Module and Application Description

PROCONTROL P
Input, Output, Signal Conditioning

Input Module for Analog Signals
14-fold, 0/4 … 20 mA, 0 … 5 mA

81EU01-E/R3410

Application

The input module is used as a substitute for the following input modules with transducers:

81EA03-E/R1010
- 2-wire transducers for 4 … 20 mA with supply from the module
- 4-wire transducers for 0/4 … 20 mA or 0 … 5 mA with external power supply

The module incorporates a total of 14 function units. Each function unit may be used for any type of input mode. Any combination is possible. The allocation as well as the settings of all the parameters can be programmed easily using the configuration list. The programmed values are stored in an EEPROM to ensure that they are not lost in the event of a power failure. They can be changed any time.

Every analog signal can be assigned up to 4 limit values. In an input module, up to 4 independent correction or filter calculations can be carried out. Programming is done by structuring the function blocks. The conditions for this application have to be taken into account.

Features

The module can be plugged into any PROCONTROL station with an external power supply unit. It is equipped with a standard interface for the PROCONTROL station bus.

The module transmits the input signals or converted input signals in the form of telegrams over the station bus to the PROCONTROL bus system. Before transmission, the telegrams are checked and marked with test flags. This ensures that the receiving module can check them for error-free transmission.

The telegrams received over the station bus, e.g. for correction calculations, are checked by the module for error-free transmission based on their test flags.

Provision is made to eliminate interference among the function units of the module and the station bus.

For each function unit, a short-circuit-proof and monitored transmitter power supply is available in case a 2-wire transducer for a range of 4 … 20 mA is connected.

A response of the internal monitoring circuits or of the input signal monitoring function is indicated in the form of a disturbance annunciation ST (general disturbance) on the front panel of the module.

Application with analog transmitters

Types of transmitters

The function units of the module can be used for

- 2-wire transducers for 4 … 20 mA with supply from the input module
- 4-wire transducers for 0 … 20 mA, 4 … 20 mA and 0 … 5 mA with external power supply

For the applicable type of connection please refer to the connection diagrams.

For programming the application-specific settings please refer to the configuration list.

Transducer power supply

The transducer power supply from the input module is short-circuit-proof, coming via the respective supply output Sn, and is monitored inside the input module.

If a transducer is supplied by an external power source, the supply contact of the respective function unit remains free.

The maximum potential difference between the reference potentials in the case of externally provided power supply has to be taken into consideration.

It is not permissible to connect several Sn supply outputs in parallel.
Analog signal input circuit and monitoring

At a high-accuracy measuring resistor, the input current signal is converted into a measuring voltage, connected to the input instrument amplifier via a multiplexer and, after that, converted into a digital 12-bit analog signal by an A/D converter.

The input instrument amplifier and the A/D converter are monitored with the help of reference voltages.

The analog signals are monitored for plausibility inside the module. The monitoring function responds as soon as an upper limit (OG) or a lower limit (UG) is violated.

These limits can be modified via the configuration list. They are preset by default to 118.75 % for the upper limit and to -6.25 % for the lower limit.

The plausibility monitoring function can be suppressed separately for each function unit. For this purpose, the maximum values for the upper and lower limits need to be entered into the configuration list.

The digital 12-bit signal is completed by the correct sign and is sent by the input module as a telegram to the station bus. As soon as the analog signal monitoring responds, the analog value telegram will be sent with the disturbance bit set.

If an input is overloaded due to faulty circuitry, for instance, the function unit concerned is switched off immediately. The ‘Process channel fault’ message in the diagnosis register and the disturbance bit set in the data telegram indicate that a fault has occurred in the function unit concerned. Every 30 seconds, there will be a new attempt to reactivate the disconnected function unit.

Application for correction and filter calculations

When being used for analog signal input, the following function units are available on the module for correcting flow rate and level measurements as well as for filtering measured values:

- Correcting function for flow-rate measurement for water/steam KOR1
- Correcting function for flow-rate measurement for gases with a variable reference pressure KOR3
- Correcting function for level measurement NIV
- Non-linear filter FIL

One function block can be used per function unit.

Function blocks KOR1, KOR3 and NIV contain the FIL function.

The function blocks include inputs for specifying the correcting quantity and basic calculation values, and outputs for issuing the corrected value and the internal status messages. The outputs of the function blocks for corrected values are allocated to the analog value telegrams of the associated function unit.

In order to be able to perform the correction, the inputs of the function blocks must be assigned module inputs, signals from the station bus, and fixed values. These are defined by the user.

This procedure is referred to as structuring. The structure list includes all of the information. The list is stored in the EEPROM of the module.

The exact procedure of structuring the function blocks is described in the function block descriptions.

For structuring, the following limit values of the module have to be considered:

- Max. number of the function blocks 4
- Max. number of the signals from the bus 20
- Max. function blocks for each function unit 1

When function blocks are being used, the respective module cycle time is increased by the specified computation time of the function block.

The cycle time required for structure processing is calculated automatically by the module and stored in module register 205. It can be read there by the PDDS.

The corrected analog values are sent to the PROCONTROL bus system in the form of a telegram. In addition, it is possible to output the uncorrected raw values as a telegram as well.

Telegrams for the function blocks, received from the bus, may be disturbed and carry a disturbance bit. The module uses the value in this telegram for calculating and forwards the calculated value as a telegram containing a disturbance bit.

The module incorporates a monitoring function for cyclic renewal of the telegrams to be received from the bus. If a signal has not been renewed for a certain time (e.g. due to failure of the sending module), the receive monitoring function in the module will respond. This function sets the disturbance bit in the receive register allocated to the telegram. The module then uses the value transferred last with this telegram for calculating and forwards the calculated value together with a disturbance bit.

Limit signals

When the module is used for analog signal input, up to 4 limit values can be programmed on the module for each function unit. For each limit value, one of four hysteresis values can be chosen.

Programming is done with the PDDS using the limit value list. The limit value list is saved in the EEPROM on the module.

For making subsequent changes, the limit value list can be filed in a RAM memory. This information is lost, however, if a power failure occurs. In such a case, the module switches immediately over to the list in the EEPROM. If the limit value list has been loaded both into the EEPROM and into the RAM, the list processing will be performed in the mode defined by the PDDS, i.e. EEPROM/RAM.

In the event mode, any violation of a limit value is immediately indicated to the station bus in the form of a limit signal telegram. The same happens when the input signal monitoring feature responds, but in this case together with the associated analog value telegram. The associated disturbance bits of the analog value and limit signal telegram will be set. All the limit values assigned to the analog value are set to "0".

The limit value range is within -150 % ... +150 % of the set signal range.
The following hysteresis values can be set individually for each limit value:
- HY1 = 0.39 %
- HY2 = 1.56 % (default setting)
- HY3 = 3.12 %
- HY4 = 6.25 %

The hysteresis may be above or below the limit value, depending on whether minimum value underflow or maximum value overflow has been selected (cf. Figure 1).

Adjustable analog value change: 0.2 % ... 6.8 %
Default setting: 1.56 %

Adjustable time value: 40 msec, 200 msec
Default setting: 200 msec

The values in the configuration list are set using the PDDS.

**Simulation**

A maximum of 32 signals can be simulated.

**Simulation of send registers**

It is possible to simulate the send registers of the analog transmitters by means of the PDDS. All of the send registers can be simulated.

**Simulation of receive registers**

Receive register simulation is possible with the function blocks for correction and filter calculations using the PDDS. It is possible to simulate all of the bus signals.

**Event generation**

The input module transmits its information in the form of telegrams to the station bus, either cyclically or in the event mode.

In the event mode, data are transmitted whenever analog values in the module have changed. In this case, the cyclic mode is interrupted and the module is immediately granted the permission to transmit.

When analog transmitters are connected, the module interprets the following occurrences as events:
- Response of a limit signal
- Response of a monitoring function
- Change of an analog value by an adjustable threshold value within an adjustable time span since the last transmission to the station bus.

As soon as the module detects an analog value change by more than the specified value, it will initiate an event transfer if the set time value has been exceeded since the last transfer as well.

Adjustable analog value change: 0.2 % ... 6.8 %
Default setting: 1.56 %

Adjustable time value: 40 msec, 200 msec
Default setting: 200 msec

**Table 1**: Configuration list

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value range</th>
<th>PDDS default setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transducer type, measuring range</td>
<td>0 ... 20 mA, 4 ... 20 mA, 0 ... 5 mA</td>
<td>0 ... 20 mA</td>
</tr>
<tr>
<td>Lower plausibility limit</td>
<td>-200 ... 0 %</td>
<td>-6.25 %</td>
</tr>
<tr>
<td>Upper plausibility limit</td>
<td>0 ... 199.9 %</td>
<td>118.75 %</td>
</tr>
<tr>
<td>Threshold</td>
<td>0.2 ... 6.8 % (increments approx. 0.2 %)</td>
<td>1.56 %</td>
</tr>
<tr>
<td>Timeout</td>
<td>40, 200 msec</td>
<td>200 msec</td>
</tr>
<tr>
<td>Raw value send</td>
<td>Yes, No</td>
<td>No</td>
</tr>
<tr>
<td>Number of the function block</td>
<td>(1 ... 4), KOR1, KOR3, NIV, FIL</td>
<td>-</td>
</tr>
<tr>
<td>Filter function</td>
<td>16 2/3, 50, 60 Hz</td>
<td>50 Hz</td>
</tr>
</tbody>
</table>

**Figure 1**: Options for limit value setting

When function blocks are used, the limit signals are always derived from the corrected analog value.

When a analog transmitters are connected, the module interprets the following occurrences as events:
- After transmission of the configuration list, the module fully participates in bus communication. The lamp goes off.
- Response of a limit signal
- Response of a monitoring function
- Change of an analog value by an adjustable threshold value within an adjustable time span since the last transmission to the station bus.

The type of application and the setting values need to be loaded in the form of a configuration list before the module can take up operation. Before that, all process inputs of the module are given a high-resistance bias and the module transmits no data telegrams on the bus. The ST lamp indicates the presence of a disturbance. Nevertheless, the module can receive information over the bus. After transmission of the configuration list to be transmitted by the PDDS.

The configuration list contains all the settings required by the module, listed according to function units (Table 1).

Settings can be made within the defined range of values. The column for standard settings contains the default value which is entered if no other value is set.
Signal output to the PROCONTROL bus

The module sends the data telegrams over its standard station bus interface. The data are transferred serially.

Signal identification

The conditioned and digitized input signals as well as the limit signals formed in the module are written into special registers. The processing section writes the following data into the address part of the data telegram:

- System address (within 0 ... 3)
- Station address (within 1 ... 249)
- Module address (within 0 ... 58)
- Register address (within 0 ... 27 for analog values and limit signals
  100 for status message
  101 ... 104 for raw values
  205 for module cycle time
  246 for diagnostic data)

Data communication with the module

Address formation

System and station addresses are identical for all the modules of a PROCONTROL station. They are set automatically by the station-bus control module.

The module address is set automatically when the module is plugged into the slot reserved in the PROCONTROL station.

The data words of the input signals and the results of the diagnosis are written into special registers of the shared memory. The register number also serves as the register address. A register is permanently assigned to each data word. This assignment is done automatically when a process signal is connected to the process connector of the module.

For unassigned function units, no telegrams will be sent.

If all of the four possible limit values of an existing input signal remain unprogrammed, the associated limit signal telegram will not be sent.

In the case of incompletely programmed limit values of an input signal, the respective bits of the unprogrammed limit values in the limit signal telegram are always set to "0".

Reading the data

Address data are needed for reading the contents of a register. Tables 2 and 3 show these address data and the contents of the individual registers.

Diagnosis and annunciation functions

Disturbance annunciations on the module

Disturbances are indicated by an LED on the module front:

- Disturbance ST

Light-emitting diode ST indicates all module disturbances and data communication disturbances involving the module.

Disturbance signals to the annunciation system

The annunciation system or the control diagnosis system CDS receive the disturbance messages from the input module via the bus.

Diagnosis

Inside the module's processing section, the telegrams received and the formation of the telegrams to be sent as well as the internal signal processing functions are monitored for fault-free condition (self-diagnosis).

In the event of a disturbance, the fault type is written into the diagnosis register and a disturbance signal is sent to the PROCONTROL system.

Upon request, the module sends a telegram with the data stored in the diagnosis register (register 246) (cf. Figure 2).

The contents of the diagnosis register, the message on the general disturbance line, the messages on the CDS and the ST lamp are shown in Figure 2.

If the "Process channel fault" message is indicated in the diagnosis register, this may be due to one of the following reasons:

- Analog signal not plausible, i.e. the values are smaller or greater than the set plausibility limits
- Disturbance of the internal reference values of the analog inputs
- Transmitter monitoring responded
- Input monitoring responded

If the "Processing fault" is indicated in the diagnosis register, this may be due to one of the following reasons:

- Invalid configuration list
- Internal module voltages disturbed
- Hardware defect on the module
### Table 2: Register allocation and bit significance of the telegrams

**Explanation:**

- **FE** = Function unit
- **SM** = General disturbance signal telegram
- **VZ** = Sign
- **MWn** = Digital measured value
- **Mn** = Single disturbance signal
- **GOn** = Max. limit value n overflow
- **GUn** = Min. limit value n underflow
- **DA** = Data type
- **a** = Address according to location

**Please note:** In limit signals (non-disturbed), the two bits GU and GO are always non-equivalent.

### Table 3: Register allocation and bit significance of the additional telegrams for structuring

**Explanation:**

- **DA** = Data type
- **SM** = General disturbance signal telegram
- **VZ** = Sign
- **MFn** = Status message (signal outputs of function blocks)
- **a** = Address according to location

**Please note:** The telegrams of registers 101 to 104 are sent only if the raw values are output as well and the associated correcting function is structured.
Figure 2: 81EU01/R3410 diagnostic messages

*) The control diagnosis system (CDS) provides a description for every message number. Among other data, this description contains:
- Information on cause and effect of the disturbance
- Recommendations for elimination of the fault.
This ensures quick elimination of a disturbance.
Function diagram

Terminal designations: The module consists of a printed-circuit board (cf. "Mechanical design"). The printed-circuit board is equipped with connectors X21 and X11. Connector X21 contains all of the process inputs. Connector X11 contains the standard station bus interface and the operating voltages for the module.
Connection diagrams

**2-wire transducer**

2-wire transducers for 4 … 20 mA with supply from the module

![Diagram of 2-wire transducer](image)

Max. static potential difference between the reference potentials \( \leq 0.5 \) V

**4-wire transducer**

4-wire transducers for 0/4 … 20 mA and 0 … 5 mA with external power supply

![Diagram of 4-wire transducer](image)
### Mechanical design

- **Board size:** 6 units, 1 division, 160 mm deep
- **Connector:** to DIN 41612
  - 1 x for station bus connection, 48-pin edge-connector, type F (connector X11)
  - 1 x for process connection, 32-pin edge-connector, type F (connector X21)
- **Weight:** approx. 0.6 kg

View of connector side:

![Connector Diagram]

### Contact assignments of the X21 process connector

View of contact side:

<table>
<thead>
<tr>
<th></th>
<th>b</th>
<th>z</th>
</tr>
</thead>
<tbody>
<tr>
<td>02</td>
<td>E09</td>
<td>E01</td>
</tr>
<tr>
<td>04</td>
<td>S09</td>
<td>S01</td>
</tr>
<tr>
<td>06</td>
<td>E10</td>
<td>E02</td>
</tr>
<tr>
<td>08</td>
<td>S10</td>
<td>S02</td>
</tr>
<tr>
<td>10</td>
<td>E11</td>
<td>E03</td>
</tr>
<tr>
<td>12</td>
<td>S11</td>
<td>S03</td>
</tr>
<tr>
<td>14</td>
<td>E12</td>
<td>E04</td>
</tr>
<tr>
<td>16</td>
<td>S12</td>
<td>S04</td>
</tr>
<tr>
<td>18</td>
<td>E13</td>
<td>E05</td>
</tr>
<tr>
<td>20</td>
<td>S13</td>
<td>S05</td>
</tr>
<tr>
<td>22</td>
<td>E14</td>
<td>E06</td>
</tr>
<tr>
<td>24</td>
<td>S14</td>
<td>S06</td>
</tr>
<tr>
<td>26</td>
<td>Z1</td>
<td>E07</td>
</tr>
<tr>
<td>28</td>
<td>Z2</td>
<td>S07</td>
</tr>
<tr>
<td>30</td>
<td>Z3</td>
<td>E08</td>
</tr>
<tr>
<td>32</td>
<td>Z4</td>
<td>S08</td>
</tr>
</tbody>
</table>
Side view and view of the module front

[Diagram showing side view and front view of the module with labeled parts X11 and X21.]

1 EPROM programmed order number: GJR2403645Pxxxx
   xxxx = Position number according to the applicable program version.
Technical data

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

**Power supply**

<table>
<thead>
<tr>
<th>Operating voltage UD</th>
<th>4.9 ... 5.1 V, typ. 5.0 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power consumption at UD = 5 V</td>
<td>220 mA</td>
</tr>
<tr>
<td>Operating voltage US</td>
<td>19.5 ... 30 V, typ. 24 V</td>
</tr>
<tr>
<td>Power consumption at US = 24 V</td>
<td>Configuration Basic current + per FU (with act. transducer)</td>
</tr>
<tr>
<td>(depending on the type of configuration)</td>
<td>2-wire transd. 140 mA 7 mA + measuring current</td>
</tr>
<tr>
<td></td>
<td>4-wire transd. 140 mA 7 mA + measuring current</td>
</tr>
<tr>
<td></td>
<td>5.5 ... 10.0 W</td>
</tr>
<tr>
<td></td>
<td>depending on operating voltage and configuration</td>
</tr>
<tr>
<td></td>
<td>Approximation formula:</td>
</tr>
<tr>
<td></td>
<td>5.5 W + 24 V • (0.2 • ∑ current per FU with active transducer)</td>
</tr>
</tbody>
</table>

**Analog transmitter**

**Input values**

<table>
<thead>
<tr>
<th>Input current, nominal range (corresponds to 0 ... 100 %)</th>
<th>0 ... 5 mA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 ... 20 mA</td>
</tr>
<tr>
<td></td>
<td>4 ... 20 mA</td>
</tr>
<tr>
<td>Maximum range</td>
<td>-1 ... 30 mA</td>
</tr>
<tr>
<td>Measuring resistor</td>
<td>± 50 mA</td>
</tr>
<tr>
<td>Destruction limits</td>
<td>≤ 100 ohms</td>
</tr>
<tr>
<td>Line resistance (forward and return line)</td>
<td>≤ 1000 m</td>
</tr>
</tbody>
</table>

**Accuracy**

All data are based on 100 % of the signal range final value (20 mA, unless specified otherwise)

<table>
<thead>
<tr>
<th>Accuracy (over a temperature range of 0 to 70 °C, aging, voltage range)</th>
<th>&lt; 0.3 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy in as-delivered condition (23 °C)</td>
<td>&lt; 0.1 %</td>
</tr>
<tr>
<td>Quantization error</td>
<td>&lt; 0.02 %</td>
</tr>
<tr>
<td>Linearity error</td>
<td>&lt; 0.1 %</td>
</tr>
<tr>
<td>Temperature sensitivity</td>
<td>&lt; 50 ppm/K (typ. 30 ppm/K)</td>
</tr>
<tr>
<td>Errors due to digital linearization</td>
<td>1 LSB</td>
</tr>
<tr>
<td>Resolution, at 0 ... 20 mA</td>
<td>12 bits</td>
</tr>
<tr>
<td>at 4 ... 20 mA</td>
<td>12 bits</td>
</tr>
<tr>
<td>Common-mode rejection</td>
<td>120 dB</td>
</tr>
<tr>
<td>Normal-mode rejection at 16 2/3, 50 and 60 Hz</td>
<td>50 dB</td>
</tr>
</tbody>
</table>

**Transducer power supply**

<table>
<thead>
<tr>
<th>Output voltage at I ≤ 25 mA</th>
<th>US – 4.5 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output voltage at I ≤ 50 mA</td>
<td>US – 5.5 V</td>
</tr>
<tr>
<td>Output current</td>
<td>max. 50 mA</td>
</tr>
<tr>
<td>Loading of outputs Z1 ... Z4, in each case</td>
<td>± 50 mA</td>
</tr>
<tr>
<td>Stat. potential difference between reference potentials of the external power supply</td>
<td>≤ 0.5 V</td>
</tr>
</tbody>
</table>
Times

Processing time
For complete module
- Analog transmitters, without function blocks 80 msec
- Additional times if function blocks are used (for each function):
  - KOR1 105 msec
  - KOR3 125 msec
  - NIV 105 msec
  - FIL 70 msec

Initialization time
Upon power connection or when the module is plugged in
- Without function blocks being used 1 ... 12 sec
- With function blocks being used 2 ... 22 sec

Interference immunity (of the process inputs and outputs)
- Electrostatic discharge immunity DIN EN 61000-4-2 8 kV / 4 kV
- Radiated, radio-frequency, electromagnetic field, immunity DIN EN 61000-4-3 10V/m
- Electrical fast transient/burst immunity DIN EN 61000-4-4 2 kV
- Surge Immunity DIN EN 61000-4-5 2 kV / 1 kV
- Conducted disturbances immunity DIN EN 61000-4-6 10 V

ORDERING DATA

Order no. for complete module:
Type designation: 81EU01-E/R3410 Order number: GJR2403600R3410

Technical data are subject to change without notice!