Module and Application Description

PROCONTROL P

Input, Output
Signal Conditioning

Input Module for Thermocouples

4–fold

81ET02–E/R1010

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Application

The input module is used to connect the following sensors:

– PtRh–Pt thermocouples
  acc. to DIN 43710 for a measuring range of 0 ... 1760 °C
– NiCr–Ni thermocouples
  acc. to DIN 43710 for a measuring range of 0 ... 1340 °C
– Fe–CuNi thermocouples
  acc. to DIN 43710 for a measuring range of 0 ... 910 °C
– TXK thermocouples for a measuring range of 0 ... 650 °C
– NiCr–CuNi thermocouples for a meas. range of 0 ... 710 °C

Each measuring circuit is monitored separately. Up to four limit signals can be generated per measured value.

Features

This module can be plugged into any multi–purpose processing station of the PROCONTROL bus system. It is provided with a standard interface for the PROCONTROL station bus.

It transfers the converted input signals in the form of telegrams over the station bus to the PROCONTROL bus system. Prior to transfer, the telegrams are checked and marked with test flags. Thus, fault–free transfer is monitored by the receiver.

The input circuits are individually supplied with power via voltage transformers and are, therefore, electrically isolated from each other. The input signals are fed to the processing section as potential–isolated signals. This provides protection against mutual interference of bus side and process side.

Any response of the input signal monitoring function is indicated as a disturbance annunciation (ST) on the module front.

If limit values are changed via the control system operator station during operation, this is indicated (SIM) on the module front.

Measuring range and adjustment to the thermocouple used are set for each function unit using the switches provided on the module. Readjustment is not required.

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Signal conditioning and monitoring

The first function unit is described below. The others operate correspondingly.

Signal input

The thermocouple is connected to inputs E11(+) and E12(−). Its voltage is fed into a differential amplifier.

After voltage/frequency conversion and electrical isolation is completed, the output signal of the differential amplifier is applied to a 16−bit counter which adds up the incoming pulses over a period of 40 ms. The 16−bit binary value is converted into a 13−bit data word (12 bits + sign) with consideration for the set measuring range, the type of thermocouple connected and the cold junction temperature. This data word is sent to the PROCONTROL bus system.

To ensure correct evaluation of the measured value, the measuring range selected and the type of the thermocouple connected are indicated to the processing section. This is done by means of switches.

Cold junction temperature

The cold junction temperature (end of the compensation line) is measured by means of a compensation resistor used as a resistance thermometer. The resistance value is measured with a measuring bridge whose output signal controls a voltage/frequency converter. The output signal of the converter is transmitted via an optical coupler to the processing side and to a 16−bit counter. The counter adds up the incoming pulses over a period of 40 ms. By the processing section, the 16−bit binary value obtained in this way is added, with its correct sign, to the binary value of the measured thermocouple value, taking the set measuring range into account.

If the compensation line is connected to inputs E11 and E12 of the input module's connector, the XP 8669 compensation resistor is plugged into inputs R11 and R12. If the compensation line ends at a subdistributor edge−connector outside the multi−purpose processing station, the XP 8670 compensation resistor can be plugged in there. The edge−connector is then connected to module inputs R11 and R12 (see also "Connection diagrams").

In the case of local collective compensation with the aid of a thermostat (cold junction temperature e.g. 70 °C) or local cold junction correction, a suitable fixed−value resistor (81ER01) is plugged into terminals R11 and R12 of the module connector.

In the case of collective compensation for all four function units, the appropriate fixed−value resistor has to be plugged also onto terminals R21/22, R31/32 and R41/42.

Effect of interference voltages

Interference voltages on the input lines are suppressed by internal protective circuits of the module.

Input signal monitoring

The digitized input signal is monitored for plausibility against permanently set limits. The monitoring system responds if the input signal exceeds 150 % of the set measuring range or falls below −18.75 %.

In the case of a TXK thermocouple used for a measuring range of 0 ... 600 °C, the input signal monitoring function responds already when 108 % (648 °C) are reached, since the control limit of the analog input circuit is nearly reached at this value.

If 108.33 % (650 °C) are exceeded, this value is put out as a fixed value together with a disturbance bit.

In the case of a NiCr−Ni thermocouple used for a measuring range of 0 ... 1000 °C, the input signal monitoring function responds already when 130 % (1300 °C) are reached, since the control limit of the analog input circuit is nearly reached at this input value.

If 134 % (1340 °C) are exceeded, this value is put out as a fixed value together with a disturbance bit.

In the case of a NiCr−CuNi thermocouple used for a measuring range of 0 ... 600 °C, the input signal monitoring function responds already when 115 % (690 °C) are reached, since the control limit of the analog input circuit is nearly reached at this input value.

If 118.5 % (711 °C) are exceeded, this value is put out as a fixed value together with a disturbance bit.

Monitoring is performed by the microprocessor of the processing section. As soon as the monitoring function responds, the red disturbance lamp ST on the module front gives off a steady light. The disturbed measured value is transmitted, however, together with a disturbance flag. Input E11 of the module has a high−resistance negative bias. This causes the thermocouple's lower plausibility limit of −18.75 % to be exceeded in the case of an open−circuit condition and a response of the monitoring system.

The plausibility limits of the cold junction temperature are −23 °C and +72 °C. In case these values are exceeded, −50 % or +175 % respectively are transmitted together with a disturbance bit, since this may indicate a short−circuit or wire rupture at the input of the cold junction temperature measurement.

To avoid disturbance annunciations from unused function units or if exceeding the limits is desired, the input signal monitoring function can be disabled for each channel by means of contact 1 of switches S501 ... S504. The diagram shows the setting for function unit 1.

Monitoring	Function unit 1
	S501 :1
disabled	OFF
effective	ON

Linearization

The digitized input signal is linearized by the microprocessor in the processing section. For this purpose, a PROM (programmable read–only memory) is available. It includes the characteristics of the Fe–CuNi, NiCr–Ni, TXK, PtRh–Pt and NiCr–CuNi thermocouples. The measured value transmitted to the station bus corresponds, within the plausibility limits, always to the temperature measured.

Limit signals

Four limit signals for each measured value can be generated in the module. For each individual limit value any one of four different hysteresis values may be selected.

Generation of the limit signal is effected in the processing section by the microprocessor. Limit values and associated hysteresis values are written in the form of a limit value list into certain memory areas of the user PROM. For the purpose of changing these values on–line, an additional copy of the limit value list is filed in a RAM memory of the module.

A changed limit signal is indicated as an ”event” to the station bus. As soon as the input signal monitoring function responds, all limit signals assigned to the measured value (GOXX, GUXX) are set to ”0” and the disturbance bits (MXX, SXX) are set to ”1” (see Table 1). After the supply voltage has been connected, the limit values are forwarded to the station bus with a time delay.

The limit value range is 0 % ... 110 % of the respective measuring range selected.

Event generation

During normal operation, the input module is prompted cyclically by the PROCONTROL bus system to transmit its measured values. If values change within this cycle time, this is treated as an ”event”.
The input module detects as events:

– a change of a limit signal
– a response of the input signal monitoring function
– a change of a measured value by an adjustable value within a second since the last transmission to the station bus (see also ”Operating modes”).

After an event has occured, the new values are given priority when being transmitted to the PROCONTROL bus system.

Measuring temperature differentials

By means of switches, operating mode ”Measuring temperature differentials” can be selected. The following data apply:

Switch position (S501 ... S504):

Contact:	2	3	4	5	6
	ON	OFF	OFF	OFF	OFF

– Thermocouple:	NiCr–Ni			
– Max. absolute temperature:	400	...	600	˚C
– Max. temperature difference:	–100	...	+350	K
– Measuring range:	0	...	200	˚C

Switch position (S501 ... S504):

Contact:	2	3	4	5	6
	ON	OFF	OFF	OFF	ON

– Thermocouple:	Fe–CuNi			
– Max. absolute temperature:	400	...	600	˚C
– Max. temperature difference:	–75	...	+262.5	K
– Measuring range:	0	...	150	˚C

Switch position (S501 ... S504):

Contact:	2	3	4	5	6
	ON	OFF	OFF	ON	OFF

– Thermocouple:	NiCr–CuNi			
– Max. absolute temperature:	400	...	600	˚C
– Max. temperature difference:	–89.3	...	+350	K
– Measuring range:	0	...	200	˚C

The two thermocouples are connected to inputs E11 and E12 (see ”Connection diagrams”).

The compensation branch (terminals R11 and R12) remains unconnected.

The other module functions (input signal monitoring, limit signal generation, event generation) also apply to this operating mode and relate to the differential temperature signal provided by the thermocouples.

When linearization is performed by the program, an absolute temperature of 500 ˚C is assumed for one of the two thermocouples.

In the case of deviations from this temperature, a measuring error arises which corresponds to the linearity deviation of the thermocouple at this temperature.

Maximum linearity error in the range from 400 to 600 ˚C:

– Fe–CuNi +/– 0.5 ˚C
– NiCr–Ni +/– 0.2 ˚C
– NiCr–CuNi +/– 0.8 ˚C

Signal output

The module transmits the data telegrams via its standard interface to the station bus. Data transfer is performed in serial mode. Therefore, the processing section carries out a parallel/serial conversion of the data.

Signal identification

The conditioned and digitized input signals as well as the limit signals generated in the module are written into specific registers (see "Data communication ..."). The processing section writes the following information into the address section of the data telegram:

– System address (possible are 0 ... 3)
– Station address (possible are 1 ... 249)
– Module address (possible are 0 ... 58)
– Register address (possible are 0 ... 7 for signals
246 for diagnosis data)

All signals are, thus, cleary identified.

Operating modes

The input module has several switches for selecting one of the various operating modes.

Location and designation of the switches on the module are described under "Mechanical design".

Standard setting on delivery

Fe–CuNi and 0 ... 600 °C.

Choice of thermocouple

Using contacts 2, 3 and 4 of switches S501 (function unit 1) through S504 (function unit 4), the processing section can be informed, by a code, of the type of thermocouple used. The setting for function unit 1 is shown below.

Thermocouple	Function unit 1		
S501	:2	:3	:4
NiCr–Ni	OFF	OFF	OFF
Fe–CuNi	OFF	OFF	ON
PtRh–Pt	OFF	ON	OFF
TXK	OFF	ON	ON
NiCr–CuNi	ON	ON	OFF
Temperature difference-Measurement (NiCr–Ni, Fe–CuNi or NiCr–CuNi)	ON	OFF	OFF

Measuring range

The analog inputs of the module and the characteristics of the thermocouples entered into the program memory are designed for input voltages of –7.2 mV to +54.4 mV. This results in the following measuring range limits for the various thermocouples:

– NiCr–Ni –316 * ... +1340 °C
– Fe–CuNi –168 ... +910 °C
– PtRh–Pt –786 * ... +1760 °C
– TXK –134 ... +650 °C
– NiCr–CuNi –147 ... +710 °C

* = theoretical value

In case the measuring range limits are exceeded, these temperature values are put out as percentage values and are given a disturbance bit.

The representable measuring range of the module is –199 % ... +199 %. The minimum and/or maximum values actually transmitted depend on the set measuring range and on the thermocouple type according to the above table.
Below –18.75 % and above +150 %, however, the monitoring function responds (for exceptions see "Input signal monitoring") unless it is inhibited.

In the case of differential measurements, the plausibility limits depend on the type of thermocouple as follows:

– NiCr–Ni +/– 45 %
– Fe–CuNi +/– 45 %
– NiCr–CuNi +45/–44 %

Using contacts 5 and 6 of switches S501 through S504, the measuring ranges can be set for each function unit. The setting for function unit 1 is shown below.

Measuring range	Measuring start	Measuring end	S501 :5	:6
1	0 °C	150 °C	OFF	Off
2	0 °C	300 °C	OFF	ON
3	0 °C	600 °C	ON	OFF
4	0 °C	1000 °C	ON	ON

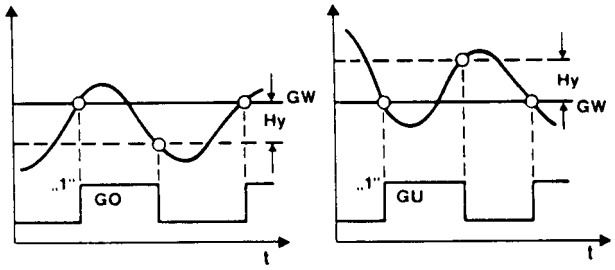
Limit signal generation

Four independent limit signals can be generated for every function unit. One of the four hysteresis values can be allocated to each individual limit value:

HY1 = 0.39 %
HY2 = 1.56 % (standard setting)
HY3 = 3.12 %
HY4 = 6.25 %

Limit value and hysteresis are written into a user PROM by programming. There are no switches provided for this purpose on the module.

The hysteresis may be above or below the limit value, depending on whether exceeding of the minimum value or the maximum value has been selected.



Upper limit value — Lower limit value

GO: Upper limit exceeded — GU: Lower limit exceeded

Figure 1: Possible limit value setting

Attention:
Even if no limit values are needed, the (empty) PROM must be plugged in for module operation. Otherwise, the module does not operate correctly.

In addition, these values are available as duplicates in a RAM. The microprocessor generally uses the RAM values. Thereby it is possible to change the values from the control system operator station or the programming, diagnosis, and display system (PDDS).

If limit values are changed from the control system operator station or the PDDS, the "SIM" lamp on the module front goes on.

In the event of a power failure, the RAM values are lost. After power supply is restored, the original PROM values needed for microprocessor operation are transferred to the RAM, thus enabling an update of the values by the above units.

Event triggering for the analog signals

Apart from direct event triggering due to a limit signal change or response of the input signal monitoring function, triggering may also be caused by an analog value change.

The processing section monitors the measured value for any change exceeding a specific percentage since the last transmission of data to the station bus took place. This percentage may be defined for each function unit as a threshold value in steps of ≥ 0,2 %, using the control system operator station. If no threshold value is programmed by the user, the module will use a value of 0.78 %.

If the processing section detects a measured value change exceeding the specified or automatically selected threshold value, it triggers an event message only if a fixed time of 1 s has expired since the last data transmission to the station bus.

Diagnosis

The processing section of the module automatically monitors the incoming signals and the processing and generation of data telegrams (self–diagnosis).

In the event of a disturbance, the type of the disturbance is filed in the diagnosis register (see "Data communication..."), and a disturbance message is simultaneously sent to the PROCONTROL system. Thereupon the diagnosis register is read out by the control system operator station for evaluation purposes.

Furthermore, it is possible at any time to request information about the present status of the module and of the data via the control system operator station (remote diagnosis).

Data communication with the module

Address formation

System and station address are identical for all modules belonging to the same multi–purpose processing station. They are set automatically and simultaneously by the station bus control module.

The module address is set automatically when the module is plugged into its specified slot of the multi–purpose processing station.

The data words of the analog input signals and the results of the diagnosis are written into specific registers of the shared memory. The number of the register is also the register address. Each data word is assigned a permanent register. This assignment takes place automatically when a process signal is connected to the process edge–connector of the module.

Reading out data

For reading out a register's contents, address information needs to be entered. Table 1 shows these address entries and the contents of the assigned registers. The addresses marked "a" can be determined by the user and depend on the place of installation of the module.

Annunciation functions

Disturbance annunciations on the module

Two red light–emitting diodes are located on the front side of the module.

Light–emitting diode ST emits a steady light when module malfunctions are detected or after the signal input monitoring function of one of the function units has responded.

Light–emitting diode SIM emits a steady light as soon as limit values have been changed on–line from the control system operator station or the PDDS.

Annunciation signals to the station bus

Events or disturbances are recognized by the processing section. Events are indicated immediately. Disturbances are stored and indicated in the diagnosis register of the module. At the same time, the signal for "General disturbance station" is set.

Type of information	Address word				Data word (bit address)															DA
	System	Station	Module	Register	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
Analog value FE1	a	a	a	0	VZ	100 %	50 %	25 %	12.5 %	6.25 %	3.125 %	1.56 %	0.78 %	0.39 %	0.195 %	0.097 %	0.048 %	MB 1		SM 1	6*
						MW1															
Binary value (out of 4 limit values) to FE1	a	a	a	1				GO 14	GU 14	M 14	GO 13	GU 13	M 13	GO 12	GU 12	M 12	GO 11	GU 11	M 11	SM 1	3
Analog value FE4	a	a	a	6	VZ	MW4												MB 4		SM 4	6*
Binary values to FE4	a	a	a	7				GO 44	GU 44	M 44	.....						GO 41	GU 41	M 41	SM 4	3
Diagnosis register	a	a	a	246	Processing and process disturbed				Bus interface disturbed				Reception disturbed				Transmission disturbed				0

Table 1 including bit significance (applies to all analog value telegrams)

Explanation:

SMX = General disturbance for individual telegram
MXX = Individual disturbance annunciation, limit value X
FEX = Function unit X
VZ = Operational sign
a = Address user–selectable (depending on the place of installation)
GOXX = Upper limit value X exceeded
GUXX = Lower limit value X exceeded
MBX = Measuring range
MWX = Digital measured value
DA = Data type

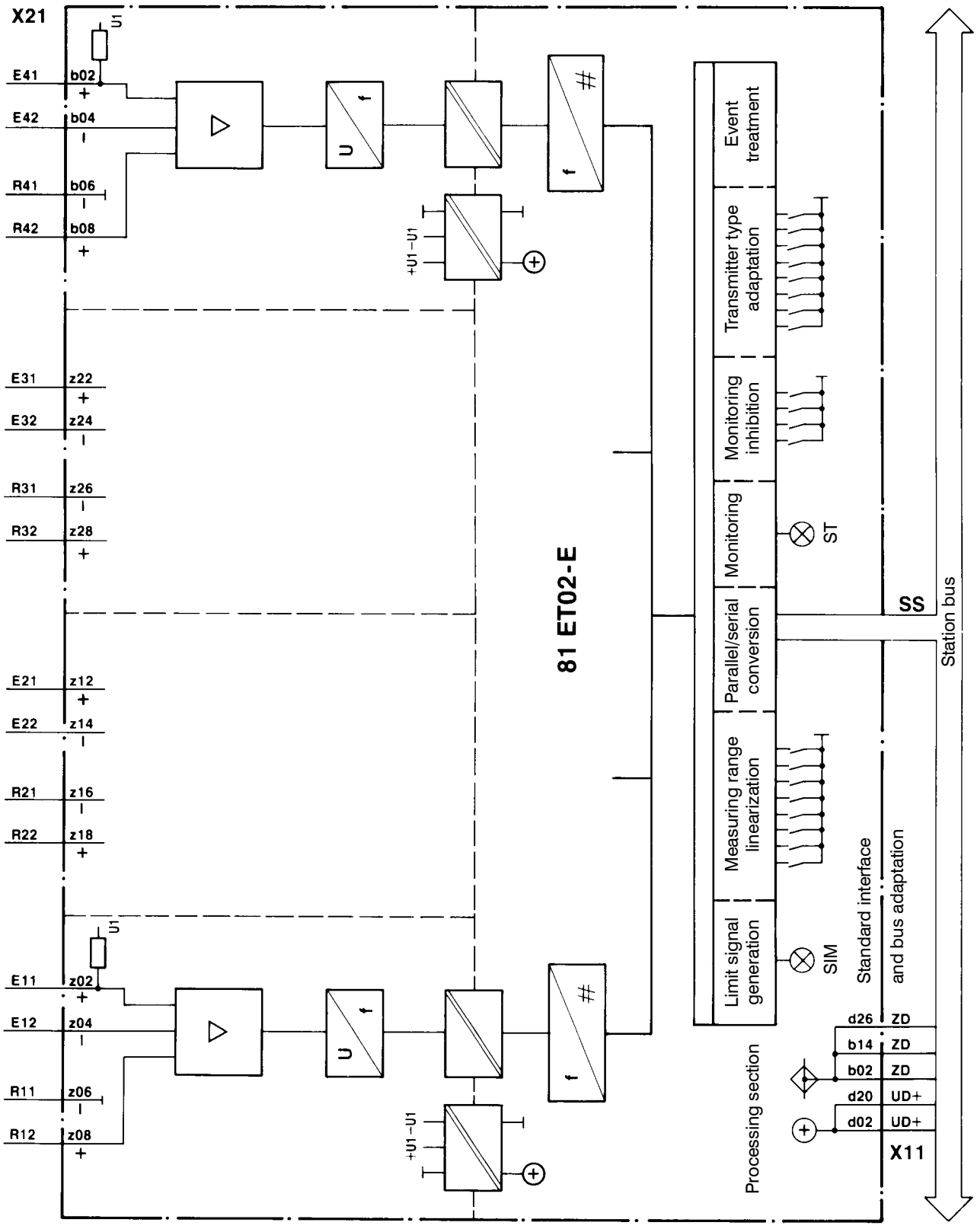
For non–programmed limit values of a function unit, the pertaining bits MXX, GUXX, and GOXX in the limit value telegram are set to ”0” as a matter of principle.

* In the case of differential measurements using NiCr–Ni or Fe–CuNi, the data type of the analog value telegrams deviates from the other operating modes DA = 7.

Function diagram

Terminal designations: The module consists of a printed circuit board (see ”“Mechanical design”). The p.c.b. is equipped with connectors X21 and X11. Connector X21 includes all process inputs.

Connector X11 contains the standard interface with the station bus and the operating voltages for the module.



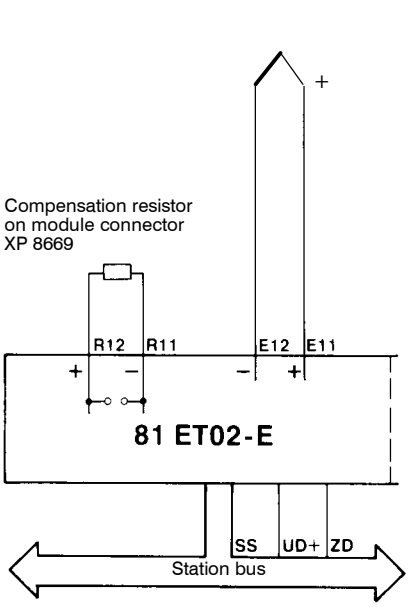
* Proper functioning of the module requires terminal X11/d18 to be connected to ZD (once per subrack).

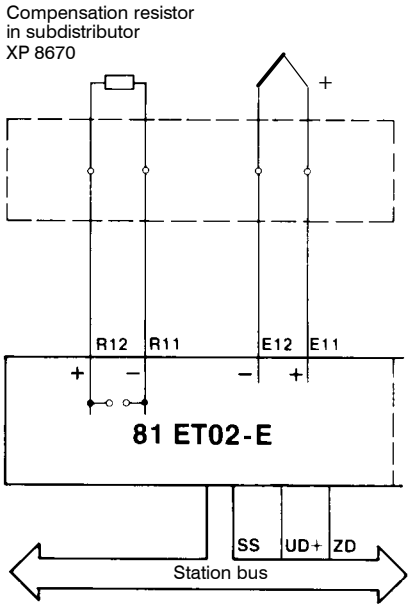
Connection diagrams

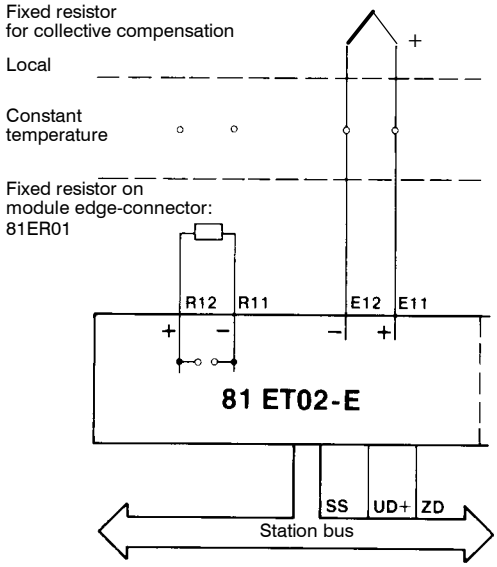
Compensation line up to subdistributor (SD) outside of multi–purpose processing station.

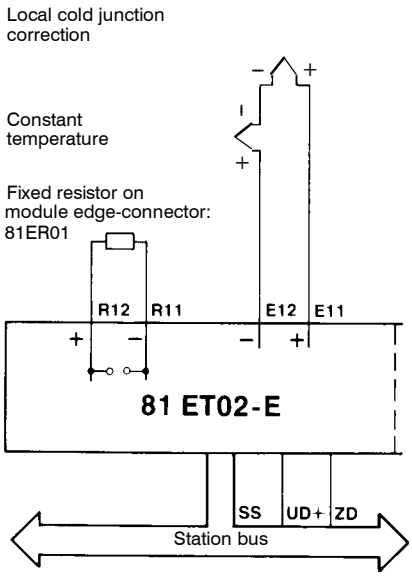
The resistor of the compensation line from SD up to the module inputs falsifies the measurement acc. to the following relationship:

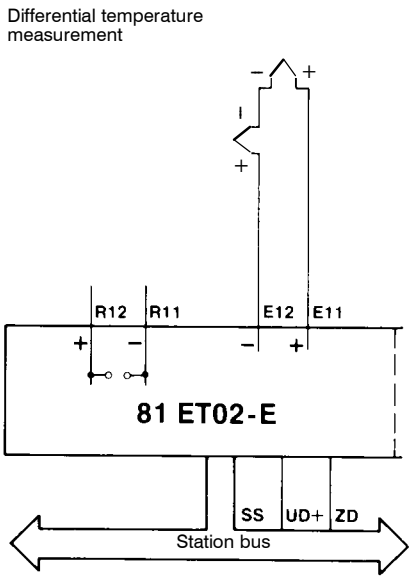
$$\Delta\delta = \frac{-R_{wire}}{6.82\ Ohm/K}$$











Mechanical design

Board size: 6 units, 1 division, 160 mm deep

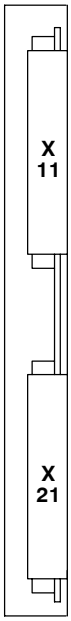
Connector: acc. to DIN 41612

1 x for station bus connection,
48–pole, edge–connector type F
(connector X11)

1 x for process connection,
32–pole, edge–connector type F
(connector X21)

Weight: approx. 0.6 kg

View of connector side:

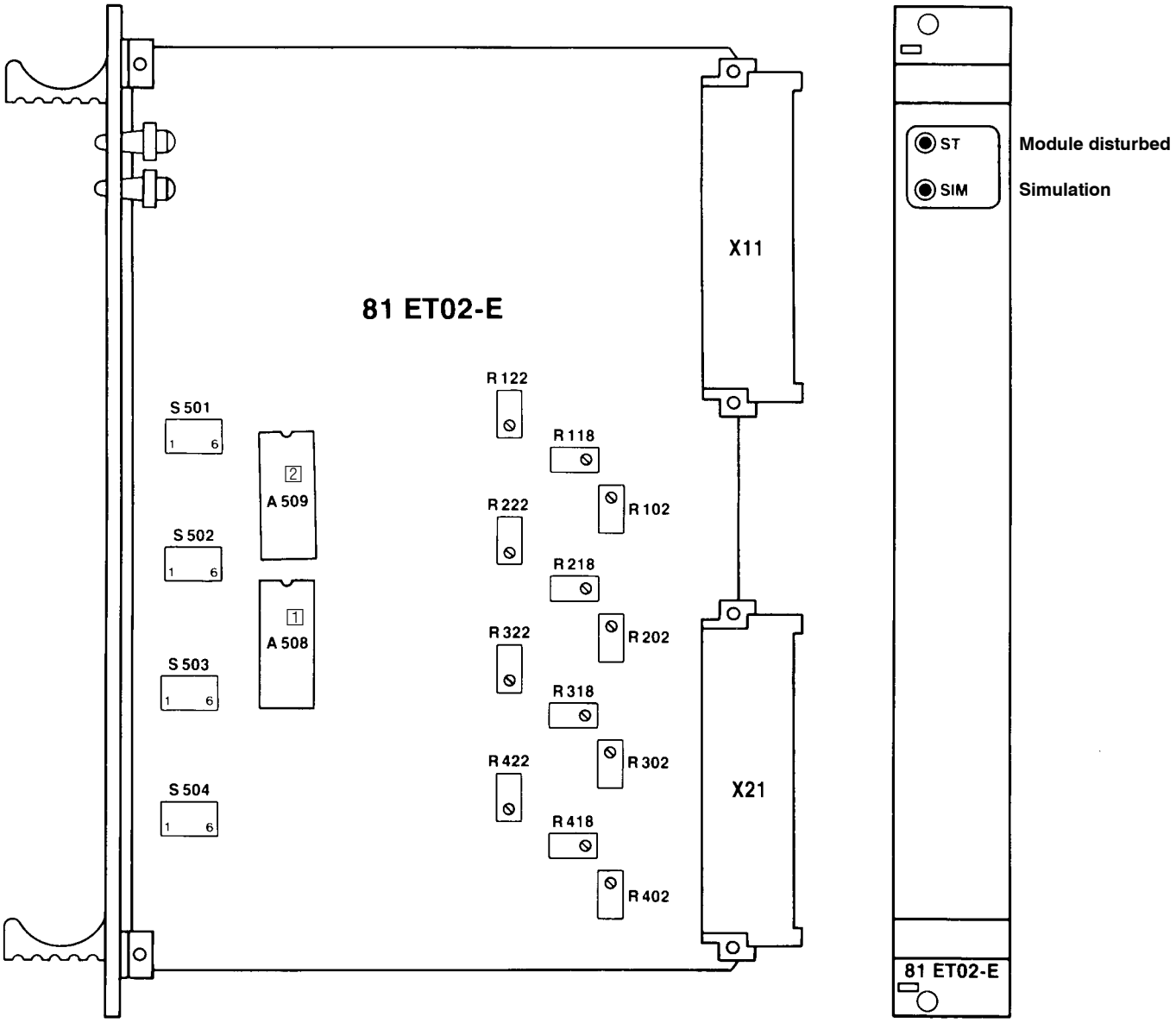


Contact assignments of process connector X21

View of contact side:

	b	*z*
02	E41	E11
04	E42	E12
06	R41	R11
08	R42	R12
10		
12		E21
14		E22
16		R21
18		R22
20		
22		E31
24		E32
26		R31
28		R32
30		
32		

Position of switches, trimmers, and pluggable memory modules; view of module front



Memory module:		Order number: (component)	Order number: (programmed PROM)
1 Limit value EPROM	A508	HETN400795P1	–
2 EPROM for bus and module program	A509	–	GJR2353402Pxxxx *)

*) xxxx = indicating the applicable program version

Technical data

In addition to the system data, the following values apply:

Power supply

Operating voltage	+ 5 V
Current assumption	1.6 A
Reference potential	0 V
Power dissipation	8 W

Input values

Thermocouple transmitter voltage	– 10 ... +54 mV
Input resistance	≥ 1.5 MOhm
Transmitter voltage for compensation resistor	< 1.5 V
Measuring current	< 1 mA
Common–mode rejection	> 120 dB
Normal–mode rejection at 50 Hz	> 60 dB
Normal–mode rejection at 60 Hz	> 20 dB

Output values

SS – standard interface with station bus

Transmission values

Error rate in as–delivered condition	< 0.1 %
Quantization error	< 0.025 %
Linearity error	< 0.2 %
Response to temperature changes	
narrowest measuring range (NiCr–Ni 0 ... 150 °C)	< 200 ppm/K
typical	< 120 ppm/K
widest measuring range (NiCr–Ni 0 ... 1000 °C)	< 50 ppm/K
typical	< 20 ppm/K
Cold junction influence in temperature range of 0 ... 70 °C	< 0.1 %
Effect of supply voltage variation (4.75 ... 5.25 V)	none
Error due to digital linearization	< 0.1 %
Total error including aging (through all measuring ranges)	< 0.6 %

ORDERING DATA

Complete module:

Type designation: 81ET02–E/R1010 Order number: GJR2374600R1010

Memory modules: see ”Mechanical design”

Technical data subject to change without notice!

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