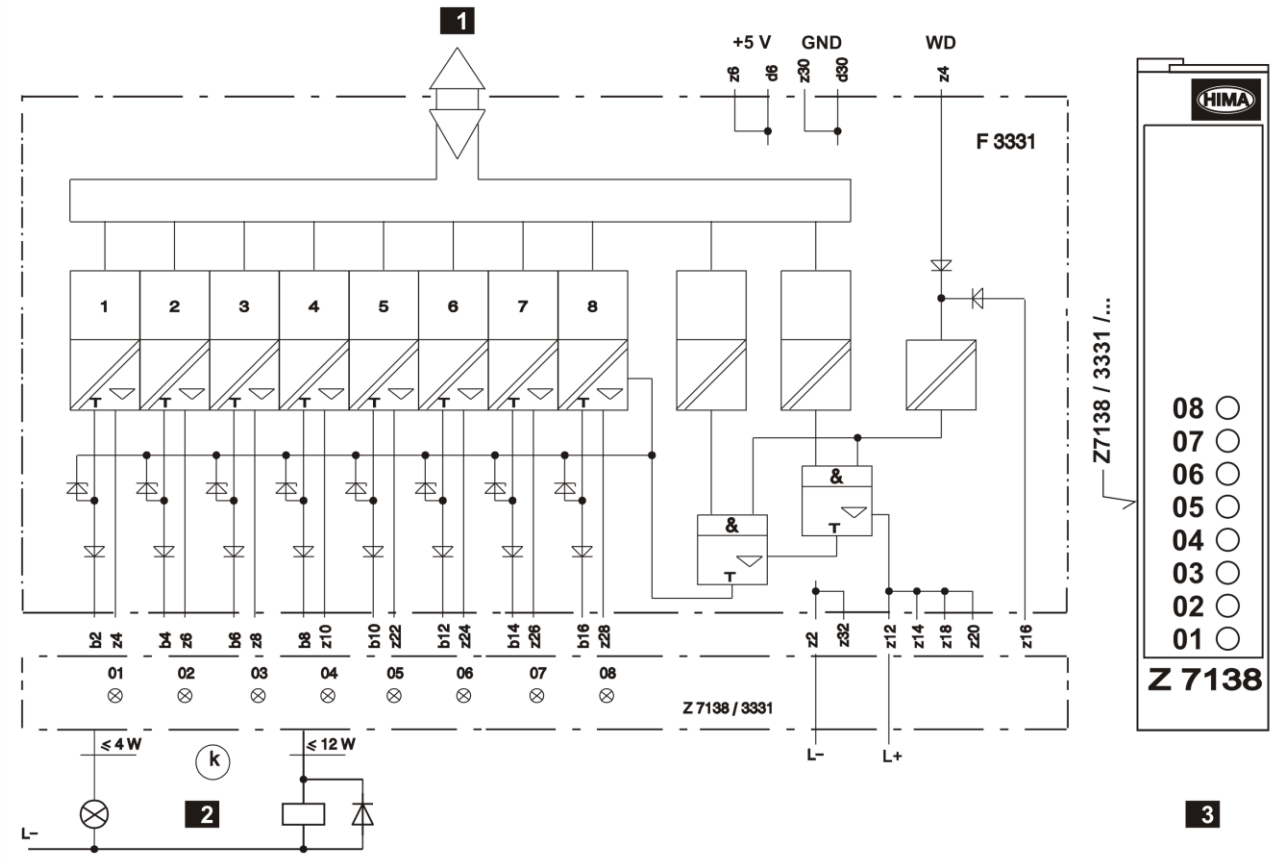
F 3331: Output Module

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

- 8 channels for ohmic or inductive loads up to 500 mA (12 W).
- Indicator lamp connection up to 4 W.
- With integrated safety shutdown, with protective separation.
- Short-circuits and open-circuits monitoring.
- No output signal upon break in L- supply.
- For HIQuad X (SILworX) and HIQuad (ELOP II, **HB-BLD-3** or **HB-BLD-4** function block required).



1 I/O bus

2 Lamp or load (ohmic or inductive)

3 Cable plug, front view

Figure 1: Module Block Diagram and Cable Plug Front View

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The module is completely and automatically tested during operation.
The main tests are:

- Switching capability of the safety shutdown.
- Reading back of the output signals. The switching threshold for read-back low signals is ≤ 6.5 V. If a fault occurs, the low level may increase up to this value without being detected.
- Crosstalk of the outputs (walking zero: The channels are set to 0 successively and only 1 channel may have this value).

The cable plug LEDs are not tested.

Specifications

Outputs	500 mA per channel, short-circuit-proof
Internal voltage drop	Max. 2 V at 500 mA load
Admissible line resistance (in + out)	Max. 11 Ω
Undervoltage tripping	≤ 16 V
Short-circuit switching threshold	0.75...1.5 A
Open-circuit switching threshold	0.5…9.5 mA
Lamp load	Max. 4 W (with series resistor up to 10 W)
Output leakage current	Max. 350 µA
Output voltage during deactivation	Max. 1.5 V
Current consumption WD	Max. 30 mA
Monitored switching time (ELOP II)	Max. 200 µs (without latency due to the function block extension)
Monitored switching time (SILworX)	Max. 250 µs (if the maximum test pulse duration is 0)
Space requirement	4 HP
Current consumption	130 mA at 5 VDC (via backplane) 180 mA at 24 VDC plus load (via cable plug)

Wiring

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

- Cable plug Z 7138/3331/Cx for 1-pole connection (Table 1).
- Cable plug Z 7138/3331/Cx/P2 for 2-pole connection (Table 2).

Channel	Pin	Color	Connection
1	b2	WH	Cable: LiYY 8 x 0.5 mm²
2	b4	BN	
3	b6	GN	
4	b8	YE	
5	b10	GY	
6	b12	PK	
7	b14	BU	
8	b16	RD	
L–	z2	BK	Female connector 2.8 x 0.8 mm² q = 1 mm², l = 750 mm
L+	z12	RD	

Table 1: Wire Color Coding of the Cable Plug Z 7138/3331/Cx

Channel	Pin	Color	Connection
1	b2	BN	Cable: LiYY 16 x 0.5 mm²
	x2	WH	
2	b4	YE	
	x4	GN	
3	b6	PK	
	x6	GY	
4	b8	RD	
	x8	BU	
5	b10	VT	
	x10	BK	
6	b12	WHGN	
	x12	WHBN	
7	b14	WHGY	
	x14	WHYE	
8	b16	WHBU	
	x16	WHPK	
L-	z2	BK	Female connector 2.8 x 0.8 mm² q = 1 mm², l = 750 mm
L+	z12	RD	

Table 2: Wire Color Coding of the Cable Plug Z 7138/3331/Cx/P2 for 2-Pole Connection

General Configuration Notes

- The outputs can be connected in parallel without using external decoupling diodes.
- Lamp loads greater than 4 W but not exceeding 10 W are allowed in conjunction with a series resistor 4.7 Ω, 5 W.
- A suitable free-wheeling diode must be used for inductive loads.
- The connection of purely capacitive loads is not permitted.
- Provided that the line capacity does not exceed 1 µF, the cable length may achieve 3 km.
- A maximum of 10 output modules with nominal load may be operated within one rack.

Configuration Notes for ELOP II

- In ELOP II, the HB-BLD-3 function block is required for 1-channel operation and the HB-BLD-4 function block for 2-channel operation. For further details on the function blocks, refer to the ELOP II online help.
- For lamp loads, a short-circuit monitoring delay applying to all the channels can be configured in the function block. The delay for short-circuit monitoring is configured in the function block input *Max OC/SC Time in ms* within the range 1…50 ms.
- Open-circuit monitoring requires a minimum load of 10 mA.
- Short-circuits and open-circuits can be evaluated in the user program through the function block. The *Open-Circuit* signal is evaluated with SIL 1.

Configuration Notes for SILworX

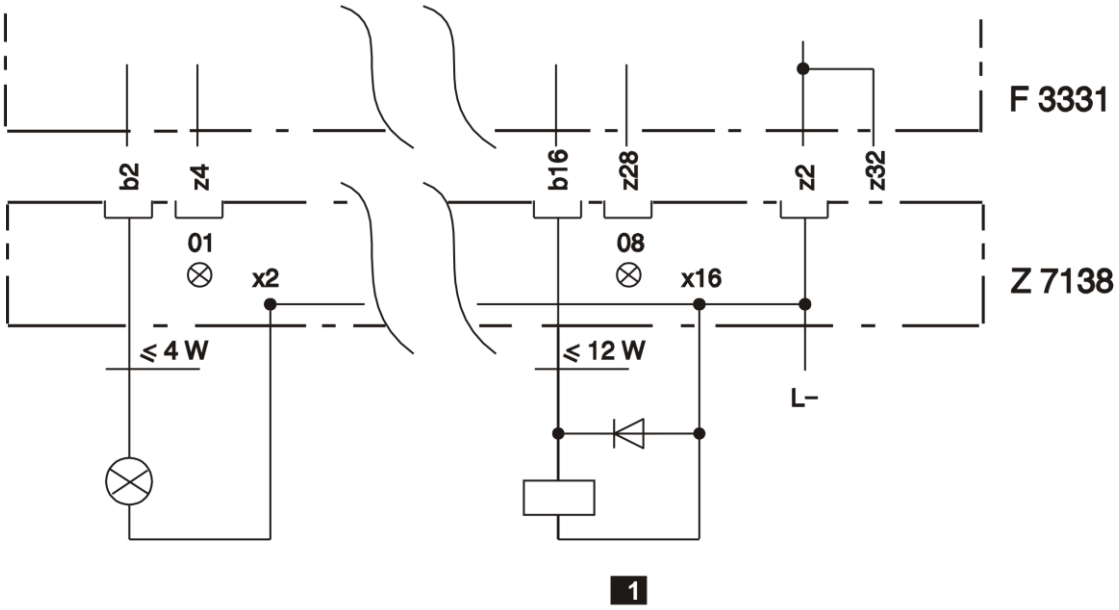
- Line monitoring can be configured in SILworX.
- For lamp loads, a short-circuit monitoring delay applying to all the channels can be configured in the Hardware Editor. The delay for short-circuit monitoring is set by configuring the *Max. Test Pulse Duration [ms]* within the range 0…50 ms.
- Open-circuit monitoring requires a minimum load of 10 mA.
- Short-circuits and open-circuits can be evaluated in the user program by using global variables. The open-circuit signal is evaluated with SIL 1.

Configuration Notes for the Redundant Use of the F 3331

- If an open-circuit occurs, the double current can flow through the load until the short-circuit is diagnosed.
- The minimum current must be twice as high (20 mA) to prevent open-circuits from being displayed.
- If the L- supply line is interrupted, the safe shutdown of the outputs is no longer ensured.

2-Pole Connection at the Outputs

Cable plug Z 7138/3331/Cx/P2 must be used for the 2-pole connection on the outputs.



1 Inductive Load with Free-Wheeling Diode

Figure 2: 2-Pole Connection

1 Configuration in SILworX

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

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 more information on the statuses and parameters, refer to the tables starting with Chapter 1.1.
- 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.

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.

1.1 The Module Tab

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

System parameters	Data type	S [1)]	R/W	Description
Name	---	---	W	Module name.
Noise Blanking	BOOL	Y	W	Noise blanking performed by the system module allowed (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. Refer to the system manual (HI 803 211 E) for more details on noise blanking.
Test Interval [ms]	UDINT	Y	W	Interval of the test pulses. Range of values: (1000 … MAXUDINT) ms Granularity: 1000 ms Default value: 1000 (1 s)
Max. Test Pulse Duration [ms]	UDINT	Y	W	Maximum duration of a test pulse. Range of values: 0…50 ms Default value: 0
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.

<table>
<tr><th>System parameters</th><th>Data type</th><th>S [1)]</th><th>R/W</th><th>Description</th></tr>
<tr><td>Module OK</td><td>BOOL</td><td>Y</td><td>R</td><td><table><tr><td>TRUE</td><td>No internal fault detected by the system.</td></tr><tr><td>FALSE</td><td>▪ Internal fault detected by the system.
▪ Module in the STOP state.
▪ Connection loss.</td></tr></table></td></tr>
<tr><td>Module Process Value OK</td><td>BOOL</td><td>Y</td><td>R</td><td><table><tr><td>TRUE</td><td>No channel fault detected by the system.</td></tr><tr><td>FALSE</td><td>▪ At least one channel fault detected by the system.
▪ Module in the STOP state.
▪ Connection loss.</td></tr></table></td></tr>
<tr><td>Restart on Error Suppressed</td><td>BOOL</td><td>Y</td><td>W</td><td>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).<table><tr><td>TRUE</td><td>No automatic restart after a module or channel fault.</td></tr><tr><td>FALSE</td><td>Automatic restart after a module or channel fault.</td></tr></table>Default setting: FALSE</td></tr>
<tr><td colspan="5">[1)] The operating system handles the system parameter in a safety-related manner, yes (Y) or no (N).</td></tr>
</table>

Table 3: The **Module** Tab in the Hardware Editor

1.2 The F 3331_1: Channels Tab

The **F 3331_1: Channels** tab contains the following system parameters for each channel:

System parameters	Data type	S [1)]	R/W	Description
Channel no.	---	---	R	Channel number, preset and cannot be changed.
Channel Value [BOOL] ->	BOOL	Y	R	Binary value in accordance with the switching level LOW (dig) and HIGH (dig). TRUE: Channel energized. FALSE: Channel de-energized.
-> 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. The channel value is valid. FALSE: ▪ Faulty channel. ▪ Module in the STOP state. ▪ Connection loss.
SC/OC Active	BOOL	Y	W	Short-circuit and open-circuit monitoring (activated/deactivated). Default setting: Activated.
SC/OC Mode [UINT] ->	UINT	Y	R	Mode 0: No line monitoring (SC/OC) for this channel, error messages are suppressed. Unused inputs are handled like Mode = 0. Mode 1: Line monitoring (SC/OC) active for this channel. Mode 2: „Inverse“ line monitoring (SC/OC): ▪ SC on the channel → FALSE ▪ No SC on the channel → TRUE. The output circuit should be open.
-> OC [BOOL]	BOOL	Y	R	TRUE: Open-circuit. FALSE: ▪ No open-circuit. ▪ Module fault. ▪ Module in the STOP state. ▪ Connection loss.
-> SC [BOOL]	BOOL	Y	R	TRUE: Short-circuit. FALSE: ▪ No short-circuit. ▪ Module fault. ▪ 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: TRUE

[1)] The operating system handles the system parameter in a safety-related manner, yes (Y) or no (N).

Table 4: Tab **F 3331_1: 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.

1.3 Description 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 internal errors were detected in the module.

Internal errors cannot be remedied by the user. The module must be replaced!

Bit	Coding	Description
0	0x00000001	This bit is set whenever an internal module fault is detected.
1	0x00000002	The module slot is empty or equipped with another module type.
2	0x00000004	Module defective (the error code is for internal purposes only).
…	…	
31	0x80000000	

Table 5: Diagnostic Entry Coding

1.3.1 Channel Status

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

Bit	Coding	Description
0	0x01	This bit is set whenever a channel fault is detected. The module must be replaced!
6	0x40	Module defective (the error code is for internal purposes only).
7	0x80	Module defective (the error code is for internal purposes only).

Table 6: Channel Status for the F 3331