parameters of the 10Base-T ETHERNET standard

Wiring of the fieldbus nodes with 10Base-T technology

A crossover cable is required for direct connection of a fieldbus node to the network card of the PC.

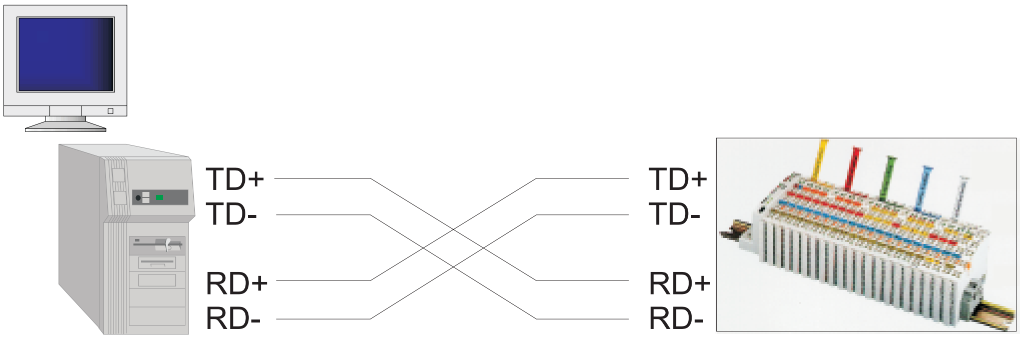


Fig. 5-2: Direct connection of a node with crossover cable g012906d

If several fieldbus nodes are to be connected to a network card, the fieldbus nodes can be connected via an ETHERNET switch or hub with straight through/parallel cables.

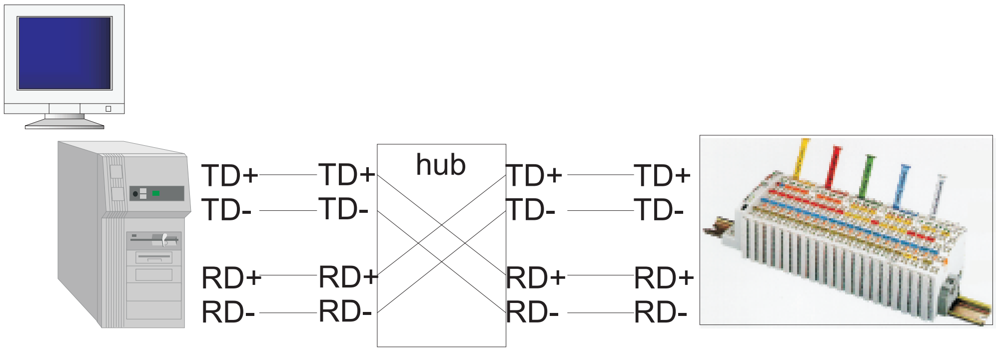


Fig. 5-3: Connection of a node by means of a hub with parallel cables g012908e

A switch/**hub** is a device that allows all connected devices to transmit and receive data with each other. This can also be viewed as a "data traffic cop" where the hub "polices" the data coming in and going out so that it will be transmitted to the correct node. WAGO recommends using a switch rather then a hub, this will allow for a more deterministic architecture.

Attention
The cable length between the node and the hub can not be longer than 100 m (328 ft.) without adding signal conditioning systems (i.e. repeaters). Various possibilities are described in the ETHERNET standard for networks covering larger distances.

5.1.2 Network topologies

In the case of 10Base-T several stations (nodes) are connected using a star topology according to the 10Base-T ETHERNET Standard.

Therefore, this manual only deals with the star topology, and the tree topology for larger networks in more detail.

Star topology

A star topology consists of a network in which all nodes are connected to a central point via individual cables.

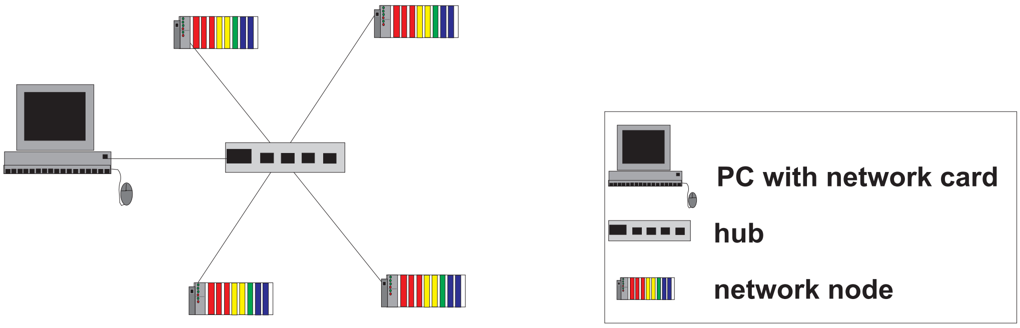


Fig. 5-4: Star topology G012906e

A star topology offers the advantage of allowing the extension of an existing network. Stations can be added or removed without network interruption. Moreover, in the event of a defective cable, only the network segment and the node connected to this segment is impaired. This considerably increases the fail-safe of the entire network.

Tree topology

The tree topology combines characteristics of linear bus and star topologies. It consists of groups of star-configured workstations connected to a linear bus backbone cable. Tree topologies allow for the expansion of an existing network, and enables schools, etc. to configure a network to meet their needs.

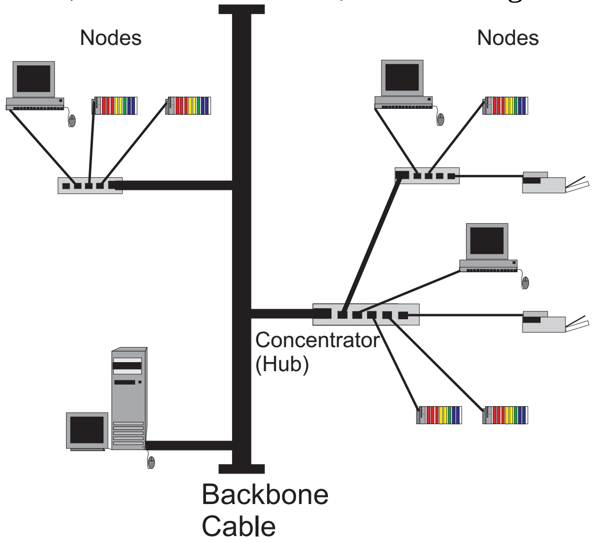


Fig. 5-5: Tree topology G012904e

5-4-3 Rule

A consideration in setting up a tree topology using ETHERNET protocol is the 5-4-3 rule. One aspect of the ETHERNET protocol requires that a signal sent out on the network cable must reach every part of the network within a specified length of time. Each concentrator or repeater that a signal goes through adds a small amount of time. This leads to the rule that between any two nodes on the network there can only be a maximum of 5 segments connected through 4 repeators/concentrators. In addition, only 3 of the segments may be populated (trunk) segments if they are made of coaxial cable. A populated segment is one which has one or more nodes attached to it. In Figure 5-5, the 5-4-3 rule is adhered to. The furthest two nodes on the network have 4 segments and 3 repeators/concentrators between them.

This rule does not apply to other network protocols or ETHERNET networks where all fiber optic cabling or a combination of a backbone with UTP cabling is used. If there is a combination of fiber optic backbone and UTP cabling, the rule is simply translated to 7-6-5 rule.

Cabling guidelines

"Structured Cabling" specifies general guidelines for network architecture of a LAN, establishing maximum cable lengths for the grounds area, building and floor cabling.

Standardized in the standards EN 50173, ISO 11801 and TIA 568-A, "Structured Cabling" forms the basis for a future-orientated, application-independent and cost-effective network infrastructure.

The cabling standards define a domain covering a geographical area of 3 km and for an office area of up to 1 million square meters with 50 to 50,000 terminals. In addition, they describe recommendations for setting up of a cabling system.

Specifications may vary depending on the selected topology, the transmission media and coupler modules used in industrial environments, as well as the use of components from different manufacturers in a network. Therefore, the specifications given here are only intended as recommendations.

5.1.3 Coupler modules

There are a number of coupler modules that allow for flexible arrangement for setting up an ETHERNET network. They also offer important functions, some of which are very similar.

The following table defines and compares these modules and is intended to simplify the correct selection and appropriate application of them.

Module	**Characteristics/application**	**ISO/OSI layer**
Repeater	Amplifier for signal regeneration, connection on a physical level.	1
Bridge	Segmentation of networks to increase the length.	2
Switch	Multiport bridge, i.e. each port has a separate bridge function. Logically separates network segments, thereby reducing network traffic. Consistent use makes ETHERNET collision-free.	2 (3)
Hub	Used to create star topologies, supports various transmission media, does not prevent any network collisions.	2
Router	Links two or more data networks. Matches topology changes and incompatible packet sizes (i.e. industrial and office areas).	3
Gateway	Links two manufacturer-specific networks which use different software and hardware (i.e. ETHERNET and Interbus-Loop).	4-7

Tab. 5-3: Comparison of coupler modules for networks

5.1.4 Important terms

Data security

If an internal network (Intranet) is to be connected to the public network (i.e. Internet) then data security is an extremely important aspect.

Undesired access can be prevented by a **Firewall**.
Firewalls can be implemented in software or network components. They are interconnected in a similar way to routers as a switching element between Intranets and the public network. Firewalls are able to limit or completely block all access to the other networks, depending on the access direction, the service used and the authenticity of the network user.

Real-time ability

Transmission above the fieldbus system level generally involves relatively large data quantities. The permissible delay times may also be relatively long (0.1...10 seconds).
However, real-time behavior within the fieldbus system level is required for ETHERNET in industry.
In ETHERNET it is possible to meet the real-time requirements by, i.e. restricting the bus traffic (< 10 %), by using a master-slave principle, or also by implementing a switch instead of a hub.
MODBUS/TCP is a master/slave protocol in which the slaves only respond to commands from the master. When only one master is used, data traffic over the network can be controlled and collisions avoided.

TCP/IP

TCP/IP was developed for standardized information exchange between any amount of different networks. TCP/IP is not dependent upon the hardware and software used. Although it is often used as one term, it consists of a suite of superimposed protocols: i.e. IP, TCP, UDP, ARP and ICMP.

- IP: The Internet Protocol IP specifies the correct addressing and delivery of the data packets.
- TCP The Transmission Control Protocol TCP superimposed on IP is a connection-orientated transport protocol.
- UDP UDP is a connectionless transport protocol.
- ICMP Internet Control Message Protocol
- ARP Conversion of IP addresses into MAC addresses

Shared ETHERNET

Several nodes linked via a hub share a common medium. When a message is sent from a station, it is broadcast throughout the entire network and is sent to each connected node. Only the node with the correct target address processes the message. Collisions may occur and messages have to be repeatedly transmitted as a result of the large amount of data traffic. The delay time in a Shared ETHERNET cannot be easily calculated or predicted.

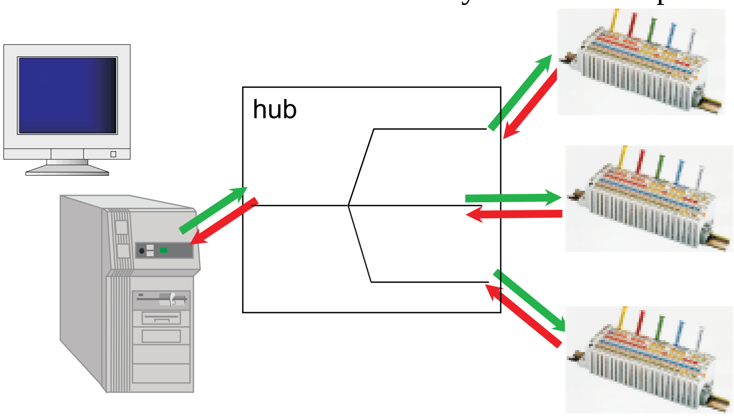


Fig. 5-6: Principle of Shared ETHERNET
G012910e

Deterministic ETHERNET

The TCP/IP software or the user program in each subscriber can limit transmittable messages to make it possible to determine real-time requirements. At the same time the maximum medium message rate (datagram per second), the maximum medium duration of a message, and the minimum time interval between the messages (waiting time of the subscriber) is limited. Therefore, the delay time of a message is predictable.

Switched ETHERNET

In the case of Switched Ethernet, several fieldbus nodes are connected by a switch. When data from a network segment reaches the switch, it saves the data and checks for the segment and the node to which this data is to be sent. The message is then only sent to the node with the correct target address. This reduces the data traffic over the network, extends the bandwidth and prevents collisions. The runtimes can be defined and calculated, making the Switched Ethernet deterministic.

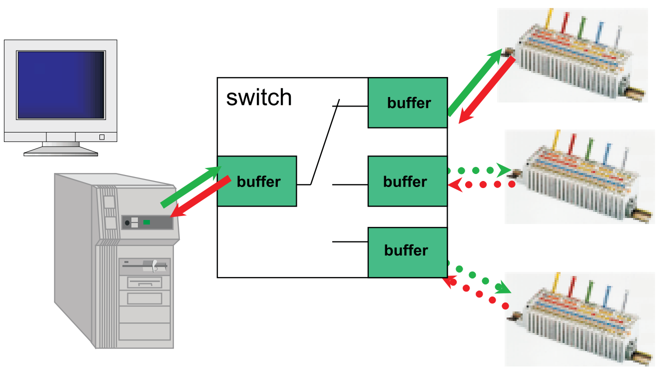


Fig. 5-7: Principle of Switched ETHERNET G012909e

5.2 Network communication

5.2.1 Channel access method

In the ETHERNET Standard, the fieldbus node accesses the bus using CSMA/CD (Carrier Sense Multiple Access/ Collision Detection).

- Carrier Sense: The transmitter senses the bus.
- Multiple Access: Several transmitters can access the bus.
- Collision Detection: A collision is detected.

Each station can send a message once it has established that the transmission medium is free. If collisions of data packets occur due to several stations transmitting simultaneously, CSMA/CD ensures that these are detected and the data transmission is repeated.
However, this does not make data transmission reliable enough for industrial requirements. To ensure that communication and data transmission via ETHERNET is reliable, various communication protocols are required.

5.2.2 Communication protocols

In a WAGO ETHERNET fieldbus coupler, several important communication protocols are implemented in addition to the ETHERNET Standard:

➤ IP, ICMP and ARP on the third ISO/OSI layer (network layer)

➤ TCP and UDP on the fourth ISO/OSI layer (transport layer).

Moreover, the fieldbus coupler contains several additional user protocols, which use these protocols for transmitting and receiving data.
The following diagram is intended to explain how the protocols and their functions are layered and their data packets nested in each other for transmission. A detailed description of the tasks and addressing schemes of these protocols is contained in the following chapter.

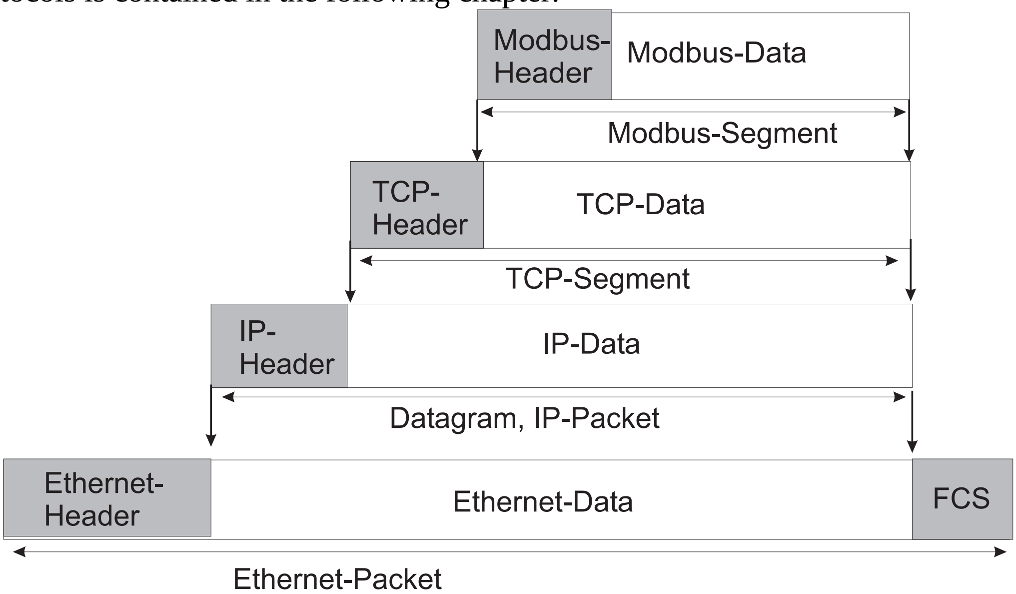


Fig. 5-8: Communication protocols G012907e

ETHERNET layers with TCP/IP compared to the ISO-OSI reference model

The communication software TCP/IP is superior to ETHERNET. Together with ETHERNET, TCP/IP represents the typical layer structure.

- ETHERNET = layer 1 to 4
- TCP/IP = layer 3 and 4

ISO-OSI-layer		in comparison with ETHERNET	Tasks
7	**Application Layer**	Application = Application software, protocols and services	- Ensures the compatibility between applications
6	**Presentation Layer**		- Data interpretation
5	**Session Layer**		- Opening and closing sessions - Communication control
4	**Transport Layer**	Transport = Transport Control Protocol TCP	- Transmission control
3	**Network Layer**	Internet = Internet Protocol IP	- Addressing and routing
2	**Data Link Layer**	Network-Interface = Packet-Driver	- Frame format - Medium access control - Coding and medium access
1	**Physical Layer**	Hardware = ETHERNET –Coupler	- Making electrical connection - Laying down all physical and mechanical parameters

5.2.2.1 ETHERNET

ETHERNET address (MAC-ID)

Each WAGO ETHERNET fieldbus coupler is provided from the factory with a unique and internationally unambiguous physical ETHERNET address, also referred to as MAC-ID (Media Access Control Identity). This can be used by the network operating system for addressing on a hardware level.
The address has a fixed length of 6 Bytes (48 Bit) and contains the address type, the manufacturer's ID, and the serial number.

Examples for the MAC-ID of a WAGO ETHERNET fieldbus coupler (hexadecimal): 00_H-30_H-DE_H-00_H-00_H-01_H.

ETHERNET does not allow addressing of different networks.
If an ETHERNET network is to be connected to other networks, higher-ranking protocols have to be used.

Note
If you wish to connect one or more data networks, routers have to be used.

ETHERNET Packet

The datagrams exchanged on the transmission medium are called "ETHERNET packets" or just "packets". Transmission is connectionless; i.e. the sender does not receive any feedback from the receiver. The data used is packed in an address information frame. The following figure shows the structure of such a packet.

Preamble	ETHERNET-Header	ETHERNET_Data	Check sum
8 Byte	14 Byte	46-1500 Byte	4 Byte

Fig. 5-9: ETHERNET-Packet

The preamble serves as a synchronization between the transmitting station and the receiving station. The ETHERNET header contains the MAC addresses of the transmitter and the receiver, and a type field.
The type field is used to identify the following protocol by way of unambiguous coding (i.e. 0800_{hex} = Internet Protocol).

5.2.2.2 IP-Protocol

The Internet protocol divides datagrams into segments and is responsible for their transmission from one network subscriber to another. The stations involved may be connected to the same network or to different physical networks which are linked together by routers.
Routers are able to select various paths (network transmission paths) through connected networks, and bypass congestion and individual network failures.
However, as individual paths may be selected which are shorter than other paths, datagrams may overtake each other, causing the sequence of the data packets to be incorrect.
Therefore, it is necessary to use a higher-level protocol, for example, TCP to guarantee correct transmission.

IP addresses

To allow communication over the network each fieldbus node requires a 32 bit Internet address (IP address).

Attention
Internet addresses have to be unique throughout the entire interconnected networks.

As shown below there are various address classes with net identification (net ID) and subscriber identification (subscriber ID) of varying lengths. The net ID defines the network in which the subscriber is located. The subscriber ID identifies a particular subscriber within this network.
Networks are divided into various network classes for addressing purposes:

- **Class A:** (Net-ID: Byte1, Host-ID: Byte2 - Byte4)

z. B: 101 . 16 . 232 . 22

01100101		00010000	11101000	00010110
0	Net-ID	Host-ID		

The highest bit in Class A networks is always 0.
I.e. the highest byte can be in a range of
0 0000000 to 0 1111111.
Therefore, the address range of a Class A network in the first byte is always between 0 and 127.

- **Class B:** (Net-ID: Byte1 - Byte2, Host-ID: Byte3 - Byte4)

z. B: 181 . 16 . 232 . 22

10110101		00010000	11101000	00010110
10	Net-ID		Host-ID	

The highest bits in Class B networks are always 10.
I.e. the highest byte can be in a range of
10 000000 to 10 111111.
Therefore, the address range of Class B networks in the first byte is always between 128 and 191.

- **Class C:** (Net-ID: Byte1 - Byte3, Host-ID: Byte4)

z. B: 201 . 16 . 232 . 22

11000101		00010000	11101000	00010110
110	Net-ID			Host-ID

The highest bits in Class C networks are always 110.
I.e. the highest byte can be in a range of
110 00000 to 110 11111.
Therefore, the address range of Class C networks in the first byte is always between 192 and 223.

Additional network classes (D, E) are only used for special tasks.

More information
A more detailed description of these principles is found on the Internet under http://www.WuT.de/us_printmed.html (W&T, Manual TCP/IP-ETHERNET for Beginners).

Key data

	Address range of the subnetwork	Possible number of networks	Possible number of Subscribers per network
Class A	1.XXX.XXX.XXX - 126.XXX.XXX.XXX	127 (2^7)	Ca. 16 Million (2^{24})
Class B	128.000.XXX.XXX - 191.255.XXX.XXX	Ca. 16 thousand (2^{14})	Ca 65 thousand (2^{16})
Class C	192.000.000.XXX - 223.255.255.XXX	Ca. 2 million (2^{21})	254 (2^8)

Each WAGO ETHERNET fieldbus coupler/controller can be easily assigned an IP address via the implemented BootP protocol. For small internal networks we recommend selecting a network address from Class C.

Attention
Never set all bits to equal 0 or 1 in one byte (byte = 0 or 255). These are reserved for special functions and may not be allocated. I.e. the address 10.0.10.10 may not be used due to the 0 in the second byte.

If a network is to be directly connected to the Internet, only registered, internationally unique IP addresses allocated by a central registration service may be used. These are available i.e. from Inter*NIC* (International Network Information Center).

Attention
Direct connection to the Internet should only be performed by an authorized network administrator and is therefore not described in this manual.

Subnets

To allow routing within large networks a convention was introduced in the specification *RFC 950*. Part of the Internet address, the subscriber ID is divided up again into a subnetwork number and the station number of the node. With the aid of the network number it is possible to branch into internal subnetworks within the partial network, but the entire network is physically connected together. The size and position of the subnetwork ID are not defined; however, the size is dependent upon the number of subnets to be addressed and the number of subscribers per subnet.

1		8	16	24	32
1	0	Net-ID	Subnet-ID	Host-ID	

Fig. 5-10: Class B address with field for subnetwork ID

Subnet mask

A subnet mask was introduced to encode the subnets in the Internet. This involves a bit mask, which is used to mask out or select specific bits of the IP address. The mask defines the subscriber ID bits used for subnet coding, which denote the ID of the subscriber. The entire IP address range theoretically lies between 0.0.0.0 and 255.255.255.255. Each 0 and 255 from the IP address range are reserved for the subnet mask.

The standard masks depending upon the respective network class are as follows:

- **Class A Subnet mask:**

255	.0	.0	.0

- **Class B Subnet mask:**

255	.255	.0	.0

- **Class C Subnet mask:**

255	.255	.255	.0

Depending on the subnet division the subnet masks may, however, contain other values beyond 0 and 255, such as i.e. 255.255.255.128 or 255.255.255.248, etc.
Your network administrator allocates the subnet mask number to you. Together with the IP address, this number determines which network your PC and your node belongs to.

The recipient node, which is located on a subnet initially, calculates the correct network number from its own IP address and the subnet mask.
Only then does it check the node number and delivers the entire packet frame, if it corresponds.

Example of an IP address from a class B network:

IP address	172.16.233.200	10101100 00010000 11101001 11001000
Subnet mask:	255.255.255.128	11111111 11111111 11111111 10000000
Net-ID:	172.16.00	10101100 00010000 00000000 00000000
Subnet-ID:	0.0.233.128	00000000 00000000 11101001 10000000
Host-ID:	72	00000000 00000000 00000000 01001000

Attention
Specify the network mask defined by the administrator in the same way as the IP address when installing the network protocol.

Gateway

The subnets of the Internet are normally connected via gateways. The function of these gateways is to forward packets to other networks or subnets.
This means that in addition to the IP address and network mask for each network card it is necessary to specify the correct IP address of the standard gateway for a PC or fieldbus node connected to the Internet. You should also be able to obtain this IP address from your network administrator.
The IP function is limited to the local subnet if this address is not specified.

IP Packet

In addition to the data units to be transported, the IP data packets contain a range of address information and additional information in the packet header.

IP-Header	IP-Data

Fig. 5-11: IP packet

The most important information in the IP header is the IP address of the transmitter and the receiver and the transport protocol used.

5.2.2.3 TCP protocol

As the layer above the Internet protocol, TCP (Transmission Control Protocol), guarantees the secure transport of data through the network.
TCP enables two subscribers to establish a connection for the duration of the data transmission. Communication takes place in full-duplex mode, i.e. transmission between two subscribers in both directions simultaneously.
TCP provides the transmitted message with a 16-bit checksum and each data packet with a sequence number.
The receiver checks that the packet has been correctly received on the basis of the checksum and then sets off the sequence number. The result is known as the acknowledgement number and is returned with the next self-sent packet as an acknowledgement.
This ensures that the lost TCP packets are detected and resent, if necessary, in the correct sequence.

TCP port numbers

TCP can, in addition to the IP address (network and subscriber address), respond to a specific application (service) on the addressed subscriber. For this the applications located on a subscriber, such as i.e. web server, FTP server and others are addressed via different port numbers. Well-known applications are assigned fixed ports to which each application can refer when a connection is built up.

Examples:

Telnet	Port number: 23
HTTP	Port number: 80

A complete list of "standardized services" is contained in the *RFC 1700 (1994)* specifications.

TCP segment

The packet header of a TCP data packet is comprised of at least 20 bytes and contains, among others, the application port number of the transmitter and the receiver, the sequence number and the acknowledgement number.
The resulting TCP packet is used in the data unit area of an IP packet to create a TCP/IP packet**.**

5.2.2.4 UDP

The UDP protocol, like the TCP protocol, is responsible for the transport of data. Unlike the TCP protocol, UDP is not connection-orientated; i.e. there are no control mechanisms for the data exchange between transmitter and receiver. The advantage of this protocol is the efficiency of the transmitted data and the resulting higher processing speed.

5.2.2.5 ICMP

The Internet Control Message Protocol is used to report errors in the network of the station causing or affected by the error. The ICMPO protocol is described in the *RFC 792* specification.

5.2.3 Application protocols

In addition to the communication protocols described above, various application protocols are implemented in the WAGO ETHERNET Coupler. These protocols allow the user easy access to the fieldbus nodes:

- a MODBUS/TCP server,
- a BootP client and
- an HTTP server.

5.2.3.1 MODBUS/TCP

MODBUS/TCP is a manufacturer-independent, open fieldbus standard for diverse applications in manufacturing and process automation.
The MODBUS/TCP protocol is a variation of the MODBUS protocol, which was optimized for communication via TCP/IP connections.
This protocol was designed for data exchange in the field level, i.e. for the exchange of I/O data in the process image.
All data packets are sent via a TCP connection with the **port number 502**.

The MODBUS/TCP in the WAGO ETHERNET fieldbus coupler/controller allows digital and analog output data to be directly read out at a fieldbus node and special functions to be executed by way of simple function codes from three stations simultaneously.

More information
Please refer to Chapter 6 "Common MODBUS functions" for a detailed description of these functions and their application.

MODBUS TCP segment

The general MODBUS/TCP header is as follows:

Byte:	0	1	2	3	4	5	6	7	8 - n
	Identifier (entered by receiver)		Protocol-identifier (is always 0)		Length field (High byte, Low byte)		Unit identifier (Slave address)	MODBUS function code	Data

Fig. 5-12: MODBUS/TCP header

More information
The structure of a datagram is specific for the individual functions and is, therefore, also explained in Chapter 6 "Common MODBUS functions".

5.2.3.2 Bootstrap Protocol (BootP)

The BootP protocol defines a request/response mechanism with which the MAC-ID of a fieldbus node can be assigned an IP address.
For this a network node is enabled to send requests into the network and call up the required network information, such i.e. the IP address of a BootP server. The BootP server waits for BootP requests and generates the response from a configuration database.

The dynamic configuration of the IP address via a BootP server offers the user a flexible and simple design of his network. The WAGO BootP server allows any IP address to be easily assigned for the WAGO fieldbus coupler/controller. This is available free from WAGO over the Internet at www.wago.com.

More information
The procedure for address allocation with the WAGO BootP Server is described in detail in the Chapters 3.1.6.4 and 3.2.6.4 "Allocating the IP address to the fieldbus node".

5.2.3.3 HyperText Transfer Protocol (HTTP)

HTTP is a protocol used by WWW (World Wide Web) servers for the forwarding of hypermedia, texts, images, audiodata etc.

Today, HTTP forms the basis of the Internet and is also based on requests and responses in the same way as the BootP protocol.

The HTTP server implemented in the ETHERNET fieldbus coupler is used for viewing the HTML pages saved in the fieldbus coupler. The HTML pages provide information about the fieldbus coupler (state, configuration), the network and the process image.
The HTTP server uses port **number 80**.

6 Common MODBUS functions

MODBUS functions from the *OPEN MODBUS / TCP SPECIFICATION* are found in the application layer of the WAGO ETHERNET fieldbus coupler/controller.

More information
More information on the *OPEN MODBUS / TCP SPECIFICATION* you can find in the Internet:
http://www.modicon.com/openmbus/standards/openmbus.htm

These functions allow digital or analog input and output data to be set or directly read out of the fieldbus node.

Function code	hexadecimal	Function	Description
FC1:	0x01	read coils	Reading of several input bits
FC2:	0x02	read input discretes	Reading of several input bits
FC3:	0x03	read multiple registers	Reading of several input registers
FC4:	0x04	read input registers	Reading of several input registers
FC5:	0x05	write coil	Writing of an individual output bit
FC6:	0x06	write single register	Writing of an individual output register
FC7:	0x07	read exception status	Reading of the first 8 input bits
FC11:	0x0B	get comm event counters	Communication event counter
FC15:	0x0F	force multiple coils	Writing of several output bits
FC16:	0x0010	write multiple registers	Writing of several output registers
FC23	0x0017	read/write multiple registers	Reading and writing of several output registers

Tab. 6-1: List of the MODBUS functions in the fieldbus coupler and controller

To execute a desired function, specify the respective function code and the address of the selected input or output channel.

Attention
The examples listed use the hexadecimal system (i.e.: 0x000) as their numerical format. Addressing begins with 0.
The format and beginning of the addressing may vary according to the software and the control system. All addresses then need to be converted accordingly.

6.1 Use of the MODBUS functions

The graphical overview uses a fieldbus node as an example to show which MODBUS functions can be used to access data of the process image.

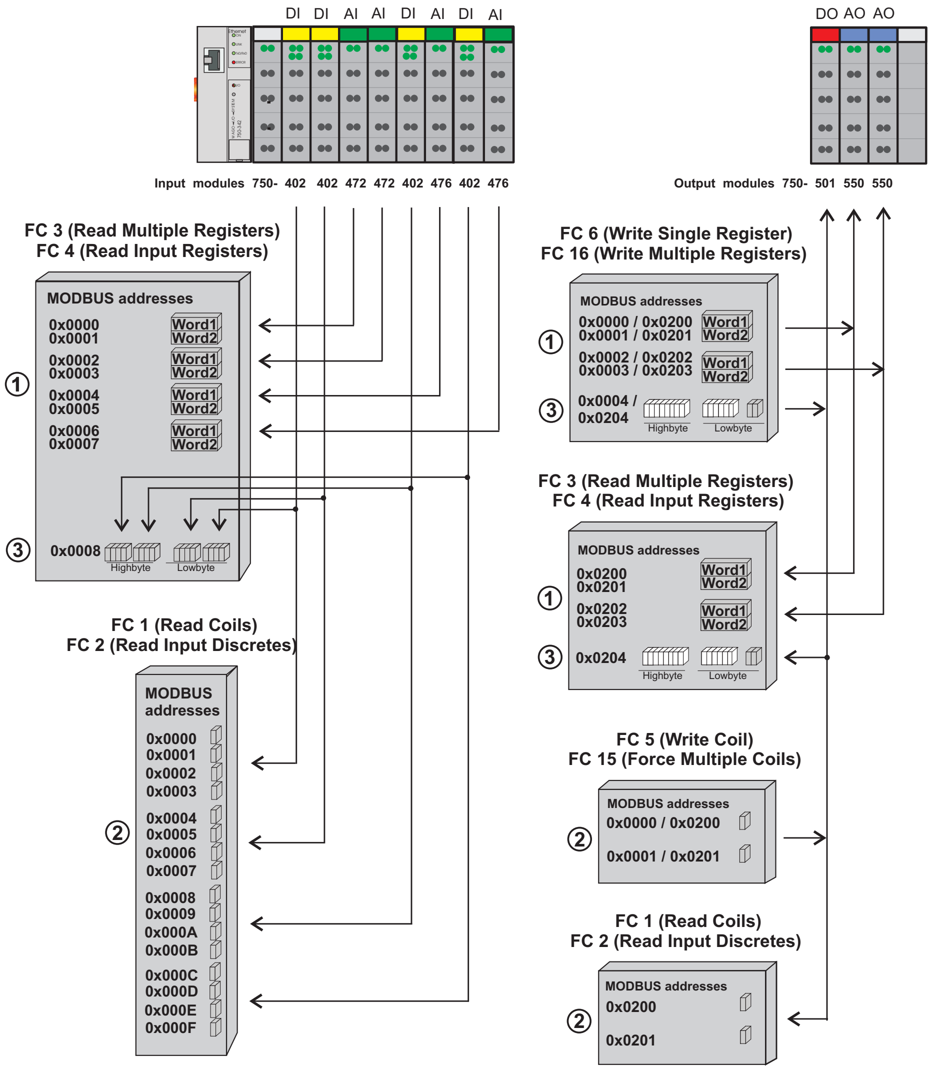


Fig. 6-1: Use of the MODBUS functions G012918e

Attention
It is recommended that analog data be accessed with register functions ① and digital data with coil functions ②.

6.2 Description of the MODBUS functions

All MODBUS functions in the WAGO ETHERNET fieldbus coupler and controller are executed as follows:

When a function code is entered, the MODBUS master (i.e. PC) makes a request to the coupler/controller of the fieldbus node.
Subsequently, the coupler/controller sends a datagram to the master as a response.

If the coupler receives an incorrect request, it sends an error datagram (Exception) to the master.

The exception code contained in the exception has the following meaning:

Exception Code	Meaning
0x01	Illegal Function
0x02	Illegal Data Address
0x03	Illegal Data Value
0x04	Slave Device Failure

The following chapters describe the datagram architecture of request, response and exception with examples for each function code.

Note
In the case of the read functions (FC1 – FC 4) the outputs can be additionally written and read back by adding an offset of 200_{hex} (0x0200) to the MODBUS address.

6.2.1 Function code FC1 (Read Coils)

The function reads the status of the input and output bits (coils) in slave.

Request

The request determines the starting address and the number of bits to be read. Example: An inquiry, with which the bits 0 to 7 are to be read.

Byte	Field name	Example
Byte 0, 1	Transaction identifier	0x0000
Byte 2, 3	protocol identifier	0x0000
Byte 4, 5	length field	0x0006
Byte 6	unit identifier	0x01 not used
Byte 7	MODBUS function code	0x01
Byte 8, 9	reference number	0x0000
Byte 10, 11	Bit count	0x0008

Response

The current values of the inquired bits are packed in the data field. A 1 corresponds to the ON status and a 0 to the OFF status. The lowest value bit of the first data byte contains the first bit of the inquiry. The others follow in ascending order. If the number of inputs is not a multiple of 8, the remaining bits of the last data byte are filled with zeroes (truncated).

Byte	Field name	Example
.....		
Byte 7	MODBUS function code	0x01
Byte 8	Byte count	0x01
Byte 9	Bit values	0x12

The status of the inputs 7 to 0 is shown as byte value 0x12 or binary 0001 0010.
Input 7 is the bit having the highest significance of this byte and input 0 the lowest value.
The assignment is thus made from 7 to 0 with OFF-OFF-OFF-ON-OFF-OFF-ON-OFF.

Bit:	0	0	0	1	0	0	1	0
Coil:	7	6	5	4	3	2	1	0

Exception

Byte	Field name	Example
.....		
Byte 7	MODBUS function code	0x81
Byte 8	Exception code	0x01 or 0x02

6.2.2 Function code FC2 (Read Discrete Inputs)

This function reads the input bits in the slave.

Requests

The request determines the starting address and the number of bits to be read.
Example: An inquiry with which the bits 0 to 7 are to be read:

Byte	Field name	Example
Byte 0, 1	Transaction identifier	0x0000
Byte 2, 3	protocol identifier	0x0000
Byte 4, 5	Length field	0x0006
Byte 6	unit identifier	0x01 not used
Byte 7	MODBUS function code	0x02
Byte 8, 9	reference number	0x0000
Byte 10, 11	Bit count	0x0008

Response

The current value of the inquired bit is packed into the data field. A 1 corresponds to the ON status and a 0 the OFF status. The lowest value bit of the first data byte contains the first bit of the inquiry. The others follow in an ascending order. If the number of inputs is not a multiple of 8, the remaining bits of the last data byte are filled with zeroes (truncated).

Byte	Field name	Example
.....		
Byte 7	MODBUS function code	0x02
Byte 8	Byte count	0x01
Byte 9	Bit values	0x12

The status of the inputs 7 to 0 is shown as a byte value 0x12 or binary 0001 0010.
Input 7 is the bit having the highest significance of this byte and input 0 the lowest value.
The assignment is thus made from 7 to 0 with OFF-OFF-OFF-ON-OFF-OFF-ON-OFF.

Bit:	0	0	0	1	0	0	1	0
Coil:	7	6	5	4	3	2	1	0

Exception

Byte	Field name	Example
.....		
Byte 7	MODBUS function code	0x82
Byte 8	Exception code	0x01 or 0x02

6.2.3 Function code FC3 (Read multiple registers)

The binary contents of holding registers are read from the slave using this function.

Request

The request determines the start word address (start register) and the number the register to be read. The addressing starts with 0.
Example: An inquiry of the registers 0 and 1:

Byte	Field name	Example
Byte 0, 1	Transaction identifier	0x0000
Byte 2, 3	protocol identifier	0x0000
Byte 4, 5	length field	0x0006
Byte 6	unit identifier	0x01 not used
Byte 7	MODBUS function code	0x03
Byte 8, 9	reference number	0x0000
Byte 10, 11	Word count	0x0002

Response

The reply register data is packed as 2 bytes per register. The first byte contains the higher value bits, the second the lower values.

Byte	Field name	Example
.....		
Byte 7	MODBUS function code	0x03
Byte 8	Byte count	0x04
Byte 9, 10	Value Register 0	0x1234
Byte 11, 12	Value Register 1	0x2345

The contents of register 0 are displayed by the value 0x1234 and the contents of register 1 is 0x2345.

Exception

Byte	Field name	Example
.....		
Byte 7	MODBUS function code	0x83
Byte 8	Exception code	0x01 or 0x02

6.2.4 Function code FC4 (Read input registers)

This function serves to read a number of input words (also ”input register”).

Request

The request determines the address of the start word (start register) and the quantity of the registers to be read. Addressing starts with 0.

Example: An inquiry of the registers 0 and 1:

Byte	Field name	Example
Byte 0, 1	Transaction identifier	0x0000
Byte 2, 3	protocol identifier	0x0000
Byte 4, 5	length field	0x0006
Byte 6	unit identifier	0x01 not used
Byte 7	MODBUS function code	0x04
Byte 8, 9	reference number	0x0000
Byte 10, 11	Word count	0x0002

Response

The register data of the answer is packed as 2 bytes per register. The first byte has the higher value bits, the second the lower values.

Byte	Field name	Example
.....		
Byte 7	MODBUS function code	0x04
Byte 8	Byte count	0x04
Byte 9, 10	Value Register 0	0x1234
Byte 11, 12	Value Register 1	0x2345

The contents of register 0 are shown by the value 0x1234 and the contents of register 1 is 0x2345.

Exception

Byte	Field name	Example
.....		
Byte 7	MODBUS function code	0x84
Byte 8	Exception code	0x01 or 0x02

6.2.5 Function code FC5 (Write Coil)

With the aid of this function a single output bit is written.

Request

The request determines the address of the output bit. Addressing starts with 0.

Example: The second output bit is set (address 1):

Byte	Field name	Example
Byte 0, 1	Transaction identifier	0x0000
Byte 2, 3	protocol identifier	0x0000
Byte 4, 5	length field	0x0006
Byte 6	unit identifier	0x01 not used
Byte 7	MODBUS function code	0x05
Byte 8, 9	reference number	0x0001
Byte 10	ON/OFF	0xFF
Byte 11		0x00

Response

Byte	Field name	Example
.....		
Byte 7	MODBUS function code	0x05
Byte 8, 9	Reference number	0x0001
Byte 10	Value	0xFF
Byte 11		0x00

Exception

Byte	Field name	Example
.....		
Byte 7	MODBUS function code	0x85
Byte 8	Exception code	0x01, 0x02 or 0x03

6.2.6 Function code FC6 (Write single register)

This function writes a value in one single output word (also ”Output register”).

Request

Addressing starts with 0. The inquiry determines the address of the first output word to be set. The value to be set is determined in the inquiry data field.

Example: The second output (address 0) is set to the value 0x1234.

Byte	Field name	Example
Byte 0, 1	Transaction identifier	0x0000
Byte 2, 3	protocol identifier	0x0000
Byte 4, 5	length field	0x0006
Byte 6	Unit identifier	0x01 not used
Byte 7	MODBUS function code	0x06
Byte 8, 9	reference number	0x0001
Byte 10, 11	Register Value	0x1234

Response

The reply is an echo of the inquiry.

Byte	Field name	Example
.....		
Byte 7	MODBUS function code	0x06
Byte 8, 9	Reference number	0x0001
Byte 10, 11	Register Value	0x1234

Exception

Byte	Feldname	Example
.....		
Byte 7	MODBUS function code	0x85
Byte 8	Exception code	0x01 or 0x02

6.2.7 Function code FC7 (Read Exception Status)

This function reads the first 8 bits of the process output image.

Request

Byte	Field name	Example
Byte 0, 1	Transaction identifier	0x0000
Byte 2, 3	protocol identifier	0x0000
Byte 4, 5	length field	0x0002
Byte 6	unit identifier	0x01 not used
Byte 7	MODBUS function code	0x07

Response

Byte	Field name	Example
...		
Byte 7	MODBUS function code	0x07
Byte 8	Reference number	0x00

Exception

Byte	Field name	Example
...		
Byte 7	MODBUS function code	0x85
Byte 8	Exception code	0x01 or 0x02

6.2.8 Function code FC15 (Force Multiple Coils)

Using this function a number of output bits are set to 1 or 0. The maximum number is 256 bits.

Request

The first point is addressed with 0.
The inquiry message specifies the bits to be set. The requested 1 or 0 states are determined by the contents of the inquiry data field.

In this example 16 bits are set, starting with the address 0. The inquiry contains 2 bytes with the value 0xA5F0 or 1010 0101 1111 0000 in binary format.

The first byte transmits the 0xA5 to the addresses 7 to 0, whereby 0 is the lowest value bit. The next byte transmits 0xF0 to the addresses 15 to 8, whereby the lowest value bit is 8.

Byte	Field name	Example
Byte 0, 1	Transaction identifier	0x0000
Byte 2, 3	protocol identifier	0x0000
Byte 4, 5	Length field	0x0009
Byte 6	unit identifier	0x01 not used
Byte 7	MODBUS function code	0x0F
Byte 8, 9	reference number	0x0000
Byte 10, 11	Bit Count	0x0010
Byte 12	Byte Count	0x02
Byte 13	Data Byte1	0xA5
Byte 14	Data Byte2	0xF0

Response

Byte	Field name	Example
.....		
Byte 7	MODBUS function code	0x0F
Byte 8, 9	Reference number	0x0000
Byte 10, 11	Bit Count	0x0010

Exception

Byte	Field name	Example
.....		
Byte 7	MODBUS function code	0x8F
Byte 8	Exception code	0x01 or 0x02

6.2.9 Function code FC16 (Write multiple registers)

This function writes values in a number of output words (also ”Output register”).

Request

The first point is addressed with 0.

The inquiry message determines the registers to be set. The data is sent as 2 bytes per register.

The example shows how data is set in the two registers 0 and 1:

Byte	Field name	Example
Byte 0, 1	Transaction identifier	0x0000
Byte 2, 3	protocol identifier	0x0000
Byte 4, 5	length field	0x000B
Byte 6	Unit identifier	0x01 not used
Byte 7	MODBUS function code	0x10
Byte 8, 9	reference number	0x0000
Byte 10, 11	Word count	0x0002
Byte 12	Byte Count	0x04
Byte 13, 14	Register Value 1	0x1234
Byte 15, 16	Register Value 2	0x2345

Response

Byte	Field name	Example
.....		
Byte 7	MODBUS function code	0x10
Byte 8, 9	Reference number	0x0000
Byte 10, 11	Register Value	0x0002

Exception

Byte	Field name	Example
.....		
Byte 7	MODBUS function code	0x85
Byte 8	Exception code	0x01 or 0x02

6.2.10 Function code FC11 (Get comm event counter)

This function returns a status word and an event counter from the slave's communication event counter. By reading the current count before and after a series of messages, a master can determine whether the messages were handled normally by the slave.

Following each successful new processing, the counter counts up. This counting process is not performed in the case of exception replies, poll commands or counter inquiries.

Request

Byte	Field name	Example
Byte 0, 1	Transaction identifier	0x0000
Byte 2, 3	protocol identifier	0x0000
Byte 4, 5	length field	0x0002
Byte 6	Unit identifier	0x01 not used
Byte 7	MODBUS function code	0x0B

Response

The reply contains a 2-byte status word and a 2-byte event counter. The status word only contains zeroes.

Byte	Field name	Example
.....		
Byte 7	MODBUS function code	0x10
Byte 8, 9	Status	0x0000
Byte 10, 11	Event Count	0x0003

The event counter shows that 3 (0x0003) events were counted.

Exception

Byte	Field name	Example
.....		
Byte 7	MODBUS function code	0x85
Byte 8	Exception code	0x01 or 0x02

6.2.11 Function code FC23 (Read/Write multiple registers)

This function reads the register values and writes the values into a number of output words (also ”Output Register“).

Request

The first register is addressed with 0.

The inquiry message determines the registers to be read and set. The data is sent as 2 bytes per register.

Example: The data in register 3 is set to value 0x0123, and values 0x0004 and 0x5678 are read out of the two registers 0 and 1.

Byte	Field name	Example
Byte 0	MODBUS function code	0x17
Byte 1-2	reference number for read	0x0000
Byte 3-4	Word count for read (1-125)	0x0002
Byte 5-6	reference number for write	0x0003
Byte 7-8	Word count for read (1-100)	0x0001
Byte 9	Byte Count (B = 2 x word count for read)	0x02
Byte 10-(B+9)	Register Values	0x0123

Response

Byte	Field name	Example
Byte 0	MODBUS function code	0x17
Byte 1	Byte Count (B = 2 x word count for read)	0x04
Byte 2-(B+1)	Register Values	0x0004 0x5678

Exception

Byte	Field name	Example
Byte 0	MODBUS function code	0x97
Byte 1	Exception code	0x01 or 0x02

Note
Should register areas for read and write overlap, the results are undefined.

6.2.12 Watchdog (Fieldbus failure)

The watchdog serves for monitoring the data transfer between the master controls and the coupler/controller. For this the master cyclically actuates a time function (Time-out) in the coupler/controller.

In the case of fault free communication, the watchdog timer does not reach its end value. After each successful data transfer, the timer is reset.

If this time has elapsed a fieldbus failure has occurred.
In this case, the fieldbus coupler/controller answers all following MODBUS TCP/IP requests with the exception code 0x0004 (Slave Device Failure).

In the coupler/controller special registers are present for the selection and status inquiry of the watchdog by the master (Register addresses 0x1000 to 0x1008).

After switching on the supply voltage the watchdog is not yet activated. First step is to set the time-out value (Register 0x1000). The watchdog can be activated by writing a function code in the mask register (0x1001), which is unequal 0. A second activation possibility is to write a value in the toggle register (0x1003) deviating from 0.

Reading the minimum trigger time (Register 0x1004) reveals whether the watchdog fault reaction was activated. If this time value is 0, a fieldbus failure is assumed. The watchdog can be restarted in accordance with the previously mentioned two possibilities or using the register 0x1007.

If the watchdog is started it can only be stopped by the user for safety reasons via a certain path (register 0x1005 or 0x1008).

Watchdog Register:

The watchdog registers can be addressed in the same way as the described in MODBUS function codes (read and write). Specify the respective register address in place of the address of a module channel.

Register address 0x1000	
Designation	Watchdog time, WS_TIME
Access	read / write
Default	0x0000
Description	This register saves the value for time exceeded (Time-out). To be able to start, the watchdog default value must have a value which is not equal to zero. The time is set as a multiple of 100 ms, 0x0009 means a time out time of 0.9 s. This value cannot be changed when the watchdog is running.

Register address 0x1001	
Designation	Watchdog function coding mask, function code 1...16, WDFCM_1_16
Access	Read / write
Default	0x0000
Description	Using this mask the function codes can be set to trigger the watchdog function. The function code can be selected via a ‘1’ to (= 2(Function code-1)+ ....) Bit 1001.0 corresponds to function code1, Bit 1001.1 corresponds to function code2... The watchdog function is started if a value is not equal to zero. If codes from non-supported functions are entered in the mask the watchdog will not start. An existing fault is reset and writing into the process illustration is possible. Also here changes cannot be made while the watchdog is running.

Register address 0x1002	
Designation	Watchdog function coding mask, function code 17...32, WD_FCM_17_32
Access	Read / write
Default	0x0000
Description	Same function as above, however, with the function codes 17 to 32. These codes are not supported, for this reason the default value of this register should not be changed. It is not possible to modify this value while the watchdog is running.

Register address 0x1003	
Designation	Watchdog trigger, WD_TRIGGER
Access	Read / write
Default	0x0000
Description	This register is used for an alternative trigger method. The watchdog is triggered by writing different values in this register. Values following each other must differ in size. Writing of a value not equal to zero starts the watchdog. In case of a watchdog fault this register is reset to zero.

Register address 0x1004	
Designation	Minimum current trigger time, WD_AC_TRG_TIME
Access	read / write
Default	0xFFFF
Description	Using this value the current watchdog status can be read. If the watchdog is triggered, the saved value is compared with the current value. If the current value is smaller than the saved value, this is replaced by the current value. The unit is 100 ms/digit. The saved value is changed by writing new values, which does not affect the watchdog. 0x000 is not permissible.

Register address 0x1005	
Designation	Stop watchdog, WD_AC_STOP_MASK
Access	read / write
Default	0x0000
Description	The watchdog is stopped if here the value 0xAAAA is written first, followed by 0x5555. The watchdog fault reaction is blocked. A watchdog fault is reset and writing on the process data is possible again.

Register address 0x1006	
Designation	While watchdog is running, WD_RUNNING
Access	Read
Default	0x0000
Description	Current watchdog status. at 0x0: Watchdog not active, at 0x1: Watchdog active.

Register address 0x1007	
Designation	Restart watchdog, WD_RESTART
Access	read / write
Default	0x0001
Description	Writing 0x1 into the register starts the watchdog again. If the watchdog was stopped before the overrun, it is not restarted.

Register address 0x1008	
Designation	Simply stop watchdog WD_AC_STOP_SIMPLE
Access	read / write
Default	0x0000
Description	The watchdog is stopped by writing the value 0x0AA55 or 0X55AA, if it was already active. The watchdog fault reaction is deactivated. An existing watchdog fault is reset and it is possible to write in the watchdog register again.

In all registers the length is 1, i.e. with each access only one word can be written or read.

Example:

- Setting the watchdog for a time overrun of more than 1 s
  1. Write 0x000A (=1000 ms / 100 ms) in the register for time overrun (0x1000).
  2. Write 0x0010 (=$2^{(5-1)}$) in the coding mask (register 0x1001) to start the watchdog.
  3. Use the function ‘Force Single Coil’ to trigger the watchdog.
  4. Read the register of the minimum current trigger time and compare this with zero to check whether a time overrun has occurred.

  Repeat step 3 and 4.

- Setting the watchdog for a time overrun of more than 10 min
  1. Write 0x1770 (=10*60*1000 ms / 100 ms) in the register for time overrun (0x1000).
  2. Write 0x0001 in the watchdog trigger register (0x1003) to start the watchdog.
  3. Write 0x0001, 0x0000, 0x0001... or a counter value in the watchdog trigger register (0x1003) to trigger the watchdog.
  4. Read the register of the minimum current trigger time and compare it with zero to check if a time overrun has occurred.

  Repeat step 3 and 4.

6.2.13 Diagnostic function

The following registers can be read to determine errors in the network node:

Register address 0x1020	
Designation	LedErrCode
Access	Read
Description	Declaration of the Error code

Register address 0x1021	
Designation	LedErrArg
Access	Read
Description	Declaration of the Error argument

6.2.14 Configuration function

The following registers can be read, in order to determine the configuration of the connected modules:

Register address 0x1022	
Designation	CnfLen.AnalogOut
Access	Read
Description	Number of I/O bits with the process data words of the outputs

Register address 0x1023	
Designation	CnfLen.AnalogInp
Access	Read
Description	Number of I/O bits with the process data words of the inputs

Register address 0x1024	
Designation	CnfLen.DigitalOut
Access	Read
Description	Number of I/O bits with the process data bits of the outputs

Register address 0x1025	
Designation	CnfLen.DigitalInp
Access	Read
Description	Number of I/O bits with the process data bits of the inputs

Register address 0x1027	
Designation	Perform an internal bus cycle
Access	Read
Description	

Register address 0x1028	
Designation	Activate/deactivate configuration via BootP
Access	read / write
Description	0: No BootP is used 1: BootP is active

Register address 0x2030	
Designation	Description of the connected I/O modules
Access	Read
Description	Length 65 words

6.2.15 Firmware information

The following registers are used to read out information related to the coupler and/or controller firmware:

Register address 0x2010	
Designation	Revision, INFO_REVISION
Access	Read
Description	Firmware index, z. B. 0005 for version 5

Register address 0x2011	
Designation	Series code, INFO_SERIES
Access	Read
Description	WAGO series number, i.e. 0750 for WAGO-I/O-SYSTEM 750

Register address 0x2012	
Designation	Item number, INFO_ITEM
Access	Read
Description	WAGO order number, i.e. 342 for coupler, 842 for controller

Register address 0x2013	
Designation	Major sub item code, INFO_MAJOR
Access	Read
Description	Extended WAGO order number for special firmware versions or settings; 0xFFF for coupler/controller

Register address 0x2014	
Designation	Minor sub item code, INFO_MINOR
Access	Read
Description	Extended WAGO order number for special firmware versions or settings; 0xFFF for coupler/controller

Register address 0x2020	
Designation	Description, INFO_DESCRIPTION
Access	Read
Description	Information on coupler/controller, 128 words

Register address 0x2021	
Designation	Description, INFO_DESCRIPTION
Access	Read
Description	Time of firmware version, 16 words

Register address 0x2022	
Designation	Description, INFO_DATE
Access	Read
Description	Date of firmware version, 16 words

Register address 0x2023	
Designation	Description, INFO_LOADER_INFO
Access	Read
Description	Information on firmware programming, 32 words

6.2.16 General Registers

The following registers contain constants which can be used to test the communication with the master:

Register address 0x2000	
Designation	Zero, GP_ZERO
Access	Read
Description	Constant with zero

Register address 0x2001	
Designation	Ones, GP_ONES
Access	Read
Description	Constant with ones. Is –1 if this is declared as "signed int" or MAXVALUE with "unsigned int"

Register address 0x2002	
Designation	1,2,3,4, GP_1234
Access	Read
Description	Constant value to test whether High and Low byte is changed over (Intel/Motorola format). Should appear in master as 0x1234. If 0x3412 appears, High and Low byte have to be changed over.

Register address 0x2003	
Designation	mask 1, GP_AAAA
Access	Read
Description	Constant to check whether all bits are available. Used together with the 0x2004 register.

Register address 0x2004	
Designation	mask 1, GP_5555
Access	Read
Description	Constant to check whether all bits are available. Used together with the 0x2003.

Register address 0x2005	
Designation	Highest positive number, GP_MAX_POS
Access	read
Description	Constant to check the arithmetic.

Register address 0x2006	
Designation	Highest negative number, GP_MAX_NEG
Access	read
Description	Constant to check the arithmetic.

Register address 0x2007	
Designation	Highest half positive number, GP_HALF_POS
Access	read
Description	Constant to check the arithmetic.

Register address 0x2008	
Designation	Highest half negative number, GP_HALF_NEG
Access	read
Description	Constant to check the arithmatic.

6.2.17 Special PFC Register (only for controller 750-842)

The following register is only significant for the fieldbus controller. The PFC register is used as an interface for WAGO-I/O-PRO, i.e. for debugging purposes:

Register address 0x1040	
Designation	Process data communication channel
Access	read / write
Description	

7 Application examples

7.1 Test of MODBUS protocol and fieldbus nodes

You require a MODBUS master to test the function of your fieldbus node. For this purpose, various manufacturers offer a range of PC applications that you can, in part, download from the Internet as free of charge demo versions. One of the programs which is particularly suitable to test your ETHERNET TCP/IP fieldbus node, is for instance **ModScan** from **Win-Tech.**

More information
A free of charge demo version from ModScan32 and further utilities from Win-Tech can be found in the Internet under:
http://www.win-tech.com/html/demos.htm.

ModScan32 is a Windows application that works as a MODBUS master. This program allows you to access the data points of your connected ETHERNET TCP/IP fieldbus node and to proceed with the desired changes.

More information
For a description example relating to the software operation, please refer to:

http://www.win-tech.com/html/modscan32.htm

7.2 Visualization and control using SCADA software

This chapter is intended to give insight into how the WAGO ETHERNET fieldbus coupler/controller can be used for process visualization and control using standard user software.

There is a wide range of process visualization programs, called SCADA Software, from various manufacturers.

More information
For a selection of SCADA products, look under i.e.:
http://www.abpubs.demon.co.uk/scadasites.htm.

SCADA is the abbreviation for Supervisory Control and Data Acquisition.

It is a user-orientated tool used as a production information system in the areas of automation technology, process control and production monitoring.

The use of SCADA systems includes the areas of visualization and monitoring, data access, trend recording, event and alarm processing, process analysis and targeted intervention in a process (control).

The WAGO ETHERNET fieldbus node provides the required process input and output values.

Attention!
When choosing suitable SCADA software, ensure that it provides a MODBUS device driver and supports the MODBUS/TCP functions in the coupler.

Visualization programs with MODBUS device drivers are available from i.e. Wonderware, National Instruments, Think&Do or KEPware Inc., some of which are available on the Internet as demo versions.

The operation of these programs is very specific.
However, a few essential steps are described to illustrate the way an application can be developed using a WAGO ETHERNET fieldbus node and SCADA software in principle.

- The initial prerequisite is that the MODBUS ETHERNET driver has been loaded and MODBUS ETHERNET has been selected.

- Subsequently, the user is requested to enter the IP address for addressing the fieldbus node.
  At this point, some programs allow the user to give the node an alias name, i.e. to call the node "Measuring data". The node can then be addressed with this name.

- Then, a graphic object can be created, such as a switch (digital) or a potentiometer (analog).
  This object is displayed on the work area and is linked to the desired data point on the node.

- This link is created by entering the node address (IP address or alias name) of the desired MODBUS function codes (register/bit read/write) and the MODBUS address of the selected channel.
  Entry is, of course, program specific.
  Depending on the user software the MODBUS addressing of a bus module can be represented with 3 or, as in the following example, with 5 digits.

Example of the MODBUS function code

In the case of SCADA Software Lookout from National Instruments the MODBUS function codes are used with a 6 bit coding, whereby the first bit represents the function code:

Input code:	MODBUS function code	
0	FC1 ⇔ read coils	Reading of several input bits
1	FC2 ⇔ read input discretes	Reading of several input bits
3	FC3 ⇔ read multiple registers	Reading of several input registers
4	FC4 ⇔ read input registers	Reading of an individual input register

The following five digits specify the channel number of the consecutively numbered digital or analog input and/or output channels.

Examples:

- Read the first digital input: i.e. 0 0000 1
- Read the second analog input: i.e. 3 0000 2

Application example:

Thus, the digital input channel 2 of the above node "Measuring data" can be read out with the input: "Measuring data. 0 0000 2".

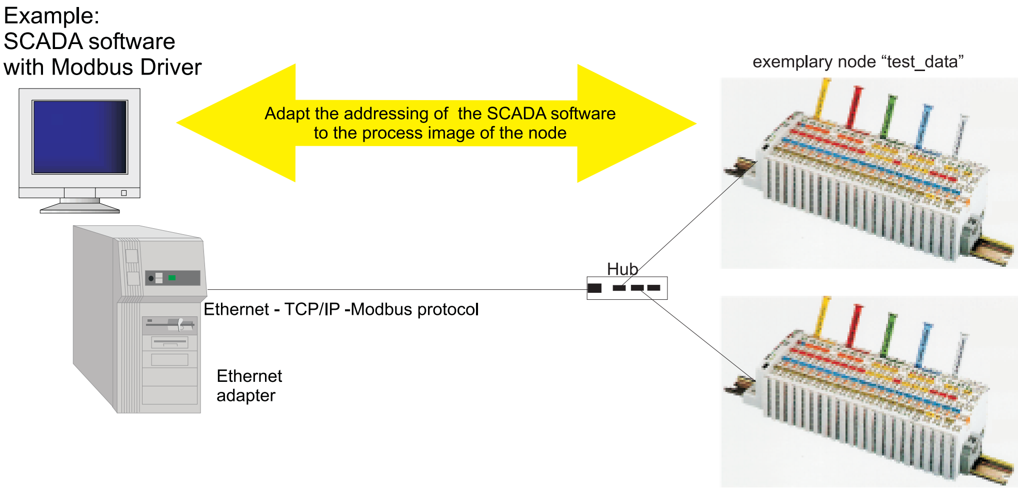


Fig. 7-1: Example of user software G012913e

More information
Please refer to the respective SCADA product manual for a detailed description of the particular software operation.

8 Application in Explosive Environments

8.1 Foreword

Today's development shows that many chemical and petrochemical companies have production plants, production, and process automation machines in operation which use gas-air, vapor-air and dust-air mixtures which can be explosive. For this reason, the electrical components used in such plants and systems must not pose a risk of explosion resulting in injury to persons or damage to property. This is backed by law, directives or regulations, on a national and international scale. WAGO-I/O-SYSTEM 750 (electrical components) is designed for use in zone 2 explosive environments. The following basic explosion protection related terms have been defined.

8.2 Protective measures

Primarily, explosion protection describes how to prevent the formation of an explosive atmosphere. For instance by avoiding the use of combustible liquids, reducing the concentration levels, ventilation measures, to name but a few. But there are a large number of applications, which do not allow the implementation of primary protection measures. In such cases, the secondary explosion protection comes into play. Following is a detailed description of such secondary measures.

8.3 Classification meeting CENELEC and IEC

The specifications outlined here are valid for use in Europe and are based on the following standards: EN50... of CENELEC (European Committee for Electrotechnical Standardisation). On an international scale, these are reflected by the IEC 60079-... standards of the IEC (International Electrotechnical Commission).

8.3.1 Divisions

Explosive environments are areas in which the atmosphere can potentially become explosive. The term explosive means a special mixture of ignitable substances existing in the form of air-borne gases, fumes, mist or dust under atmospheric conditions which, when heated beyond a tolerable temperature or subjected to an electric arc or sparks, can produce explosions. Explosive zones have been created to describe the concentrations level of an explosive atmosphere. This division based on the probability of an explosion occurring is of great importance both for technical safety and feasibility reasons, knowing that the demands placed on electrical components permanently employed in an explosive environment have to be much more stringent than those placed on electrical components that are only rarely and, if at all, for short periods, subject to a dangerous explosive environment.

Explosive areas resulting from gases, fumes or mist:

- Zone 0 areas are subject to an explosive atmosphere (> 1000 h /year) continuously or for extended periods.
- Zone 1 areas can expect the occasional occurrence of an explosive atmosphere (> 10 h ≤ 1000 h /year).
- Zone 2 areas can expect the rare or short-term occurrence of an explosive atmosphere (> 0 h ≤ 10 h /year).

Explosive areas subject to air-borne dust:

- Zone 20 areas are subject to an explosive atmosphere (> 1000 h /year) continuously or for extended periods.
- Zone 21 areas can expect the occasional occurrence of an explosive atmosphere (> 10 h ≤ 1000 h /year).
- Zone 22 areas can expect the rare or short-term occurrence of an explosive atmosphere (> 0 h ≤ 10 h /year).

8.3.2 Explosion protection group

In addition, the electrical components for explosive areas are subdivided into two groups:

Group I: Group I includes electrical components for use in fire-damp endangered mine structures.

Group II: Group II includes electrical components for use in all other explosive environments. The group is further subdivided by pertinent combustible gases in the environment.
Subdivision IIA, IIB and IIC takes into account that different materials/substances/gases have various ignition energy characteristic values. For this reason the three sub-groups are assigned representative types of gases:

- IIA – Propane
- IIB – Ethylene
- IIC – Hydrogen

Minimal ignition energy of representative types of gases				
Explosion group	I	IIA	IIB	IIC
Gases	Methane	Propane	Ethylene	Hydrogen
Ignition energy (µJ)	280	250	82	16

Hydrogen being commonly encountered in chemical plants, frequently the explosion group IIC is requested for maximum safety.

8.3.3 Unit categories

Moreover, the areas of use (zones) and the conditions of use (explosion groups) are subdivided into categories for the electrical operating means:

Unit categories	Explosion group	Area of use
M1	I	Fire-damp protection
M2	I	Fire-damp protection
1G	II	Zone 0 Explosive environment by gas, fumes or mist
2G	II	Zone 1 Explosive environment by gas, fumes or mist
3G	II	Zone 2 Explosive environment by gas, fumes or mist
1D	II	Zone 20 Explosive environment by dust
2D	II	Zone 21 Explosive environment by dust
3D	II	Zone 22 Explosive environment by dust

8.3.4 Temperature classes

The maximum surface temperature for electrical components of explosion protection group I is 150 °C (danger due to coal dust deposits) or 450 °C (if there is no danger of coal dust deposit).

In line with the maximum surface temperature for all ignition protection types, the electrical components are subdivided into temperature classes, as far as electrical components of explosion protection group II are concerned. Here the temperatures refer to a surrounding temperature of 40 °C for operation and testing of the electrical components. The lowest ignition temperature of the existing explosive atmosphere must be higher than the maximum surface temperature.

Temperature classes	**Maximum surface temperature**	**Ignition temperature of the combustible materials**
T1	450 °C	> 450 °C
T2	300 °C	> 300 °C - 450 °C
T3	200 °C	> 200 °C - 300 °C
T4	135 °C	> 135 °C - 200 °C
T5	100 °C	>100 °C -135 °C
T6	85°C	> 85 °C - 100 °C

The following table represents the division and attribution of the materials to the temperature classes and material groups in percent:

<table>
<tr><th colspan="7">Temperature classes</th></tr>
<tr><td>T1</td><td>T2</td><td>T3</td><td>T4</td><td>T5</td><td>T6</td><td>Total*</td></tr>
<tr><td>26.6 %</td><td>42.8 %</td><td>25.5 %</td><td rowspan="2">4.9 %</td><td rowspan="2">0 %</td><td rowspan="2">0.2 %</td><td rowspan="2">432</td></tr>
<tr><td colspan="3">94.9 %</td></tr>
<tr><th colspan="7">Explosion group</th></tr>
<tr><td>IIA</td><td>IIB</td><td>IIC</td><td></td><td></td><td></td><td>Total*</td></tr>
<tr><td>80.2 %</td><td>18.1 %</td><td>0.7 %</td><td></td><td></td><td></td><td>436</td></tr>
</table>

* Number of classified materials

8.3.5 Types of ignition protection

Ignition protection defines the special measures to be taken for electrical components in order to prevent the ignition of surrounding explosive atmospheres. For this reason a differentiation is made between the following types of ignition protection:

Identification	CENELEC standard	IEC standard	Explanation	Application
EEx o	EN 50 015	IEC 79-6	Oil encapsulation	Zone 1 + 2
EEx p	EN 50 016	IEC 79-2	Overpressure encapsulation	Zone 1 + 2
EEx q	EN 50 017	IEC 79-5	Sand encapsulation	Zone 1 + 2
EEx d	EN 50 018	IEC 79-1	Pressure resistant encapsulation	Zone 1 + 2
EEx e	EN 50 019	IEC 79-7	Increased safety	Zone 1 + 2
EEx m	EN 50 028	IEC 79-18	Cast encapsulation	Zone 1 + 2
EEx i	EN 50 020 (unit) EN 50 039 (system)	IEC 79-11	Intrinsic safety	Zone 0 + 1 + 2
EEx n	EN 50 021	IEC 79-15	Electrical components for zone 2 (see below)	Zone 2

Ignition protection “n“ describes exclusively the use of explosion protected electrical components in zone 2. This zone encompasses areas where explosive atmospheres can only be expected to occur rarely or short-term. It represents the transition between the area of zone 1, which requires an explosion protection and safe area in which for instance welding is allowed at any time.

Regulations covering these electrical components are being prepared on a world-wide scale. The standard EN 50 021 allows electrical component manufacturers to obtain certificates from the corresponding authorities for instance KEMA in the Netherlands or the PTB in Germany, certifying that the tested components meet the above mentioned standards draft.

Type “n” ignition protection additionally requires electrical components to be marked , with the following extended identification:

- A – non spark generating (function modules without relay /without switches)
- AC – spark generating, contacts protected by seals (function modules with relays / without switches)
- L – limited energy (function modules with switch)

Further information
For more detailed information please refer to the national and/or international standards, directives and regulations!

8.4 Classifications meeting the NEC 500

The following classifications according to NEC 500 (National Electric Code) are valid for North America.

8.4.1 Divisions

The "Divisions" describe the degree of probability of whatever type of dangerous situation occurring. Here the following assignments apply:

Explosion endangered areas due to combustible gases, fumes, mist and dust:	
Division 1	encompasses areas in which explosive atmospheres are to be expected occasionally (> 10 h ≤ 1000 h /year) as well as continuously and long-term (> 1000 h /year).
Division 2	encompasses areas in which explosive atmospheres can be expected rarely and short-term (>0 h ≤ 10 h /year).

8.4.2 Explosion protection groups

Electrical components for explosion endangered areas are subdivided in three danger categories:

Class I (gases and fumes):	Group A (Acetylene) Group B (Hydrogen) Group C (Ethylene) Group D (Methane)
Class II (dust):	Group E (Metal dust) Group F (Coal dust) Group G (Flour, starch and cereal dust)
Class III (fibers):	No sub-groups

8.4.3 Temperature classes

Electrical components for explosive areas are differentiated by temperature classes:

Temperature classes	Maximum surface temperature	Ignition temperature of the combustible materials
T1	450 °C	> 450 °C
T2	300 °C	> 300 °C - 450 °C
T2A	280 °C	> 280 °C - 300 °C
T2B	260 °C	> 260 °C - 280 °C
T2C	230 °C	>230 °C - 260 °C
T2D	215 °C	>215 °C - 230 °C
T3	200 °C	>200 °C - 215 °C
T3A	180 °C	>180 °C - 200 °C
T3B	165 °C	>165 °C - 180 °C
T3C	160 °C	>160 °C - 165 °C
T4	135 °C	>135 °C - 160 °C
T4A	120 °C	>120 °C - 135 °C
T5	100 °C	>100 °C - 120 °C
T6	85 °C	> 85 °C - 100 °C

8.5 Identification

8.5.1 For Europe

According to CENELEC and IEC

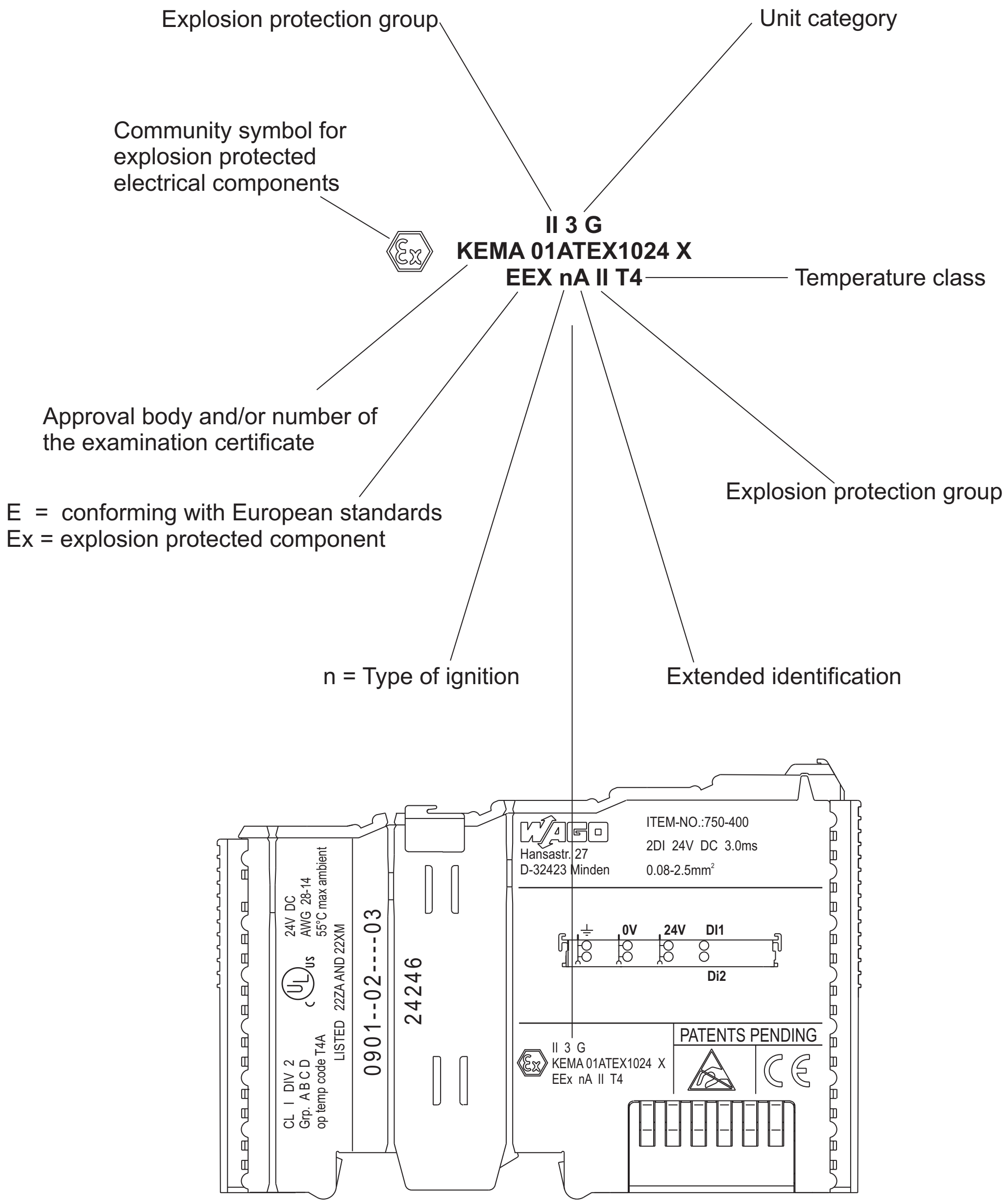


Fig. 8-1: Example for lateral labeling of bus modules
(750-400, 2 channel digital input module 24 V DC) g01xx03e

8.5.2 For America

According to NEC 500

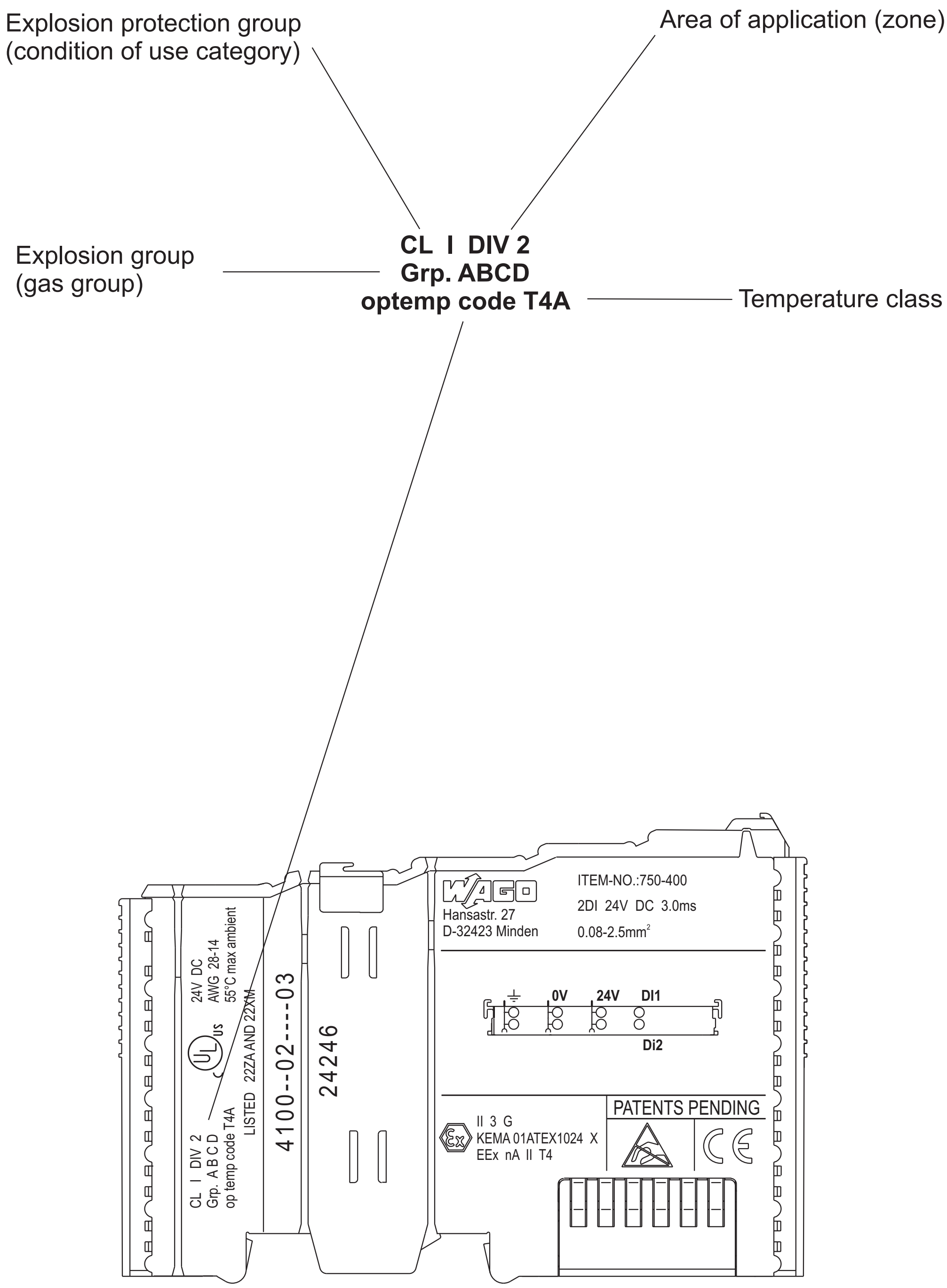


Fig. 8-2: Example for lateral labeling of bus modules
(750-400, 2 channel digital input module 24 V DC) g01xx04e

8.6 Installation regulations

In the **Federal Republic of Germany,** various national regulations for the installation in explosive areas must be taken into consideration. The basis being the ElexV complemented by the installation regulation DIN VDE 0165/2.91. The following are excerpts from additional VDE regulations:

DIN VDE 0100	installation in power plants with rated voltages up to 1000 V
DIN VDE 0101	installation in power plants with rated voltages above 1 kV
DIN VDE 0800	installation and operation in tele-communication plants including information processing equipment
DIN VDE 0185	lightning protection systems

The **USA** and **Canada** have their own regulations. The following are excerpts from these regulations:

NFPA 70	National Electrical Code Art. 500 Hazardous Locations
ANSI/ISA-RP 12.6-1987	Recommended Practice
C22.1	Canadian Electrical Code

Danger
For the use of WAGO-I/O SYSTEM 750 (electrical operating means) with Ex approval the observance of the following points is mandatory:

- The electrical operating means are exclusively suitable for applications in explosion endangered areas (Europe Group II, Zone 2 or America: Class I, Division 2, Group A, B, C, D) or in non explosion endangered areas!
- Ensure that only approved modules of the electrical operating means will be used. Replacement of components can jeopardize the suitability of the system in explosion endangered zones!
- Only disconnect and/or connect electrical operating means when the voltage supply is isolated or when a non-explosive atmosphere has been ascertained!
- Adhere to the specified data regarding voltage supply and fusing. (See data on the fuse holder)!

Further Information
Proof of certification is available on request.

Also take note of the information given on the module technical information sheet.

9 Glossary

B	

Baseband

Systems which operate without carrier frequencies, i.e. with unmodulated signals. Therefore, they only offer one channel which has to be logically tailored to the various requirements. Opposite: Wideband.

Bit

Smallest information unit. Its value can either be 1 or 0.

Bit rate

Number of bits transmitted within a time unit.

BNC

Bayonet Navy Connector. Socket for coaxial cable.

BootP

the bootstrap protocol is a protocol which specifies how system and network information is to be transmitted from a *server* to work stations.

Bridge

Connects two separate networks.

Broadcast

Message which is sent to all stations connected to the network.

Bus

A structure used to transmit data. There are two types, serial and parallel. A serial bus transmits data bit by bit, whereas a parallel bus transmits many bits at one time.

Byte

Binary Yoked Transfer Element. A byte generally contains 8 bits.

C

Client

A system that requests the services of another. With the aid of the service request, the client can access objects (data) on the *server*. The service is provided by the server.

Coaxial cable

This cable contains a single wire and a radial shield to transmit information.

CSMA/CD

Carrier Sense Multiple Access with Collision Detection. When a collision is detected, all subscribers back off. After waiting a random delay time, the subscribers attempt to re-transmit the data.

D

Data bus

see *Bus*.

Deterministic ETHERNET

The ETHERNET data is transferred at a defined time constant. The ETHERNET network can be defined and calculated. A *Switched ETHERNET* architecture makes this possible.

DHCP

Dynamic Subscriber Configuration Protocol. This protocol allows the automatic network configuration of a computer.

Driver

Software code which communicates with a hardware device. This communication is normally performed by internal device registers.

E

ETHERNET

Specifies a Local Area Network (LAN), which was developed by Xerox, Intel and DEC in the 70's. The bus access process takes place according to the *CSMA/CD* method.

ETHERNET Standard

In 1983 ETHERNET was standardized by *IEEE 802.3* 10Base-5. ISO took over the standardization in the ISO Standard 8802/3. The essential differences between ETHERNET and the IEEE standard are to be found in the frame architecture and treatment of pad characters.

F

Fieldbus

System for serial information transmission between devices of automation technology in the process-related field area.

Firewall

Collective term for solutions which protect *LANs* connection to the *Internet* from unauthorized access. They are also able to control and regulate the traffic from the LAN into the Internet. The crucial part of firewalls are static *routers* which have an access control list used to decide which data packets can pass from which *subscriber*.

Frame

Unit of data transferred at the Data-Link layer. It contains the header and addressing information.

FTP

(File Transfer Protocol) A standard application for *TCP/IP* which allows users on one machine to transfer files to/from another.

Function

Module that always returns the same result (as a function value), prerequisite being identical input values; it has no local variables that store values beyond an invoke.

Function block

Module that delivers one or more values when being executed. They can be stored as local variables („Memory“).

G

Gateway

Device for connecting two different networks. It converts the different protocols.

H

Hardware

Electronic, electrical and mechanic components of a module/subassembly.

Header

A portion of the data packet, containing, among others, the address information of the receiver.

Host computer / Subscriber

Originally used to describe a central mainframe computer accessed from other systems. The services provided by the subscriber can be called up by means of local and remote request. Today, this term is also used to refer to simple computers which provide particular central *Services* (i.e. UNIX-Subscribers on the *Internet*).

HTML

Abbreviation of hypertext markup language
HTML is the description language for documents on the *World Wide Web*. It contains language elements for the design of hypertext documents.

HTTP

(Hyper Text Transfer Protocol) *client server TCP/IP* protocol which is used on the *Internet* or *Intranets* for exchanging HTML documents. It normally uses *port* 80.

Hub

A device which allows communication between several network users via *twisted pair* cable.
Similar to a *repeater*, but with many outputs, a hub is used to form a star topology.

Hypertext

Document format used by *HTTP*. Hypertext documents are text files which allow links to other text documents via particularly highlighted keywords.

I

IAONA Europe

IAONA Europe (Industrial Automation Open Networking Alliance) is an organization for industrial network technology with the objective to establish ETHERNET in automation technology.
Further information on this subject is available on the Internet under: www.iaona-eu.com.

ICMP protocol

TA protocol for the transmission of status information and error messages of the *IP*, *TCP* and *UDP* protocols between IP network nodes. ICMP offers, among others, the possibility of an echo (ping) request to determine whether a destination is available and is responding.

IEC 61131-3

International standard published in 1993 for modern systems with PLC functionality. Based on a structured software model, it defines a number of high performance programming languages that can be used for various automation tasks.

IEEE

Institute of Electrical and Electronic Engineers.

IEEE 802.3

IEEE 802.3 is a IEEE standard. ETHERNET only supports the yellow cable as a medium. IEEE 802.3 also supports *S-UTP* and wideband coaxial cable. The segment lengths range from 500 m for yellow cable, 100 m for TP and 1800 m for wideband coaxial cable. A star or a bus topology is possible. ETHERNET (IEEE 802.3) uses *CSMA/CD* as a channel access method.

Intel format

Set configuration of the fieldbus coupler / controller to establish the process image. In the coupler/controller memory, the module data is aligned in different ways, depending on the set configuration (Intel/Motorola-Format, *word-alignment*,...). The format determines whether or not high and low bytes are changed over. They are not changed over with the Intel format.

Internet

A collection of networks interconnected to each other throughout the world. Its most well known area is the *World Wide Web*.

Intranet

A network concept with private network connections over which data can be exchanged within a company.

IP

Internet Protocol. The connectionless network layer, which relies on upper protocols to provide reliability.

ISA

Industry Standard Architecture. Offers a standard interface for the data exchange between CPU and periphery.

ISO/OSI reference model

Reference model of the ISO/OSI for networks with the objective of creating open communication. It defines the interface standards of the respective software and hardware requirements between computer manufacturers. The model treats communication removed from specific implementations, using seven layers.

L

LAN

Local Area Network.

Library

Compilation of modules available to the programmer in the programming tool **WAGO-I/O-*PRO 32*** for the creation of a control program according to IEC 61131-3.

M

Manchester encoding

In this encoding system, a 1 is encoded as a transition from *low* to *high* and a 0 as a transition from *high* to *low*.

Modules

Functions, function blocks and programs are modules.
Each module has a declaration part and a body, the latter being written in one of the IEC programming languages IL (instruction list), ST (structured text), SFC (sequential flow), FBD (function block diagram) or LD (ladder diagram).

MS-DOS

Operating system, which allows all applications direct access to the hardware.

O

Open MODBUS/TCP specification

Specification which establishes the specific structure of a MODBUS/TCP data packet. This is dependent upon the selected function code or from the selected function (readin/readout bit or register).

Operating system

Software which links the application programs to the hardware.

P

Ping command

When a ping command (ping <IP address>) is entered, the ping program *ICMP* generates echo *request* packets. It is used to test whether a node is available.

Port number

The port number, together with the IP address, forms an unambiguous connection point between two processes (applications).

Predictable ETHERNET

The delay time of a message on an ETHERNET network can be predicted. The measures which have been taken in predictable ETHERNET make it virtually possible to realize realtime requirements.

Proxy gateway

A proxy gateway (or proxy *server*, too) allows systems which do not have direct access to the *Internet*, indirect access to the network. These can be systems which are excluded from direct access by a *firewall* for security reasons.

A proxy can filter out individual data packets between the Internet and a local network to increase security. Proxies are also used to limit access to particular servers.
In addition, proxy gateways can also have a cache function, in which case they check whether the respective *URL* address is already available locally and return it immediately, if necessary. This saves time and costs when there are multiple accesses. If the URL is not in the cache, the proxy forwards the *request* as normal.
The user should not notice the proxy *gateway* apart from the single configuration in the *web browser*. Most web browsers can be configured so that they use different or no proxy gateways per access method (*FTP*, *HTTP*).

R

Repeater

Repeaters are physical amplifiers without their own processing function. They refresh data without detecting damaged data and forward all signals. Repeaters are used for longer transmission distances or when the maximum number of nodes of 64 devices per *twisted pair* segment is exceeded. A request from a client to server is a provision to act on a serivce or funtion call.

Request

A service request from a client which requests the provision of a service from a server.

Response

The server's reply to a client's request.

RFC specifications

Specifications, suggestions, ideas and guidelines regarding the *Internet* are published in the form of RFCs (Request For Comments).

RJ45 connector

Also referred to as a Western connector. This connector allows the connection of two network controllers via *twisted pair* cables.

Router

Connects neighboring *subnets*, the router operating with addresses and protocols of the third *ISO/OSI* layer. As this layer is hardware independent, the routers allow transition to another transmission medium.
To transmit a message the router evaluates the logical address (source and destination address) and finds the best path if there are several possibilities. Routers can be operated as *repeaters* or *bridges*.

Routing

Method of selecting the best path over which to send data to a distant network.

S

SCADA

Abbreviation for Supervisory Control and Data Acquisition. SCADA software is a program for the control and visualization of processes.

Segment

Typically, a network is divided up into different physical network segments by way of *routers* or *repeaters*.

Server

Device providing services within a client/server system. The service is requested by the *Client*.

Service

An operation targeted at an object (read, write).

Socket

Is a software interface introduced with BSD-UNIX for inter-process communication. Sockets are also possible in the network via TCP/IP. As from Windows 3.11, they are also available in Microsoft operating systems.

Structured cabling

This specifies the maximum permissible cable lengths (EIA/TIA 568, IS 11801) and gives recommendations for the different types topology for ground area, building and floor cabling.

Subnet

A portion of a network that shares the same network address as the other portions. These subnets are distinguished through the subnet mask.

Subnet mask

The subnet mask can be used to manipulate the address areas in the IP address room with reference to the number of *subnets* and *subscribers*. A standard subnet mask is, for example, 255.255.255.0.

S-UTP

Screened unshielded *twisted pair* cable which only has one external shield. However, the twisted pair cables are not shielded from each other.

Switch

Switches are comparable to *bridges*, but with several outputs. Each output uses the full ETHERNET bandwidth. A switch switches a virtual connection between an input port and an output port for data transmission. Switches learn which nodes are connected and filter the information transmitted over the network accordingly. Switches are inteligent devices that learn the node connections and can transfer data at the switch and not have to send it back to the main server.

Switched ETHERNET

The segments of this type of ETHERNET are connected by *switches*. There are many applications for switching technologies. ETHERNET switching is becoming increasingly popular in local networks as it allows the realization of a *deterministic ETHERNET*.

T

TCP

Transport Control Protocol.

TCP/IP protocol stack

Network protocols which allow communication between different networks and technologies.

Telnet

The Telnet protocol fulfils the function of a virtual terminal. It allows remote access from the user's computer to other computer systems on the network.

Twisted pair

Twisted pair cables (abbreviated to TP).

U

UDP protocol

The user datagram protocol is a transport protocol (layer 4) of the *ISO/OSI-reference model* which supports data exchange between computers without a connection. UDP runs directly on top of the underlying *IP* protocol.

URL

Abbreviation for uniform resource locator.
Address form for *Internet* files which are mostly applied within the World Wide Web (*WWW*). The URL format makes the unambiguous designation of all documents on the Internet possible by describing the address of a document or object which can be read by a *web browser*. URL includes the transmission type (http, ftp, news etc.), the computer which contains the information and the path on the computer. URL has the following format:
Document type//Computer name/List of contents/File name.

W

WAGO-I/O-*PRO* 32

Uniform programming environment, programming tool from WAGO Kontakttechnik GmbH for the creation of a control program according to IEC 61131-3 for all programmable fieldbus controllers. Allows testing, debugging and the start-up of a program.

Web browser

Program for reading *hypertext*. The browser allows the various documents to be viewed in hypertext and navigation between documents.

Wide band

Transmission technology which operates with a high bandwidth, thereby permitting high transmission rates. This allows several devices to transmit simultaneously.
Opposite: Baseband.

Word-alignment

Set configuration of the fieldbus coupler/controller for the creation of a process image. Word-alignment is used to establish the process image word-by-word (2 bytes).

World Wide Web

HTTP server on the Internet.

10 Literature list

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