

Employer
SAKO BRNO A.S.

Project
**High-efficient combined heat and power facility utilizing renewable sources (OHB
II - line K1)**

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PART III, APPENDIX 14.6

INSTRUMENTATION FOR PROCESS



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1. GENERAL

1.1 Introduction

This document specifies requirements to instrumentation of the entire plant including instrumentation inside panels. All instruments and interfaces to consumers shall be controlled and supervised by the CMS.

A short guideline for electrical installation of electrical components is included in section 4 of this document.

Instrumentation covers all the necessary devices/electronics that are needed to collect the plant signals, both analog information as well as Boolean information.

The instrumentation shall consist of intelligent signal collecting devices that transfers the information to the CMS.

Definitions:

- Sw Switches with contact interface
- Ps Proximity switches with NPN or PNP output
- Sxb Local intelligent device for boolean signals, transmitted via bus
- Tx. Analog transmitters 4..20mA signals

All transmitters shall in general be connected to the CMS via hardwire AI 4-20 mA or DI/DO 24V DC . If the transmitter does not have a bus interface another transmitter must be found, or alternatively a 4..20mA signal can be used. The transmitters shall be powered via the communication cable.

It is intended to use intelligent transmitters.

The final concept shall be developed by the Contractor and presented to the Employer for approval.

1.2 General demands, the responsibility of the Contractor

The instrumentation shall comply with the specifications, to be suitable for use in the actual application.

All bus components shall provide the needed process information to the CMS. The components shall also be maintainable from the CMS, Engineering level, where it shall be possible to maintain the settings and view the O&M information from the components.

All instruments shall be of accuracy class 1 or higher. Indications shall be in SI units. The Contractor shall propose the type of SI units displayed in the Control Room and on local displays to be approved by the Employer.

Instruments shall be designed for cleaning with high pressure water cleaning.

Instruments shall as a minimum have Enclosure Class IP 65, unless otherwise stated in section 2.

Only pressure transmitter should have local display. The local display can be integrated into the instrument or as a stand-alone display.

Instrument pipes, measuring points, thermowells, instrument stands, etc. shall be installed in accordance with Appendix A14.5a and A14.5b "*Measurement Connections - Flue Gas/Air Systems*" and "*Measurement Connections - Water/Steam Systems*", respectively.

Documentation of instruments shall be in accordance with A14.7 *Documentation*.

Labelling of instruments shall be in accordance with A14.8 *Identification and Labelling of Components*.

For non-bus components a HARTING M12 connection shall be used for quick instrument change.

Permissible ambient temperature: -20 to +65°C.

Accuracy analog instruments:
 $\leq 0.3\%$ of full scale (FS),

Zero-point drift as a function of ambient temperature:
 $\leq 0.3\%$ of FS / 10° at 0-65°C.

Amplification variation as a function of ambient temperature:
 $\leq 0.3\%$ of FS / 10° at 0-65° C.

1.3 Arrangement

All transmitters and local indicating instruments shall be fixed approximately 1.5 m above floor- or gallery level in order to ensure simple and comfortable maintenance, service and operation.

Indicating instruments shall be supplied with a dial, the diameter of which shall be at least 100 mm.

1.4 Analog Classical Transmitters

Two-wire transmitter with output signal 4-20 mA.

Loading resistance: $\geq 500 \text{ } \Omega$ at 20 V DC.

1.5 Binary and Proximity Switches

In general, the following applies for binary switches:

The switch shall be a self-cleaning spring contact of precious metal and may not corrode in sulphur- and chlorine-containing atmosphere, or for proximity switches have an NPN or PNP interface to the CMS.

Speed switches shall have internal pulse detection, with a logic "1" signal for "pulses".

Electrical Properties

The switch shall be designed for low current, i.e. voltage over open switch is 24 V DC (resistance over open switch > 10 k Ω).

The minimum current load of the switch shall not be expected to exceed 1 mA, and continuous maximum load is expected to be 150 mA.

1.6 Instrumentation in panels

Refer to Appendix A6 *Technical Specifications for Electrical Equipment* for details.

1.7 Valves

To be supplied with 24 V DC coils, for direct connection to DO signals (current < 50 mA), together with proximity switches

1.8 Pneumatic actuators

Actuators with proximity feedback. Valve blocks of high quality. Unique overall installation.

2. INSTRUMENTS

Various instruments are described in the following. The connection to CMS is described on basis of a classical connection to CMS. If bus technology is used, the connection from the instrument to CMS shall be based on the chosen technology.

2.1 Temperature measurement with Pt 100

2.1.1 PT 100 ELEMENT AND TRANSMITTER

The Pt 100 sensors shall be supplied with the transmitter built into the sensor head (head transmitter). It shall be possible to change the sensor without disconnecting the transmitter.

Physically, the Pt100 sensor shall correspond to the sensor thermowell.

Termination between sensor and transmitter shall be with screw termination.

Type:	According to DIN 43760 class B 1/3 DIN depending on use.
Output:	Two-wire/four-wire if transmitter and sensor are not one unit.
Time constant with pocket	Time constant for 90% of change for $v = 0.4$ m/sec. Water: $t < 80$ sec. Air: $t < 400$ sec.
Enclosure class:	Minimum IP 65

Resistance Temperature detectors (4 wire) is allowed to be used for the cable distance lower than 10 meters between the instrument and the RIO cabinets with RTD INPUT module.

2.1.2 PT100 ELEMENT

Input:	Pt 100 three-wire according to DIN 43760
Scale:	Adjustable / optional
Indication:	Built-in local indication, SI-units
Load:	Min. 400Ω
Accuracy incl. hysteresis, linearity and repeat accuracy:	Min. $\pm 0.5\%$ of full scale (FS), cf. VDE/VDI 2184
Current limiter max.:	40 mA

The space within the thermowell shall be filled with thermally resistant grease or oil in order to minimize the difference of temperature between the sensor and the thermowell. No thermopaste may be used.

2.2 Temperature measurement with Thermocouple

The Contract Object comprises thermowell, thermocouple and transmitter.

Measurement by thermocouple shall be used at temperatures over 600 °C. The thermocouple and transmitter shall be independently replaceable.

Thermocouple and transmitter shall be installed as two separate units. A compensation cable with a connection unit intended for the specific thermocouple shall be used between the thermocouple and the transmitter. The maximum allowable length of the compensation cable is 3 m.

Connection shall be through screw termination. Plug connection shall be applied, if the thermocouple is considered a wear part with a short lifetime and need for frequent exchange.

Temperature detector is allowed to be used for the cable distance lower than 10 meters between the instrument and the RIO cabinets with temperature detector INPUT module.

2.2.1 THERMOCOUPLE

Input:	Thermocouple – IEC 60584
Indication:	Built-in local indication, SI-units
EMC data:	EN 61000-6-4 and EN 61000-6-1
Accuracy incl. hysteresis, linearity and repeat accuracy:	$\leq 0.2\%$ of FS
I _{max.} :	100 mA

Compensation for cold junction shall be built into the transmitter.

2.2.2 PLACEMENT OF TRANSMITTERS

General when designing temperature transmitters, it must be taken into consideration that there are certain places where it is so hot that head transmitters are impossible to mount. In these locations a box should be placed nearby with the transmitter.

2.3 Temperature Switch

Enclosure class:	Min. IP 65
Ambient temperature:	-20 to +65°C

Construction

The switch shall be a potential-free changeover contact or a separate make-and-break contact with mechanical connection in order to prevent double 1-signal.

The switch shall be a self-cleaning spring contact of precious metal and may not corrode in sulphur- and chlorine-containing atmosphere.

Electrical Properties

The switch shall be designed for low current, i.e. voltage over open switch is 24 V DC (resistance over open switch > 10 kΩ).

The minimum current load of the switch shall not be expected to exceed 1 mA, and continuous maximum load is expected to be 150 mA.

2.4 Pressure Transmitter

Output:	Two-wire, 4-20 mA DC; Load: > 500Ω at 24 V DC $\pm 20\%$
Accuracy incl. hysteresis, linearity and repeat accuracy:	Min. $\pm 0.2\%$ of FS, cf. VDE/VDI 2184
Scale:	Adjustable / optional
Indication:	Built-in local indication, SI-units
Current limiter max.:	40 mA
Ambient temp.:	-20 - +65°C
Enclosure class:	Minimum IP 65
Connection:	½" or 3/8" pipe thread
Measuring principle:	Pressure cell

The pressure transmitters shall be delivered complete with sensor and instrument valve, including testing nozzle, draining valve, and fittings for wall mounting, cf. Appendix A14.5a "*Measurement Connections - Flue Gas/Air Systems*" and A14.5b "*Measurement Connections - Water/Steam Systems*".

2.5 Differential Pressure Transmitter

Process pressure:	To be stated in offer
Output:	Two-wire, 4-20 mA DC; Load: > 500Ω at 24 V DC ± 20%
Measuring range:	Adjustable / optional
Indication:	Built-in local indication, SI-units
Accuracy incl. hysteresis, linearity and repeat accuracy:	≤ 0.2% of FS, cf. VDE/VDI 2184
Enclosure class:	Minimum IP 65
Connection:	1/2" or 3/8" pipe thread
Ambient temp.:	-20 - +65°C
Measuring principle:	Pressure cell

The differential pressure transmitter shall be delivered complete with fittings for wall mounting and valve block including closing, ventilation, testing nozzle and equalising, cf. Appendix A14.5a "Measurement Connections - Flue Gas/Air Systems" and A14.5b "Measurement Connections - Water/Steam Systems".

2.6 Pressure Switch

Pressure switches should be replaced by pressure transmitters.

Switch:	Double, 24 V 1A, potential-free
Max. permissible pressure, min.:	80 bar
Set-point:	To be stated in offer
Hysteresis min.:	To be stated in offer
Accuracy:	≤ 0.5% of FS
Encapsulation:	Minimum IP 65
Ambient temp.:	-20 - +65°C
Connection:	1/2" or 3/8" pipe thread

The pressure switch shall be delivered complete with instrument valve, including testing nozzle, draining valve, and fittings for wall mounting.

Construction

The switch shall be a potential-free changeover contact or a separate make-and-break contact with mechanical connection in order to prevent double 1-signal.

The switch shall be a self-cleaning spring contact of precious metal and may not corrode in sulphur- and chlorine-containing atmosphere.

Electrical Properties

The switch shall be designed for low current, i.e. voltage over open switch is 24 DC (resistance over open switch > 10 k Ω).

The minimum current load of the switch shall not be expected to exceed 1 mA, and continuous maximum load is expected to be 150 mA.

2.7 Differential Pressure Switch

Switch:	Double, 24 V 1A, potential-free
Max. permissible pressure, min.:	To be stated in offer
Set-point:	To be stated in offer
Hysteresis min.:	$\leq 1\%$ of FS
Accuracy:	$\leq 0.5\%$ of FS
Enclosure class:	Minimum IP 65
Ambient temp.:	-20 - +65°C
Connection:	1/2" or 3/8" pipe thread

The differential pressure switch shall be delivered complete with instrument valve, including testing nozzle, draining valve, and fittings for wall mounting.

Construction

The switch shall be a potential-free changeover contact or a separate make-and-break contact with mechanical connection in order to prevent double 1-signal.

The switch shall be a self-cleaning spring contact of precious metal and may not corrode in sulphur- and chlorine-containing atmosphere.

Electrical Properties

The switch shall be designed for low current, i.e. voltage over open switch is 24 V DC (resistance over open switch > 10 k Ω).

The minimum current load of the switch shall not be expected to exceed 1 mA, and continuous maximum load is expected to be 150 mA.

2.8 Flow Measurement, Liquid

2.8.1 DISTRICT HEATING

Ultrasonic measuring

Output:	Two-wire, 4-20 mA DC ; Load: > 500Ω
Output: (digital)	Pulse outputs: Optically isolated dry contacts, 30 VDC, 50 mA, programmable scale of pulse and pulse duration
Accuracy:	< 0.5%
Ambient temp.:	-20 - +65°C
Enclosure class:	Minimum IP 65
Connection:	1/2" or 3/8" pipe thread

2.8.2 CONDENSATE/FEED WATER

Ultrasonic measuring

Output:	Two-wire, 4-20 mA DC; Load:> 500Ω
Accuracy:	< 0.5%
Ambient temp.:	-20 - +65°C
Enclosure class:	Minimum IP 65
Connection:	1/2" or 3/8" pipe thread

Annubar

Output:	Bus connection
Output:(alternative)	Two-wire, 4-20 mA DC; Load:> 500Ω
Accuracy:	< 0.5%
Ambient temp.:	-20 - +65°C
Enclosure class:	Minimum IP 65
Connection:	1/2" or 3/8" pipe thread

2.9 Flow Measuring, Steam

Venturi Differential Pressure

Output:	Bus connection
Output:(alternative)	Two-wire, 4-20 mA DC; Load:> 500Ω
Accuracy:	< 0.5%
Ambient temp.:	-20 - +65°C
Enclosure class:	Minimum IP 65
Connection:	1/2" or 3/8" pipe thread

2.10 Flow Measuring, Flue Gas

Venturi Differential Pressure

Output:	Two-wire, 4-20 mA, linear 24 V DC; Load: > 500Ω
Accuracy:	< 0.5%
Surrounding temp.:	-20 - +65°C
Enclosure class:	Minimum IP 65
Connection:	1/2" or 3/8" pipe thread

2.11 Solenoid Valves

The following applies to remote-controlled, pneumatically operated units provided with solenoid valves:

Enclosure class \geq IP 65

Permissible ambient temperature: -20 to +65°C.

The solenoid valve shall be enclosed in impact-resistant and corrosion-resistant material.

Solenoid valves of mono-stable type are preferred for mono-stable, pneumatic units, i.e. a continuous signal shall be applied to the solenoid coil.

In cases where the pneumatically operated unit has a safety function, the de-energised or de-pressurised unit shall assume the safe position on its own.

- Feedback: Pneumatic, units shall be equipped with changeover switches for feedback on/off,
- Requirements for position switch as for binary switches.

The coil of the solenoid valve shall be designed for reliable function at 24 V DC \pm 6 V. Wherever possible, the magnetic valves shall be controlled directly from the control equipment, which has a limited output power.

In view of the above and to meet voltage drop, solenoid valves with minimum power requirements should be chosen. The power requirements shall be stated in the offer.

Connection of the coil shall be through a connector incorporated in the solenoid valve, with screw terminals for a flexible 1.5 mm² cable to be terminated in a junction box or a connection box for fixed installation.

2.12 Motor-driven on/off Actuators

Must be intelligent, non-intrusive type, bus connected with integrated control and diagnose facilities.

Must comply with EN 15714-2.

Duty class according to IEC34/VDE 0530.

Enclosure class: \geq IP 65

Permissible ambient temperature: -20 to +65°C.

The actuators shall be installed with local control panel built into the actuator, from which the actuator can be operated. The local operation must only be possible when this has been enabled from the main control room.

If the actuators are installed with switch for local/remote control, this shall be lockable.

The local control panel shall have the following functions:

- Switch for local/remote control
- Push button for operation on/open
- Push button for operation off/closed
- Indication for local control allowed
- Indication for on/open
- Indication for off/closed
- Indication for fault
- Local mechanical position indicator

The actuators shall be easy to maintain and replace, and oil/lube intervals shall be minimum 1 year. Standard motors are preferred. The actuator must be equipped with a manual hand wheel.

Connection to signal contacts shall be through a flexible cable with shield and a cross-section of 0.75 mm², terminated in multi-plug.

Connection to motor shall be through a flexible cable of min. 2.5 mm², terminated in separate multi-plug.

For electrical motors and power supply, refer to Appendix A6 *Technical Specifications for Electrical Equipment*.

2.13 Motor-driven Modulating Actuators

Must be intelligent, non-intrusive type, with integrated control and diagnose facilities.

Actuators for closed loop control shall be operated by the Control and Monitoring System and shall be driven by an electric motor.

Most comply with EN 15714-2.

Enclosure class: \geq IP 65

Permissible ambient temperature: -20 - +65°C.

In addition to what applies to motor-driven on-off actuators for control, the following applies:

The actuator shall be provided with magnetic brake or cone brake in order to minimise afterrun.

Afterrun shall be stated in percentage of total travel.

The actuator shall be designed for min. 1200 position changes per hour.

A mechanical position indicator shall be incorporated for local indication.

Requirements for position transmitters are the same as for analog transmitters.

For electrical motors and power supply, refer to Appendix A6 *Technical Specifications for Electrical Equipment*.

2.14 Electro-Pneumatic Positioners

Must be bus connected with integrated control and diagnose facilities.

Position signal shall be of contactless inductive sensor type.

If this is not possible the following applies:

Setpoint input 4-20 mA, 2-wire. Position signal shall be of contactless inductive sensor type. 4-20 mA, 2-wire.

Pressure gauge block with pressure gauge, filter controller and integrated operation panel.

The design must consider the failsafe state in case of missing air or electric power.

2.15 Local Control Boxes

Local control boxes shall be made and installed in a way, that they don't prohibit access to the process and machinery. The boxes shall be relatively small, have the size to carry the control buttons and the information LED's.

They shall be produced in a standard way accepted by the Employer.

If they will be prohibiting the access way, they shall be made in a way that they can be moved temporary, or have another fixed location, where they can be accessed, at the same time that the operator can see the object, and where it will give no limited access.

The Local boxes shall early in the project be documented and description and drawings shall be presented to the Employer.

3. INSTRUMENT RACK

Instruments and transmitters, including valve block, shall be mounted on instrument stands/boards.

The instrument stand shall be mounted on either floor or platforms. If they are placed on walk ways, they must be off the walk way. It shall be possible to view all instruments from the floor or walkways without the use of tools or ladders.

The Contractor shall recommend instrument racks, which shall be commented by the Employer.

Instrument stands shall be protected against corrosion and surface-treated according to Appendix A14.2 *Steel Constructions for Process*.

4. INSTALLATION TO RIO PANEL

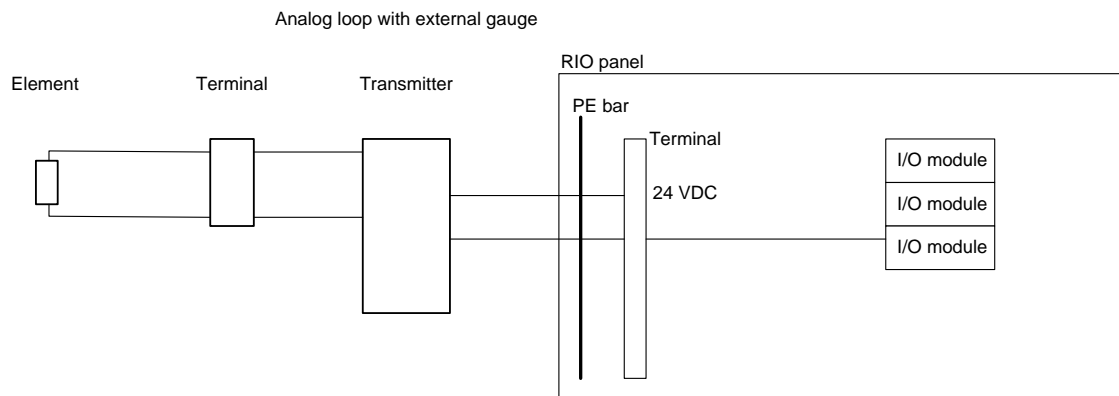
A number of RIO panels shall be placed in the process area, some for boiler and some for flue gas, and others for utility. The signals that are to be connected to the RIO panels shall have a short connection cable between the instrument and the RIO panel. Signals and instruments shall belong to the area where the RIO panel are located.

If a single or few signals are located far away from the belonging RIO panel, it will be allowed to be connected to the nearest RIO panel, where the routing then have to done in the CMS.

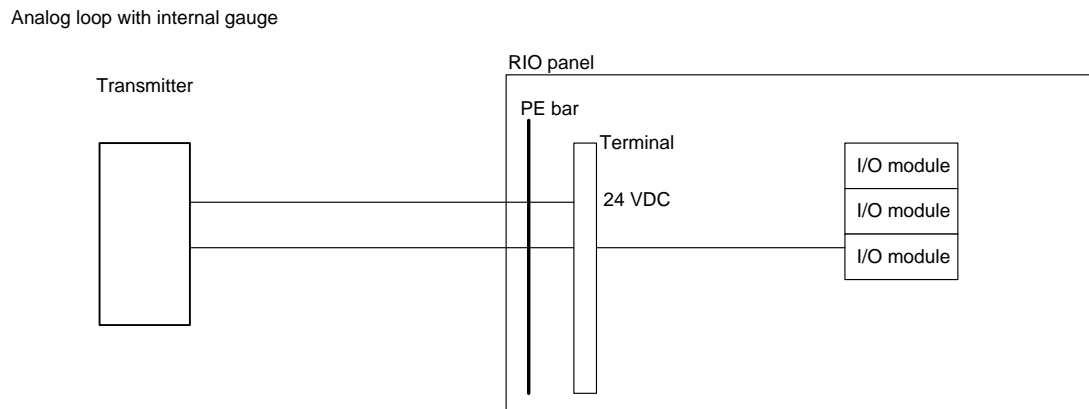
5. PRINCIPLE AND LOOP CONNECTIONS

The following sketches are an example of the interconnections between electrical components as well as defining the structure for loop drawings.

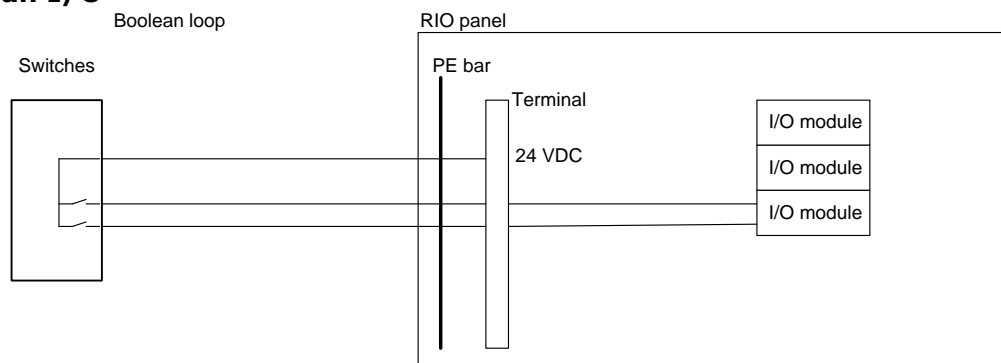
5.1 4..20 mA loop: Analog signal with separate gauge



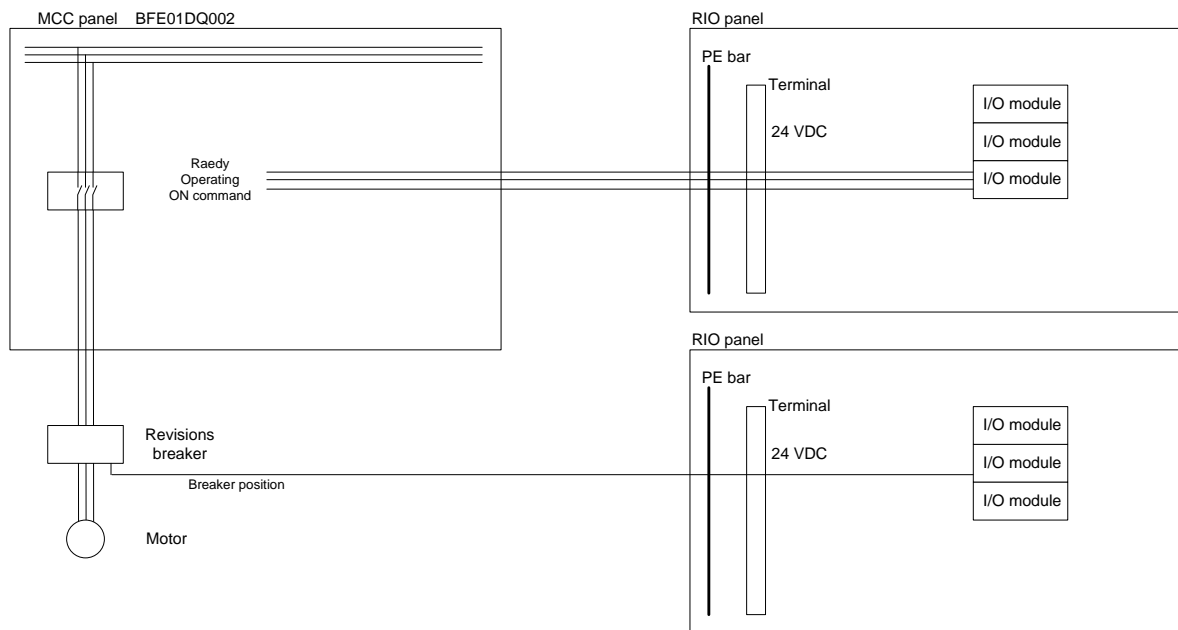
5.2 4..20 mA loop: Analog signal with integrated gauge



5.3 RIO Boolean I/O



5.4 Motor installation with safety breaker



5.5 Motor installation with Local control panel

