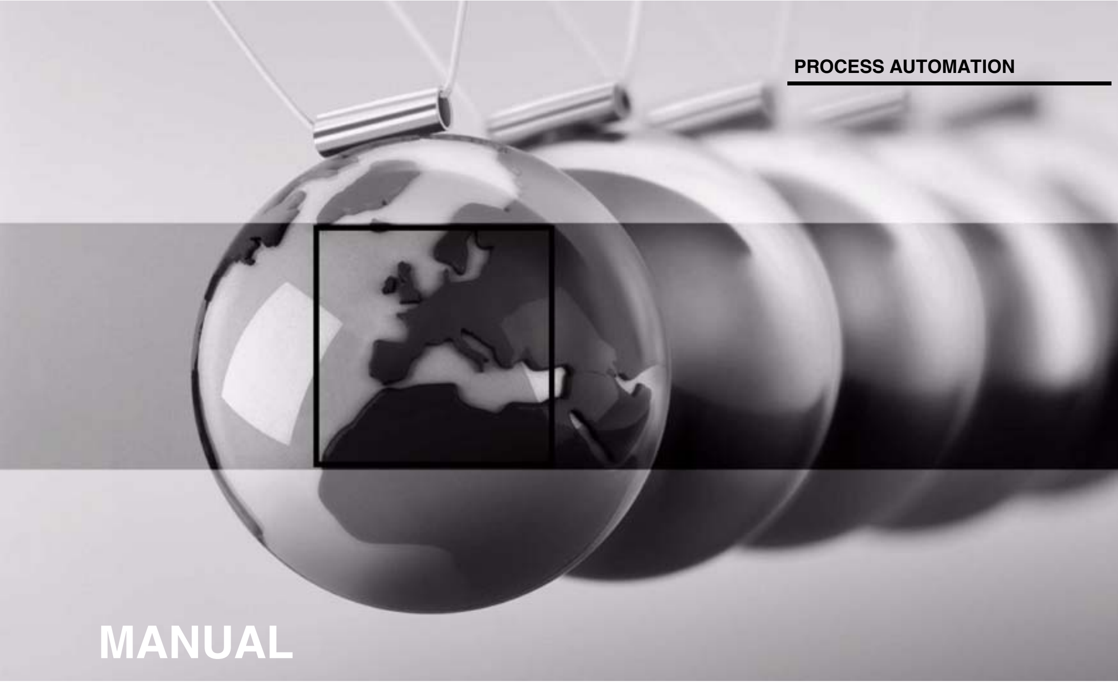
PROCESS AUTOMATION



MANUAL

Trip Amplifier

2/209

ISO9001

PEPPERL+FUCHS

PROTECTING YOUR PROCESS

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1 Safety information

Target group: experiences skilled electricians.

The trip amplifier must not be converted or altered in any way.

Attention

Device must be mounted outside hazardous areas.

Attention

When working on the trip amplifier always comply with national safety and accident prevention regulations and the safety information contained in this manual. Safety information is printed in italics like this paragraph and marked accordingly.

Screened cables are recommended for all wiring which leaves the building.

According to IEC 801-5 application class 0 analog inputs must not be subjected to high energy pulses. In all other respects the unit fulfils IEC 801 to the more stringent applications class 3.

Redundant analog inputs A and B should be fed from separate sources. The signals must not differ by more than 5 % since the sister channels are continuously compared with each other.

In safety applications front push buttons should not be incorporated in those parts of the program which are relevant to safety. Trip settings should not be changed during operation. Front push buttons can be locked by placing the jumper KEY in the LOCK position. The push buttons will then only be used to read values sequentially rather than alter them (protection against unauthorized changes).

Programs for safety applications should try and avoid conditional branches because this would simplify the final approval test considerably. This could then be restricted to a functional test concentrating on the reaction of outputs to input changes.

For safety applications relay outputs must be configured to be normally energized. After a power down the device will restart automatically. For safety applications it is therefore necessary to establish suitable external means to resume production in an orderly fashion.

The serial data link is not a safety related part of the circuitry.

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2 Technical data

2.1 Features

- 4-channel isolated barrier
- Input 0/4 mA ... 20 mA
- 4 relay contact outputs
- Programmable
- Simple operation via front buttons
- Lead monitoring
- Galvanic isolation between input, power supply and contact output
- With computational function SIL3
- LCD display
- Self-monitoring

2.2 Technical data

General specifications	
Signal type	analog input
Supply	
Connection	z2+, z4-, z6 (PE)
Rated voltage	18 ... 30 V DC, 18 ... 26.4 V AC 48 ... 62 Hz
Power consumption	2 W/2.5 VA
Input	
Connection	Input A I: d32+, z32- Input A II: d30+, z30- Input A III: d28+, z28- Input A IV: d26+, z26- Input B I: b32+, z32- Input B II:b30+, z30- Input B III: b28+, z28- Input B IV: b26+, z26-
Input resistance	50 Ω (mA) 10 kΩ (V)
Current range	0/4 ... 20 mA (0/1 ... 5 V)

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Output	
Connection	Output I: z10, d12, d10 Output II: d14, z14, z12 Output III: z16, d18, d16 Output IV: d20, z20, z18
Relay	
Switching voltage	50 V
Switching current	2 A AC/DC
Switch power	500 VA/60 W
Mechanical life	50 mio. cycles
Electrical lifetime	0.5 mio. cycles
Response time	> 20 ms (variable)
Transfer characteristics	
Temperature influence	< 0.1 %/10 K
Indicators/settings	
Display elements	LED 1: trip value 1 LED 2: trip value 2 LED 3: trip value 3 LED 4: trip value 4 LED green: Power on
Configuration	via RS 485 interface at the front side
Directive conformity	
Electromagnetic compatibility Directive 2004/108/EC	EN 61326-1:2006
Conformity	
Protection degree	IEC 60529
Ambient conditions	
Ambient temperature	-10 ... 60 °C (14 ... 140 °F)
Storage temperature	-25 ... 80 °C (-13 ... 176 °F)
Relative humidity	< 75 % (annual mean) < 95 % (30 d/year), no moisture condensation
Mechanical specifications	
Protection degree	IP20
Mass	300 g
Dimensions	22 x 143 x 193 mm (0.9 x 5.6 x 7.6 in)
Construction type	Eurocard 100 x 160 mm (3.9 x 6.3 in) acc. to DIN 41494, front panel 4TE, mountable in 19" rack

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2.3 Mounting

Attention

Devices must be mounted outside hazardous areas.

Fits 19" racks or DIN rail enclosures.

2.4 Options

Additional functions	basic functions like mathematics and logical operations are freely configurable.
Configuration	via RS 232 serial data link via commercial PCs or PC-like units such as SIEMENS PG 685, PG 730, PG770, PG 790 or MS-DOS PC.
Handling	Menu support to SAA standard.
Storage	Non volatile EEPROM storage. Function disable via jumpers.

2.5 Safety applications/certificates

SIL classification acc. to IEC 61508	SIL3, TÜV Rheinland, 968/EL 292-03/08

Attention

Device must be mounted outside hazardous areas.

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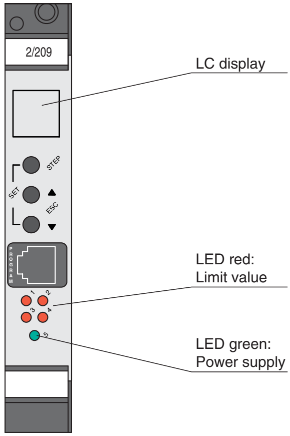
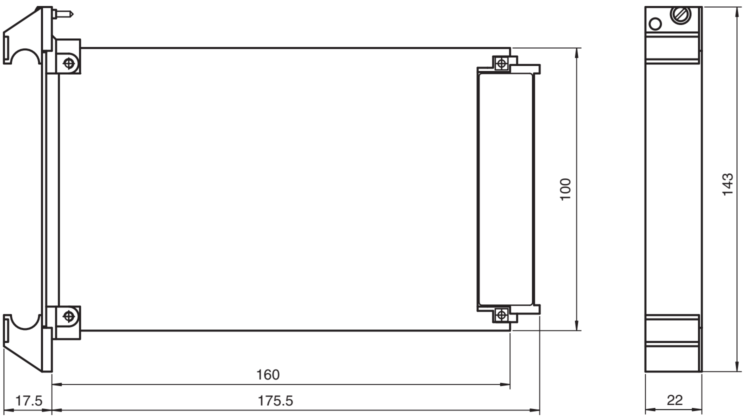
2.6 Front view



2.7 Dimensions



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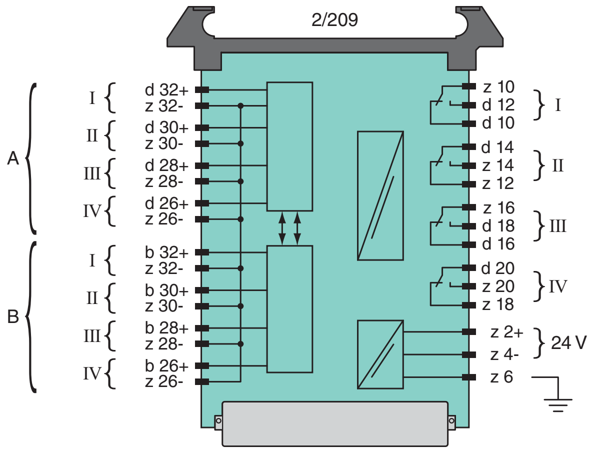
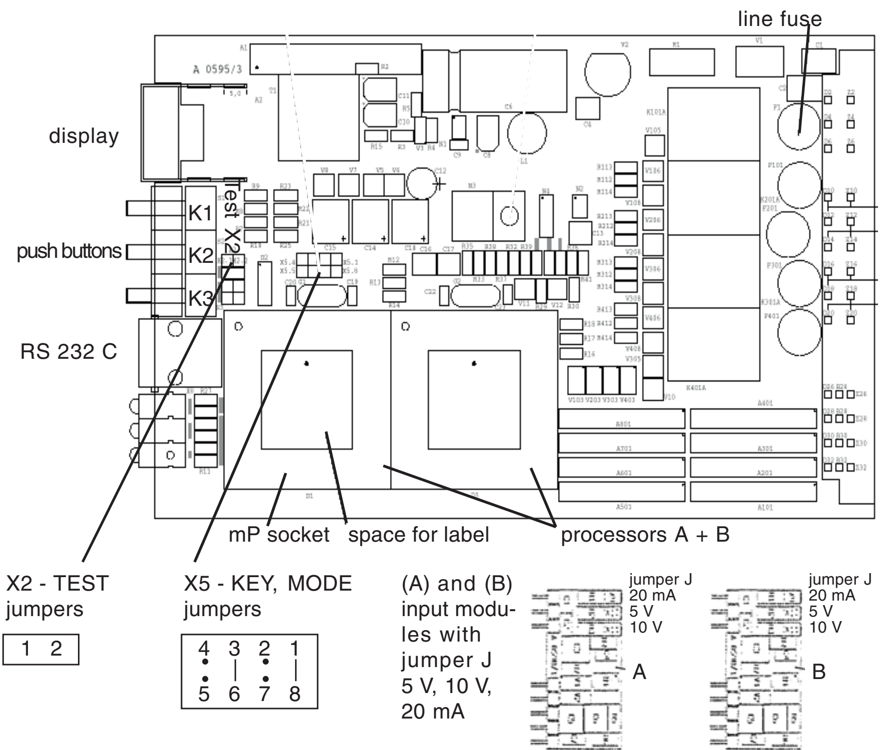
2.8 Connection



2.9 Device layout



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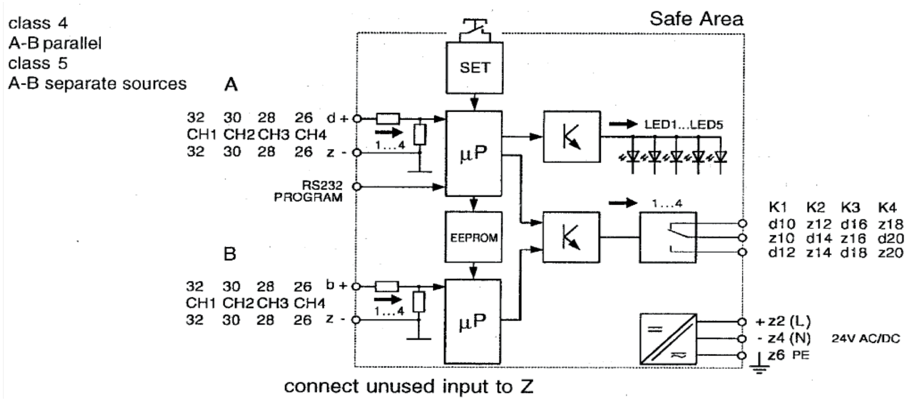
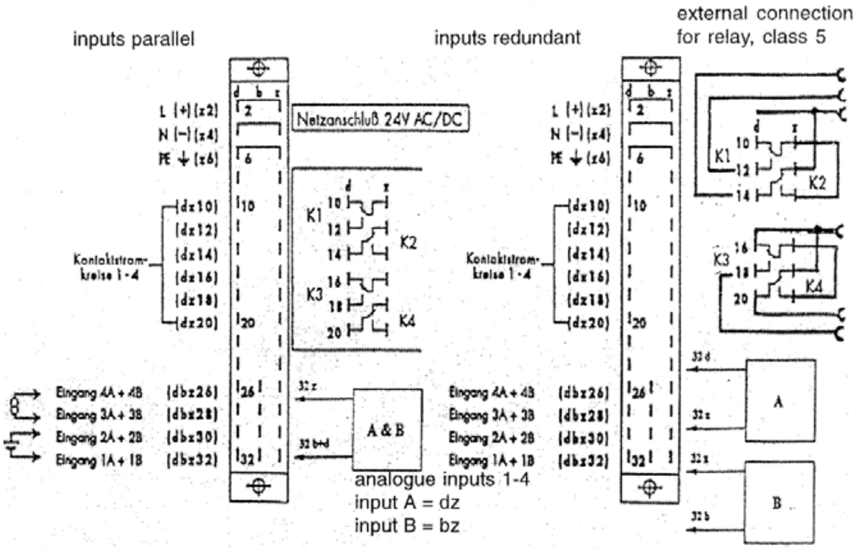
2.10 Block diagram



2.11 Connection diagram



Connectors illustrated bridged are connected internal multi-pole connectors as per DIN 41 612, series F

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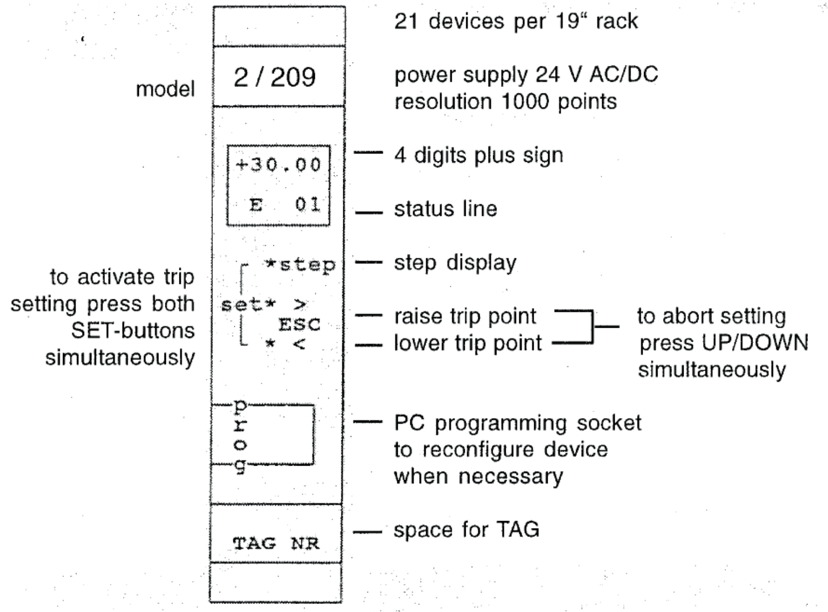
2.12 Front control elements



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3 Hardware description

3.1 Mounting instructions

Attention

Devices must be mounted outside hazardous areas.

The devices are manufactured as narrow plug-in units for 19" racks. The exact dimensions can be taken from the section "Technical data".

The racks should be mounted in easily accessible positions on walls, in panels, in cabinets or protective enclosures so that the front panels of the devices take on a vertical position. The mounting position should be dry and dust-free. Heavy vibrations, mechanical stress, and strong heat sources are unacceptable. Maximum ambient conditions must be observed.

The units are EMC-RFI tested to IEC 801.2-5 plus NAMUR AK EMV. Despite their excellent RFI immunity, the mounting position should not be in the immediate vicinity of strong electromagnetic fields and be low on RFI. To avoid radio frequency interference shielded racks and screened cables are recommended. Please observe installation code of practice. For advice on EMC - RFI see application notes EAN 1610. For best EMC performance make sure to earth the assigned connector pin.

The units are pushed into the racks fitted with guide rails and female connectors until the front panels are flush with the front frame of the rack. The units are then connected to the external wiring via the female connectors. Screw or snap-in fasteners secure the units against unintentional removal from the rack.

The following mounting recommendations should be observed. A maximum of 21 devices can be fitted in a rack. Power dissipation can be taken form the section "Technical data". In order to disperse the heat sufficiently the racks should be mounted in such a way as to ensure best ventilation. The following advice may be useful:

1. It is recommended in particular that permanent overvoltages should be avoided.
2. In particularly adverse operating conditions check the ambient temperature in the vicinity of the devices (approx. 1 cm away from the front panels). The temperature should not exceed 60 °C under worst case conditions.
3. Normally natural convection is sufficient for 19" racks in open frames. It has to be noted however that the topmost rack should not be covered over unless by a cover plate with sufficient air vents to avoid heat build-up.

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3.2 Cabinet design and heat dissipation

Electronic devices will dissipate some of the energy applied to them in the form of heat. The resulting cabinet temperature must not impair the device function. Therefore the cabinets should be designed not to exceed the maximum permissible ambient temperatures as given in the section "Technical data". The following table is based on an over-temperature of 25 K.

The devices have been designed for 60 °C ambient. Further assuming that the control room temperature does not exceed 40 °C, the permissible power dissipation in the cabinet can be given as follows:

1. unforced draught convection 400 W
2. draught convection using vents and filters 800 W
3. draught convection using vents without filters 1600 W
4. unforced natural convection 160 W
5. forced convection ventilators per rack 320 W
6. forced convection using heat exchangers plus forced convection inside and out 1500 W

The number of devices per cabinet can then be computed as follows:

$$Z = \frac{V}{G}$$

Z = number of devices per cabinet
V = permissible power dissipation
G = power per device

For mixed installations the individual power dissipation of devices can be used to compute the total power loss to compare with the permissible values.

3.3 Connections

Attention

For all device types the rules and regulations for the installation of electrical equipment and wiring (e. g. VDE 0100) of the user country must be observed.

Power and measuring cables have to be kept separate.

Devices are electrically connected using a male and female connector to DIN 41612, type F. Connections see section "Technical data". The male connector is mounted on the printed circuit board while the female connector is fitted at the back of the rack.

External connections are normally soldered to the connectors. The solder points are covered by a heat shrunk sheath e. g. Drakavita Ray Quality H, manufacturer: Deutsche Schrumpfschlauch Gesellschaft. Other wiring techniques are also acceptable (wire-wrap, termipoint, crimp snap-in etc.).

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3.4 Commissioning

The following checks are recommended prior to start-up.

1. Output relay: observe the voltage and current ratings of the relay or electronic output.
2. Input
   - Ensure that the measuring circuit is not subjected to overvoltages.
   - Check the input connections and the corresponding jumper setting if the factory setting is not required.
   - For multiple analog inputs check that galvanic isolation is used where appropriate (e. g. if several signals are also transmitted to another multiple input device).
3. Power supply: check the supply voltage (see section "Technical data")

nn T	4 digits plus sign, status line with one alpha character plus 2 numerals

Most device settings will be carried out in Software. Check the setting using the parameter list. This can be addressed via the PC menu

Example

PC menu (details see disk)

Place jumper X5 in position 4–5 for programming.

Connect the device to COM1 or COM2 RS 232 serial data links on your PC. Set your PC MENU to COM1 or COM2 accordingly via <ALT><C>.

Use the command <ALT><U> to read all data from the device and then printing it (1 A4 page)

1. LOAD DATA from the device (<ALT><L>).
2. Check constants (<F4> ... <ESC>).
3. Check the program (<F5> ... <ESC>).

Before attempting any changes the old parameters should be stored on disk using <ALT><W> (see PC HELP TEXT). After effecting the changes these must be stored in the device using <ALT><S>. Again a back-up copy on disk or WINCHESTER under a suitable file name is recommended.

After these checks the unit can be plugged into its rack position. Devices are calibrated ex works. Recalibration is therefore not normally required (see section "Calibration").

A simple functional test can be carried out as for conventional trip amplifiers by connecting input signal sources to check the relays trip at the setpoint.

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3.5 Functional test

3.5.1 General

The device will be calibrated ex works following the specifications given with orders. The unit is operational and approximately 0.2 % accurate as soon as the power is turned on. It has to be noted however that best performance is only achieved once temperature balance is reached between the device and its ambient conditions. A device taken from stock inserted in a warm rack may therefore take 1 ... 2 hours before it reaches its full accuracy given that the ambient temperature is stable and within the boundaries mentioned in the section "Technical data".

Factory calibration is carried out at 20 °C ... 25 °C after a 72 hour soak test. Due to the excellent long term stability of the device no regular maintenance is needed. An annual check of zero and span is regarded as being sufficient. The PCB carries a row of jumpers:

Standard setting for row of jumpers X2, X5:

X2

1	2

X5

4	3	2	1
:	|	:	|
5	6	7	8

- MODE: X5
  - jumper 4–5 — PROGRAM
    programming mode (program execution stops)
  - jumper 3–6 — RUN
    run mode (device cannot be programmed)
- KEY: X5
  - jumper 2–7 — KEY LOCK
    disable front push button changes
  - jumper 1–8 — KEY UNLOCK
    enable front push button changes
- TEST: X2
  - jumper 1–2 — TEST
    if this jumper is set during the programming mode X5 4–5 testing is enabled. Device calibration is only possible in this mode of operation.

MODE jumper 4–5 is required for testing. The unit goes offline.

MODE jumper 3–6 for normal operation.

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3.5.2 Testing analog inputs

Analog inputs are tested via the LCD-Display in the front of the device. Download a program into the device which enables tests of analog inputs (e. g. program TESTE.EDT in the DEMO directory). The program TESTE.EDT will allow you to display analog inputs E01 ... E04 in percentage values in the display. Use the push button marked "STEP" to advance the display to the next input.

The device connections are explained in the data sheet. Inputs A and B have to have the same input signals applied to them because the program carries out a continuous cross check between the two for safety reasons.

Use precision signal sources to apply to the inputs. Display readings will be in engineering units or percentage values depending on the device software.

Use also PC MENUE "TERMINAL EMULATORS". There are the following parameter:

- P711 = input 1
- P712 = input 2
- P713 = input 3
- P714 = input 4

3.5.3 Testing push buttons

Front push buttons are used to set alarm points and to step the display to show measured values, trip points or computed values. In safety applications changes via push buttons are sometimes not permitted. Values may then only be read via push button access.

Download a program into the device which allows several values to be displayed under push button control (e. g. program TESTE.EDT in the DEMO directory). The program TESTE.EDT will allow you to display analog inputs E01 ... E04 in percentage values in the display. Use the push button marked "STEP" to advance the display to the next input.

Setpoints can be altered after placing jumper "KEY" in position 1–8. Press the upper and lower push buttons "SET" simultaneously. The display will start to flash. Adjust trip points by using the UP ">" and DOWN "<" push buttons. Store the setting by using the "STEP" button. Return to normal operation by pressing the two lower push buttons "<" and ">" simultaneously (ESC). The flashing stops. All three push buttons have now been tested.

Download your operating program and replace the jumpers as shown in section "Functional test – Generals".

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3.5.4 Testing relay outputs

Relay outputs are used to generate alarms or to identify trip conditions. Download a program into the device which allows setpoints to be checked by applying input signals (e. g. program TESTE.EDT in the DEMO directory).

The program offers two lower trips at 20 % and at 40 % plus two high trips at 60 % and at 80 % with a deadband (hysteresis) of 1 % (pulse stream normally active). A red LED is assigned to each output to light up on alarm.

After finalizing the output test download your operating program and replace the jumpers as shown in section "Functional test – Generals".

3.5.5 Testing LEDs

Front LEDs are used to indicate the relay status (red). A green LED can be employed to indicate the status of the self monitoring feature.

The LEDs can also be used to fulfil other tasks e. g. all LEDs flash: device fault. The display will then show the error code (see section "Calibration").

LEDs can be tested together with the relays or by placing the MODE jumper in position 4–5 and the TEST jumper X2 to 1–2. The 4 LEDs will then light up in sequence.

3.5.6 Testing the display

The front panel display is used to read measured values, device parameters or trip settings (top line 4 digits plus sign).

The bottom line offers status indication. An alpha character and 2 digits show which value is being displayed in the upper line.

Example

T01 = temperature in input 1

L01 = low trip for input 1

The display can be tested together with the push buttons as shown in section "Testing Push Buttons" or by placing the MODE jumper in position 4–5 and the TEST jumper X2 to 1–2. The display segments will then be turned on.

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3.6 Changing current inputs/voltage inputs

These changes should only be carried out in the laboratory.

Remove and replace jumpers as shown in the following table. Desoldering should only be carried out using a desoldering wick. Do not use a pump as this may damage the solder pads. The device does not have to be recalibrated once the changes have been completed because the components are accurate to within 0.1 %.

In class 4 (DIN V 19250) applications inputs A and B may be driven from the same source. In this case A and B are to be connected in parallel as shown in figure inputs in parallel in section "Layout". Open all the jumpers on module B and connect the positive end of the sister channels together.

Input	**0/4 mA ... 20 mA jumper X9**		**0/1 V ... 5 V jumper X10**		**0/2 V ... 10 V jumper X11**	
1	A101	A501	A101	A501	A101	A501
2	A201	A601	A201	A601	A201	A601
3	A301	A701	A301	A701	A301	A701
4	A401	A801	A401	A801	A401	A801
channel/module	A	B	A	B	A	B

For jumper locations see device layout in section "Layout".

3.7 Maintenance

The devices do not employ mechanical components which are exposed to wear and tear other than the front push buttons and relays. The circuits are well selected only incorporating high quality parts.

Therefore no regular maintenance is required as long as the maximum operating conditions are observed. Due to the excellent long-term stability calibration of zero and span need only be checked once a year. The relay life is given in technical data in section "Technical data".

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3.8 Service instructions

In case of dubious measuring results please check all external connections carefully. It is also good practice to check that the desired program has actually been stored in EPROM. A TAG number can be stored for identification purposes (also see section "Commissioning"). If there is no doubt about the fault lying with the device, it is seldom possible to repair the unit on site. Local analysis should be restricted to a check of the fuses.

Each fuse is tagged with its nominal value. Fuses must always be replaced by their equivalents. Fuse positions may be taken from section "Technical data" figure device layout.

Fuse	Value	Function
F1	0.630 A	Power supply
F101	3.15 A	Relay 1
F201	3.15 A	Relay 2
F301	3.15 A	Relay 3
F401	3.15 A	Relay 4

Other faults require laboratory tests. Circuit diagrams can be made available at request. Repairs can be carried out by our service department quickly and efficiently if units are returned to the factory. Spares help to maintain production in such cases.

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4 Software description

4.1 General

The device is freely programmable like a PLC.

Attention

Make sure to use the dedicated 2/209 - PC connector cable.

The following sections explain the software features of the unit. They are of interest mainly to those users who intend to write their own software. For standard applications skip reading sections "Programm and commands" to "System parameters".

Devices can be programmed using a personal computer. A MENU supported software package is available for PC users (see PC MENU disk).

Programming or reconfiguring is not required for standard applications. Therefore the following sections will mainly be used for writing new software.

In the normal way trip settings are accomplished via front panel push buttons. Additional options are explained in the following sections. A personal computer will allow for maximum user friendliness since all device functions are MENU supported via context sensitive HELPs.

numerical range:
+ /-1.18E-38 ... +/-3.39E+38

accuracy:
7 decimals

The trip amplifier is designed around a 16 Bit microprocessor.

Hardware and Software have been developed to safety standards (see section "Safety concept").

4.2 Numerical parameter list

All device parameters are listed in numerical order.

4.2.1 Program and commands P100 ... P299

Program changes can only be undertaken with jumper <MODE> in the <ENABLE> position.

Trips are only monitored with jumper MODE disabled (RUN).

Parameters P100 to P299 contain up to 200 programming steps. User programs can be entered to adapt the device to various applications. A powerful EDITOR is available for PC users. Once edited using (F2) programs must be compiled using compiler (F3).

Available commands and operands can be taken from the following list.

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4.2.2 Operands

AE1 ... AE4	analog inputs 1 ... 4 return up-to-date values (0 ... 1) of analog inputs (read only)
DE1 ... DE4	digital inputs 1 ... 4 derived from analog inputs DEx = -1 when AEx < 33 % DEx = 0 when AEx >= 33 % and <= 66 % DEx = 1 when IAEx > 66 % (read only)
TE1 ... TE3 TR2 ... TR3	push button inputs (1 when pressed) push button inputs (0 when pressed)
X01 ... X20	variables 1 .. 20 read and write
K01 ... K20	constants 1 .. 20 stored in EEPROM (read only)

Fixed values (program) and corresponding figures									
Z00	Z01	Z02	Z03	Z04	Z05	Z10	ZM1	Z1H	Z1T
0	1	2	3	4	5	10	-1	100	1000

CRP CRC	checksum of the user program checksum of user constants and calibration

4.2.3 Mathematical operations

Command	Call	Formula
Add	ADD,op1,op2,op3	op3 = op1 + op2
Subtract	SUB,op1,op2,op3	op3 = op1 - op2
Multiply	MUL,op1,op2,op3	op3 = op1 x op2
Divide	DIV,op1,op2,op3	op3 = op1/op2
Square root	SQR,op1,op2	op2 = SQR(op1)
Absolute	ABS,op1,op2	op2 = ABS(op1)
Logarithm (nat. LOG)	LOG,op1,op2	op2 = LOG(op1)
Exponential function	EXP,op1,op2	op2 = e^op1
Sine	SIN,op1,op2	op2 = SIN(op1)
Cosine	COS,op1,op2	op2 = COS(op1)
Tangent	TAN,op1,op2	op2 = TAN(op1)
Arc-tangent	ATN,op1,op2	op2 = ATN(op1)
Move	MOV,op1,op2	op2 = op1
Clear	CLR,op1	op1 = -1
Clear all var.	CLA	X01 ... X20 = -1
Logical AND	AND,op1,op2,op3	op3 = op1 and op2 op3 = 1 when op1 and op2 = 1 op3 = -1 when op1 or op2 = -1
Logical OR	ORA,op1,op2,op3	op3 = op1 and op2 op3 = 1 when op1 or op2 = 1 op3 = -1 when op1 and op2 = -1

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4.2.4 Conditional branches

Branch on equal Call: IEQ,op1,op2,op3 Formula: if op1 = op2 branch to op3
Branch on not equal Call: INE,op1,op2,op3 Formula: if op1 <> op2 branch to op3
Branch on greater or equal Call: IGE,op1,op2,op3 Formula: if op1 >= op2 branch to op3
Branch on lower Call: ILO,op1,op2,op3 Formula: if op1 < op2 branch to op3
Unconditional branch Call: GTO,op1 Formula: branch to op3

4.2.5 Timers and other operations

Command	Call	Formula
End of program	END	end of program
No operation	NOP	no operation
Timer	TIM,op1	read timer and delete (time in ms)
Timer	TIN,op1	read timer (time in ms)
Wait	WAI,op1	wait so many ms (max. 10,000 ms)
Filter analog in	FIL,op1	number of averaged input values (max. 100) program waits for execution
Watchdog	WDT,op1	starts the watchdog (max 10,000 ms)

4.2.6 Output operations

Command	Call	Formula
De-energize relay	RD1...RD4, op1	relay de-energized within limits op1 = -1 relay off op1 = 0 previous status op1 = 1 relay energized
Energize relay	RE1...RE4,op1	relay energized within limits op1 = -1 relay off op1 = 0 previous status op1 = 1 relay energized
Set LEDs	SL1...SL5,op1	set LEDs op1 = -1 off op1 = 0 previous status op1 = 1 on
Set LEDs reverse logic	RL1...RL5,op1	set LEDs op1 = 1 off op1 = 0 previous status op1 = -1 on
LED flash	FL5,op1	flashing LED 5 (green) op1 = -1 off op1 = 0 previous status op1 = 1 on
The following commands must be placed at the beginning of a program		
On delay	ND1...ND4, op1	ON-Delay op1 = delay (max 10,000ms)
Off delay	FD1...FD4, op1	OFF-Delay op1 = delay (max 10,000ms)

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4.2.7 Special Operations

Display menu:

The DSP command has to be placed at the beginning of a program. DISPLAY commands must be in sequence. Other commands follow.

The order in which display commands are used determines the sequence of parameters displayed when pushing the STEP key on the device front.

Example

- input 1, trip point 1,
  input 2, trip point 2
  or
- input 1, input 2,
  trip point 1, trip point 2

Front push buttons will operate ONLINE, i. e. trip points continue to be monitored while the buttons are pushed. The program will read the push buttons once every cycle. It may therefore be necessary to press a push buttons several times before the unit responds.

Push buttons can be used to change constants. This is used to set trip points. Press SET to initiate changes (two keys simultaneously to protect against unintentional changes). The STATUS line will flash.

Use UP/DOWN ">" "<" push buttons to adjust the value.

Store the result in non-volatile EEPROM by pressing STEP key. Prior to storing the value in EEPROM you can restore the previous setting by pressing the UP/DOWN buttons simultaneously "ESC". The keys terminate the programming mode (display stops flashing). If keys are not pressed for 30 seconds the SET mode is terminated automatically.

Action:

Display operand op1 in mode op2.
The lower line will carry the alpha character **a** and the numerals **nn**. DSP commands have to be placed at the beginning of a program. The front push buttons are used to step DSP commands or change constants.

Call	DSP,op1,op2,op3,op4 DSP = display op1 = variable or constant upper line op2 = mode: (0 = float, 1 ... 4 = (n° - 1)decimals) op3 = ASCII: (A ... Z e. g. "#E") op4 = num. (0 ... 9 e. g. "#1") lower line op5 = num. (0 ... 9 e. g. "#0")

In the EDITOR operands op3 ... op5 are grouped together.

Example

DSP,X01,Z00,**E01** (see example programs in DEMO directory)

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4.2.8 Live zero conversion

Call	CLI, op1, op2, op3, op4 (convert live input) CLI = live zero - measuring range op1 = input (AE1 ... AE4) op2 = beginning of range op3 = full scale op4 = result
Formula	op4 = (op1-0.2) / 0.8 x (op3-op2) + op2

This command serves to convert live zero input signals into engineering units. That way measured values and trip points can be displayed as °C, m^3/h, % or other engineering units. The user does not have to establish conversion formula for himself.

Example

- Begin = 180 at 4 mA
- Full scale = 380 at 20 mA
- Display = 280 at 12 mA

The device front offers space for entering TAG numbers and engineering units. Enter

- 0 = beginning
- 100 = full scale

in order to display percentage values.

Live zero signals: 4 mA ... 20 mA, 1 V ... 5 V, 2 V ... 10 V

4.2.9 Dead zero conversion

Convert dead zero input signals into engineering units.

Call	CDI, op1, op2, op3, op4 (convert dead input) CDI = dead zero - measuring range op1 = input (AE1 ... AE4) op2 = beginning of range op3 = full scale op4 = result
Formula	op4 = op1 x (op3-op2) + op2

The function is equivalent to the live zero conversion.

Dead zero signals: 0 mA ... 20 mA, 0 V ... 5V, 0 V ... 10 V

EN

4.2.10 Trip high on mid – hysteresis

This command is used to monitor a high alarm. You can monitor inputs or computed values.

Call	AHM,op1,op2, op3, op4 (alarm high mid hysteresis) AHM = alarm high contact on centre hysteresis op1 = value to be monitored (e. g. AE1 ... AE4) op2 = trip point op3 = hysteresis op4 = result
Formula	op4 = 1 for alarms or if op4 was 1 before op4 = 0 while inside deadband or if op4 was 0 before op4 = -1 when there is no alarm

Example

ADD, AE1, AE2, op1

Monitors the average of input 1 and input 2 etc.

Use Operand op4 to energize or de-energize relays.

Trip points are in engineering units as determined by the beginning and end of range (full scale) values. This relieves the user from tedious conversion tasks. This command sets the trip point in the centre of the deadband (hysteresis op3 as with conventional trip amplifiers).

Example

- high contact = 60 %
- hysteresis = 6 %
- alarm > 63 %
- no alarm < 57 %

The hysteresis is also set in engineering units (0.1 % to 100 %).

4.2.11 Trip low on mid – hysteresis

This command is used to monitor a low alarm. You can monitor inputs or computed values.

Call	ALM,op1,op2, op3, op4 (alarm low mid hysteresis) ALM = alarm low contact on centre hysteresis op1 = value to be monitored (e. g. AE1 ... AE4) op2 = trip point op3 = hysteresis op4 = result
Formula	op4 = 1 for alarms or if op4 was 1 before op4 = 0 while inside deadband or if op4 was 0 before op4 = -1 when there is no alarm

Example

- high contact = 60 %
- hysteresis = 6 %
- alarm > 57 %
- no alarm < 63 %

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4.2.12 Trip high on set-point

This command is used to monitor a low alarm. You can monitor inputs or computed values. In contrast to previous alarms this one triggers exactly on the preset trip point. The hysteresis or deadband will then be to one side of the set-point.

Call	AHS,op1,op2,op3,op4 (alarm high on set-point) AHS = alarm high contact exactly on set-point op1 = value to be monitored (e. g. AE1 ... AE4) op2 = trip point op3 = hysteresis op4 = result
Formula	op4 = 1 for alarms or if op4 was 1 before op4 = 0 while inside deadband or if op4 was 0 before op4 = -1 when there is no alarm

Example

- high contact = 60 %
- hysteresis = 3 %
- alarm > 60 %
- no alarm < 57 %

The hysteresis is also set in engineering units (0.1 % to 100 %).

4.2.13 Trip low on set-point

This command is used to monitor a low alarm. You can monitor inputs or computed values.

Call	ALS,op1,op2,op3,op4 (alarm low on set-point) ALS = alarm low contact exactly on set-point op1 = value to be monitored (e. g. AE1 ... AE4) op2 = trip point op3 = hysteresis op4 = result
Formula	op4 = 1 for alarms or if op4 was 1 before op4 = 0 while inside deadband or if op4 was 0 before op4 = -1when there is no alarm

Example

- high contact = 60 %
- hysteresis = 3 %
- alarm < 60 %
- no alarm > 63 %

The hysteresis is also set in engineering units (0.1 % to 100 %).

EN

4.2.14 Trip 2 of 3 selector

Call	SEL,op1,op2,op3,op4,op5,op6,op7,op8,op9 SEL = select the deviating channel op1 = input 1 op2 = input 2 op3 = input 3 op4 = tolerance band op5 = tolerance band hysteresis op6 = signal alarm -1, 0, 1 (channels are deviates) op7 = channel alarm -1, 0, 1(channels are different) op8 = average of acceptable inputs op9 = faulty channel (0, 1, 2, 3, 123)
Formula	op5 and op6 show: op4= 1 for alarms or if op. was 1 before op4 = 0 while inside deadband or if op. was 0 before op4 = -1 when there is no alarm

Example

SEL,E01,E02,E03,K01,K02,X01,X02,X03,X04

Normal operation

- signal alarm = -1
- channel alarm = -1
- average = (E1 + E2 + E3) / 3
- faulty channel = 0

Single fault

- signal alarm = 1
- channel alarm = -1
- average = (Ex + Ey) / 2
- faulty channel = E1 or E2 or E3

Multiple fault

- signal alarm = 1
- channel alarm = 1
- average = previous value
- faulty channel = 123

Three input signals op1, op2, op3 are monitored for equality. If one input leaves the tolerance band op4 around the average of the signals, the signal alarm op6 will be activated. If all inputs are different, the channel alarm op7 will be activated.

The faulty channel can be read in op9. Use the DISPLAY command to read the value in the display in the front panel. The average op8 of those values which are within the tolerance band can also be displayed. Variables op6, op7, op8, op9 must not be overwritten during the remaining user program.

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4.2.15 Trip rate of change alarm

Prior to calling this rate of change alarm use the timer command TIM,op5 to enter the time since the last call in memory cell op5.

An input or a computed value op1 is monitored for change op3 per time interval op2. The up-to-date value of op1 will be compared with the old value in op6 (op3 = op1 - op6) when the time integral op7 > op2. If the change per time interval op3 is above 0 the gradient is positive. If the change per time interval op3 is less 0 the gradient is negative.

Memory cells op6 to op9 must not be overwritten during the remaining user program.

Call	GRD,op1,op2,op3,op4,op5,op6,op7,op8,op9 GRD = (gradient) monitor rate of change op1 = input value to be monitored op2 = time interval in ms op3 = max change per time interval op4 = hysteresis op5 = time since last call op6 = input memory (start value) op7 = time memory (integral of op5 in ms) op8 = alarm memory op9 = alarm -1, 0, 1
Formula	op9 = 1 for alarms or if op9 was 1 before op9 = 0 while inside deadband or if op9 was 0 before op9 = -1 when there is no alarm

Example

GRD,E01,K01,K02,K03,X01,X02,X03,X04,X05

EN

4.2.16 Trip stuck sensor alarm

Prior to calling this rate of change alarm use the timer command TIM,op5 to enter the time since the last call in memory cell op5.

An input signal or a computed value op1 is monitored to see if the value has changed by more than the required minimum value op3 during the sample time (time interval op2). If the minimum change has not been achieved, an alarm is generated because it must now be assumed that there is a fault in the circuit which is under observation.

Memory cells op6 to op9 must not be overwritten during the remaining user program.

Call	STS,op1,op2,op3,op4,op5,op6,op7,op8,op9,op10 STS = stuck sensor op1 = input op2 = time interval in ms op3 = min change per time interval op4 = hysteresis op5 = time since last call in ms op6 = min input memory op7 = max input memory op8 = time memory (integral of op5) op9 = alarm memory op10 = alarm -1,0,1
Formula	op10 = 1 for alarms or if op10 was 1 before op10 = 0 while inside deadband or if op10 was 0 before op10 = -1 when there is no alarm

Example

STS,E01,K01,K02,K03,X01,X02,X03,X04,X05,X06

4.2.17 Trip Analog Monitor (setpoint and line monitor)

An input signal op2 (op1 = live or dead zero) in converted into engineering units using op3 = beginning o.r. and op4 = full scale.

The result is stored in op12. The signal will then be monitored for line interrupts and overrange (Fault) plus a setpoint (op5) depending on op6 = low limit or high limit.

Call	ANA,op1,op2,op3,op4,op5,op6,op7,op8,op9,op10,op11,op12 ANA = analog input monitor op1 = input mode op2 = input op3 = beginning of range op4 = full scale op5 = trip point op6 = trip mode (0=low limit; 1=high limit) op7 = Reset (> 0 then reset) op8 = delay (delay = op8 x program cycle) op9 = delay counter op10 = alarm memory op11 = line interrupt/overrange (fault) op12 = analog output
Formula	op10 = 1 for alarms or if op10 was 1 before op10 = -1 while inside deadband op11 = 1 for fault or if op11 was 1 before op11 = -1 while inside deadband

Example

ANA,Z01,AE1,K01,K02,K03,Z00,X01,K04,X03,X04,X05,X06

Comment

	Line monitor trips at	
op1 = input mode	0 = dead zero	(21 mA)
	1 = live zero	(3.6 mA and 21 mA)
	2 = live zero	(0.5 mA and 21.5 mA)

The reset variable op7 is used to clear alarm or fault conditions. This allows you to HOLD the Alarm and RESET it via a variable value (op7) under software control. The variable may be governed by an analog input or the front push buttons.

The alarm will be delayed by op8. The delay will reach 1 second, if op8 = 25 and the average program execution time is estimated to be 40 ms.

If an alarm or fault are detected this information will be stored. If both fault and alarm are detected, fault will be predominant.

Memory cells op9 to op11 may only be read during the remaining program. They must not be overwritten.

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4.3 System parameters

System parameters help to analyse problems and locate faults.

4.3.1 Software version P700 (read only)

This parameter gives access to the number of the current software version.

Example

2/209 V 1.18

4.3.2 Device ID P701 (read and write)

This parameter contains a device identification or TAG No. of up to 12 characters. It does not have any influence on program execution. It can be employed to advantage when storing data of several devices on a personal computer.

Example

2/209

4.3.3 Jumper KEY P704

Displays the status of the jumper KEY.

Example

Enter: P704 <Enter>

Display: P704 = 1 (1 = KEY ENABLE)
1 = push button changes unlocked
0 = push button changes locked

4.3.4 Jumper MODE P705

Displays the status of the jumper MODE.

Example

Enter: P705 <Enter>

Display: P705 = 0 (0 = MODE DISABLE)
0 = programming disabled
1 = programming enabled. Trips are NOT monitored

4.3.5 Jumper TEST P706

Displays the status of the TEST jumper.

Example

Enter: P706 <Enter>

Display: P706 = 0 (0 = TEST DISABLE)
1 = TEST Mode (calibration enabled)
0 = normal mode (calibration disabled)

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4.3.6 Device Programming P707 (PC menu only)

Entering parameter P707 = 1 will delete all data in EEPROM. The device will then expect to receive a new identification ID, 20 constants, 200 programming steps and a CRC (checksum) following data transmission.

Once data transmission has been completed successfully data are copied to EEPROM followed by an echo of 0. Otherwise 1 is echoed. The PC program will control data transmission and the generation of the CRC.

4.3.7 Test parameters

Test parameters are used for electrical device checks.

Check analog inputs and push buttons (ONLINE)

P711	analog input 1 corresponding to 0 ... 1 (read)
P712	analog input 2 corresponding to 0 ... 1 (read)
P713	analog input 3 corresponding to 0 ... 1 (read)
P714	analog input 4 corresponding to 0 ... 1 (read)

Check calibration data (ONLINE). Both microprocessors contain calibration data about the redundant analog inputs assigned to them.

	CPU A
P781	read calibrate analog input 1A
P782	read calibrate analog input 2A
P783	read calibrate analog input 3A
P784	read calibrate analog input 4A
	CPU B
P785	read calibrate analog input 1B
P786	read calibrate analog input 2B
P787	read calibrate analog input 3B
P788	read calibrate analog input 4B

4.3.8 Calibration

Devices are calibrated ex works. Therefore recalibration is not normally required after commissioning. An annual check is regarded as being sufficient. Range changes or live/ dead zero changes do not involve recalibration.

Recalibration is also not required after changing from current to voltage inputs or vice versa (also 5V ... 10V) because precision resistors have been used.

Set the MODE jumper to PROG (4–5) and the TEST jumper to X2. Connect the device to the PC using the TERMINAL EMULATOR <ALT><E> (see section "Numerical parameter list").

1. Set all analog inputs to 100 %
2. Enter P790=1 (calibrate analog inputs)
3. Display P790 = n   n = 0 o.k.
   n = 1...8 error in channel **n**
   n = 9 jumper TEST disabled

After calibration has been completed the jumpers have to be changed back to the operating mode. MODE = RUN (X5 3–6) and TEST jumper removed.

The calibration procedure eliminates tolerances of the precision resistors in the input channels of the device. Conventional potentiometers have been replaced by non-volatile EEPROM memory.

4.3.9 Constants

P801 ... P820 contain constants K01 ... K20.

Constants are stored in EEPROM and can be altered ONLINE using the front push buttons (see special commands). External access is often not permitted in safety applications.

Data will be retained upon loss of power.

4.3.10 Variables

P901 ... P920 contain variables X01 ... X20.

Variables are stored in RAM and will be used for computed or interim values.

RAM contents will be lost upon loss of power.

4.4 Programming example

Install your PC software for the 2/209 trip amplifier (see section "How to install your program").

Power the trip amplifier (24 V DC) and connect it to the personal computer (COM1 or COM2). Analog inputs should be connected to signal sources.

Set the MODE jumper (X5) to programming X5.4 - X5.5 (see section "Functions – General").

Start the PC program by entering START/1 (device connected at COM1 of the PC) or enter START/2 (device connected at COM2). The screen will now show the main MENU.

Open communication by entering keys <ALT><E> simultaneously. The selected serial data link COM1 or COM2 should be echoed in the display window. Now enter the command P700 followed by RETURN (ENTER).

The communication window will display as follows:

P700

P700=2/209-V3.0 (device version)

In case there is no reply from the device, please check your connection:

a) use the correct cable
b) use the correct serial data link COM1 or COM2
c) check the jumper positions

of the device (see above).

Once communication has been established between the PC and the device close the communication window using <ESC>.

Now activate the EDITOR using key <F2>. Press RETURN <ENTER>, to enter the selection box.

Move to the DEMO directory using arrow keys and acknowledging with <ENTER>. Select the file TEST_E.EDT and acknowledge with RETURN. The test program will now be displayed.

Colons are used to introduce comments. You can step through the program using the arrow keys. A program always consists of constants K01 ... K20 and statements.

The software example is used to monitor 4 inputs.

E01	low limit
20 %	normally energized
1%	hysteresis
LED 1	On for alarm
E02	low limit
40 %	normally energized
1%	hysteresis
LED 2	On for alarm
E03	high limit
60 %	normally energized
1%	hysteresis
LED 3	On for alarm
E04	high limit
80 %	normally energized
1%	hysteresis
LED 4	On for alarm

The WDT,K08 statement starts a watchdog which will halt the system after 1,000 ms should the program fail to pass this statement.

The following values can be addressed on the front LCD display:

E01 analog input 1 in %
E02 analog input 2 in %
E03 analog input 3 in %
E04 analog input 4 in %
L01 low limit for E01 in %
L02 low limit for E02 in %
H01 high limit for E03 in %
H02 high limit for E04 in %
C00 checksum of device (program, constants, calibration)
P00 checksum of the program
T00 program execution time in ms.

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Leave the EDITOR using ESC. At the top of the screen the question "SAVE Y/N" will appear. Reply "N" unless you want save changes.

If you have made changes in the source code and you want to safe it, please reply with "Y".

The program now has to pass the COMPILER to become executable. Activate the COMPILER using key <F3>. Any program which has just passed the EDITOR will automatically be addressed by the COMPILER. Acknowledge using RETURN. The screen will show "data loaded from compiler". Acknowledge using ESC.

Send the translated program to the trip amplifier using <ALT><S> (press <ALT> and <S> simultaneously). Acknowledge the question "are you sure" with RETURN. A new window will appear on the screen and you will be able to watch data being transferred to the trip amplifier. After about 2 minutes data transfer will be completed and a checksum is formed to be stored as an unmistakable value in EEPROM (P00).

Set jumper MODE to RUN X5.3 - X5.6 (see section "Functions – General"). The trip amplifier will now perform the desired function.

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4.5 Error messages

When an error is detected while a program is being executed, the processor will halt and all LEDs will flash. Relay outputs will be de-energized. The error code will be shown on the display.

Example

Error 54 in line 100 will lead to the following display.

PC screen: F54 in 100

Display:

100 F54

Fault	Meaning	Action
11	analog input 1 difference in CPU A and B	Check input signals.
12	analog input 2 difference in CPU A and B	
13	analog input 3 difference in CPU A and B	
14	analog input 4 difference in CPU A and B	
15	difference in the program monitor of CPU A and B	
20	wrong length of start bits for communication	
21	time-out in the parallel CPU (no data from parallel CPU)	
22	time-out on main program (user programs are interrupted)	
23	unused interrupt	
24	time-out through watchdog WDT command	Check program execution time.
39	program runtime error in the operating system	
38	program runtime error in the user program	
40	CRC error in RAM (retransmit program and constants)	Briefly switch off power to generate a RESET.
41	ERROR unable to switch off relay output 1	Briefly switch off power to generate a RESET. Repair if necessary.
42	ERROR unable to switch off relay output 2	
43	ERROR unable to switch off relay output 3	
44	ERROR unable to switch off relay output 4	
45	power monitor (internal 5V-supply < 4.5V or > 5.5V)	
46	CPU not functioning properly	
49	AD converter, MUX, reference input faulty	
51	RAM fault	Inverter and cross talk check failed.
52	CRC error in EPROM	Briefly switch off power to generate a RESET.
53	faulty statement e. g. ADD,Z00,Z01,Z00 The result of an operation cannot be stored in a fixed value (Z00).	
54	faulty statement e. g. ADD,X01,X02,X03,X04,... The ADD statement should only be followed by 3 operands. These are to be followed by the next statement (X04 is wrong).	
55	program counter less than 100 or greater 299	Check your program and its statements.

EN

Errors lead to a program interrupt. All the LEDs will be turned on and the output relays are de-energized.

- Error Axx: the error has been recognized by CPU A.
- Error Bxx: the error has been recognized by CPU B.

As a first action briefly switch off the power supply to the device. The card will be RESET and all functions will be tested.

You may be able to correct faults in the execution of a program by setting the MODE jumper to PROG and then back again to RUN. If necessary reload the program from the PC.

Should the device indicate an error during programming due to strong electromagnetic bursts briefly switch off power before resuming your task.

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4.6 Installation of the PC program

The 2/209 software will operate on any IBM compatible PC with 512 kB memory and an MS-DOS or PC-DOS operating system Version 3.0 or higher.

For maximum user friendliness install a Mouse and an EGA or VGA monitor. However, the program will also run without a Mouse and with a monochrome monitor. If you want to use a Mouse, make sure the corresponding driver is loaded. It is best to incorporate the driver in the start batch using an editor to do so (file: START.BAT).

If a WINCHESTER drive is available, a new directory should be generated. Afterwards all the files should be copied from the floppy disk to the new directory.

Example

- c:
- md PC2209
- cd PC2209
- xcopy a:*.* /s
- dir

Now the following files should be listed:

START	BAT	Start batch
MAIN_209	EXE	Menu support
COMP_209	EXE	Compiler
SIMU_209	EXE	Emulator
EDIT_209	EXE	Editor
SYNATAX	OPL	Syntax for the compiler
TXT_209G	TXT	German menu
TXT_209E	TXT	English menu
HLP_209G	HLP	German help
HLP_209E	HLP	English help
EDT_209G	HLP	German help for editor functions
EDT_209E	HLP	English help for editor functions
DEMO	DIR	Subdirectory with sample programs
STD	DIR	Subdirectory with standard programs

While in DOS type **TYPE START.BAT** to display the START file.

REM MOUSE that	here you may want to add the MOUSE driver; in case please remove the **REM** statement.
MAIN_209 %1 %2	this program starts the menu support.

Activate the english version by entering **START /e /2**. The menu will then appear on the screen.

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The following START-up parameters are possible:

/g	German help *
/e	English help
/0	DEMO mode active *
/1	Serial link via COM1
/2	Serial link via COM2

Start options marked by a star * will be assumed unless other parameters are used.

Connect the trip amplifier via a serial data link (RS 232) to the personal computer. The desired PC port "COM" is assigned during start-up (/2 = COM2) as shown above. The port may be changed under MENU support using (<ALT><C>). Only lines GND (7), TXD (2) and RXD (3) of the PC need to be connected with the trip amplifier. A suitable cable is available as an accessory.

Menu items are explained via HELP text. Use key **F1** for HELP. Context sensitive HELP texts simplify matters when working with the program. Every line of the menu can thus be explained in detail. HELP is also accessible using alphabetical search.

EN

5 Handling without a PC

In the normal way front panel push buttons can be used to adjust set points read on the digital display. Set points are secured against unintentional adjustments (jumper X5 2–7). Enable push button adjustments by setting jumper X5 to 1–8.

In order to activate the UP/DOWN push buttons both SET buttons must be pressed simultaneously. The display will start to flash. Set points can now be raised using **>** or lowered using **<** push buttons. Keep the push button down to accelerate.

Use the STEP button to save the new setting. The new value will not be accepted until STEP is pressed and the next value is displayed. If you want to restore the previous setting and erase the new one you can do so by pressing both **>** and **<** simultaneously (ESC) prior to pressing the STEP button.

The status line indicated which value is being displayed at present e. g.

- E01 = input 1
- T01 = temp. 1
- F01 = flow 1
- L01 = low alarm 1,
- H01 = high alarm 1

Front push buttons can be disabled via an internal jumper (see section "Functional test – Generals").

In that case measured values and trip setting can be displayed online, but alterations will not be possible. The basic device function is outlined on the TAG covering the microprocessor. You can replace the label yourself after changing the factory setting. Carefully use your thumb and digit finger to lever the cover off the socket. The position of the TAG can be taken from the device layout drawing in section "Layout".

- The disk contains a print program TYPENG.TXT with some examples. These can be altered using the EDITOR. Use the PRINT command in your DOS operating system to print the label in IBM compatible printers. Proceed as follows:
  Call the EDITOR in the main MENU using key <F2>. Select file TYPENG.TXT using the tabulator key <TAB> and the arrow keys. Activate the file using <ENTER>. Make sure only to overwrite lines in this file. Do not alter the line length. Do not go beyond the markers. Do not enter new lines.
- After saving file TYPENG.TXT using <ESC> leave the menu and return to the DOS operating system pressing keys <ALT><X>.
- Now enter the command PRINT TYPENG.TXT. Your IBM compatible printer will now print a label of just the right size.

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6 Handling with a PC

The trip amplifier can be reconfigured under menu support using a PC or LAPTOP with the enclosed disk. Every item on the MENU is supported by HELP functions which are accessible via key **F1**. The following section explains a simple example:

Device handling

- Action 1 – preparing the hardware
- Action 2 – preparing the software
- Action 3 – preparing a back-up copy
- Action 4 – how to edit standard programs
- Action 5 – how to save and send programs
- Action 6 – how to check edited programs
- Action 7 – how to EDIT a program
- Action 8 – ending a job

6.1 Action 1 – Preparing the hardware

2/209	Device to be connected to 24 V DC power supply.
2/209	Device to be connected to a PC via an RS 232 link.
2/209	Set jumper MODE to 4–5 (programming mode, trip monitor disabled).

Insert a copy of the disk supplied with this manual. Remove WRITE protection. Alternatively use hard disk.

6.2 Action 2 – Preparing the software

A: <ENTER>	Select drive A, A> displayed on screen.
START <ENTER>	Start program in English, the main MENU will appear on the screen.
<ALT><C>	Select PC communications link.
1	Enter figure 1 or 2, select COM1 or COM 2.

6.3 Action 3 – Preparing a back-up copy

<ALT><L>	Load data from the trip amplifier.
<ALT><W>	Save data in a file This is to produce a back-up copy of the factory or original setting.
NAME.209	Enter NAME and save with <ENTER>. If you want to save data from several devices, repeat above action from <ALT><L> and issue a file name per device (TAG No).

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6.4 Action 4 – How to edit standard programs

<F6>	Call a standard program.	
1 <ENTER>	Select the desired program number 1 (example 1). A window will be opened for user entries (<F1> HELP).	
zero	0	Use <TAB> key to move forward.
full scale	100	Towards entry fields.
display	E01	Use <SHIFT-TAB> to move backwards.
display mode	2	
input zero	( ) live	Change using arrow keys.
	( ) dead	Change using arrow keys.
trip point	50	
hysteresis	1	
display	L01	
display mode	2	
relay action	( ) OFF	Change using arrow keys.
	( ) ON	Change using arrow keys.
switch at	( ) set	Change using arrow keys.
	( ) hyst	Change using arrow keys.
contact	( ) LOW	Change using arrow keys.
	( ) HIGH	Change using arrow keys.
	( ) Line - toggle using space key (X = active).	

Changes become valid once you have accepted entries by pressing 0 = OK or select **OK** via the <TAB> key (will be highlighted) followed by <ENTER>. Abort using <ESC>.

6.5 Action 5 – How to save and send programs

<ALT><W>	Save data on file. This is to establish a back-up copy of a standard copy after effecting changes. The copy can later be used to configure spares or new devices (see <ALT><S>). However the changes cannot be displayed in the same menu supported way as the original standard setting.
NAME.209	Type the desired name and press <ENTER>. If you want to create several identical devices, repeat above action from <ALT><W> and issue a file name per device (TAG No).
<ALT><S>	Save data in the trip amplifier. If you want to create several identical devices, connect them to your personal computer one by one and save data with <ALT><S>.

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6.6 Action 6 – How to check edited programs

<ALT><R>	Load parameters from file.
NAME.209	Enter the desired file name or
<ALT><L>	load parameters from the trip amplifier. Data are now accessible.
<F5>	Check the program. Changes can now be made immediately. Use the tabulator <TAB> key to move to the programming step which is to be altered and overwrite with the new command.
<F4>	Check constants. Changes can now be made immediately. Use the tabulator <TAB> key to move to the constant which is to be altered and overwrite with the new value.

Alterations should be saved as explained in action 5.

6.7 Action 7 - How to edit a program

This task will not have to be undertaken very often. You should have prior programming experience before attempting it.

<F2>	Call the editor.
NAME.EDT	Enter the name of the FILE to be edited. Existing programs can be altered using the editor or new programs can be established. <F1> offers extensive HELP during an EDIT session. Program examples are to be found in the **DEMO** directory under DEMOE.EDT ... or in directory **STD** under STD_1.EDT ... STD_8.EDT. Comments must be preceded by ";". Once a program has been established it must pass the compiler. Only then will you have an executable program which can be transferred to the trip amp using action 5.

6.8 Action 8 - Ending a job

2/209	Remove the connector cable from the PCs serial data link.
2/209	Place jumper MODE in position 3-6 (run mode).

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7 Fault finding

Error	Solution
No communication between PC and the device 2/209	Check the cable. Check that the correct COM link is being used typing <ALT><C>. Check that the jumper MODE is in position 4–5.
Device doesn't work. Display shows **P**.	Check that the jumper MODE in position 3–6.
Trip points cannot be set.	Jumper KEY must be in position 1–8.
High alarm instead of low alarm or vice versa.	Use action 6 to load parameters from the trip amplifier with <ALT><L>. Modify the program with <F5>. Use the <TAB> key to move to the command which determines the MIN or MAX-contact. Overwrite the line in question. e. g. AHS MAX-contact which switches exactly on the set point. Change to: ALS MIN-contact which switches exactly on the set point. End action by saving the program in the trip amplifier following action 5 <ALT><S>. The display can be altered in the same way, e. g. overwrite H01 with L01.

8 Test programs using the EMULATOR

The EMULATOR allows you to check programs which have been written for the trip amplifier 2/209. Once the program has been tested successfully it can be stored in the trip amplifier (see <ALT><S>).

This tool replaces the hardware during program development. This effectively speeds up the process of writing applications software. The program simulates the device 2/209 in all its functions. You can generate input signals on screen to check the relay and LED action as well as that of the front display.

Call a program which you have written with the aid of the EDITOR. Run the program through the COMPILER. Load this program into the EMULATOR by entering its NAME.209 (NAME the program of your choice).

The EMULATOR offers:

- single stepping (F7)
- a monitor for variables (F8)
- a monitor for constants (F9)
- a monitor for the system (F10)

The basic EMULATOR input setting is for 0 % ... 100 % signals. However it is also possible to apply hardware equivalents of 0 mA ... 20 mA, 0 V ...10 V, 0 V ... 5 V. Reconfigure the EMULATOR dialling <F9>.

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9 Safety concept

The fault detection calculations and measures meet the requirements of SIL3. From a safety-related point of view, the configuration program is suitable for programming and configuring the devices.

Conditions

1. The devices must only be operated in housings/control cabinets meeting at least IP54.
2. Two functionally diverse selector relays must be connected in series (NO/NC series connection).
3. The analog input circuits must be checked regularly and recurrently (e.g. annually) in the context of calibration.
4. It must not be possible to modify the programmed switching thresholds (trip values) via the function buttons on the front plate during operation. This must be ensured through organizational measures.
5. The user program must be checked during factory/on-site acceptance testing:
   - Correct implementation of the specified function in the instruction list must be verified, e. g. by means of a function check.
   - The printout of the read-back instruction list must be compared with the compiled instruction list for this purpose.
   - The user programs must be written such that the application-dependent response times relating to the process requirements and fault tolerance times, including in conjunction with the overall control system, are not exceeded (e. g. 1 s for plants complying with DIN VDE 0116).
6. If branch commands are used, it must be demonstrated that the cyclic processing of the commands for activation of the relay/dynamic pulse outputs is maintained under all branch conditions. If necessary, the output commands must be protected by means of a watchdog function (the WTD command must be programmed immediately before the output commands).
7. The installation conditions for the trip amplifier inputs and outputs must comply with the IEC 801-5 [7] standard in terms of immunity against transient voltages (well protected electrical environment, no transient voltages exceeding 25 V) or protected via external measures.
8. The application notes in the manufacturer’s operating instructions must be observed.

Additional conditions for SIL2 or SIL3 applications

1. For SIL3 applications, the use of paired output contacts in a safety chain is mandatory.
2. For SIL2 applications, it must be ensured that a safe status has been achieved and is maintained upon detection of a potentially hazardous fault during the repeat check (proof test).
   Single-channel use of an output for a safety function is only permissible if “one fault” safety is not required and the application does not require an equivalent according to category 3, EN 954-1. Otherwise, configurations according to SIL3 must be used.
3. When determining the checks to be performed at regular intervals, the determined proof-test intervals must be observed.

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The following basic principles have been applied:

1. Manipulations are excluded during operation,
2. 2 lines of a digital display give access to important data without disturbing the plant operation,
3. 4 pairs of analog inputs ensure that single errors on these circuits will be detected.
4. 2 processors monitor each other, a self monitoring feature will generate error codes in case of faults,
5. a dynamic watch dog circuit together with other safety functions will ensure that relays.
6. the user program is stored in non-volatile EEPROM,
7. the relay position is monitored continuously,
8. relays are de-energized if program execution is disrupted,
9. single faults will drive the unit to a safe position,
10. each contact circuit is fused are de-energized in case of faults,
11. free programming of the device functions on the basis of safety-tested software via a PC menu with help texts,
12. approved structure of commands and operating system,
13. safe state after restart,
14. monitoring of the operation and data transfer,
15. structured programming and
16. detailed documentation.

9.1 CE marking

- The unit 2/209 is designed to be used in an industrial environment.
- Noise immunity acc. to EN 61000-6-2:2005 and EN 61326-3-2

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9.2 Safety related parameters

9.2.1 Safety parameters for SIL2

In consultation with TÜV Rheinland, the PFH value for this device can be calculated as follows:

PFH = PFD_{avg} x 2 / proof test interval [h]; at 1 year test interval

Configuration: 8 inputs (use in pairs for a physical value)
4 outputs

Device	SSF 1-channel part HFT = 0 Set ≥ 90 %	SSF 2-channel part HFT = 1 Set ≥ 60 %	Safety integrity level	PFD_{avg}	Share of the logic in the safety chain	Proof test interval [a]
2/209	90.4 %	94.6 %	SIL2	7.9×10^{-4}	7.9 %	0.3
2/209	90.4 %	94.6 %	SIL2	15.0×10^{-4}	15.0 %	0.5
2/209	90.4 %	94.6 %	SIL2	31.6×10^{-4}	31.6 %	1.0

PFH = 31.6×10^{-4} x 2 / 8760 h = 72.2×10^{-8} 1/h (share of the logic in the safety chain = 72.2 %)

Configuration: 4 inputs (use in pairs for a physical value)
2 outputs

Device	SSF 1-channel part HFT = 0 Set ≥ 90 %	SSF 2-channel part HFT = 1 Set ≥ 60 %	Safety integrity level	PFD_{avg}	Share of the logic in the safety chain	Proof test interval [a]
2/209	90.7 %	93.7 %	SIL2	4.0×10^{-4}	4.0 %	0.3
2/209	90.7 %	93.7 %	SIL2	7.9×10^{-4}	7.9 %	0.5
2/209	90.7 %	93.7 %	SIL2	15.0×10^{-4}	15.0 %	0.9
2/209	99.5 %	90.4 %	SIL2	31.7×10^{-4}	31.7 %	2.0

PFH = 16.67×10^{-4} x 2 / 8760 h = 38×10^{-8} 1/h (share of the logic in the safety chain = 38 %)

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9.2.2 Safety parameters for SIL3

In consultation with TÜV Rheinland, the PFH value for this device can be calculated as follows:

PFH = PFD_{avg} x 2 / proof test interval [h]; at 1 year test interval

Configuration: 8 inputs (use in pairs for a physical value)
4 outputs (use in pair for a safety function)

Device	SSF 1-channel part HFT = 0 Set ≥ 90 %	SSF 2-channel part HFT = 1 Set ≥ 60 %	Safety integrity level	PFD_{avg}	Share of the logic in the safety chain	Proof test interval [a]
2/209	99.5 %	90.4 %	SIL3	3.6×10^{-5}	3.6 %	0.5
2/209	99.5 %	90.4 %	SIL3	7.3×10^{-5}	7.3 %	1.0
2/209	99.5 %	90.4 %	SIL3	15.0×10^{-5}	15.0 %	2.0

PFH = 7.3×10^{-5} x 2 / 8760 h = 16.7×10^{-9} 1/h (share of the logic in the safety chain = 16.7 %)

Configuration: 4 inputs (use in pairs for a physical value)
2 outputs (use in pair for a safety function)

Device	SSF 1-channel part HFT = 0 Set ≥ 90 %	SSF 2-channel part HFT = 1 Set ≥ 60 %	Safety integrity level	PFD_{avg}	Share of the logic in the safety chain	Proof test interval [a]
2/209	99.5 %	90.4 %	SIL3	1.9×10^{-5}	1.9 %	0.5
2/209	99.5 %	90.4 %	SIL3	3.9×10^{-5}	3.9 %	1.0
2/209	99.5 %	90.4 %	SIL3	7.9×10^{-5}	7.9 %	2.0
2/209	99.5 %	90.4 %	SIL3	15.0×10^{-5}	15.0 %	3.7

PFH = 3.9×10^{-5} x 2 / 8760 h = 8.91×10^{-9} 1/h (share of the logic in the safety chain = 8.91 %)

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