WAGO I/O SYSTEM 750

Fieldbus Independent I/O Modules

2 AI RTD EEx i 750-481/003-000

Manual

Version 1.0.3

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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We wish to point out that the software and hardware terms as well as the trademarks of companies used and/or mentioned in the present manual are generally trademark or patent protected.

CONTENT

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 explanations are carefully read and abided by.

1.1 Legal Principles

1.1.1 Copyright

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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 & Co. KG 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 permitted 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 & Co. KG.

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

1.2 Symbols

Danger
Always abide by this information to protect persons from injury.

Warning
Always abide by 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 on additional literature, manuals, data sheets and INTERNET pages

1.3 Number Notation

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

1.4 Safety Notes

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

In the event of deformed contacts, the module in question is to be replaced, as its functionality can no longer be ensured on a long-term basis.

The components are not resistant against materials having seeping and insulating properties. Belonging to this group of materials is: e.g. aerosols, silicones, triglycerides (found in some hand creams).

If it cannot be ruled out that these materials appear in the component environment, then additional measures are to be taken:
- installation of the components into an appropriate enclosure
- handling of the components only with clean tools and materials.

Attention
Cleaning of soiled contacts may only be done with ethyl alcohol and leather cloths. Thereby, the ESD information is to be regarded.

Do not use any contact spray. The spray may impair the functioning of the contact area.

The WAGO-I/O-SYSTEM 750 and its components are an open system. It must only be assembled in housings, cabinets or in electrical operation rooms. Access must only be given via a key or tool to authorized qualified personnel.

The relevant valid and applicable standards and guidelines concerning the installation of switch boxes are to be observed.

ESD (Electrostatic Discharge)
The modules are equipped with electronic components that 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.

1.5 Scope

This manual describes the Analog Input Module 750-481/003-000
2 AI RTD EEx i of the modular WAGO-I/O-SYSTEM 750.

Handling, assembly and start-up are described in the manual of the Fieldbus Coupler. Therefore this documentation is valid only in the connection with the appropriate manual.

2 I/O Modules

2.1 Analog Input Modules

2.1.1 750-481/003-000 [2 AI RTD EEx i]

2-Channel Analog Input Module for RTDs, EEx i

2.1.1.1 View

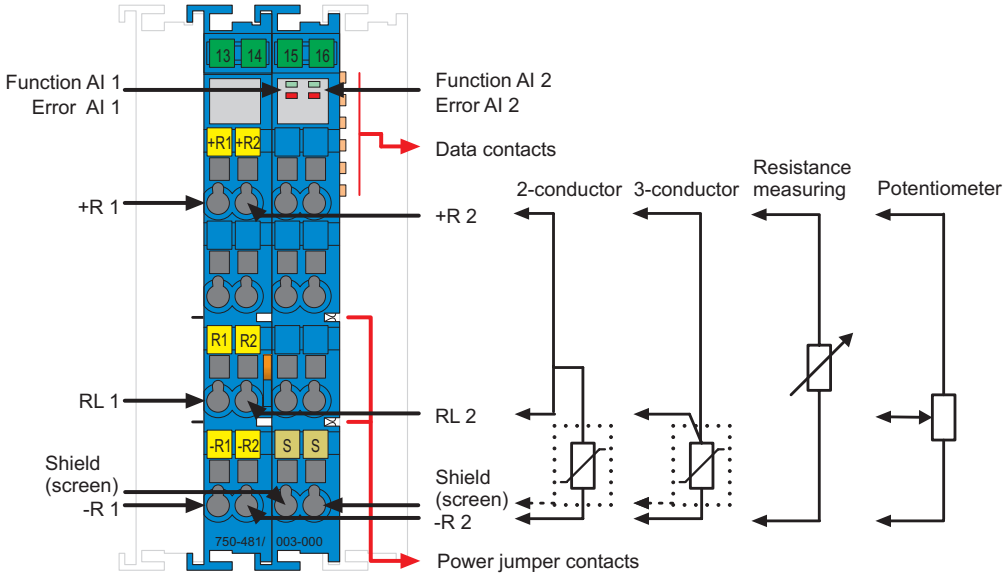


Fig. 2.1.1-1: 2-Channel Analog Input Module 750-481/003-000 g048100e

2.1.1.2 Description

The 750-481/003-000 analog input module processes signals from resistance sensors that are operating in hazardous environments of Zones 0 and 1. It allows the connection of Pt and Ni resistance sensors potentiometers.

The installation of the WAGO-I/O-SYSTEM 750 is to be done in Zone 2 or in non- hazardous environments.

The operating mode of the 750-481/003-000 can be set by using the **WAGO-I/O-*CHECK* 2** start-up and diagnostic tool (Item No.: 759-302). The default setting is Pt 100.

Depending on the operating mode, the resistance value is converted to a temperature or directly sent out by the module. A microprocessor within the module is used for converting and linearizing the measured resistance value into a numeric value proportional to the temperature of the selected resistance sensor.

The module has two input channels allowing the direct connection of two 2- or 3-wire resistance sensors.
For example, two 3-wire sensors can be connected either to +R1, RL1 and –R1 or to +R2, RL2 and –R2.

The 24 V power supply is made via the power jumper contacts.

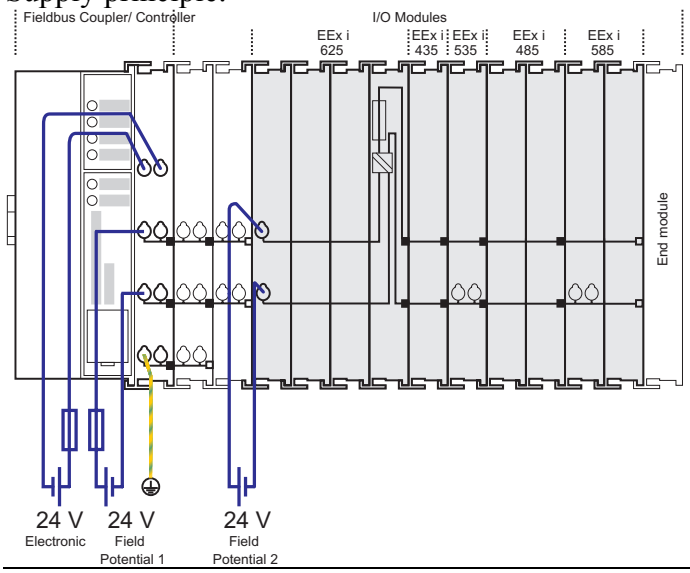
Each input channel of a module has a shield (screen) connection (S). The shield (screen) is directly connected to the DIN rail. A capacitive connection is made automatically when snapped onto the DIN rail.

An optocoupler is used for electrical isolation between the bus and the field side.

The operational readiness and trouble-free internal data bus communication of the channels are indicated via a green Function LED. Broken wire, short circuit, overrange or underflow of the measuring range is indicated via a red error LED.

Any configuration of the input modules is possible within an intrinsically safe segment when designing the fieldbus node. Grouping of module types is not necessary.

Attention
An additional supply module 750-625, DC 24 V EEx i must be added for the approved intrinsically safe field side supply voltage of 24 V.
Supply principle:



The supply voltage for the field side is made automatically through the individual I/O modules by means of power jumper contacts.

Note
If the employment of further DC 24 V EEx i Supply modules is necessary for reasons of extent of utilization, four Separation modules (750-616) must be used to guarantee the distance between the intrinsically safe segments.

Warning
The maximum current of the internal power jumper contacts is 10 A. When configuring the system it is important not to exceed the maximum/sum current. However, if such a case should occur, another supply module must be added.

The analog input module 750-481/003-000 can be used with all couplers/controllers of the WAGO-I/O-SYSTEM 750 (except for the economy types 750-320, -323, -324 and -327).

Further Information
General information on explosion prevention is described in the manual in section “Use in Hazardous Environments“!

2.1.1.3 Display Elements

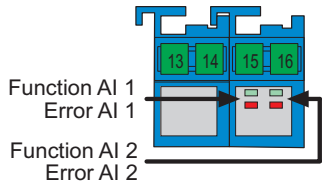


Fig. 2.1.1-2: Display Elements g048102d

LED	Channel	Meaning	State	Function
green	1	Function AI 1	off	No operational readiness or the internal data bus communication is interrupted
			on	Operational readiness and trouble-free internal data bus communication
red		Error AI 1	off	Normal operation
			on	Overrange/underflow of the admissible measuring range, broken wire, short circuit
green	2	Function AI 2	off	No operational readiness or the internal data bus communication is interrupted
			on	Operational readiness and trouble-free internal data bus communication
red		Error AI 2	off	Normal operation
			on	Overrange/underflow of the admissible measuring range, broken wire, short circuit

2.1.1.4 Schematic Diagram

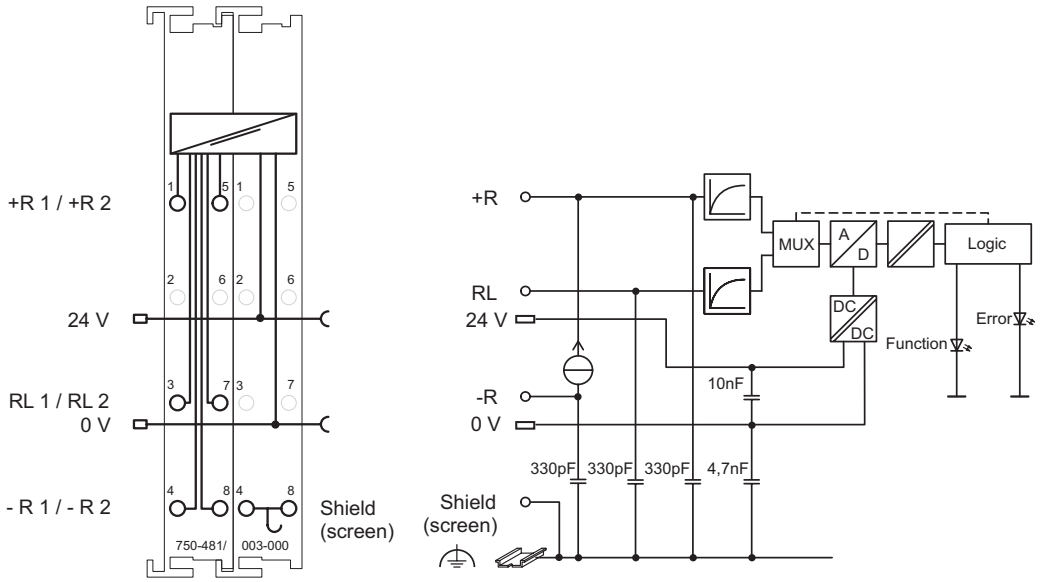


Fig. 2.1.1-3: 2-Channel Analog Input Module 750-481/003-000 g048101e

2.1.1.5 Technical Data

Module Specific Data		
Number of inputs	2	
Voltage via power jumper contacts	DC 24.7 V Supply via 750-625 Supply Module EEx i	
Current consumption $_{typ.}$ (internal)	25 mA	
Current consumption $_{typ.}$ (24 V)	12 mA	
Measuring current	< 0.5 mA	
Sensor types (setting over software **WAGO-I/O-*CHECK* 2**)	Resistance temperature: Pt 100 (factory preset), Pt 200, Pt 500, Pt 1000, Ni 100, Ni 120, Ni 1000 Resistance measuring: 1,2 kΩ, 5 kΩ Potentiometer: 1.2 kΩ (0 ... 100 %), 5 kΩ (0 ... 100 %)	
Sensor connection	3-wire (factory preset) or 2-wire	
Temperature range	-200 °C ... +850 °C (Pt) -60 °C ... + 250 °C (Ni) -80 °C ... +320 °C (Ni120)	
Resolution (over whole range)	0.1 °C, 0.1 Ω, 0.0049 %	
Resolution	150 ms ... 500 ms per channel	
Measuring error $_{25°C}$	<± 0.2 % of full scale value	
Temperature coefficient	<± 0.01 % /K of full scale value	
Power consumption $_{Pmax.}$	0.45 W	
Power loss $_{P v}$	0.45 W	
Isolation	500 V (Field/System)	
Bit width	2 x 16 bits data 2 x 8 bits control/status (option)	
Dimensions (mm) W x H x L	24 x 64* x 100 * from upper edge of 35 DIN rail	
Weight	ca. 105 g	
Standards and Regulations (cf. Chapter 2.2 of the Coupler/Controller Manual)		
EMC-Immunity to interference (CE)	acc. to EN 61000-6-2 (99)	
EMC-Emission of interference (CE)	acc. to EN 61000-6-4 (02)	
EC-EMV directive	89/336/EEC	
EC low voltage directive	73/23/EEC	
Approvals (cf. Chapter 2.2 of the Coupler/Controller Manual)		
cULus	$_{C}UL_{US}$ (UL508)	
TÜV	02ATEX1875 X	
CE	Conformity Marking	

Explosion Protection					
Ex directive	94/9/EC EN 50014, EN 50020, EN 50021				
Marking	II 3 (1) GD EEx nA [ia] IIC/IIB T4				
Safety data	U_0 = 7.2 V I_0 = 5.8 mA P_0 = 10.5 mW Line characteristic: linear				
Reactance without consideration of the simultaneousness	EEx ia IIC			EEx ia IIB	
	L_0	C_0		L_0	C_0
	0.9 H	13.5 µF		1 H	240 µF
Reactance with consideration of the simultaneousness	IIC			IIB	
	L_0	C_0		L_0	C_0
	≤ 0.01 mH	7.40 µF		≤ 0.01 mH	60.0 µF
	0.2 mH	2.60 µF		0.2 mH	15.0 µF
	1.0 mH	1.80 µF		1.0 mH	9.7 µF
	10.0 mH	1.20 µF		10.0 mH	6.3 µF
	100.0 mH	0.97 µF		100.0 mH	4.8 µF

More Information
Detailed references to the approvals are listed in the document "Overview Approvals WAGO-I/O-SYSTEM 750", which you can find on the CD ROM ELECTRONICC Tools and Docs (Item-No.: 0888-0412)
or in the internet under:
www.wago.com → Documentation → WAGO-I/O-SYSTEM 750 → System Description

2.1.1.6 Process Image

The input module 750-481/003-000 transmits 16-bit measured values and 8 optional status bits per channel.

Some fieldbus systems can process input channel status information by means of a status byte.
This status byte can be displayed via the starting tool WAGO-I/O-CHECK 2. However, processing via the coupler / controller is optional, which means that accessing or parsing the status information depends on the fieldbus system.

Attention
The representation of the process data of some I/O modules or their variations in the process image depends on the fieldbus coupler/-controller used. Please take this information as well as the particular design of the respective control/status bytes from the section "Fieldbus Specific Design of the Process Data" included in the description concerning the process image of the corresponding coupler/controller.

2.1.1.6.1 Configuration for Pt Resistance Sensors

Pt resistance sensors
Evaluation of Pt 100 (Measuring range: -200 °C ... +850 °C)
Evaluation of Pt 200 (Measuring range: -200 °C ... +850 °C)
Evaluation of Pt 500 (Measuring range: -200 °C ... +850 °C)
Evaluation of Pt 1000 (Measuring range: -200 °C ... +850 °C)

To evaluate the platinum resistance sensors, the measured values of the resistance are converted and sent as temperature values.
All temperature values are represented in a standard numeric format. The possible numerical range matches the defined temperature range of the Pt sensors from -200 °C to +850 °C..

In the Pt 100, Pt 200, Pt 500 and Pt 1000 settings, the temperature values of the sensors are represented with a resolution of 1 digit per 0.1 °C within a word (16 bits). Thus, 0 °C corresponds to the numeric value 0x0000 and 100 °C to 0x03E8 (dec. 1000).
Temperature values below 0 °C are represented in two’s complement binary form.

Configuration for Pt 100, Pt 200, Pt 500 and Pt 1000					
Temperature °C	Numerical value [1] binary	hex.	dec.	Status-byte hex.	LED Error AI 1, 2
<-200.0	'1000.0000.0000.0001'	0x8001	-32767	0x41	on
-200.0	'1111.1000.0011.0000'	0xF830	-2000	0x00	off
-100.0	'1111.1100.0001.1000'	0xFC18	-1000	0x00	off
0.0	'0000.0000.0000.0000'	0x0000	0	0x00	off
100.0	'0000.0011.1110.1000'	0x03E8	1000	0x00	off
200.0	'0000.0111.1101.0000'	0x07D0	2000	0x00	off
500.0	'0001.0011.1000.1000'	0x1388	5000	0x00	off
750.0	'0001.1101.0100.1100'	0x1D4C	7500	0x00	off
800.0	'0001.1111.0100.0000'	0x1F40	8000	0x00	off
850.0	'0010.0001.0011.0100'	0x2134	8500	0x00	off
>850.0	'0010.0001.0011.0100'	0x2134	8500	0x42	on
Broken wire against R_L	'0010.0001.0011.0100'	0x2134	8500	0x42	on

[1] Temperature values below 0 °C are represented in two's complement binary form.

The measured value can exceed the range from –2000 to 8500 until the limitation applies.

2.1.1.6.2 Configuration for Ni Resistance Sensors

Ni resistance sensors
Evaluation of Ni 100 (Measuring range: -60 °C ... +250 °C)
Evaluation of Ni 120 (Measuring range: -80 °C ... +320 °C)
Evaluation of Ni 1000 (Measuring range: -60 °C ... +250 °C)

To evaluate the nickel resistance sensors, the measured values of the resistance are converted and sent as temperature values.
All temperature values are represented in a standard numeric format. The possible numerical range matches the defined temperature range of the Ni sensors from -60 °C to +250 °C or from -80 °C to +320 °C.

In the Ni 100, Ni 120 and Ni 1000 settings, the temperature values of the sensors are represented with a resolution of 1 digit per 0.1 °C within a word (16 bits). Thus, 0 °C corresponds to the numeric value 0x0000 and 100 °C to 0x03E8 (dec. 1000).
Temperature values below 0 °C are represented in two's complement binary form.

Configuration for Ni 100 and Ni 1000					
Temperature °C	Numerical value [1] binary	hex.	dec.	Status-byte hex.	LED Error AI 1,2
<-60.0	'1000.0000.0000.0001'	0x8001	-32767	0x41	on
-60.0	'1111.1101.1010.1000'	0xFDA8	-600	0x00	off
-50.0	'1111.1110.0000.1100'	0xFE0C	-500	0x00	off
0.0	'0000.0000.0000.0000'	0x0000	0	0x00	off
50.0	'0000.0001.1111.0100'	0x01F4	500	0x00	off
100.0	'0000.0011.1110.1000'	0x03E8	1000	0x00	off
150.0	'0000.0101.1101.1100'	0x05DC	1500	0x00	off
200.0	'0000.0111.1101.0000'	0x07D0	2000	0x00	off
250.0	'0000.1001.1100.0100'	0x09C4	2500	0x00	off
>250.0	'0010.0001.0011.0100'	0x2134	8500	0x42	on
Broken wire against R_L	'0010.0001.0011.0100'	0x2134	8500	0x42	on

[1] Temperature values below 0 °C are represented in two's complement binary form.

The measured value can exceed the range from –600 to 2500 until the limitation applies.

Configuration for Ni 120					
Temperature °C	Numerical value [1] binary	hex.	dec.	Status-byte hex.	LED Error AI 1,2
<-80.0	'1000.0000.0000.0001'	0x8001	-32767	0x41	on
-80.0	'1111.1100.1110.0000'	0xFCE0	-800	0x00	off
-50.0	'1111.1110.0000.1100'	0xFE0C	-500	0x00	off
0.0	'0000.0000.0000.0000'	0x0000	0	0x00	off
50.0	'0000.0001.1111.0100'	0x01F4	500	0x00	off
100.0	'0000.0011.1110.1000'	0x03E8	1000	0x00	off
150.0	'0000.0101.1101.1100'	0x05DC	1500	0x00	off
200.0	'0000.0111.1101.0000'	0x07D0	2000	0x00	off
250.0	'0000.1001.1100.0100'	0x09C4	2500	0x00	off
300.0	'0000.1011.1011.1000'	0x0BB8	3000	0x00	off
320.0	'0000.1100.1000.0000'	0x0C80	3200	0x00	off
>320.0	'0010.0001.0011.0100'	0x2134	8500	0x42	on
Broken wire against R_L	'0010.0001.0011.0100'	0x2134	8500	0x42	on

[1] Temperature values below 0 °C are represented in two's complement binary form.

The measured value can exceed the range from –800 to 3200 until the limitation applies.

2.1.1.6.3 Configuration for Resistance Measuring

Resistance measuring
Resistance measuring, Measuring range: 10 Ω ... 1.2 kΩ
Resistance measuring, Measuring range: 10 Ω ... 5.0 kΩ

Resistance measuring is only possible using 2-wire devices.

The measured values are sent out directly when measuring the resistance.

In the measuring range from 10 Ω to 1.2 kΩ, the resolution is 1 digit per 0.1 Ω.
In the measuring range from 10 Ω to 5.0 kΩ, the resolution is 1 digit per 0.5 Ω.

Configuration for measuring range 10 Ω ... 1.2 kΩ					
Resistance Ω	Numerical value [1)] binary	hex.	dec.	Status-byte hex.	LED Error AI 1,2
0	'1110.1100.0000.0000'	0xEC00	-5120	0x00	off
10	'0000.0000.0110.0100'	0x0064	100	0x00	off
100	'0000.0011.1110.1000'	0x03E8	1000	0x00	off
200	'0000.0111.1101.0000'	0x07D0	2000	0x00	off
300	'0000.1011.1011.1000'	0x0BB8	3000	0x00	off
400	'0000.1111.1010.0000'	0x0FA0	4000	0x00	off
500	'0001.0011.1000.1000'	0x1388	5000	0x00	off
750	'0001.1101.0100.1100'	0x1D4C	7500	0x00	off
1000	'0010.0111.0001.0000'	0x2710	10000	0x00	off
1200	'0010.1110.1110.0000'	0x2EE0	12000	0x00	off
>ca.1200	'0010.0001.0011.0100'	0x2134	8500	0x42	on

Values marked with "ca." are not calibrated.

Configuration for measuring range 10 Ω ... 5 kΩ					
Resistance Ω	Numerical value [1)] binary	hex.	dec.	Status-byte hex.	LED Error binary
0	'1110.1100.0000.0000'	0xEC00	-5120	0x00	off
10	'0000.0000.0001.0100'	0x0014	20	0x00	off
100	'0000.0000.1100.1000'	0x00C8	200	0x00	off
200	'0000.0001.1001.0000'	0x0190	400	0x00	off
300	'0000.0010.0101.1000'	0x0258	600	0x00	off
1000	'0000.0111.1101.0000'	0x07D0	2000	0x00	off
2000	'0000.1111.1010.0000'	0x0FA0	4000	0x00	off
3000	'0001.0111.0111.0000'	0x1770	6000	0x00	off
4000	'0001.1111.0100.0000'	0x1F40	8000	0x00	off
5000	'0010.0111.0001.0000'	0x2710	10000	0x00	off
>ca.5000	'0010.0111.0001.0000'	0x2710	10000	0x42	on

Values marked with "ca." are not calibrated.

2.1.1.6.4 Configuration for Potentiometer Measuring

Potentiometer measuring
Total resistance 1.2 kΩ, Output of measured value in percent
Total resistance 5.0 kΩ, Output of measured value in percent

Potentiometer measuring is only possible using 3-wire devices.

When a potentiometer is used for measurement, the relative position of the connected potentiometer is expressed in percent:

$$x = 100\ \% * \frac{R_{slider}\ (R_S)}{R_{total}\ (R_G)}.$$

Two settings are available, one for potentiometers with total resistance up to 1.2 kΩ and one for potentiometers up to 5.0 kΩ.

The resolution is 1 digit per 0.0049 %. The increment is determined by the total resistance R_G of the potentiometer.
As R_G is measured with 16 bit resolution, using R_G = 200 Ω in the measuring range of 5.0 kΩ, the increment is given by

$$d = \frac{100\ \% * 5.0\ k\Omega}{65536 * 200\ \Omega} = 0.04\ \%.$$

Configuration for potentiometer measuring					
Percentage %	Numerical value [1)] binary	hex.	dec.	Status-byte hex.	LED Error AI 1,2
0.0	'0000.0000.0000.0000'	0x0000	0	0x00	off
20.0	'0000.0111.1101.0000'	0x1000	4096	0x00	off
40.0	'0000.1111.1010.0000'	0x2000	8192	0x00	off
60.0	'0001.0111.0111.0000'	0x3000	12288	0x00	off
80.0	'0001.1111.0100.0000'	0x4000	16384	0x00	off
100.0	'0010.0111.0001.0000'	0x4FFF	20479	0x00	off
>ca. 100.0	'0010.0111.0001.0000'	0x4FFF	20479	0x40	on

Values marked with "ca." are not calibrated.

2.1.1.7 Configuration with WAGO-I/O-*CHECK* 2

The operating mode of the 750-481/003-000 module can be parameterized using the **WAGO-I/O-*CHECK* 2** start-up and diagnostic tool (Item No.: 759-302). The default setting is Pt 100.

The parameter dialog box of **WAGO-I/O-*CHECK* 2** contains select boxes that are used to set this module.

Select box	Available settings	
RTD Type	Pt100 (-200 °C – 850 °C)* / Ni100 (-60 °C – 250 °C) / Pt1000 (-200 °C – 850 °C) / Pt500 (-200 °C – 850 °C) / Pt200 (-200 °C – 850 °C) / Ni1000 (-80 °C – 320 °C) / Ni120 (-80 °C – 320 °C) / Ohm (10.0 Ω – 5000.0 Ω) / Ohm (10.0 Ω – 1200.0 Ω)	
Connection	2-wire	Two-wire connection
	3-wire*	Three-wire connection
State Bits	OFF*	State bits are not mapped
	ON	State bits are mapped to the lower three bits of the output value: Bit 0:overrun. Bit is set if measuring value runs out of range. Bit 1:error. Bit is set if the module detects an error in internal functions or a shortcut at the input. Bit 2: 0
Watchdog Timer	OFF	Watchdog timer not active
	ON*	Watchdog timer active. If no data are exchanged with the buscoupler for 100 ms, the green LEDs will turn off.
Amount Sign	OFF*	Two´s complement indication
	ON	Amount/Sign indication
Filter Constants	12.5 Hz – 500 ms / 25 Hz – 250 ms* / 50 Hz – 125 ms / 60 Hz – 110 ms / 100 Hz – 65 ms	
Overrange Protection	OFF	The output value is not limited
	ON*	If the temperature exceeds 850°C, the status bits are set and the output value is limited to 850°C
User Scaling	OFF*	User scaling not active
	ON	User scaling active
WAGO Scaling	OFF	WAGO scaling not active
	ON*	WAGO scaling active

* default settings

In **WAGO-I/O-*CHECK* 2,** the following input boxes allow you to set the offset and gain values of the user and manufacturer scaling.

Input box	...	Offset	Gain
User Scaling	...	0x0000	0x0100
WAGO Scaling	...	0x0000	0x00A0

The following input boxes are available in **WAGO-I/O-*CHECK* 2** for hardware calibration.

Input box	Settings
Offset resistance	0xECF0
Gain resistance	0x2700
2-wire-offset	0x0180

Input box	Settings
Offset potentiometer	0xFFC0
Gain potentiometer	0xFE00

Further information
You can find detailed information on parameterizing this module in the **WAGO-I/O-*CHECK* 2** manual or on the Internet at www.wago.com.

3 Use in Hazardous Environments

3.1 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.

3.2 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.

3.3 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 Standardization). On an international scale, these are reflected by the IEC 60079-... standards of the IEC (International Electrotechnical Commission).

3.3.1 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).

3.3.2 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. This 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.

3.3.3 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

3.3.4 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 to 450 °C
T3	200 °C	> 200 °C to 300 °C
T4	135 °C	> 135 °C to 200 °C
T5	100 °C	>100 °C to 135 °C
T6	85°C	> 85 °C to 100 °C

The following table represents the division and attributes of the materials to the temperature classes and material groups in percent:

Temperature classes						
T1	T2	T3	T4	T5	T6	Total*
26.6 %	42.8 %	25.5 %				
94.9 %			4.9 %	0 %	0.2 %	432
Explosion group						
IIA	IIB	IIC				Total*
85.2 %	13.8 %	1.0 %				501

* Number of classified materials

3.3.5 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!

3.4 Classifications meeting the NEC 500

The following classifications according to NEC 500 (National Electric Code) are valid for North America.

3.4.1 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).

3.4.2 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

3.4.3 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 to 450 °C
T2A	280 °C	> 280 °C to 300 °C
T2B	260 °C	> 260 °C to 280 °C
T2C	230 °C	>230 °C to 260 °C
T2D	215 °C	>215 °C to 230 °C
T3	200 °C	>200 °C to 215 °C
T3A	180 °C	>180 °C to 200 °C
T3B	165 °C	>165 °C to 180 °C
T3C	160 °C	>160 °C to 165 °C
T4	135 °C	>135 °C to 160 °C
T4A	120 °C	>120 °C to 135 °C
T5	100 °C	>100 °C to 120 °C
T6	85 °C	> 85 °C to 100 °C

3.5 Identification

3.5.1 For Europe

According to CENELEC and IEC

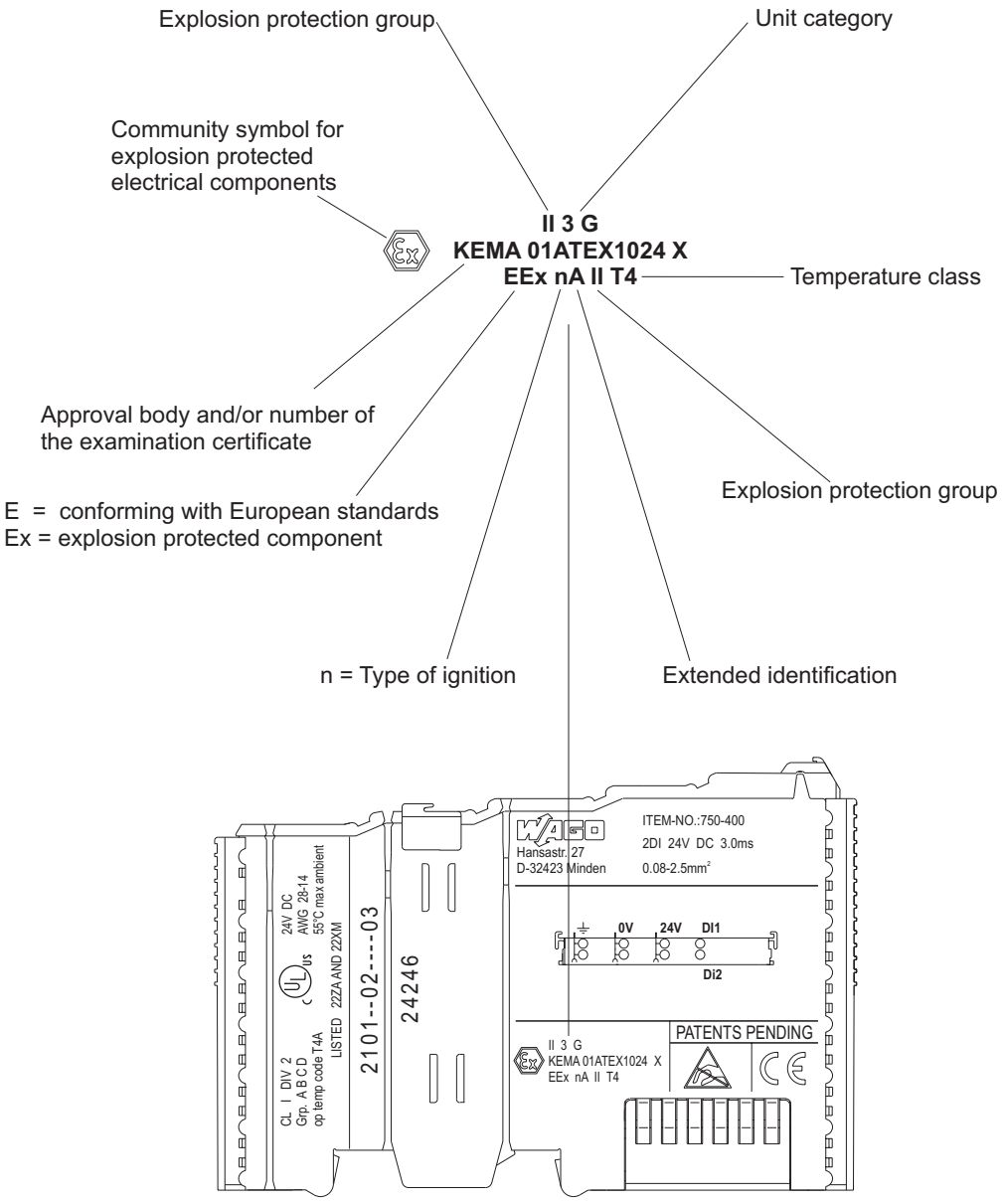


Fig. 3.5.1-1: Example for lateral labeling of bus modules
(750-400, 2 channel digital input module 24 V DC)

g01xx03e

3.5.2 For America

According to NEC 500

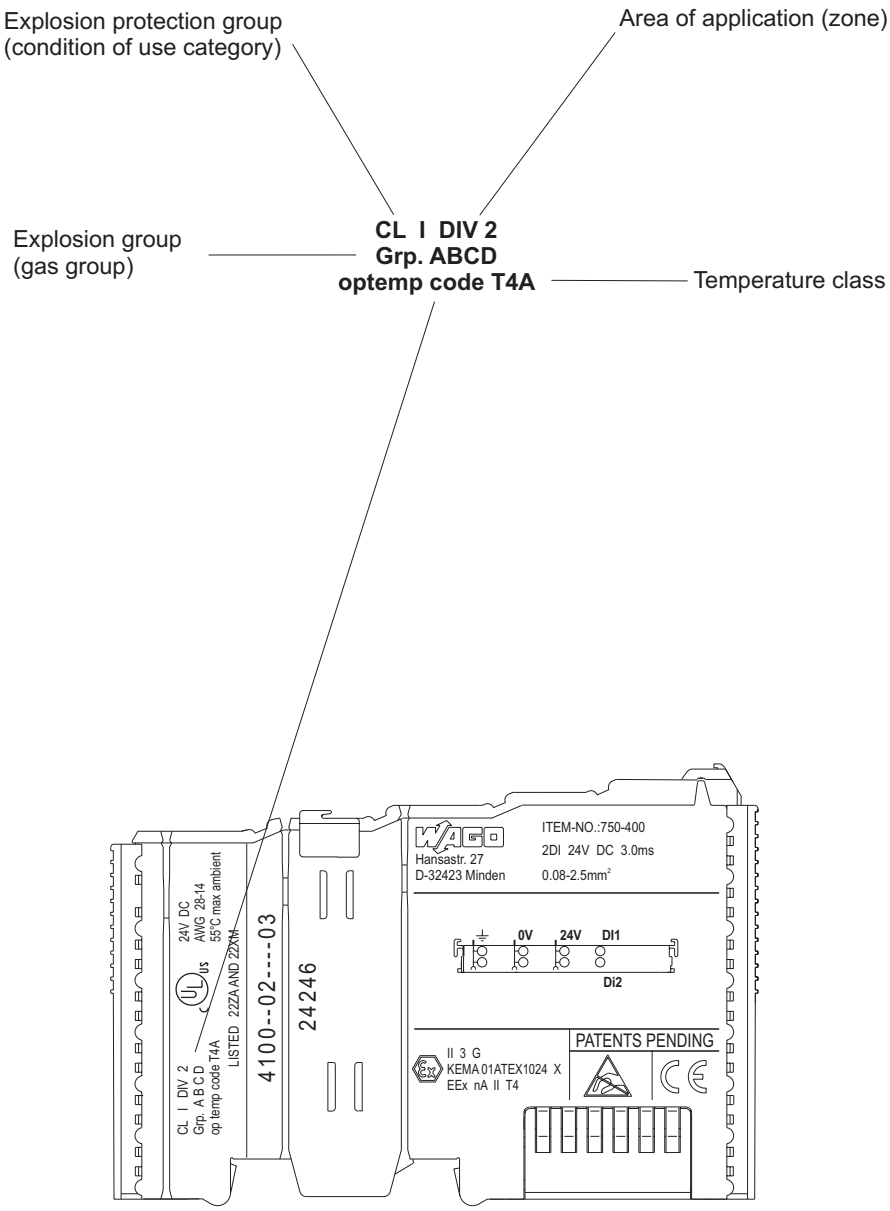


Fig. 3.5.2-1: Example for lateral labeling of bus modules
(750-400, 2 channel digital input module 24 V DC)

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3.6 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 telecommunication 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
When using the WAGO-I/O SYSTEM 750 (electrical operation) with Ex approval, the following points are mandatory:

A. The fieldbus independent I/O System Modules Type 750-xxx are to be installed in enclosures that provide for the degree of ingress protection of at least IP54.
For use in the presence of combustible dust, the above mentioned modules are to be installed in enclosures that provide for the degree of ingress protection of at least IP64.

B. The fieldbus independent I/O system may only be installed in hazardous areas (Europe: Group II, Zone 2 or America: Class I, Division 2, Group A, B, C, D) or in non-hazardous areas!

C. Installation, connection, addition, removal or replacement of modules, fieldbus connectors or fuses may only take place when the system supply and the field supply are switched off, or when the area is known to be non-hazardous.

D. Ensure that only approved modules of the electrical operating type will be used. The Substitution or Replacement of modules can jeopardize the suitability of the system in hazardous environments!

E. Operation of intrinsically safe EEx i modules with direct connection to sensors/actuators in hazardous areas of Zone 0 + 1 and Division 1 type requires the use of a 24 V DC Power Supply EEx i module!

F. DIP switches and potentiometers are only to be adjusted when the area is know to be non-hazardous.

Further Information
Proof of certification is available on request. Also take note of the information given on the module technical information sheet.

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