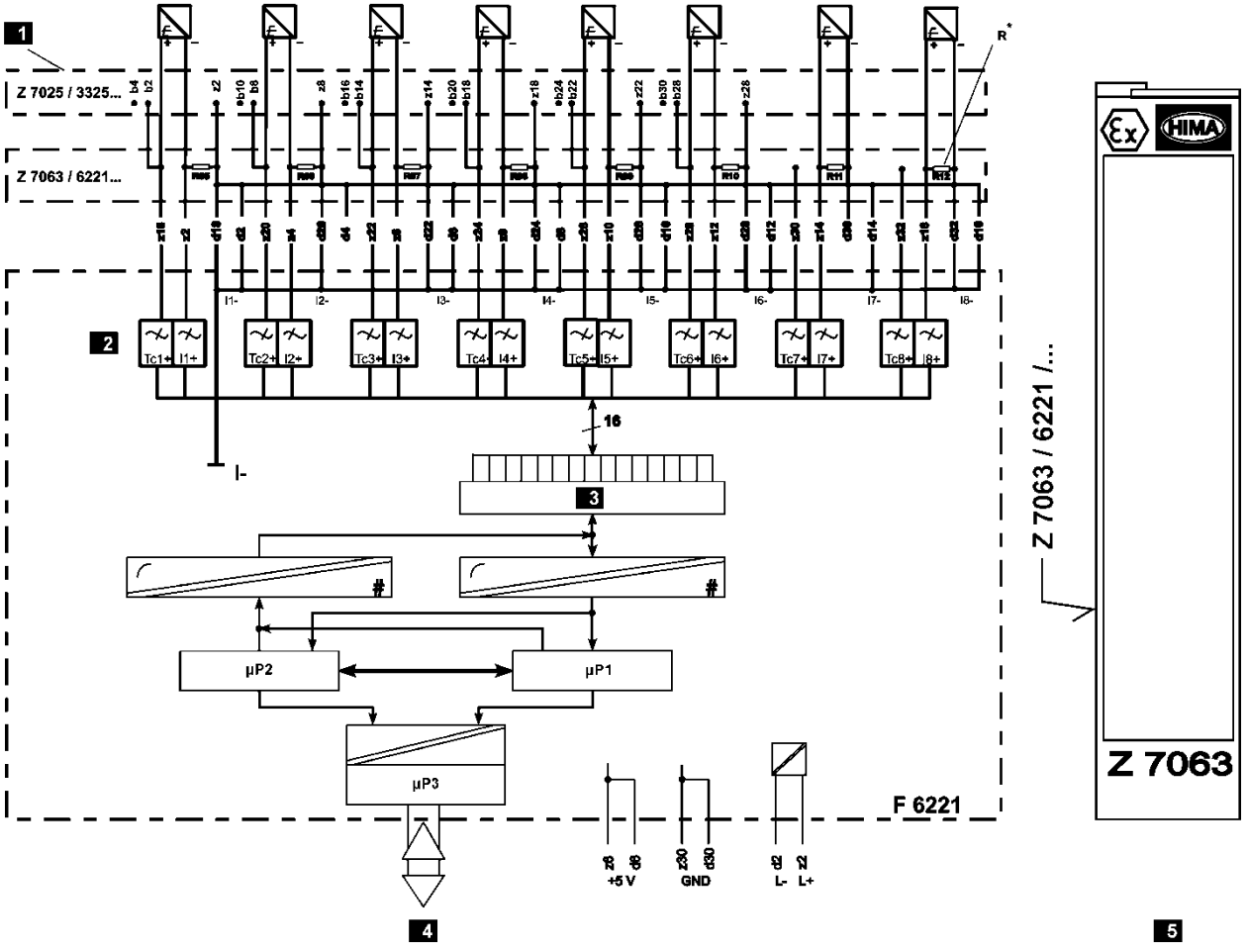
F 6221: Analog Input Module (Ex)i

Safety-related, TÜV-tested in accordance with IEC 61508 for applications up to SIL 3

- 8 channels, as current inputs 0/4...20 mA, or voltage inputs 0…1 V.
- 8 monitoring channels to test the transmitter feeding voltages (0…30 V).
- Short-circuit and open-circuit configurable in SILworX.
- EU Type Test Certificate: TÜV 18 ATEX 8173.
- For HIQuad X (SILworX) and HIQuad (ELOP II, **HF-AIX-3** function block required).



1 F 3325 supply module, transmitter supply

2 I1+…I8+: transmitter signal measurement
TC1+…TC8+: monitoring of transmitter supply voltage

3 Multiplexer

4 I/O bus

5 Cable plug, front view

Figure 1: Module Block Diagram and Cable Plug Front View

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i The block diagram for the F 6221 represents the wiring to the F 3325 supply module. The first six channels are used for passive transmitters. In this wiring, channels 7 and 8 are used for active transmitters (see variants A1 and A2).

Pins d4 and d30 of Z 7063 cable plug must be equipped with coding pins.

Specifications

Ex category	II (1) GD [Ex ia Ga] IIC, [Ex ia Da] IIIC
Withstand voltage	375 V (ex circuit to non-ex circuit) 7 V (ex circuit to ex circuit)
Interference voltage suppression	> 60 dB (common mode 50/60 Hz)
Inputs	8, as current or voltage inputs
Rated input voltage	0…1.00 V
Rated input current	0…20 mA (via shunt)
Voltage operating range	-0.1…+1.1 V
Current operating range	-2…+22 mA
R*: Shunt for current measurement	50 Ω, T < 10 ppm/K Tolerance 0.05 %
Resolution	24-bit
Measured value refresh	< 80 ms
Input resistance	Min. 1 MΩ
Time constant for input filter	Approx. 7 ms
Conversion time	Max. 1.8 ms for one channel
Maximum error	0.1 % at 25°C
Maximum temperature error coefficient	0.1 % / 10 K
Maximum temperature error	0.2 % at -10… +70 °C
Withstand voltage of the inputs	5 V
Maximum current via shunt	80 mA
Space requirement	4 HP
Current consumption	125 mA at 5 VDC (via backplane) 300 mA at 24 VDC (via backplane)

Monitoring of the transmitter supply voltage for channels 1…8

Input voltage	Max. 30 V
Switch-off threshold	< 16.0 V
Input resistance	Min. 30 kΩ
Withstand voltage of the inputs	30 V

i The module may only be operated with forced cooling, fans K 9203A or K 9212. Systems without forced cooling must be retrofitted with fans as soon as an F 6221 is used.

To ensure forced cooling, the M 7201 air deflector (1 RU) must be installed above the K 9203A fan or above the H 41q kit.

The M 7201 air deflector deflects the warm air backwards to avoid temperature increase of the racks and modules installed one above the other.

Wiring

Refer to the corresponding tables for the wire color coding of the following cable plugs:

- Cable plug Z 7063/6221/Ex/Cx/ITI with blue cable (Table 1). Channels 7 and 8 are not connected to the transmitter supply.
- Cable plug Z 7063/6221/Ex/Cx/I (U1V) with blue cable, for signal measurement (Table 2)

Channel	Pin	Color	Connection
I1+	z2	WH	Cable: LiYY 8 x 2 x 0.2 mm² (shielded)
TC1+	z18	BN	
I2+	z4	GN	
TC2+	z20	YE	
I3+	z6	GY	
TC3+	z22	PK	
I4+	z8	BU	
TC4+	z24	RD	
I5+	z10	BK	
TC5+	z26	VT	
I6+	z12	GYPK	
TC6+	z28	RDBU	
I7+	z14	WHGN	
TC7+	d14	BNGN	
I8+	z16	WHYE	
TC8+	d16	YEBN	
Shield			

Table 1: Wire Color Coding of the Cable Plug Z 7063/6221/Ex/Cx/ITI…

Channel	Pin	Color		Connection
I1+	z2	WH	1)	Cable: LiYCY 16 x 2 X 0.2 mm² (shielded)
I1-	d2	BN		
I2+	z4	GN		
I2-	d4	YE		
I3+	z6	GY		
i3-	d6	PK		
I4+	z8	BU		
I4-	d8	RD		
I5+	z10	BK		
I5-	d10	VT		
I6+	z12	GYPK		
I6-	d12	RDBU		
I7+	z14	WHGN		
I7-	d14	BNGN		
I8+	z16	WHYE		
I8-	d16	YEBN		
TC1+	z18	WHGY	2)	
I1-	d2	GYBN		
TC2+	z20	WHPK		
I2-	d4	PKBN		
TC3+	z22	WHBU		
i3-	d6	BNBU		
TC4+	z24	WHRD		
I4-	d8	BNRD		
TC5+	z26	WHBK		
I5-	d10	BNBK		
TC6+	z28	GYGN		
I6-	d12	YEGY		
TC7+	z30	PKGN		
I7-	d14	YEPK		
TC8+	z32	GNBU		
I8-	d16	YEBU		
Shield				

1) Channels for signal measuring
2) Channels for transmitter supply monitoring

Table 2: Wire Color Coding of the Cable Plug Z 7063/6221/Ex/Cx/I (U1V)

i The potential inputs (I1-…I8-) are combined on the module to one potential (I-). The signals (I1-…I8-) may only be interconnected on the module. Other nodes are not allowed.

In Ex applications, the cable shield must be connected to the equipotential bonding. In non-Ex applications, the cable shield is connected to the protective ground rail of the rack.

1 Application

The field of application of the F 6221 module is the operation with transmitters (0/4...20 mA) that can be supplied via the intrinsically safe F 3325 supply module. For safety reasons, the supply voltage of the transmitters is monitored with the F 6221 module.

The F 6221 module includes a measuring facility for up to eight signal inputs (I1+…I8+). Additional eight signal inputs (TC1+...TC8+) are available for monitoring the transmitter supply voltages. These signal inputs monitor the switch-off threshold and are not available to the user program as measuring data.

The signal inputs, **I** and **TC**, have a fixed assignment to one another (I1+ to TC1+, I2+ to TC2+, … , I8+ to TC8+).

1.1 Wiring Variants

Suitable cable plugs are available for the various wiring variants (Table 3 and Table 4). Only the switching variables and corresponding HIMA cable plugs described in the F 6221 and F 3225 data sheets are allowed.

1.1.1 Permissible Wiring Variants with Passive 2-Wire Transmitters

HIMA variant	Variant [1)]	Description
A1	1	Mono supply, mono current measurement Wiring via cables
B	1	Mono supply, mono current measurement Wiring via terminal block
C1	3	Mono supply, redundant current measurement Wiring via cables
D	3	Mono supply, redundant current measurement Wiring via terminal block
[1)] In accordance with the appended *Technical Report*, No. 70013102.4 (/.1/.2)		

Table 3: Permissible Wiring Variants with Passive 2-Wire Transmitters

i The remaining variants listed in the *Technical Report*, are only intended for theoretical considerations.

1.1.2 Permissible Wiring Variants with Active Transmitters

HIMA variant	Description
A2	Mono current measurement
C2	Redundant current measuring, wiring via cables
E	Voltage measurement
F	Current measurement via shunt

Table 4: Permissible Wiring Variants with Active Transmitters

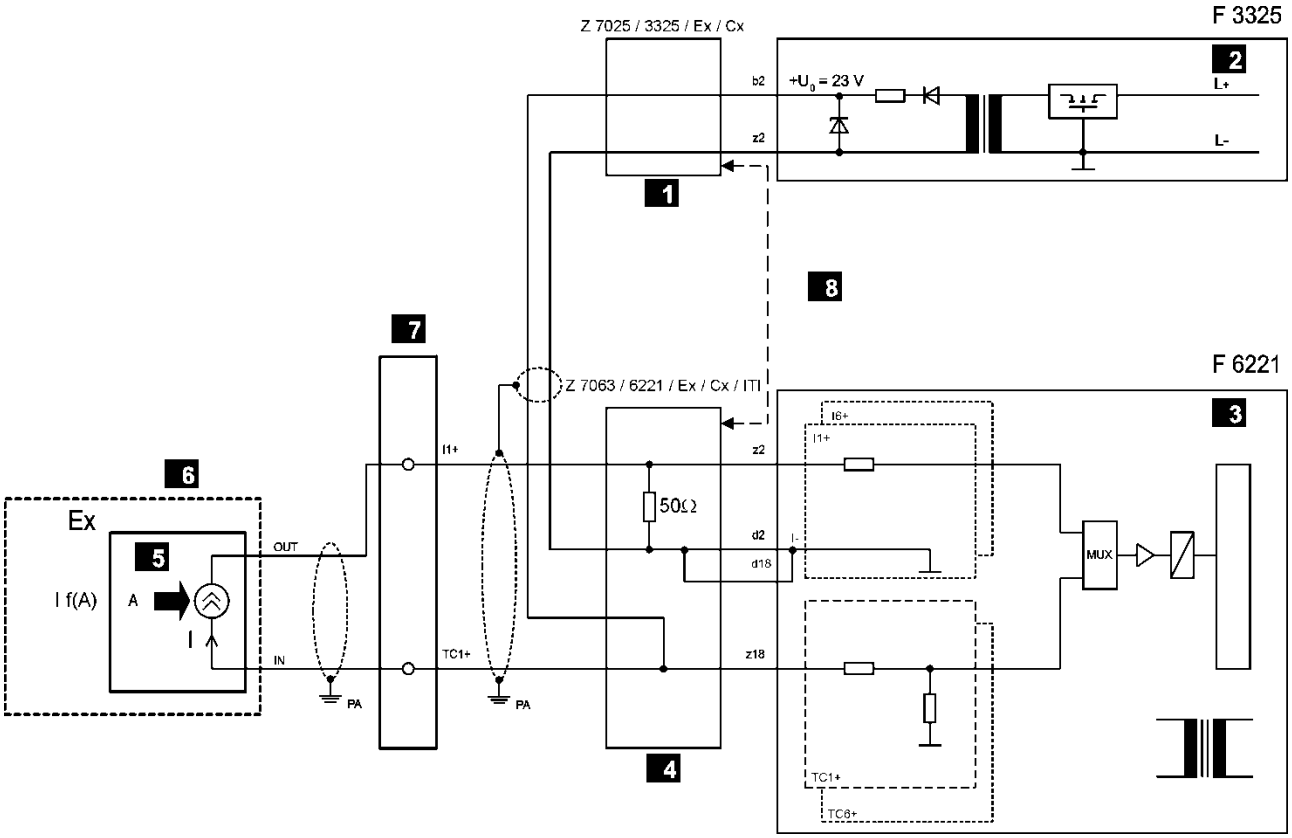
i Generally, the relevant Ex standards must be observed for these wiring variants.

For interconnection of intrinsically safe equipment, the PTB report ThEx-10 and the operating instructions for the F 6221 module must be observed.

1.1.3 Wiring Variant A1

Wiring variant A1 with passive 2-wire transmitter is implemented as follows:

- Mono operation with transmitter supply for channels 1…6.
- Cable plug: Z 7063/6221/Ex/Cx/ITI.
- Cable plug: Z 7025/3325/Ex/Cx.
- Channels 7 and 8 are not used (reserved for active transmitters).



1 Cable plug for transmitter supply
2 Non-safety-related Ex transmitter supply
3 Safety-related Ex measuring equipment
4 Cable plug for the measuring facility
5 Physical value
6 Passive transmitter
7 Terminal block
8 Maximum cable length 10 m

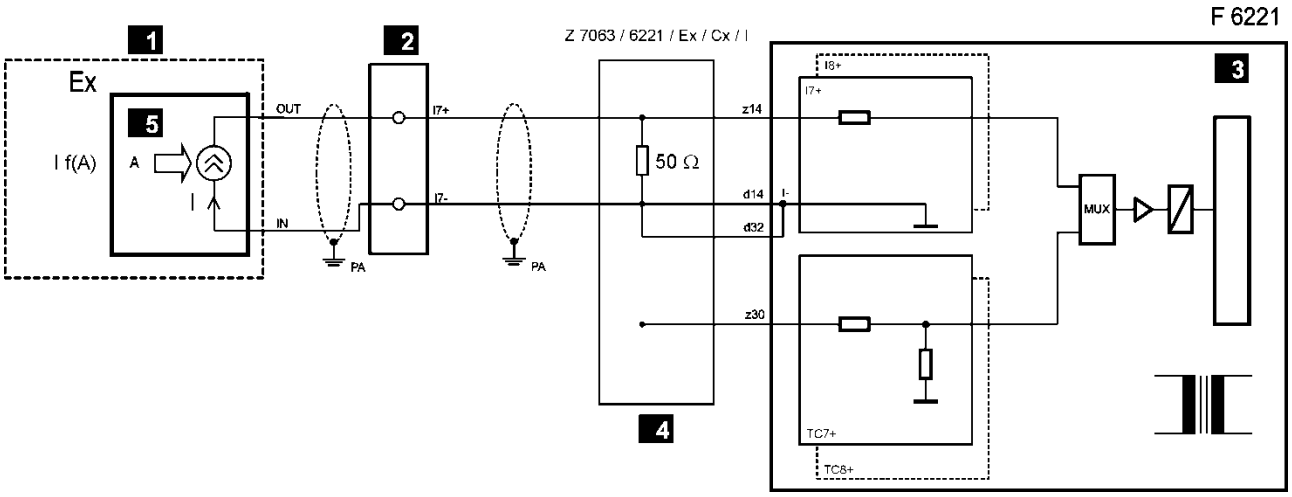
Figure 2: Mono Supply, Mono Current Measuring, Wiring via Cables

i Cable plugs Z 7063/6221/Ex/Cx/ITI and Z 7025/3325/Ex/Cx must be used for wiring variant A1 and must be connected through a wire. The maximum length of the wire used between the cable plugs is 10 m.

1.1.4 Wiring Variant A2

Wiring variant A2 with active transmitter is implemented as follows:

- Mono operation without transmitter supply for channels 7 und 8.
- Cable plug: Z 7063/6221/Ex/Cx/I.



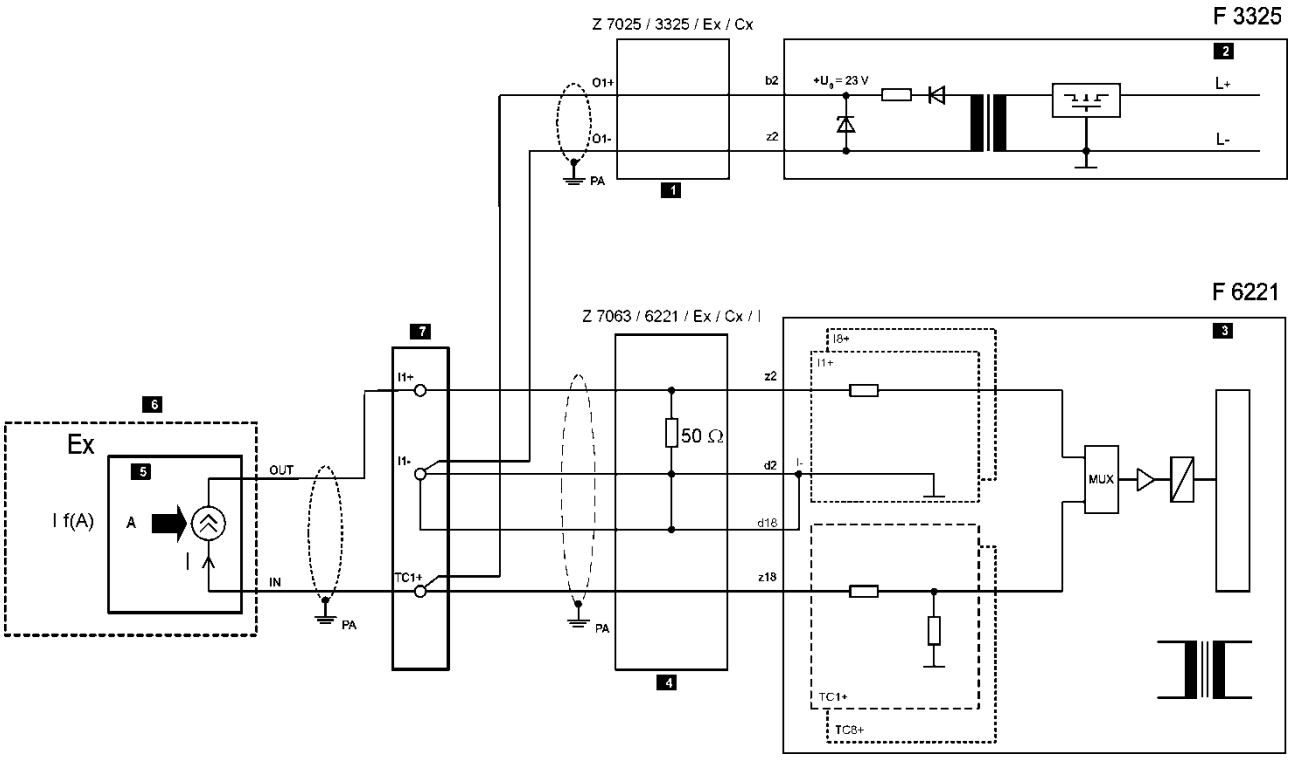
1 Active transmitter
2 Terminal block
3 Safety-related Ex measuring equipment
4 Cable plug for the measuring facility
5 Physical value

Figure 3: Mono Current Measurement

1.1.5 Wiring Variant B

Wiring variant B with passive 2-wire transmitter is implemented as follows:

- Mono operation with transmitter supply for channels 1...8.
- Cable plug: Z 7063/6221/Ex/Cx/I.
- Cable plug: Z 7025/3325/Ex/Cx.



1 Cable plug for transmitter supply
2 Non-safety-related Ex transmitter supply
3 Safety-related Ex measuring equipment
4 Cable plug for the measuring facility
5 Physical value
6 Transmitter
7 Terminal block

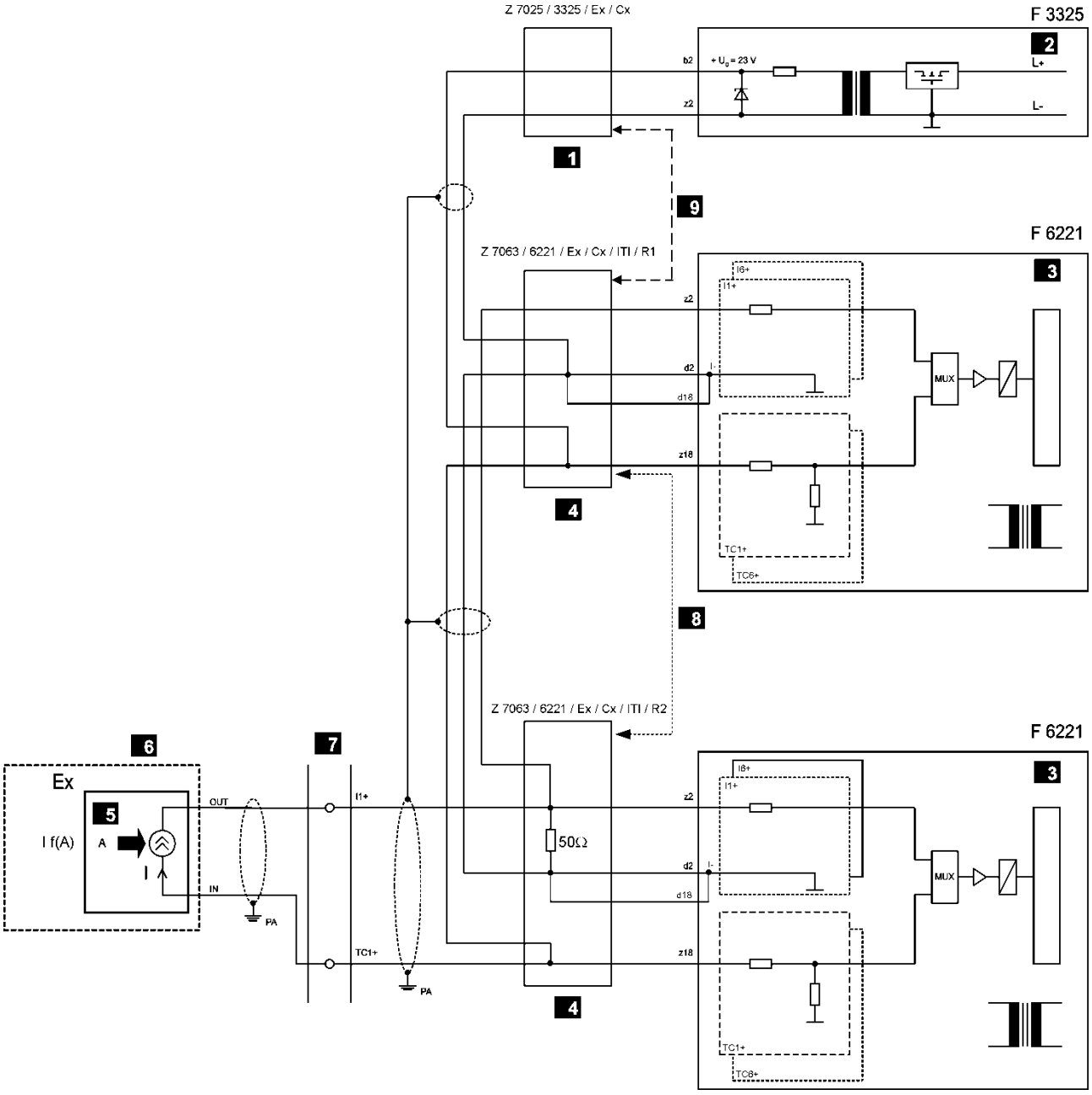
Figure 4: Mono Supply, Mono Current Measuring, Wiring via Terminal Block

i In the wiring variant B, an Ex repeater power supply may also be used instead of the F 3325 supply module. In such a case, observe that a residual current (Re = 30 kΩ) flowing through the monitoring inputs (TC1…TC8) impacts the non-intrinsically safe side of the Ex repeater power supply and must be compensated. The HART protocol can also be transmitted if suitable transmitters are used.

1.1.6 Wiring Variant C1

Wiring variant C1 with passive 2-wire transmitter is implemented as follows:

- Redundancy operation with transmitter supply for channels 1…6.
- Cable plugs: Z 7063/6221/Ex/Cx/ITI/R1 and Z 7063/6221/Ex/Cx/ITI/R1
- Cable plug: Z 7025/3325/Ex/Cx.
- Channels 7 and 8 are not used (reserved for active transmitters).



1 Cable plug for transmitter supply
2 Non-safety-related Ex transmitter supply
3 Safety-related Ex measuring equipment
4 Cable plug for the measuring facility
5 Physical value
6 Transmitter
7 Terminal block
8 Maximum cable length 2 m
9 Maximum cable length 10 m

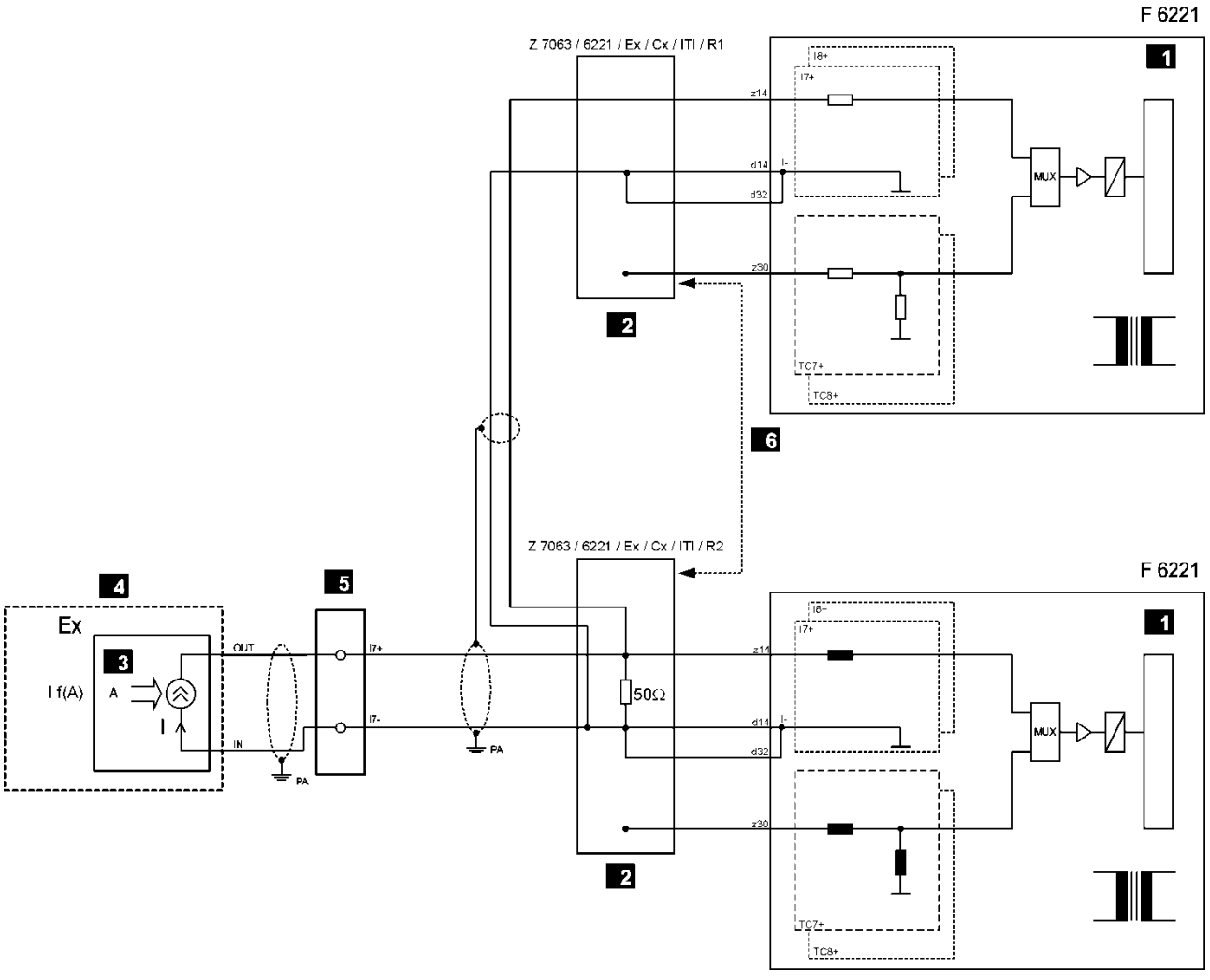
Figure 5: Mono Supply, Redundant Current Measuring, Wiring via Cables

i Cable plugs Z 7063/6221/Ex/Cx/ITI/R1, Z 7063/6221/Ex/Cx/ITI/R2 and Z 7025/3325/Ex/Cx must be used for wiring variant A1 and must be connected through a wire. The maximum length of the wire used between cable plugs Z 7025/3325/Ex/Cx and Z 7063/6221/Ex/Cx/ITI/R1 is 10 m. The maximum length of the wire used between cable plugs Z 7063/6221/Ex/Cx/ITI/R1 and Z 7063/6221/Ex/Cx/ITI/R2 is 2 m; this also applies to wiring variant C2.

1.1.7 Wiring Variant C2

Wiring variant C2 with active transmitter is implemented as follows:

- Redundancy operation without transmitter supply for channels 7 and 8.
- Cable plugs: Z 7063/6221/Ex/Cx/ITI/R1 and Z 7063/6221/Ex/Cx/ITI/R2



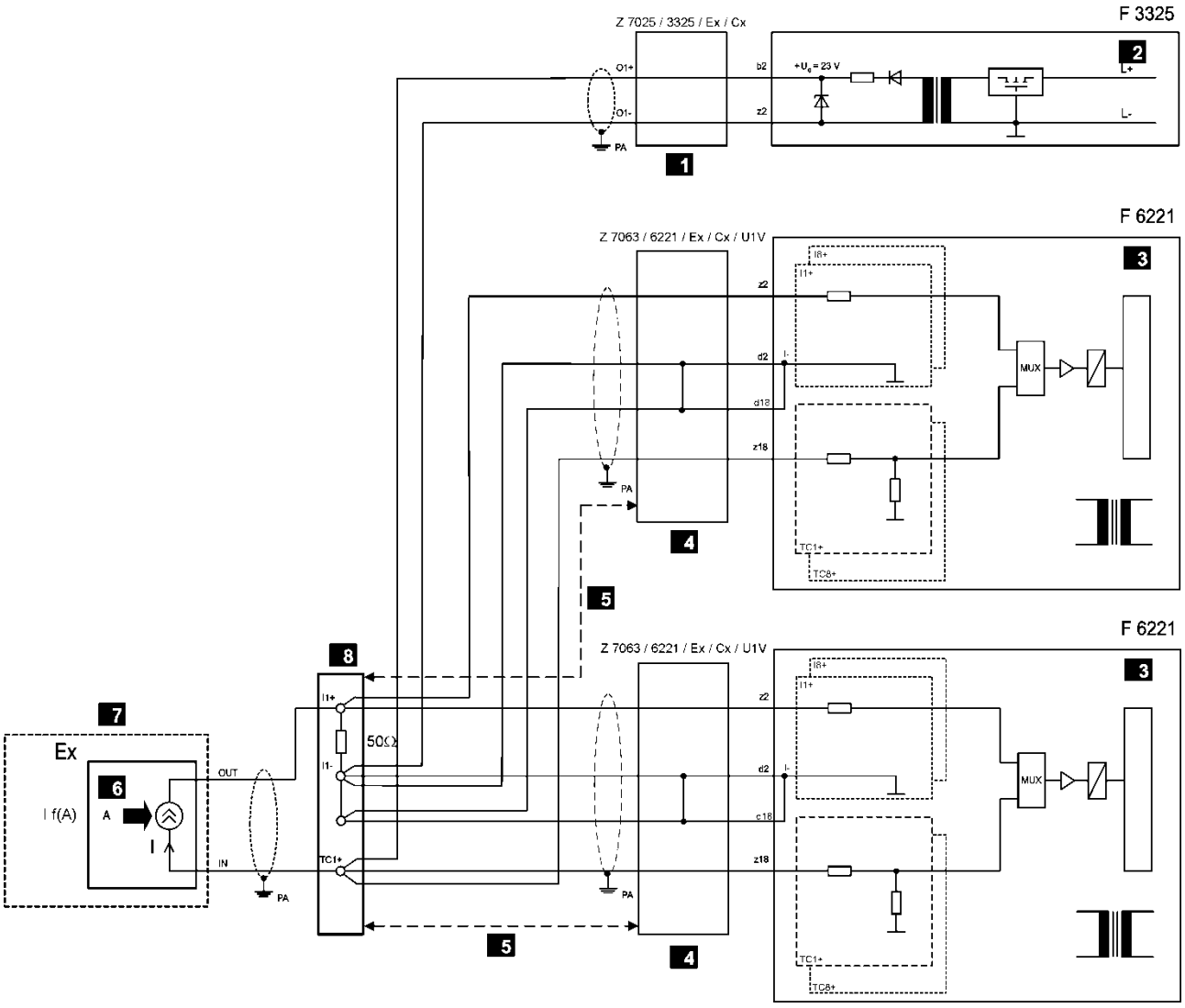
1 Safety-related Ex measuring equipment
2 Cable plug for the measuring facility
3 Physical value
4 Active transmitter
5 Terminal block
6 Maximum cable length 2 m

Figure 6: Redundant Current Measuring, Wiring via Terminal Block

1.1.8 Wiring Variant D

Wiring variant D with passive 2-wire transmitter is implemented as follows:

- Redundancy operation with transmitter supply for channels 1…8.
- 2 cable plugs: Z 7063/6221/Ex/Cx/U1V.
- Cable plug: Z 7025/3325/Ex/Cx.



1 Cable plug for transmitter supply
2 Non-safety-related Ex transmitter supply
3 Safety-related Ex measuring equipment
4 Cable plug for the measuring facility
5 Maximum cable length 10 m
6 Physical value
7 Transmitter
8 Terminal block

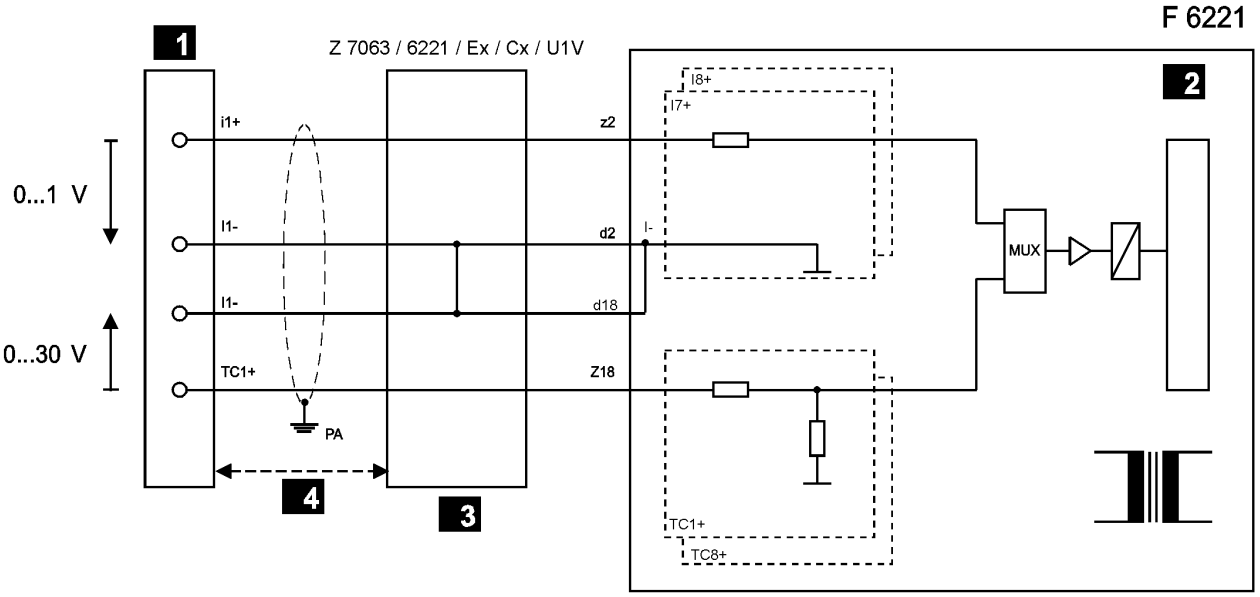
Figure 7: Mono Supply, Redundant Current Measuring, Wiring via Terminal Block

i In the wiring variant D, an Ex repeater power supply may also be used instead of the F 3325 supply module. In such a case, observe that a residual current (Re = 15 kΩ) flowing through the monitoring inputs (TC1…TC8) impacts the non-intrinsically safe side of the Ex repeater power supply and must be compensated. The HART protocol can also be transmitted if suitable transmitters are used.

1.1.9 Wiring Variant E

Wiring variant E with active transmitter is implemented as follows:

- Voltage measuring for signals (I1+…I8+) and supply voltage monitoring (TC1+…TC8+) for channels 1…8.
- Cable plug: Z 7063/6221/Ex/Cx/U1V.



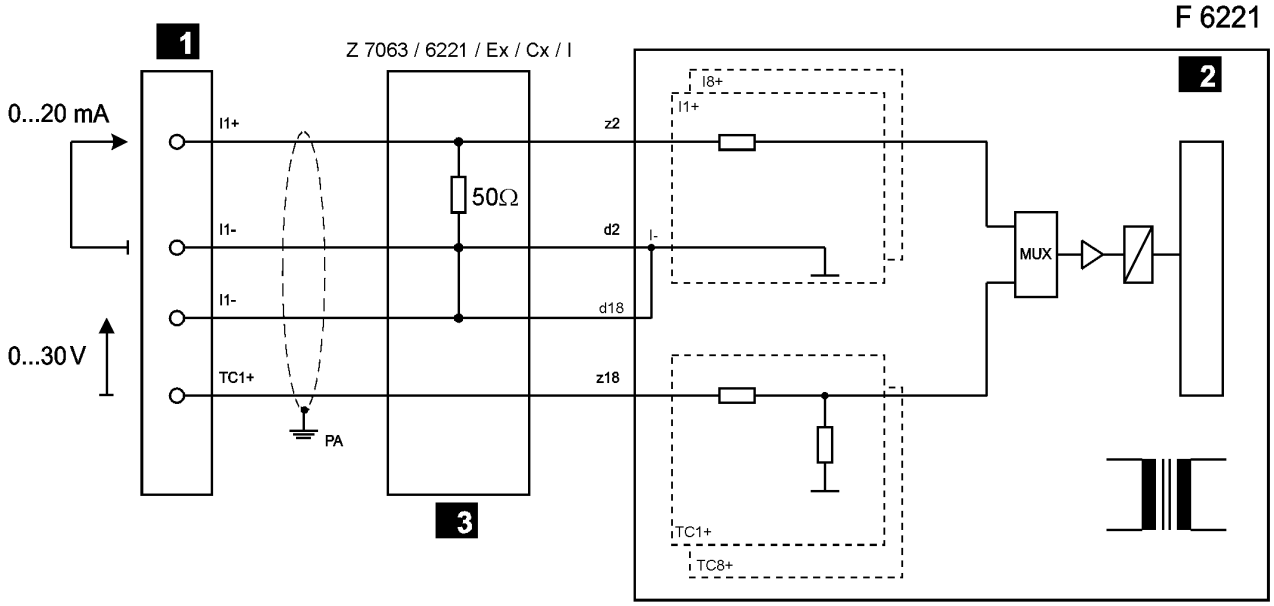
1 Terminal block
2 Safety-related Ex measuring equipment
3 Cable plug for the measuring facility
4 Maximum cable length 10 m

Figure 8: Voltage Measurement

1.1.10 Wiring Variant F

Wiring variant F with active transmitter is implemented as follows:

- Current measuring for signals (I1+…I8+) and supply voltage monitoring (TC1+…TC8+) for channels 1…8.
- Cable plug: Z 7063/6221/Ex/Cx/I.



1 Terminal block
2 Safety-related Ex measuring equipment
3 Cable plug for the measuring facility

Figure 9: Current Measurement via Shunt

2 Configuration in SILworX

The module is configured in the Hardware Editor of the SILworX programming tool.

To ensure safety-related use, the limit values preset in SILworX for short-circuits and open-circuits must be set in accordance with their use. The limit values must be configured individually for each channel.

A safety-related evaluation of the setting *Voltage Input* is only permissible within -100…+100 mV. A metrological accuracy exceeding this range cannot be ensured.

A safety-related evaluation of the setting *Thermocouple Type X* is only permissible within the monitored operating range specific to each thermocouple type. Refer to the F 6220 data sheet (HI 803 194 E) for details. A metrological accuracy exceeding the monitored operating ranges cannot be ensured. Additionally, the cold junction temperature range for Pt100 (-40 … +80 °C) must be maintained.

The *-> Process Value [REAL]* parameter automatically adopts the configured initial value if the limit values are violated or if an internal channel fault occurs. The users must adopt measures in the user program to ensure that this initial value causes the respective safety function to enter the safe state.

The *-> Raw Value [1 °C/1 mV = 10 000] [DINT]* parameter may only be used under the following conditions:

1. The measuring range for the voltage input or for the thermocouples is maintained. The cold junction temperature range for Pt100 (-40 … +80 °C) is maintained.
2. Additional evaluation of the *-> Process Value OK [BOOL]* parameter within the user program. FALSE must cause the respective safety function to enter the safe state.
3. Evaluation of the limit values for open-circuits and short circuits as *-> Process Value OK [BOOL]* automatically changes to FALSE when the set limit values are exceeded. Alternatively, the thresholds can also be evaluated in the user program.

4. Programming of a substitute value (initial value) in the user program, which causes the respective safety function to enter the safe state.

Additionally, observe the following points when configuring the module:

- In addition to the measuring values, the system parameters can be evaluated in the user program to diagnose the module or channels. For further details on the statuses and parameters, refer to the tables in Chapter 2.1 and following chapters.
- Depending on the cable plug, the parameters *4 mA*, *20 mA* and *-> Process Value [REAL]* must be scaled as follows during voltage measurement:
  - Voltage measurement 1 V:
    Process value **x** scaling factor **=** 4 mA **x** 50.0 **=** 200.0 corresponding to 200.0 mV
    Process value **x** scaling factor **=** 20 mA **x** 50.0 **=** 1000.0 corresponding to 1000.0 mV
- When scaling, the value range of the REAL data type must be taken into account to be able to represent the input values as REAL variables.
- If redundancy groups are created, their configuration is defined in the associated tabs. The redundancy group tabs differ from those of the individual modules, see the following tables.
- If 2 inputs are redundantly configured, the larger of the two scaled values is written to the redundant system parameter *-> Process Value [REAL].* This applies provided that both modules are in proper working order. If faults occur, only the value of the fault-free module is processed. This requires an identical signal source for both inputs, e.g., a measured value. Any deviation between the two measured values must be within the safety-related accuracy.

To evaluate the system parameters in the user program, they must be assigned to global variables. The necessary steps are to be performed in the detail view of the Hardware Editor.

The following tables present the system parameters for the module in the same order as in the SILworX Hardware Editor.

2.1 The Module Tab

The **Module** tab contains the following system parameters:

System parameter	Data type	S [1]	R/W	Description
Name	---	---	W	Module name.
Noise Blanking	BOOL	Y	W	Allow noise blanking performed by the system (Activated/Deactivated). After a transient fault, the system delays the fault response until the safety time. The user program retains its last valid process value. Default setting: Activated (not changeable). Refer to the system manual (HI 803 211 E) for further details on noise blanking.
The following statuses and parameters can be assigned global variables and used in the user program.				
Explicitly Triggered Restart Required	BOOL	Y	R	TRUE: The module must be explicitly required to restart. FALSE: ▪ Restart is necessary and the module performs it automatically. ▪ Module in the STOP state. ▪ Connection loss.
Background Test Noise Blanking Active	BOOL	Y	R	TRUE: Error detected by a background test. FALSE: ▪ No errors detected by the background tests. ▪ Module in the STOP state. ▪ Connection loss.
Initialization Active	BOOL	Y	R	TRUE: The module is performing initial tests. FALSE: ▪ The initial tests are complete. ▪ Module in the STOP state. ▪ Connection loss.
Module OK	BOOL	Y	R	TRUE: No internal fault detected by the system. FALSE: ▪ Internal fault detected by the system. ▪ Module in the STOP state. ▪ Connection loss.
Module Process Value OK	BOOL	Y	R	TRUE: No channel fault detected by the system. FALSE: ▪ At least one channel fault detected by the system. ▪ Module in the STOP state. ▪ Connection loss.
Restart on Error Suppressed	BOOL	Y	W	Automatic restart after errors can be suppressed by the user. To cause the automatic restart to be performed after an error, the system parameter must have been set to FALSE for longer than the F-CPU safety time (does not apply to field faults). TRUE: No automatic restart after a module or channel fault. FALSE: Automatic restart after a module or channel fault. Default setting: FALSE
[1] The operating system handles the system parameter in a safety-related manner, yes (Y) or no (N).				

Table 5: The **Module** Tab in the Hardware Editor

2.2 The F 6221: Channels Tab

The **F 6221: Channels** tab contains the following system parameters for each channel:

System parameter	Data type	S [1)]	R/W	Description
Channel no.	---	---	R	Channel number, preset and cannot be changed.
4 mA	REAL	Y	W	Data point used to calculate the process value at the lowest full scale (4 mA) of the channel. The parameter must be scaled for voltage measurement: Scaling factor 50.0 (1 V) Default value: 4.0
20 mA	REAL	Y	W	Data point used to calculate the process value at the upper full scale (20 mA) of the channel. The parameter must be scaled for voltage measurement: Scaling factor 50.0 (1 V) Default value: 20.0
-> Process Value [REAL]	REAL	Y	R	Process value determined using the data points 4 mA and 20 mA.
-> Raw Value [1 mA = 10 000] [DINT]	DINT	N	R	Unhandled value measured for the channel. The safety-related use of the parameter in HIQuad X is only permitted under the specified conditions.
-> Process Value OK [BOOL]	BOOL	Y	R	TRUE: Fault-free channel. No internal fault nor fault on the field side detected. Module initialization successfully completed. FALSE: ▪ Faulty channel. Internal fault or fault on the field side detected. ▪ The initial test has not been completely performed. ▪ Module in the STOP state. ▪ Connection loss.
-> Channel OK [BOOL]	BOOL	Y	R	TRUE: Fault-free channel. FALSE: ▪ Faulty channel. ▪ Module in the STOP state. ▪ Connection loss. *-> Channel OK [BOOL]* is neither affected by a supply error nor by an external short-circuit or open-circuit. Observe the statuses *-> OC [BOOL]* and *-> SC [BOOL]* and *-> Supply Error [BOOL]*!
Sup. Mon. Used	BOOL	Y	W	Transmitter supply monitoring activated or deactivated. Default setting: Deactivated
-> Supply Error [BOOL]	BOOL	Y	R	TRUE: Fault in the transmitter supply. FALSE: ▪ No fault in the transmitter supply. ▪ Module in the STOP state. ▪ Connection loss.
OC Limit [1mA = 10000]	DINT	Y	W	Threshold in mA for detecting an open-circuit. If the process value falls under *OC Limit*, the module detects an open-circuit. Default value: 36000

System parameter	Data type	S [1]	R/W	Description
-> OC [BOOL]	BOOL	Y	R	TRUE: Open-circuit. FALSE: ▪ No open-circuit. ▪ Module in the STOP state. ▪ Connection loss.
SC Limit [1 mA = 10000]	DINT	Y	W	Threshold in mA for detecting a short-circuit. If the process value exceeds *SC Limit*, the module detects a short-circuit. Default value: 210000
-> SC [BOOL]	BOOL	Y	R	TRUE: Short-circuit. FALSE: ▪ No short-circuit. ▪ Module in the STOP state. ▪ Connection loss.
Redund.	BOOL	Y	R	Requirement: A redundant module must exist. TRUE: The channel redundancy for this channel is active. FALSE: The channel redundancy for this channel is not active. Default setting: FALSE
-> Channel Active [BOOL]	BOOL	Y	R	TRUE: ▪ The channel output parameters provide their values in accordance with the channel configuration. ▪ Module fault. ▪ Module in the STOP state. ▪ Connection loss. FALSE: The channel configuration has changed and the channel output parameters provide their values in accordance with the configuration that was previously valid. The following actions affect the *-> Channel Active [BOOL]* parameter: ▪ Changing the *Sup. Mon. Used* parameter by performing a reload.
[1] The operating system handles the system parameter in a safety-related manner, yes (Y) or no (N).				

Table 6: Tab **F 6221: Channels** in the Hardware Editor

Global variables can be assigned to the system parameters with **->** and used in the user program. The values of the system parameters without **->** must be directly defined.

2.3 Description of Diagnostic Entry

The module is completely and automatically tested for safety-related errors during operation. The diagnostic entry is not 0 if one or more errors were detected in the module.

Defective modules must be replaced with a faultless module of the same type or with an approved replacement model.

Bit	Coding [1)]	Description
0	0x00000001	Hardware module fault.
1	0x00000002	The module in the slot was not deleted. The slot is either empty or equipped with incorrect module type.
2	0x00000004	Error when configuring the system safety times. Workaround: Set the valid values for the module by performing a download, a reload or an online change.
3	0x00000008	Module's component fault.
4	0x00000010	Module defective (the error code is for internal purposes only).
…	…	
31	0x80000000	
1) The status may consist of several codings, e.g.: Module status = 0x80000001 (0x00000001 + 0x80000000).		

Table 7: Diagnostic Entry Coding

2.3.1 Channel Status

The channel status byte in the diagnostic entry shows the following status:

Bit	Coding [1)]	Description
0	0x0001	Hardware channel fault. Workaround: Check the channel wiring. F-IOP indicator: Continuous light of the channel LED.
1	0x0002	Short-circuit (SC). Workaround: Check the channel wiring and the limit values. F-IOP indicator: Blinking1 of the channel LED.
2	0x0004	Open-circuit (OC). Workaround: Check the channel wiring and the limit values. F-IOP indicator: Blinking1 of the channel LED.
3	0x0008	The transmitter supply is faulty. Workaround: Check the F 3325 supply module or the external transmitter supply. F-IOP indicator: Blinking1 of the channel LED.
4	0x0010	Module defective (the error code is for internal purposes only).
…	…	
15	0x8000	
1) The status may consist of several codings, e.g.: Channel status = 0x8001 (0x0001 + 0x8000).		

Table 8: Channel Status of the F 6221

3 Operating Instructions for F 6221

3.1 Use

The module is suitable for evaluating current loops from measuring transmitters (0/4…20 mA). These transmitters may be installed in areas with explosive atmosphere (zone 1 and higher).

Digitized process signals are issued to the outputs.

⚠ WARNING

The inputs must not be supplied with external voltage.

The module may no longer be used in (Ex)i applications as associated equipment if it has been previously operated in a general electrical plant.

Only the applications described in the F 3325 and F 6221 data sheets are allowed.

3.2 Electrical Data Concerning Intrinsic Safety

For these specifications, refer to the Annex to the EU type test certificate TÜV 18 ATEX 8173.

3.3 General Configuration Notes

If used with intrinsically safe circuits (Ex)i, adjacent F 6221 slots may be equipped with any type of module.

3.4 Notes for Configuration in ELOP II

- Resolution: 1 V = 10 000 digits, 20 mA = 10 000 digits.
- Each module input signal is configured via the **HF-AIX-3** function block. The transmitter supply voltage monitoring must be enabled in the function block.
- To configure the module, use the operating system functions manual specific to the used operating system version. Pay particular attention to the section about noise blanking.

  Setting: safety time ≥ 3 x watchdog time.
- The channel error bit must be evaluated in the user program so that a safety-related reaction to the corresponding input channel is triggered.
- To reset channel errors, the *Recalibration* input of the **HF-AIX-3** function block must be set twice to TRUE for at least one PES cycle.
- An expansion of the measured value causes the relative error to increase by the expansion factor. The measured value expansion can be configured in the **HF-AIX-3** function block.
- A reload performed when two F 6221 (see Chapter 1.1.6, 1.1.7, 1.1.8) are redundantly connected within one HRS system causes the connection to both F 6221 modules to be interrupted. The interruption may not exceed the safety time.

  Workaround: If the application requires continuous measurement, the connection interruption must be bridged, e.g., by configuring time-off delays in the user program.

3.5 Mounting

The module is mounted in a 19-inch rack. A mounting distance is not mandatory. The rack must be designed to allow dissipation of the generated power.

The module is connected to the intrinsically safe field circuits through cable plug Z 7063.

For further installation instructions, refer to the HIQuad X system manual (HI 803 211 E) or the HIQuad catalog (HI 800 263 E).

3.6 Installation

- The electronic module as associated equipment, included its connected components, must be installed to ensure achievement of degree of protection IP20 or better in accordance with EN 60529/IEC 60529.
- Either two intrinsically safe input circuits within a module may be connected in parallel, or an intrinsically safe input circuit within an F 6220 to an intrinsically safe input circuit within another F 6220, as well as to one Ex supply module for supplying the transmitter. The maximum permissible values (U0, I0, C0, L0), which are reduced in this wiring, must be taken into account (interconnection in accordance with PTB report ThEx-10). A technical report on the interconnection of the F 6221 and F 3325 modules with 2-wire transmitters is available from HIMA upon request.
- A distance of ≥ 50 mm (arcing distance) must be ensured between external, intrinsically safe and non-intrinsically safe terminals.
- A distance of ≥ 6 mm (arcing distance) must be ensured between the external terminals of adjacent, intrinsically safe circuits.
- Intrinsically safe and non-intrinsically safe lines must be separated, or the intrinsically safe lines must be additionally insulated.
- Intrinsically safe lines must be marked, e.g., using a light blue color (RAL 5015) for the sheath.
- The wiring must be mechanically protected to guarantee that the minimum distance between intrinsically safe and non-intrinsically safe connection (EN 60079-11/IEC 60079-11) is not violated due to accidental disconnection.
- In Ex applications, the wire shield must be connected to the equipotential bonding.

The wires in use must comply with the following insulation test voltages:

Intrinsically safe shielded wires	≥	500 VAC

If finely stranded wires are used, the wire ends must be provided with wire end ferrules. The terminals must be suitable for fastening the cross-sections of the cables in use.

Additionally, the applicable regulations and standards must be observed. In particular, these include:

- EN 60079-14:2014 / IEC 60079-14:2013
- EN 60079-0:2012 + A11:2013 / IEC 60079-0:2011, Revised + Cor.:2012 + Cor.:2013
- EN 60079-11:2012 / IEC 60079-11:2011 + Cor.:2012

3.6.1 Wiring Unused Inputs

Unused voltage inputs 0…1 V must be short-circuited to the terminal block. Unused current inputs are terminated with a shunt in the cable plug.

Inputs, which are not terminated, are not reported as faulty (e.g., unplugged cables).

3.6.2 Power Source Requirements

The internal resistance of the supply source must not exceed 500 Ω since internal module faults could otherwise remain undetected.

3.6.3 Redundant Connection

In case of a redundant wiring, an error at one input may generate a measuring error at the redundant faultless input. The measuring error can be up to 2.5% when the input is terminated with a 50 Ω resistor.

Due to the voltage drop on the line connecting the redundant modules, the cable length is limited to 2 m.

3.6.4 External Transmitter Connection (Variants D, E)

The maximum length of the wire connecting the F 6221 module and the corresponding measuring shunts (channel 1...8) is 10 m.

3.6.5 Maximum Cable Length and Load in the Transmitter Circuit

The maximum additional load R_b in the transmitter circuit is calculated as follows:

$$Rb = \left(\frac{\mathrm{UTC} - \mathrm{UTmin}}{\mathrm{Imax}}\right) - (50)\Omega = \left(\frac{16\,V - 14\,V}{20\,mA}\right) - 50\ \Omega = 50\ \Omega$$

R_b Additional load
U_{TC} Switch-off threshold for the transmitter supply voltage monitoring
UT_{min} Minimum supply voltage of the transmitter
I_{max} Maximum current to be measured

The contact resistors of the terminals must be taken into account.

When configuring Ex circuits, the line inductance and capacitance for the corresponding line length must be taken into account.

Minimum transmitter supply voltage UT_{min}	Maximum cable length at 0.2 mm²	Maximum cable length at 0.5 mm²
14.5 V	135 m	312 m
14 V	271 m	625 m
13.5 V	407 m	937 m
13 V	543 m	1250 m
12.5 V	679 m	1562 m
12 V	815 m	1875 m
11.5 V	951 m	2187 m

Table 9: Maximum Cable Length and Load within the Transmitter Circuit

The cable to the transmitter must be shielded and twisted in pairs.

3.7 Start-Up

Proper installation, in particular the connections of the supply voltage and intrinsically safe circuits, must be checked by an explosion protection expert prior to starting up the module for the first time.

3.8 Maintenance

If failures occur, the defective module must be replaced with a module of the same type or with an approved replacement model.

i Only the manufacturer may repair the module.

(1) EU-TYPE EXAMINATION CERTIFICATE

(2) Equipment and Protective Systems intended for use in Potentially Explosive Atmosphere - **Directive 2014/34/EU**

(3) EU-Type Examination Certificate Number

TÜV 18 ATEX 8173 Issue: 00

(4) Equipment: **HIQuad Module F 6221**

(5) Manufacturer: **HIMA Paul Hildebrandt GmbH**

(6) Address: **Albert-Bassermann-Str. 28**
68782 Brühl, Germany

(7) This product and any acceptable variation thereto are specified in the schedule to this certificate and the documents therein referred to.

(8) The TÜV Rheinland Zertifizierungsstelle für Explosionsschutz of TÜV Rheinland Industrie Service GmbH, Notified Body No. 0035 in accordance with Article 21 of the Council Directive 2014/34/EU of 26th February 2014, certifies this product which has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of equipment and protective systems intended for use in potentially explosive atmosphere, given in Annex II to the Directive.

The examination and test results are recorded in the confidential report 557/Ex8173.00/18

(9) Compliance with the Essential Health and Safety Requirements, with the exception of those listed in the schedule of this certificate, has been assessed by reference to:

EN 60079-0: 2012+A11:2013 **EN 60079-11: 2012**

(10) If the sign "X" is placed after the certificate number, it indicates that the equipment is subject to special conditions for safe use specified in the schedule to this certificate.

(11) This EU-Type Examination Certificate relates only to the design and specification for construction of the equipment or protective system. It does not cover the process for actual manufacture or supply of the equipment or protective system, for which further requirements of the directive are applicable.

(12) The marking of the equipment shall include the following:

II (1) G [Ex ia Ga] IIC
[Ex ia Da] IIIC

TÜV Rheinland Zertifizierungsstelle für Explosionsschutz Cologne, 2018-08-21

Dipl.-Ing. Andreas Maschke

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(13) Annex

(14) **EU Type Examination Certificate**

TÜV 18 ATEX 8173 Issue: 00

(15) Description of equipment

15.1 Equipment and type:

HIQuad Module F 6221

15.2 Description / Details of Change

General product information

The field of application of the F 6221 module is the operation with intrinsically safe Ex ia current transmitters (0/4 to 20mA) which can be supplied by intrinsically safe supplies [Ex ia], e.g. unit F 3325. The F 6221 module is an associated apparatus and contains the measuring device. It can be used to measure up to eight signal inputs (I1 to I8). For monitoring the transmitter supply voltages, another eight signal inputs (TC1 to TC8) are available.

Technical Data

Ambient temperature: T_a = 0°C ... + 60°C

Supply circuit UB1:
U_n = 24VDC (-15%, +20%), $UB1_{max}$ = 30V
U_m = 40V
(terminal X1 z2(L+), d2(L-))

Supply circuit UB2:
U_n = 4.5....5.5VDC, $UB2_{max}$ = 6.0V
U_m = 40V
(terminal X1 z6, d6(V_{DD}), z30, d30(GND))

Intrinsically safe values for the measuring and monitoring channels,
type of protection [Ex ia Ga] IIC/IIB
or [Ex ia Da] IIIC/IIIB

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measuring	monitoring
+I 1-8:	TC 1-8:
U_o: 5.7 V	U_o: 5.7 V
I_o: 2 mA	I_o: 0.5 mA
P_o: 2.9 mW	P_o: 0.72 mW
(terminal z2, z4,….z16	z18, z20,…….z32)

Maximum allowed external capacitance *or* inductance:

Ex ia / Ex ib	single circuit		parallel*1 circuit	
	IIC	IIB/IIIC/IIIB	IIC	IIB/IIIC/IIIB
L_o	1H	1H	1H	1H
C_o	50 µF	1000 µF	50 µF	1000 µF

Maximum allowed external capacitance *and* inductance (mixed consideration):

Ex ia / Ex ib	single circuit		parallel*1 circuit	
	IIC	IIB/IIIC/IIIB	IIC	IIB/IIIC/IIIB
L_o	5 mH	5 mH	5 mH	5 mH
C_o	1.5 µF	7.5 µF	1.5 µF	7.5 µF

Note *1: parallel operation of two measuring and two monitoring channels

(16) Test-Report No. 557/Ex8173.00/18

(17) Special Conditions for safe use

None

(18) Basic Safety and Health Requirements

Covered by afore mentioned standard

TÜV Rheinland Zertifizierungsstelle für Explosionsschutz Cologne, 2018-08-21

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Technical Report

Electrical interconnection of the modules
F 6221 and F3325

Manufacturer

HIMA Paul Hildebrandt GmbH + Co KG
Albert-Bassermann-Straße 28
68782 Brühl

Report-No.: 70013102.4 (/.1/.2)
Revision 1.0 on June 28th 2002

Notified Body:

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TÜV SÜDDEUTSCHLAND

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1 Introduction

This report examines ten different variations of electrical interconnection of the power supply module F 3325 and the measurement module F 6221. The variations of electrical interconnection of these modules allow redundancy concerning measurement value logging and/or concerning power supply of the transmitters. Every variation of electrical interconnection possess an associated characteristic curve. This characteristic curve is composed of the characteristic curves of the particular components.

Chapter 2 of this report will show an interest in the electrical specification of the intrinsically safe electric circuits of the power supply- and the measurement modules. Chapter 3 describes as a matter of principle the electrical connection of the modules and the accruement of the accumulated characteristic curves. As a result of the electrical interconnection, in chapter 4 the accumulated voltages and electric currents will be investigated and personated. In chapter 5 the arising maximal inductances and capacitances will be presented and discussed.

2 Electrical data of the intrinsically safe circuits of the modules

This chapter describes the electrical data of the intrinsically safe circuits of the power supply module and the measurement module.

2.1 Module F 6221

2.1.1 Intrinsically safe port, strip X20

The module F 6221 is an associated electrical apparatus for installation only outside an atmosphere capable of explosion. This subassembly unit for installation in a subrack consist of two PCB-boards. 16 galvanically coupled intrinsically safe input ports are connectable at the front. The output- and power supply ports are connectable at the rear of the module.

The environmental temperature averages $-20°C \leq T_{amb} \leq 60°C$.

Channel one to eight for measuring electric circuits and channel one to eight for backreading electric circuits are intrinsically safe and safety isolated up to a peak value of 375 V against the output- and power supply ports. Tab. 2.1 shows the associated pin assignment. Tab. 2.2 shows the electrical data of the measurement circuits and Tab. 2.3 shows the electrical data of the backreading circuits.

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Port, common ground	Port	Input	Function
d2	z2	I1+	Measuring circuit 1 +
	z4	I2+	Measuring circuit 2 +
d6	z6	I3+	Measuring circuit 3 +
d8	z8	I4+	Measuring circuit 4 +
d10	z10	I5+	Measuring circuit 5 +
d12	z12	I6+	Measuring circuit 6 +
d14	z14	I7+	Measuring circuit 7 +
d16	z16	I8+	Measuring circuit 8 +
d18	z18	TC1+	Backreading circuit 1 +
d20	z20	TC2+	Backreading circuit 2 +
d22	z22	TC3+	Backreading circuit 3 +
d24	z24	TC4+	Backreading circuit 4 +
d26	z26	TC5+	Backreading circuit 5 +
d28	z28	TC6+	Backreading circuit 6 +
	z30	TC7+	Backreading circuit 7 +
z32	z32	TC8+	Backreading circuit 8 +

Tab. 2.1: Pin assignment of the intrinsically safe electric circuits of the module F 6221

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2.1.2 Measurement circuits channel 1...8

Voltage, U_O	crest value DC 5,7 V / -1 V
Current, I_O	crest value DC 2 mA
Power, P_O	crest value 2,9 mW
Characteristic curve	linear
internal capacitor, C_i	negligible
internal inductance, L_i	negligible

Tab. 2.2: Electric data of the measurement circuits of the module F 6221

2.1.3 Backreading circuits 1...8

Voltage, U_O	crest value DC 5,7 V / -1 V
Current, I_O	crest value DC 0,5 mA
Power, P_O	crest value 0,72 mW
Characteristic curve	linear
internal capacitor, C_i	negligible
internal inductance, L_i	negligible

Tab. 2.3: Electric data of the backreading circuits of the module F 6221

2.2 Module F 3325

2.2.1 Intrinsically safe electric output circuits, strip X20

The module F 3325 is an associated electrical apparatus for installation only outside an atmosphere capable of explosion. This subassembly unit for installation in a subrack consist of one PCB-board. In order to supply (Ex-) transmitters six intrinsically safe power supply ports are connectable at the front. The output- and power supply ports are connectable at the rear of the module.

The environmental temperature averages $-20°C \leq T_{amb} \leq 60°C$.

Six voltages of 22 V for the supply of the (Ex-) transmitters are provided. These are intrinsically safe and safety isolated up to a peak value of 375 V against the power supply circuit. Tab. 2.4 shows the associated pin assignment. Tab. 2.5 shows the electric data of the output circuits.

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Port	Output	Function
z2	O1-	Voltage output 1 -
b2	O1+	Voltage output 1 +
b4	OR1+	Redundant voltage output 1 +
z8	O2-	Voltage output 2 -
b8	O2+	Voltage output 2 +
b10	OR2+	Redundant voltage output 2 +
z14	O3-	Voltage output 3 -
b14	O3+	Voltage output 3 +
b16	OR3+	Redundant voltage output 3 +
z18	O4-	Voltage output 4 -
b18	O4+	Voltage output 4 +
b20	OR4+	Redundant voltage output 4 +
z22	O5-	Voltage output 5 -
b22	O5+	Voltage output 5 +
b24	OR5+	Redundant voltage output 5 +
z28	O6-	Voltage output 6 -
b28	O6+	Voltage output 6 +
b30	OR6+	Redundant voltage output 6 +

Tab. 2.4: Pin assignment of the intrinsically safe electric circuits of the module F 3325

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2.2.2 Electric output circuits

Voltage per output circuit, U_O	crest value DC 23,2 V
Amperage per output circuit, I_O	crest value DC 75,6 mA
Power per output circuit, P_O	crest value 657,7 mW
Characteristic curve	trapeze
Internal capacitance per output circuit, C_i	negligible
Internal inductance per output circuit, L_i	negligible

Tab. 2.5: Electric data of the module F 3325

3 Electric interconnection of the modules

This chapter shows an interest in the electrical interconnection of the modules F 6221 and F 3325.

According to the documentation of the electrical interconnection of the modules, a parallel connection of the output supply of the module F 3325 and the backreading channels of the module F 6221 in serial with the measurement channels of the module F 6221 according to image 3.1 takes place. The accumulated characteristic curve of the electric interconnection results from the graphic summation of the characteristic lines of the output power supply of the module F 3325 in terms of the electric circuit and the graphic summation of the characteristic curves of the measurement outputs of the module F 6221 in terms of the voltage.

The variation of the electrical interconnection corresponds with the precept according to image 3.1 and differs merely by the number of power supply channels, backreading channels and measurement channels.

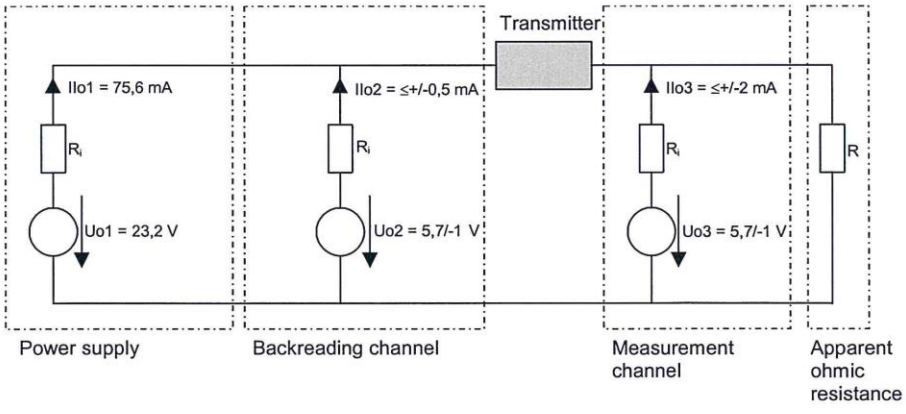

Image 3.1: Precept of electric interconnection of the modules

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Regarding the interconnection, the worst case is provided by the voltages Uo1, Uo2 and Uo3 and the electric circuits Io1, Io2 and Io3. The values of these voltages and electric circuits are personated in Tab. 3.1.

	Output channel F 3325	Measurement channel F 6221	Backreading channel F 6221
Io of the channel	Io1 = 75,6 mA	Io2 ≤ +/-2 mA	Io3 ≤ +/-0,5 mA
Uo of the channel	Uo1 = 23,2 V	Variant 1, 2, 3, 4, 9, 10 Uo2 = -1 V Variant 5, 6, 7, 8 Uo2 = 5,7 V	Variant 1, 2, 3, 4, 9, 10 Uo3 = -1 V Variant 5, 6, 7, 8 Uo3 = 5,7 V

Tab. 3.1: Most disadvantageous electric circuits and voltages regarding the interconnection of the modules

4 Cumulative electric circuits and cumulative voltages

Tab. 4.1 shows the accumulated electric circuits and voltages for the variants one to ten according to image 3.1. On the basis of this report, the interconnection of the modules is merely permitted under the following requirement: The precept of interconnection corresponds with image 3.1 and personates one of the variants of interconnection according to Tab. 4.1.

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Variant	Kind of channel	Number of channels	Io of the channel in mA	Cumulative current in mA	Uo of the channel in V	Cumulative voltage in V
1	Output channel F 3325	1	75,6	75,6	23,2	23,2
	Measurement channel F 6221	1	≤+/-2	-	-1	-1
	Backreading channel F 6221	1	≤+/-0,5	≤+/-0,5	5,7/-1	-
			Cumulative current	≤76,1	Cumulative voltage	24,2
2	Output channel F 3325	1	75,6	75,6	23,2	23,2
	Measurement channel F 6221	2	≤+/-2	-	-1	-1
	Backreading channel F 6221	1	≤+/-0,5	≤+/-0,5	5,7/-1	-
			Cumulative current	≤76,1	Cumulative voltage	24,2
3	Output channel F 3325	1	75,6	75,6	23,2	23,2
	Measurement channel F 6221	2	≤+/-2	-	-1	-1
	Backreading channel F 6221	2	≤+/-0,5	≤+/-1	5,7/-1	-
			Cumulative current	≤76,6	Cumulative voltage	24,2
4	Output channel F 3325	1	75,6	75,6	23,2	23,2
	Measurement channel F 6221	4	≤+/-2	-	-1	-1
	Backreading channel F 6221	2	≤+/-0,5	≤+/-1	5,7/-1	-
			Cumulative current	≤76,6	Cumulative voltage	24,2
5	Output channel F 3325	0	75,6	-	-	-
	Measurement channel F 6221	1	≤+/-2	≤+/-2	5,7	5,7
	Backreading channel F 6221	0	≤+/-0,5	-	-	-
			Cumulative current	≤+/-2	Cumulative voltage	5,7

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Variant	Kind of channel	Number of channels	Io of the channel in mA	Cumulative current in mA	Uo of the channel in V	Cumulative voltage in V
6	Output channel F 3325	0	75,6	-	-	-
	Measurement channel F 6221	2	≤+/-2	≤+/-4	5,7	5,7
	Backreading channel F 6221	0	≤+/-0,5	-	-	-
			Cumulative current	≤+/-4	Cumulative voltage	5,7
7	Output channel F 3325	0	75,6	-	-	-
	Measurement channel F 6221	2	≤+/-2	≤+/-4	5,7	5,7
	Backreading channel F 6221	0	≤+/-0,5	-	-	-
			Cumulative current	≤+/-4	Cumulative voltage	5,7
8	Output channel F 3325	0	75,6	-	-	-
	Measurement channel F 6221	4	≤+/-2	≤+/-8	5,7	5,7
	Backreading channel F 6221	0	≤+/-0,5	-	-	-
			Cumulative current	≤+/-8	Cumulative voltage	5,7
9	Output channel F 3325	2	75,6	151,2	23,2	23,2
	Measurement channel F 6221	2	≤+/-2	-	-1	-1
	Backreading channel F 6221	2	≤+/-0,5	≤+/-1	5,7/-1	-
			Cumulative current	≤152,2	Cumulative voltage	24,2
10	Output channel F 3325	2	75,6	151,2	23,2	23,2
	Measurement channel F 6221	2	≤+/-2	-	-1	-1
	Backreading channel F 6221	2	≤+/-0,5	≤+/-1	5,7/-1	-
			Cumulative current	≤152,2	Cumulative voltage	24,2

Tab 4.1: Cumulative currents and cumulative voltages for different variants of electrical interconnection

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5 Maximum inductances and capacitances

5.1 Results of the isolted view

Tab. 5.1 shows the maximum connectable inductances and capacitances for the isolated view.

				ib-IIC		ib-IIB		
Variant	Uo in V	Io in mA	Po in mW	Lo in mH (Co = 0)	Co in µF (Lo = 0)	Lo in mH (Co = 0)	Co in µF (Lo = 0)	Annotation
1	24,2	≤76,1	657,7	5,5	0,11	22	0,84	with F 3325
2	24,2	≤76,1	657,7	5,5	0,11	22	0,84	with F 3325
3	24,2	≤76,6	657,7	5,5	0,11	22	0,84	with F 3325
4	24,2	≤76,6	657,7	5,5	0,11	22	0,84	with F 3325
5	5,7	≤2	2,9	1000	50	1000	1000	without F 3325
6	5,7	≤4	5,7	1000	50	1000	1000	without F 3325
7	5,7	≤4	5,7	1000	50	1000	1000	without F 3325
8	5,7	≤8	11,4	540	50	1000	1000	without F 3325
9	24,2	≤152,2	1315,4	1	0,11	6,2	0,84	with F 3325
10	24,2	≤152,2	1315,4	1	0,11	6,2	0,84	with F 3325

Tab. 5.1: Maximum connectable inductances and capacitances for the isolated view

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5.2 Results of the composite view

Tab. 5.1 shows the maximum connectable inductances and capacitances for the composite view.

				ib-IIC		ib-IIB		
Variant	Uo in V	Io in mA	Po in mW	Lo in mH	Co in µF	Lo in mH	Co in µF	Annotation
1	24,2	≤76,1	657,7	1	0,06	5	0,3	with F 3325
2	24,2	≤76,1	657,7	1	0,06	5	0,3	with F 3325
3	24,2	≤76,6	657,7	1	0,06	5	0,3	with F 3325
4	24,2	≤76,6	657,7	1	0,06	5	0,3	with F 3325
5	5,7	≤2	2,9	5	1,5	5	7,5	without F 3325
6	5,7	≤4	5,7	5	1,5	5	7,5	without F 3325
7	5,7	≤4	5,7	5	1,5	5	7,5	without F 3325
8	5,7	≤8	11,4	5	1,5	5	7,5	without F 3325
9	24,2	≤152,2	1315,4	-	-	2	0,3	with F 3325
10	24,2	≤152,2	1315,4	-	-	2	0,3	with F 3325

Tab. 5.2: Maximum connectable inductances and capacitances for composite view

The composite view is not practicable for the interconnection according to variant 9 resp. 10, gas group IIC.

The power Po was estimated pessimistically.

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Group of companies TÜV Süddeutschland

Automation, Software and Electronics - IQSE
Project manager

By order

Thomas Lammel