IB IL 400 ELR 1-3A

INTERBUS Inline Power-Level Terminal as a Direct Starter for a Motor With a Power of up to 1.5 kW

Data Sheet 6050E 11/2001

This data sheet is only valid in association with the INTERBUS Inline System Manual IB IL SYS PRO UM E.

Product Description

The single-channel power-level terminal with electronic motor protection provides switching, protection and monitoring of three-phase asynchronous motors via INTERBUS. The power-level terminal is designed for use within the 24 V area of an INTERBUS Inline station.

Features

- INTERBUS protocol (EN 50254:1997)
- Integrated electronic motor protection according to IEC 60947-4:1990
- Connection option for an external passive brake module
- Operator Hand Panel operation possible
- Safe isolation between line voltage and 24 V supply voltage according to EN 50178:1997
- Diagnostic and status indicators
- Motor current monitoring
- Motor control through INTERBUS output data

Application

Three-phase asynchronous motors

- Nominal voltage 400 V AC
- Nominal motor current from 0.2 A to 3.6 A

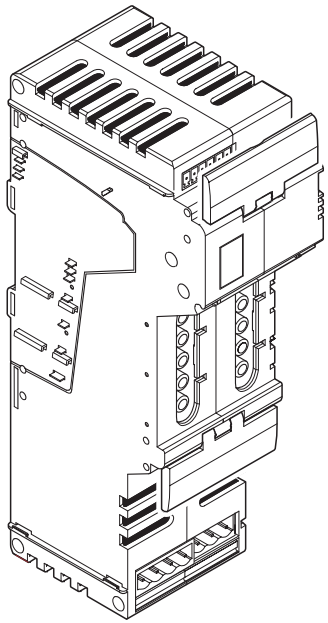


Figure 1 The IB IL 400 ELR 1-3A power-level terminal

Explanation of Symbols Used

This data sheet contains information which must be noted for your own safety and to avoid damage to equipment. This information is marked with the following symbols according to the level of danger:

The *attention* symbol refers to actions which may endanger the health and safety of personnel or cause damage to hardware or software.

The *note* symbol informs you of conditions that must strictly be observed to achieve error-free operation. It also gives you tips and advice on the efficient use of hardware and on software optimization to save you extra work.

The *text* symbol refers you to detailed sources of information (user manuals, data sheets, literature, etc.) on the subject matter, product, etc.

Safety Instructions for Electrical Equipment Used in High-Power Industrial Plants.

The electrical power-level terminal and connected machines described are equipment used in high-power industrial plants. During operation, this equipment has dangerous, live, moving or rotating parts. They can therefore cause considerable damage to health or equipment, e.g., due to the unauthorized removal of protective covers or inadequate maintenance.

– Only qualified personnel may work on the power-level terminal or system.
– When work is being carried out on the power-level terminal or system, the operation manual and the relevant product documentation must always be kept at hand and referred to.
– It is prohibited for unqualified personnel to work on the power-level terminal, on the machines or in their vicinity.

Qualified personnel are people who, because of their education, experience and instruction and their knowledge of relevant standards, regulations, accident prevention and service conditions, have been authorized by those responsible for the safety of the plant to carry out any required operations and who are able to recognize and avoid any possible dangers.
(Definitions for skilled workers according to EN 50110-1:1996.)

The process notes and circuit details presented on this data sheet should be understood in a general sense and the relevant application should be tested to see if they apply.

Phoenix Contact cannot guarantee the suitability of the procedures described or the circuit suggestions for the relevant application.

The instructions given on this data sheet must be followed during installation and startup.

Technical modifications reserved.

Table of Contents

1 Correct Usage

The power-level terminal is only to be used as specified in the catalog and this data sheet. Phoenix Contact accepts no liability if the device is used for anything other than its designated use.

Do not implement a reversing application.

This power-level terminal is not to be used to implement a reversing application with two IB IL 400 ELR 1-3A power-level terminals.

If this advice is not followed, the power-level terminal may be damaged.

Use the IB IL 400 ELR R-3A power-level terminal to implement a reversing application (Order No. 27 27 37 8).

Do not use the power-level terminal to control pole-reversing motors (dual speed) !

2 Installation Instructions

Do not replace terminals while power is connected.

Before removing or mounting an Inline terminal, disconnect power to the entire station. Make sure the entire station is reassembled before switching the power back on.

Dangerous voltage.

Before working on the power-level terminal or system, disconnect the AC line voltage and ensure that it cannot be switched on again.

If these instructions are not followed, there is a danger of damage to health, or even of a life-threatening injury.

Take measures to suppress interference.

Switching three-phase induction motors when they are not at zero current generates electromagnetic disturbance which may adversely affect the function of the system. In order to limit this type of interference, appropriate measures must be taken in accordance with standard EN 60204-1:1998 (Electrical Equipment of Machines) to attenuate the interference at its source (the motor).
In practice, RC interference suppression elements have proven to be effective.

Additional information on mounting and installing the power-level terminal and general information on the INTERBUS Inline product range can be found in the INTERBUS Inline System Manual IB IL SYS PRO UM E.

3 General Description

3.1 Diagnostic and Status Indicators

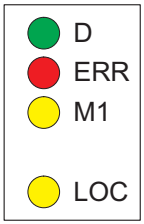


Figure 2 Diagnostic and status indicators

D	Green LED	Diagnostics
	ON:	INTERBUS is active
	Flashing:	
	0.5 Hz: (slow)	Communications power is present, INTERBUS is not active
	4 Hz: (fast)	Communications power is present, bus connection for the flashing terminal has failed; terminals to the right of the flashing module are not part of the configuration frame
	OFF:	Communications power is not present, INTERBUS is not active
ERR	Red LED	Group error message/motor protection
	ON:	Operational fault (motor protection has been triggered, power level cannot be controlled)
	OFF:	No error
M1	Yellow LED	Motor
	ON:	Motor is switched on
	OFF:	Motor is not switched on
LOC	Yellow LED	Manual mode (local)
	ON:	Manual mode is active
	OFF:	Manual mode is not active

3.2 Internal Circuit Diagram

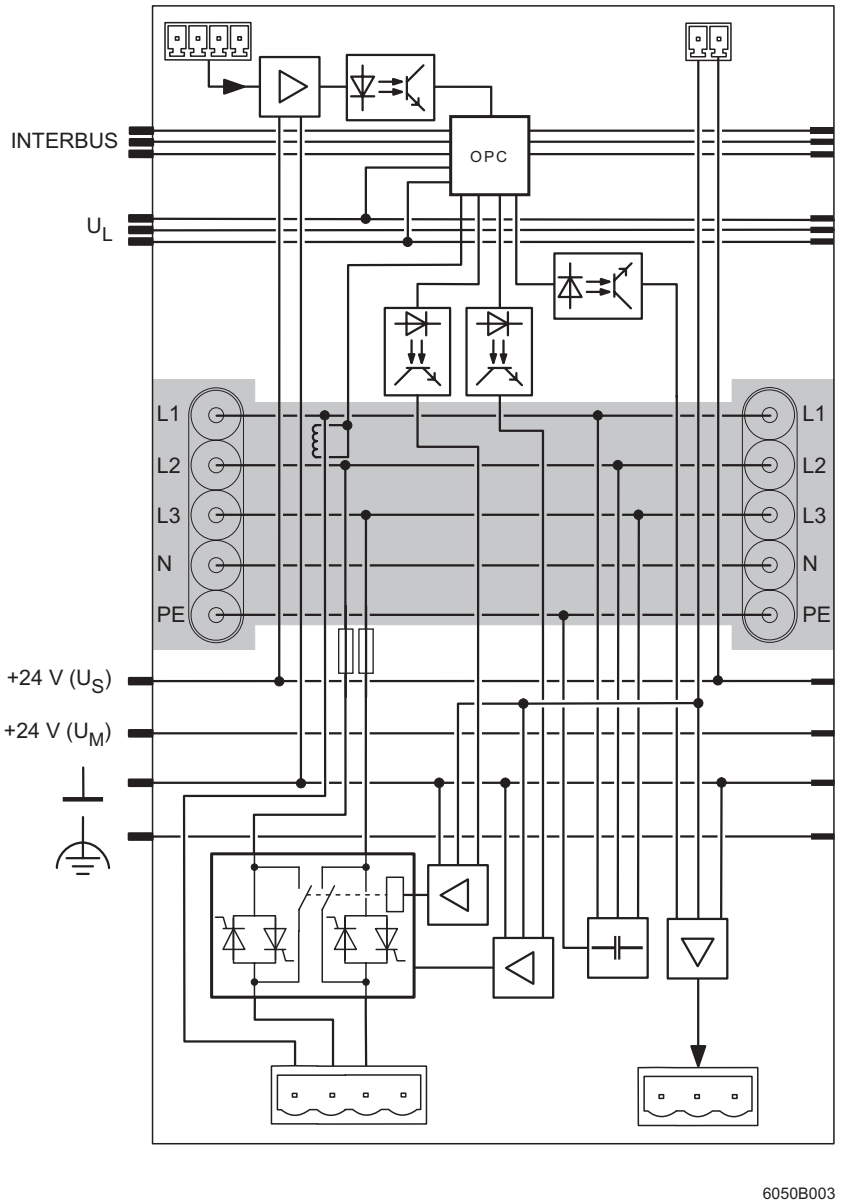
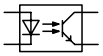


Figure 3 Internal wiring of the terminals

Key:

	4-pos. MINI-COMBICON	(X32, connection for manual mode)
	2-pos. MINI-COMBICON	(X18, connection for enabling the power level/ 24 V isolation)
	Amplifier	
	Optocoupler	
	INTERBUS protocol chip (bus logic including voltage conditioning)	
	Line connection	
	Current transformer	
	Fuse	
	Relay	
	Thyristor diode	
	Capacitor	
	Isolated area	
	4-pos. COMBICON	(X10, connection for motor output)
	3-pos. COMBICON	(X8, connection for external brake module)
	Ground	
	Functional earth ground (FE)	
	Voltage jumper	

4 Safety and Warning Instructions

Dangerous voltage

Carry out all work on the power-level terminal and the connectors when the power is not connected.

The semiconductors in the power level disconnect the motor without electrical isolation even when switched off.
Due to the leakage currents of the semiconductors, an exposed dangerous voltage may be present at the motor connection even when the power levels are disconnected.

Dangerous voltage

Please ensure that phase T1 is not connected and is always present at the motor connection.

Avoid damage to the electronics

Do not mix up the terminals, as this may damage the electronics.

5 Connections

Observe the safety and warning instructions listed under 4.

The power-level terminals with all (including optional) connectors can be found in Figure 12 on page 17.

5.1 Terminal Strips of the Power-Level Terminal

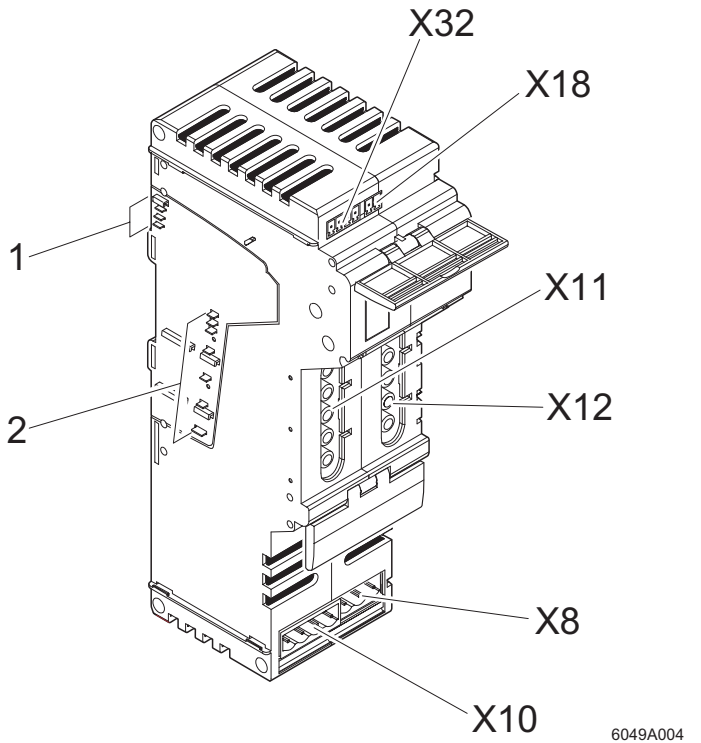


Figure 4 Connections

1	Data jumper for INTERBUS	
2	Voltage jumper for the low level signals	U_M, U_S, U_{ANA}, U_L, GND, FE
X8	Connection for an external brake module including brake switch and connection for brakes (X9)	See Figure 12 on page 17
X10	Connection for the motor output	T1, T2, T3, ⏚
X11	Connection for the incoming line	L1, L2, L3, N, PE
X12	Connection for the outgoing line	L1, L2, L3, N, ⏚
X18	Enabling the power level/connection for the 24 V isolation	See Figure 12 on page 17
X32	Connection for manual mode (Operator Hand Panel operation; HVO)	

5.2 INTERBUS and Low Level Signals

Connecting the power-level terminal to the previous terminal of an Inline station creates the voltage jumpers for INTERBUS and the low level signals.

For more detailed information, please refer to the INTERBUS Inline System Manual.

5.3 Incoming and Outgoing Lines

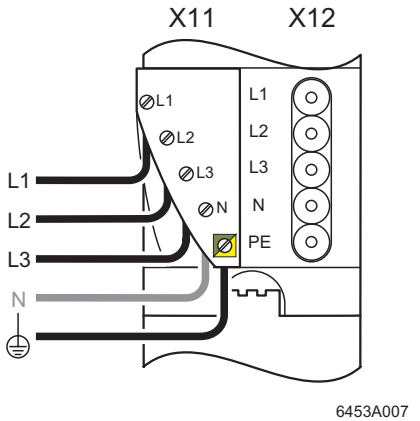


Figure 5 Assignment of the X11 and X12 slots
(with connected power connector)

There are two ways of connecting the incoming line to the power-level terminal:

1 Connect the incoming line using a power connector.

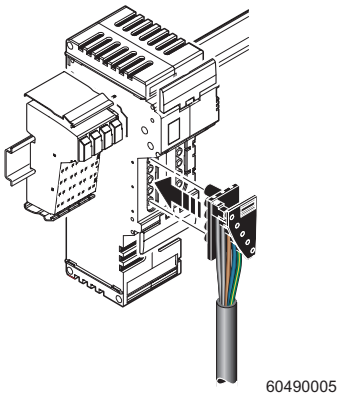


Figure 6 Connection of a power connector

2 When several power-level terminals are to be connected one after the other, it is possible to connect one power-level terminal to the preceding power-level terminal using a power bridge. If the preceding terminal is connected to the power supply, this power is transmitted via the power bridge.

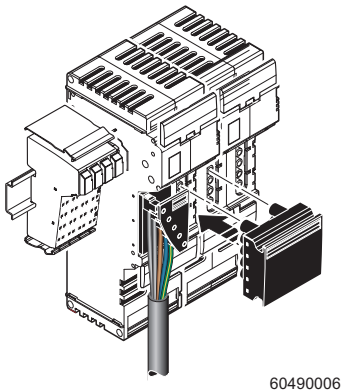


Figure 7 Inserting a power bridge

Ordering data for power connector and power bridge can be found on page 45.

Table 1 Incoming/outgoing line

X11 (LINE IN)	X12 (LINE OUT; Power Bridge)
L1	L1
L2	L2
L3	L3
N	N
PE	⏚

The N wire is not required to operate this power-level terminal.

5.4 Motor Output

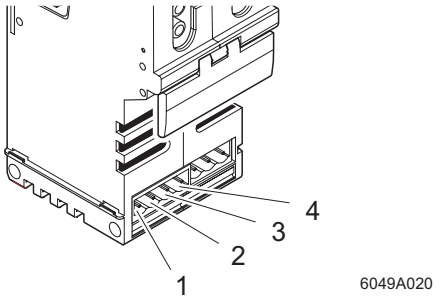


Figure 8 Assignment of the motor output

Table 2 Motor output (HV-COMBICON)

Pin	X10 (Motor)
1	Motor: T1
2	Motor: T2
3	Motor: T3
4	Motor: ⏚

5.5 Brake Module (Optional)

You can order the brake module, which can be connected to terminal strip X8 (see Figure 4 on page 11), using the ordering data on page 45.

The brake is then connected to terminal strip X9 of this brake module using a 2-pos. HV-COMBICON (see Figure 12 on page 17).

Make sure that the brake is connected with the correct polarity, otherwise it may not operate correctly.

For additional information on the brake module, please refer to the module-specific data sheet (see "Ordering Data" on page 45).

5.6 Manual Mode (Operator Hand Panel Operation)

In manual mode, all motor protection functions are deactivated.

Manual mode has priority over INTERBUS operation.
The motor protection relay function has no effect in manual mode.

The MINI-COMBICON connector for the connection of an Operator Hand Panel (X32) is under the upper release flap.

When manual mode is activated, the power-level terminal can be controlled locally, independently of the INTERBUS system. This means that the "motor ON/OFF" functions are available.

Manual mode is controlled using a temporarily connected external Operator Hand Panel. This is connected to the power-level terminal using a 4-pos. MINI-COMBICON. The slot is under the upper release flap (see Figure 9 on page 15). The Operator Hand Panel can only be connected when the release flap is upright.

You can order the Operator Hand Panel using the ordering data on page 45.

When manual mode is enabled on the power-level terminal, the LOC status indicator lights up (see Figure 2 on page 7).

After manual mode has been activated on the power-level terminal, **HVO** (manual mode confirmation) is automatically set in the input data (see "INTERBUS Input Data (Status Byte)" on page 28).

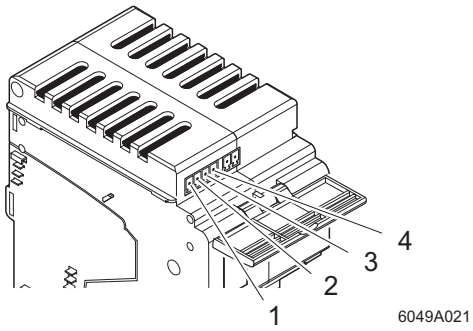


Figure 9 Assignment of connections for the Operator Hand Panel

Table 3 X32 Operator Hand Panel (MINI-COMBICON)

Pin	X32 (Operator Hand Panel)	Function
1	Reserved	Reserved
2	Input E8	Motor in manual mode
3	Input E10	Enable manual mode
4	U_S	24 V segment voltage

Manual mode is activated automatically by connecting an Operator Hand Panel.

The terminal point "24 V segment voltage" is not protected against short-circuits and overloads inside the terminal. Provide short-circuit protection for the segment voltage supply (e.g., on the power terminal or segment terminal).

Table 4 Signal assignment of the manual mode inputs

Function	Enable	Motor
Enable manual mode	1	0
Motor in manual mode	1	1
No manual mode	0	X

Key:

0 Input signal "Low", binary "0"

1 Input signal "High", binary "1"

X Any kind of input signal
(Please note the special features in direct operation)

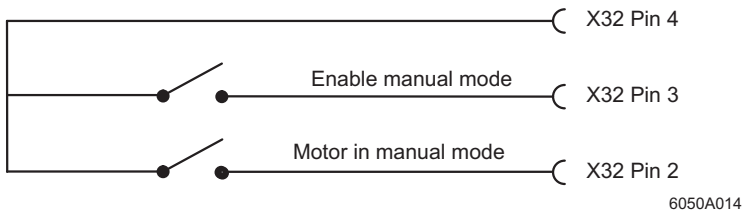


Figure 10 Function block diagram of an Operator Hand Panel

It is also possible to use pin 2 of terminal strip X32 to control the motor in direct mode (see "DM: (bit 3)" on page 26).

5.7 Enabling the Power Level/24 V Isolation

The MINI-COMBICON connector for the X18 terminal strip (Enable the power level/24 V isolation) is under the upper release flap.

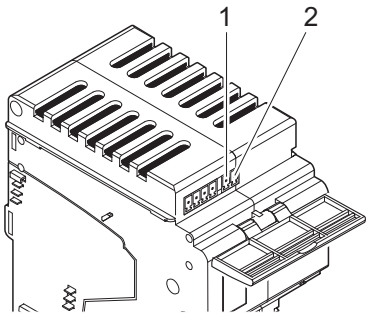


Figure 11 Assignment of the "Enable power level connection"

Table 5 Enabling the X18 power level (MINI-COMBICON)

Pin	X18 (Enable)
1	1 (24 V segment voltage U_S)
2	2 (enable power level)

No internal terminal protection against short-circuits/overloads

The "24 V segment voltage" terminal point is not protected against short-circuits and overloads inside the terminal. Provide short-circuit protection for the segment voltage supply (e.g., on the power terminal or segment terminal).

The control voltage for the power level and the brake is supplied using pin 2 of the 2-pos. MINI-COMBICON. The power level cannot be controlled without the 24 V control voltage.

The segment voltage U_S is used to enable the power level, which can be made available using a jumper or a switch:

1 The X18 terminal strip is supplied as standard with a jumper inserted between pins 1 and 2.
If no switch is connected to X18, the jumper can be inserted. The power level of the power-level terminal is enabled by the directly available 24 V segment voltage.

2 If an external switch is connected between pins 1 and 2 on the X18 terminal strip, the power level of the power-level terminal is enabled when closed.

Please note that a alloyed valve is also conducting without control voltage.

Ensure that the motor is switched off before enabling the power level.

5.8 Connections to a Power-Level Terminal

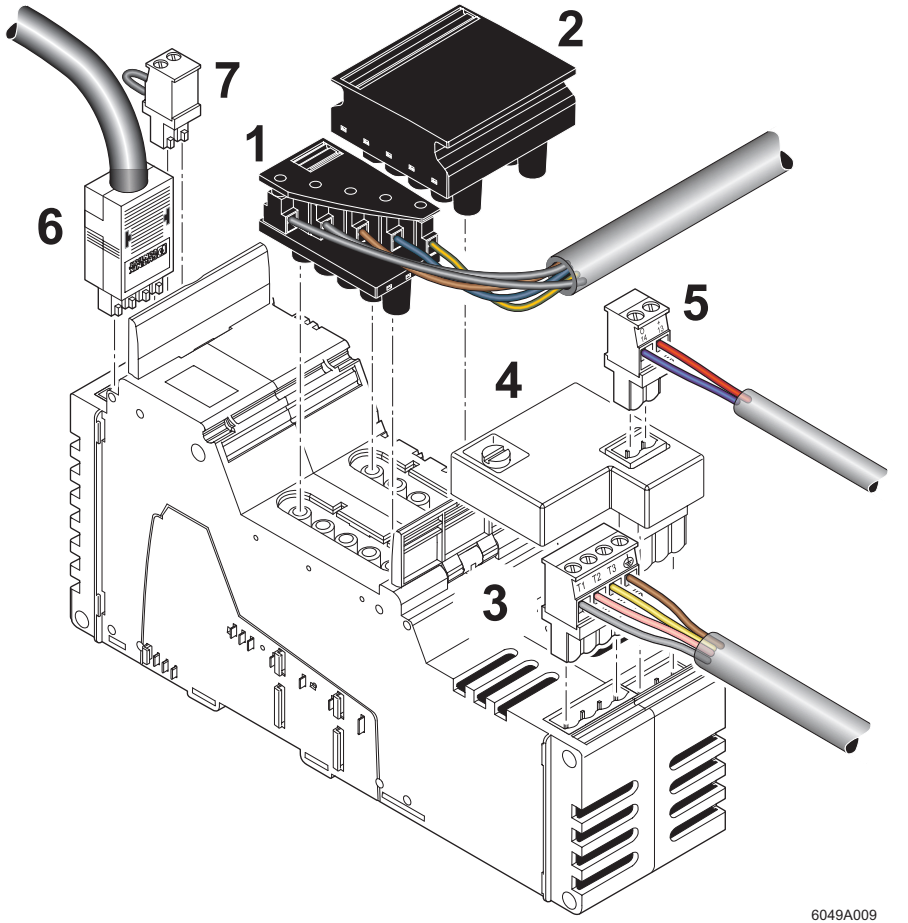


Figure 12 Power-level terminal with all connections

1	X11	Incoming line (X11) (here: power connector)
2	X12	Outgoing line (X12) (power bridge)
3	X10	Motor output (X10)
4	X8	Brake module (X8)
5	X9	Connection of the brake to the brake module (X9)
6	X32	Operator Hand Panel (X32)
7	X18	Enable power level (X18)

6 Programming Data

ID code	BF_{hex} (191_{dec})
Length code	81_{hex} (129_{dec})
Process data channel	8 bits
Input address area	1 byte
Output address area	1 byte
Parameter channel (PCP)	0 bytes
Register length	1 byte

7 INTERBUS Process Data

7.1 Assignment of the Power-Level Terminal Input and Output Data to the INTERBUS Process Data

Assignment of Power-Level Terminal Output Data to the INTERBUS Output Data Byte (Control Byte)

(Byte.Bit) View	Byte	Byte 0							
	Bit	7	6	5	4	3	2	1	0
	Assignment	RES_03	M	RESET	RES_02	DM	RES_01	EBC	BR

M	Motor ON/OFF
RESET	Error acknowledgment
DM	Direct Mode
EBC	Enable Brake Control
BR	Brake
RES_XX	Reserved

Assignment of Power-Level Terminal Output Data to the INTERBUS Output Data Byte (Parameterization Byte)

(Byte.Bit) View	Byte	Byte 0							
	Bit	7	6	5	4	3	2	1	0
	Assignment	P7	P6	P5	P4	P3	P2	P1	P0
		1	1	Nominal current code					

P7 to P0	Parameterization bits

Assignment of Power-Level Terminal Input Data to the INTERBUS Input Data Byte

(Byte.Bit) View	Byte	Byte 0							
	Bit	7	6	5	4	3	2	1	0
	Assignment	F1	F0	RUN	HVO	MB3	MB2	MB1	MB0

F1 and F0	Diagnostic code
RUN	Motor running
HVO	Operator Hand Panel Operation Confirmation (Manual mode)
MB3 to MB0	Motor current monitoring

For the assignment of the output and input data bytes to the user set control or computer system, please refer to data sheet DB GB IBS SYS ADDRESS, Part. No. 90 00 99 0.

7.2 INTERBUS Output Data

For the Inline power-level terminal, one byte is available for output data.

If bits 7 and 6 of the output data byte are set (code 11_{bin}), this byte is used for parameterization (parameterization byte), and the power-level terminal is in **parameterization mode**. In this mode, the nominal motor current is transmitted as an operating parameter.

If the code of bits 7 and 6 of the output data byte is **not** equal to 11_{bin}, then process data is being transmitted (control byte). The power-level terminal is in **process data mode**. In this operating mode, the power-level terminal function is affected by the process data.

7.2.1 Parameterization of the Nominal Motor Current

The motor is automatically switched off during parameterization.

If the 7.5 V power supply U_L fails, the parameter settings will not be stored. In this case you will have to parameterize the power-level terminal again.

The diagnostic code 00_{bin} is displayed after every successful parameterization.

Parameterizing the nominal motor current serves as an overcurrent protection. The parameter is the nominal current of the drive (nominal motor current). The nominal motor current that can be set ranges from 0.2 A to 3.6 A. The nominal motor current is specified through bits 5 to 0 of the parameterization byte.

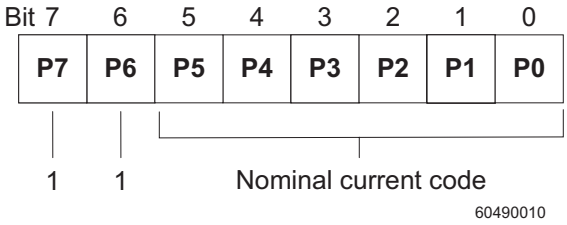


Figure 13 Parameterization of the nominal motor current

There is no linear relationship between nominal motor current and nominal current code. Steps of 50 mA, 100 mA and 200 mA are used. For the nominal current code, refer to Table 6 on page 23 or calculate it yourself.

When calculating the three motor current ranges, note that three different equations must be used.

For a nominal motor current ranging **from 0.2 A to 1.2 A** (in steps of 50 mA) the nominal current code is calculated according to equation 1.

$$\text{CODE} = \frac{I_{nom} - 0.2\ \text{A}}{0.05\ \text{A}}$$

With:

I_{nom}	Nominal current I_{nom} in A
CODE	Nominal current code

For a nominal motor current ranging **from 1.3 A to 3.0 A** (in steps of 100 mA) the nominal current code is calculated according to equation 2:

$$\text{CODE} = \frac{I_{nom} + 0.8\ \text{A}}{0.1\ \text{A}}$$

For a nominal motor current ranging **from 3.2 A to 3.6 A** (in steps of 200 mA) the nominal current code is calculated according to equation 3:

$$\text{CODE} = \frac{I_{nom} + 4.6\ \text{A}}{0.2\ \text{A}}$$

If you do not parameterize the nominal motor current or if you enter a nominal current code of 0, the default value of $\mathbf{I_{nom} = 0.2\ A}$ is valid.

Table 6 Assignment of the nominal current code to the nominal motor current

I_{nom} [A]	CODE dec (hex)	
	Bits 5 to 0	Byte
0.20	0 (00)	192 (C0)
0.25	1 (01)	193 (C1)
0.30	2 (02)	194 (C2)
0.35	3 (03)	195 (C3)
0.40	4 (04)	196 (C4)
0.45	5 (05)	197 (C5)
0.50	6 (06)	198 (C6)
0.55	7 (07)	199 (C7)
0.60	8 (08)	200 (C8)
0.65	9 (09)	201 (C9)
0.70	10 (0A)	202 (CA)
0.75	11 (0B)	203 (CB)
0.80	12 (0C)	204 (CC)
0.85	13 (0D)	205 (CD)

I_{nom} [A]	CODE dec (hex)	
	Bits 5 to 0	Byte
0.90	14 (0E)	206 (CE)
0.95	15 (0F)	207 (CF)
1.00	16 (10)	208 (D0)
1.05	17 (11)	209 (D1)
1.10	18 (12)	210 (D2)
1.15	19 (13)	211 (D3)
1.20	20 (14)	212 (D4)
1.30	21 (15)	213 (D5)
1.40	22 (16)	214 (D6)
1.50	23 (17)	215 (D7)
1.60	24 (18)	216 (D8)
1.70	25 (19)	217 (D9)
1.80	26 (1A)	218 (DA)
1.90	27 (1B)	219 (DB)

I_{nom} [A]	CODE dec (hex)	
	Bits 5 to 0	Byte
2.00	28 (1C)	220 (DC)
2.10	29 (1D)	221 (DD)
2.20	30 (1E)	222 (DE)
2.30	31 (1F)	223 (DF)
2.40	32 (20)	224 (E0)
2.50	33 (21)	225 (E1)
2.60	34 (22)	226 (E2)
2.70	35 (23)	227 (E3)
2.80	36 (24)	228 (E4)
2.90	37 (25)	229 (E5)
3.00	38 (26)	230 (E6)
3.20	39 (27)	231 (E7)
3.40	40 (28)	232 (E8)
3.60	41 (29)	233 (E9)

The binary nominal current code of bits 5 to 0 of the parameterization byte or of the entire byte corresponds to the decimal or hexadecimal value given in the table.

Parameterization of the nominal current using a value greater than 3.6 A is not permitted. If the power-level terminal is parameterized using a nominal current that is not permitted, the last valid nominal current parameterization is maintained.

Example for Power-Level Terminal Parameterization

Parameterize with the value: nominal motor current = 2.5 A.

The bit sequence for the nominal current code to be entered in the parameterization byte can be calculated or read from Table 6 on page 23.

Calculation

The motor current I_{nom} = 2.5 A is in the range between 1.3 A and 3.0 A. The result according to equation 2 is:

$$CODE = \frac{I_{nom} + 0.8\ A}{0.1\ A} = \frac{2.5\ A + 0.8\ A}{0.1\ A} = 33_{dec} = 21_{hex} = 10\ 00\ 01_{bin}$$

Reading from the table

Either the **nominal current code (bits 5 to 0)** or the value for the entire **byte** can be read from Table 6.

For I_{nom} = 2.5 A you will obtain:

– Nominal current code: $21_{hex} = 10\ 00\ 01_{bin}$

– Byte: $225_{dec} = E1_{hex} = 1110\ 0001_{bin}$.

Result

The parameterization byte is $E1_{hex}$ (nominal current code = $10\ 00\ 01_{bin}$; byte = $11\ 10\ 00\ 01_{bin}$).

Bit	7	6	5	4	3	2	1	0
Assignment			Nominal current code					
	1	1	1	0	0	0	0	1
Code	E				1			

The parameterization procedure

Step	Output Data Byte	Diagnostic Code	Comment
1	$E1_{hex}$		Specification of the nominal current = 2.5 A
2		$<>01_{bin}$	Wait until a diagnostic code not equal to 1 is returned; No error: diagnostic code = 0
3	00_{hex}		Parameterization completed

In the example, parameterization is complete and you can set the control byte to switch over to process data operation (see "Control Byte" on page 25).

7.2.2 Control Byte

The control byte transmits process data in the output data byte.

Before you can work with the control byte, you must specify the nominal motor current (see "Parameterization of the Nominal Motor Current" on page 21).

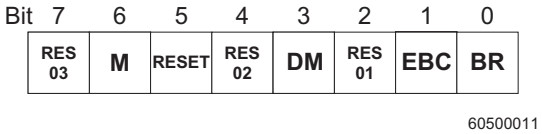


Figure 14 Control byte

RES_03: **Reserved**

(bit 7) Set the reserved bit to 0.

M: **Motor ON/OFF**

(bit 6) **M** switches the motor on and off. If the brake module is connected, **M** closes and opens the brake switch as long as it has not been defined as freely controllable.

M = 1 Motor ON, brake switch closed (brake is released)

M = 0 Motor OFF, brake switch open (motor is decelerated)

RESET: **Error Acknowledgment**

(bit 5) By setting **RESET** you can acknowledge an error that caused the motor to shut down, after the error cause has been removed. **RESET** must remain set until the error message is reset.

Avoid damage to motor, power-level terminal or persons.

If in the event of a critical error you repeatedly issue a RESET without rectifying the fault, this may result in damage to the motor, the power-level terminal or to persons.

Local Error Acknowledgement via the Bus or at the Power-Level Terminal

The enable input X32, pin 3, provides another method of error acknowledgment. If you enable manual mode, an error that has occurred is reset. This means that by inserting the IBS HVO Operator Hand Panel (see Ordering Data on page 45), the error status in the plant can be reset locally (see also "HVO:" on page 30).

RES_02: **Reserved**

(bit 4) Set the reserved bit to 0.

DM: **Direct Mode**
(bit 3)

The "Enable manual mode" input (X32 pin 3) must be set to 0 for this operating mode.

Bit 3 = 0: **No** direct mode.

Bit 3 = 1: Direct mode. The motor is directly switched by the manual mode input (X32 pin 2).
The motor can no longer be controlled by the process data (bit 6) in this operating mode.
The protection is the same as when switching via INTERBUS (overcurrent, minimum current).

The shutdown delay is approximately 200 ms in direct mode.

When connecting the cable to control direct mode, ensure that a **shielded** cable is used to minimize the effects of interference.

RES_01 **Reserved**

(bit 2) Set the reserved bit to 0.

EBC: **Enable Brake Control**
(bit 1)

The descriptions for the brake switch and for the brake only apply when the brake module is connected to the X8 terminal strip of the power-level terminal and the brake is connected to the X9 terminal strip of the brake module.

EBC enables free control of the brake switch (and also the brake).
If EBC = 1, the brake switch can be freely controlled i.e., independently of the motor control (M). In this case, the brake switch is controlled with **BR**.

If EBC = 0, the brake switch cannot be freely controlled. It is controlled through the motor controller (M).

In "Enable brake control" operating mode, the user has to control the brake even if an error occurs (F1 in the diagnostic code = 1).

BR: (bit 0)

Brake (With Freely Controllable Brake (EBC = 1))

The descriptions for the brake switch and for the brake only apply when the brake module is connected to the X8 terminal strip of the power-level terminal and the brake is connected to the X9 terminal strip of the brake module.

In "Enable brake control" operating mode, the user has to control the brake.

The brake switch is closed by setting **BR** (BR = 1). The brake is released and the motor enabled.
When the bit is set to zero (BR = 0), the brake switch is opened, the brake takes effect and the motor is decelerated.

The **manual mode** and an **INTERBUS reset** are special cases in this operating mode. In these cases, the brake is automatically controlled.

In "Enable brake control" operating mode, the user has to control the brake even if an error occurs (F1 in the diagnostic code = 1).

If bit 1 (EBC) is set to 0 again, the brake is set depending on the motor status. If the motor is on, the brake is released. If the motor is off, the brake is enabled.

Table 7 Relationship between EBC and BR

EBC (Bit 1)	Meaning	BR (Bit 0)	Meaning
0	Brake switch not freely controllable	X	No function
1	Brake switch freely controllable	0	Brake switch open, motor is decelerated
		1	Brake switch closed, motor is enabled

7.3 INTERBUS Input Data (Status Byte)

The status of the motor is indicated by an input data byte.

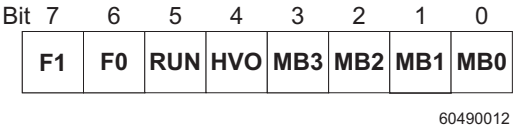


Figure 15 Status byte

F1 and F0:
(bit 7 and bit 6)

Diagnostic Code

Bits **F1 and F0** indicate the status of the power-level terminal or any errors that have occurred.
F1 (bit 7) differentiates between status and error messages. **F1** is only set for error messages.
If the diagnostic code equals 0, no error occurred.
If the diagnostic code does not equal 0, status or error messages are present.

Error Messages in the Diagnostic Code

If an error occurs, the motor is shut down immediately and the diagnostic display (ERR) lights up.

The error that occurred first is indicated until it is removed and acknowledged by a reset. The message is deleted once it has been acknowledged (see "Restart Behavior After an Error" on page 34). Only then can the motor be restarted.

Table 8 Error messages in the diagnostic code

Code	F1	F0	Description
11_{bin}	1	1	Overcurrent; is generated if the overcurrent protection has been triggered
10_{bin}	1	0	Power level cannot be controlled

During error-free operation, the control system only needs to evaluate **F1** (bit 7). If **F1** is set, a subprogram can be called to evaluate the diagnostic code.

Avoid damage to the motor

The motor will not shut down automatically every time the error message 10_{bin} appears in the diagnostic code (e.g., an alloyed valve).
In this case, you must ensure that the 400 V operating voltage of the power-level terminal is switched off to avoid damaging the motor.
An example of shutdown is shown in Figure 16.

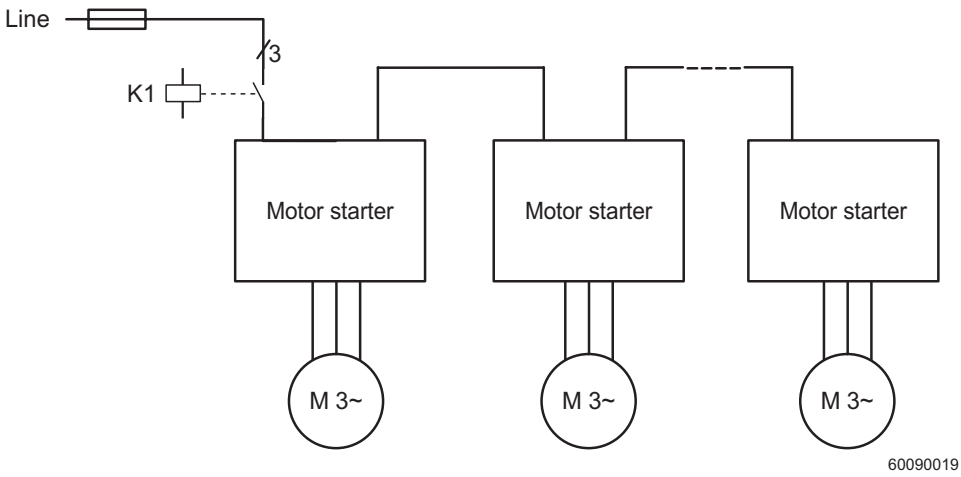


Figure 16 Example of disconnecting the operating voltage

Error message 10_{hex} is set:

– If the control signal for the power level is present and the permissible minimum motor current has fallen below 0.1 A.

– If the control signal for the power level is not present and the measured motor current is greater than 0.1 A (alloyed valve).

The error message is generated if the error lasts for more than 1 second.
These errors are caused by defective power levels or the interruption of a phase in the motor supply.

If the 10_{bin} error message occurs, the application program can evaluate the error type. In addition to the error message, the application program must evaluate the control signal M (bit 6 of the output data byte).

Status Messages in the Diagnostic Code

If status messages are generated, this does **not** cause the motor to shut down. Status messages do not need to be acknowledged.

Table 9 Status messages in the diagnostic code

Code	F1	F0	Description
0_{hex}	0	0	No status message
1_{hex}	0	1	Parameterization not yet carried out The bit is set after the operating voltage U_L is switched on and after a restart (voltage reset). It indicates that the motor has not yet been parameterized.

RUN: **"Motor Running"**

(bit 5) The bit is set if the power level (motor output) is controlled.

HVO: **Operator Hand Panel Operation Confirmation (Manual mode)**

(bit 4) Manual mode is activated by connecting an Operator Hand Panel to the X32 terminal strip. If manual mode is activated, HVO is set as a confirmation (HVO = 1).

MB3 to MB0: Motor Current Monitoring

(bit 3 to bit 0) The motor current monitoring indicates the relationship between the actual motor current and the parameterized motor current.

The code of the motor current monitoring α can be read in **MB3 to MB0** of the input data byte in INTERBUS.

The motor current ratio I_{act}/I_{nom} is calculated according to the equation:

$$\frac{I_{act}}{I_{nom}} = \frac{\alpha}{32} + 0.75$$

The resolution of the motor current ratio I_{act}/I_{nom} is 1/32.
Values of 0 to 15 can be transmitted for α.
A range of 0.75 to 1.22 is covered, with offset taken into account for the ratio I_{act}/I_{nom}. If the motor current ratio I_{act}/I_{nom} exceeds the value 1.22, the value 1.22 (α = 15) will still be transmitted.

For the motor current ratio, the current I_{act} of phase T1 is evaluated (see Table 2 on page 14). The indication is updated every 120 ms.

Motor Current Ratio α Mapped to the Input Byte					I_{act}/I_{nom}	$\beta = I_{act}/I_{nom}$ in %
				Dec		
MB3	MB2	MB1	MB0			
0	0	0	0	0	≤ 0.75	≤ 75
0	0	0	1	1	0.78	78
0	0	1	0	2	0.81	81
0	0	1	1	3	0.84	84
0	1	0	0	4	0.88	88
0	1	0	1	5	0.91	91
0	1	1	0	6	0.94	94
0	1	1	1	7	0.97	97

Motor Current Ratio α Mapped to the Input Byte					I_{act}/I_{nom}	$\beta = I_{act}/I_{nom}$ in %
				Dec		
MB3	MB2	MB1	MB0			
1	0	0	0	8	1.00	100
1	0	0	1	9	1.03	103
1	0	1	0	10	1.06	106
1	0	1	1	11	1.09	109
1	1	0	0	12	1.13	113
1	1	0	1	13	1.16	116
1	1	1	0	14	1.19	119
1	1	1	1	15	≥ 1.22	≥ 122

Calculation of the Motor Current

The following equations are available for calculating the actual motor current from the motor current ratio:

Equation 1

$$\beta = \left(\frac{\alpha}{32} + 0.75 \right) \times 100\,\% = \frac{I_{act}}{I_{nom}} \times 100\,\%$$

Equation 2

$$I_{act} = \left(\frac{\alpha}{32} + 0.75 \right) \times I_{nom}$$

With:

α	The motor current ratio mapped to the input data byte represented as a decimal value
β	I_{act} as a percentage value of I_{nom}
I_{nom}	Parameterized nominal motor current I_{nom} in A
I_{act}	Measured motor current I_{act} in A

Example for Calculating the Motor Current:

Parameterized nominal motor current:

1.1 A (= 12_{hex} = 10010_{bin} in the output data byte, bits 5 to 0 (MB5 to MB0))

Indicator in MB3 to MB0: $0011_{bin} = 3_{dec} = \alpha$

According to equation 1:

$$\beta = \left(\frac{3}{32} + 0.75 \right) \times 100\% = 84\%$$

The actual motor current is 84% of the parameterized nominal motor current.

According to equation 2:

$$I_{act} = \left(\frac{3}{32} + 0.75 \right) \times 1.1\ A = 0.93\ A$$

The actual motor current is 0.93 A.

8 Description of Functions

8.1 Manual mode

In manual mode, all motor protection functions are deactivated.

If the "Enable manual mode" input is connected to the power-level terminal, manual mode has priority over INTERBUS operation. Manual mode is enabled via two inputs.

Input functions:

E10 → Enable manual mode

E8 → Motor in manual mode

(See also "Manual Mode (Operator Hand Panel Operation)" on page 14)

Delay Time

When enabling or disabling the manual mode, the firmware maintains a delay time of 1 second. During the delay time, the power-level terminal switches the motor off. If a brake switch is connected, it opens.

In manual mode, free control of the brake is ignored, so that the brake is automatically controlled. Once manual mode is cancelled, the brake is freely controllable again (the preset value is reinstated).

When switching from INTERBUS operation to manual mode, the "Manual mode confirmation" (HVO) bit is set immediately in the INTERBUS input data byte. When switching from manual mode to INTERBUS operation, the power-level terminal maintains the delay time. This means that if the HVO bit is not set, the motor can be started immediately via INTERBUS.

Error During Manual mode

If an error occurs in manual mode, this error will **not** appear in the INTERBUS input data byte.

Even in manual mode, status messages are copied to the input data byte.

If manual mode is selected while an error is present, the error will not be indicated in manual mode.

On switching to manual mode, all removed errors are acknowledged, just as is the case when there is a RESET in the control word.

When manual mode is exited, errors are no longer displayed if the cause has been removed.

Exception: If manual mode is enabled during the 60 seconds waiting time after overcurrent, the waiting time starts again from the beginning and the error is displayed again when manual mode is exited.

All errors that are not removed, and therefore still present, are displayed again after exiting manual mode.

When a motor is switched on via the "ON/OFF" switch on the Operator Hand Panel, the connected brake switch is closed at the same time (brake is released).

8.2 Shutdown Behavior in the Event of Errors

– The motor is shut down whenever an error occurs.
– A status message does not cause the motor to shut down.

See "Diagnostic Code" on page 28.

8.3 Restart Behavior After an Error

The error cause must be removed to restart the motor after it has been shut down due to a power-level terminal error. Acknowledge the error by setting **RESET** (bit 5). It is also possible to acknowledge an error at the terminal through the manual mode socket by inserting the Operator Hand Panel (IBS HVO). See "Local Error Acknowledgement via the Bus or at the Power-Level Terminal" on page 25.

An overcurrent error (diagnostic code 11_{bin}) can only be acknowledged after a recovery time of at least **60 seconds**.

The "Power level cannot be controlled" error (diagnostic code 10_{bin}) can be acknowledged after 0.3 seconds.

The integrated energy counter for motor protection is **not immediately** reset. Depending on the shutdown conditions, the counter is reset after a defined time function (approximately 2 to 3 minutes) when the motors are switched off.

If the error cause was not removed, the error message is still indicated in the status byte.

Avoid damage to the motor, power-level terminal or persons.

If in the event of a critical error you repeatedly issue a RESET without rectifying the fault this may result in damage to the motor, the power-level terminal or to persons.

If the power-level terminal accepts the error acknowledgment, the diagnostic code is reset. All error messages will be deleted.

8.4 INTERBUS Reset or INTERBUS Not Active

In the event of an **INTERBUS reset**, the motor shuts down immediately and the brake switch opens (the brakes are activated and the motor shaft is decelerated). If **INTERBUS is not active**, this will be determined 640 ms after the last data cycle. Thereafter the motor is immediately switched off, the brake switch opens (the brake is activated and the motor shaft is decelerated).

The descriptions for the brake switch and for the brake only apply when the brake module is connected to the X8 terminal strip of the power-level terminal and the brake is connected to the X9 terminal strip of the brake module (see Figure 12 on page 17).

Manual mode remains possible both during an **INTERBUS reset** or when **INTERBUS is not active**.

Direct mode remains possible both during an **INTERBUS reset** or when **INTERBUS is not active**. The motor starter can still be controlled in direct mode via the input.

8.5 Thermal Motor Protection Through the Inline Thermistor Terminal (Optional)

Thermal motor protection can be provided for motors that have integrated thermistors.

The thermistors can be monitored with the IB IL 24 TC Inline thermistor terminal.

The thermistor terminal is designed for integration in an INTERBUS Inline station. It is used to evaluate PTC in accordance with DIN 44081.

The thermistor terminal monitors the motor thermistor in the following states:

– Operating range (resistance between 50 Ω and 2.25 kΩ)
– Tripping range (resistance ≥ 4 kΩ)
– Warning if the motor temperature is approximately 5 K below tripping temperature
– Short-circuit (resistance ≤ 50 Ω)

The thermistor terminal can have an indirect effect (via INTERBUS) on the motor in this power-level terminal.

For additional information on the thermistor terminal, please refer to the terminal-specific data sheet (see "Ordering Data" on page 45).

8.6 Brake (Optional)

The descriptions for the brake only apply when the brake module is connected to the X8 terminal strip of the power-level terminal and the brake is connected to the X9 terminal strip of the brake module (see Figure 12 on page 17).

The power-level terminal provides a terminal strip for the connection of an external passive brake module.

This brake module contains a DC or AC brake switch (semiconductor, 2-wire technology).

If the brake is not parameterized as freely controllable (EBC = 0), this brake switch is directly coupled with the switching states of the motor output. If the motor is controlled, the brake switch closes (brake is released).

If the brake is parameterized as freely controllable (EBC = 1), the brake switch is controlled by the BR bit (see page 27).

9 Technical Data

General Data	
Housing dimensions (width x height x depth)	63 mm x 224 mm x 109 mm (2.480 in. x 8.819 in. x 4.291 in.)
Weight	450 g (without connector)
Operating mode	Process data operation with 1 byte
Permissible temperature (operation)	-25° to +55 °C (-13°F to +131°F)
Permissible temperature (storage/transport)	-25°C to +85°C (-13°F to +185°F)
Permissible humidity (operation)	75%, on average, 85%, occasionally
In the range from -25°C to +55°C (-13°F to +131°F) appropriate measures against increased humidity (> 85%) must be taken.	
Permissible humidity (storage/transport)	75%, on average, 85%, occasionally
For a short period, slight condensation may appear on the housing if, for example, the terminal is brought into a closed room from a vehicle.	
Permissible air pressure (operation)	80 kPa to 106 kPa (up to 2000 m [6562 ft.] above sea level)
Permissible air pressure (storage/transport)	70 kPa to 106 kPa (up to 3000 m [9843 ft.] above sea level)
Degree of protection	IP 20 according to IEC 60529
Class of protection	Class 1 according to VDE 0106, IEC 60536
Line protection of the line feeder	20 A, maximum
Compulsory mounting position	Panel mounting on horizontal DIN mounting rail (corresponding to Figure 6 on page 13)
Mounting distances	At least 50 mm (1.969 in.) above and below
Observe the mounting distances. The vertical distances are necessary to guarantee sufficient ventilation of the power-level terminal.	

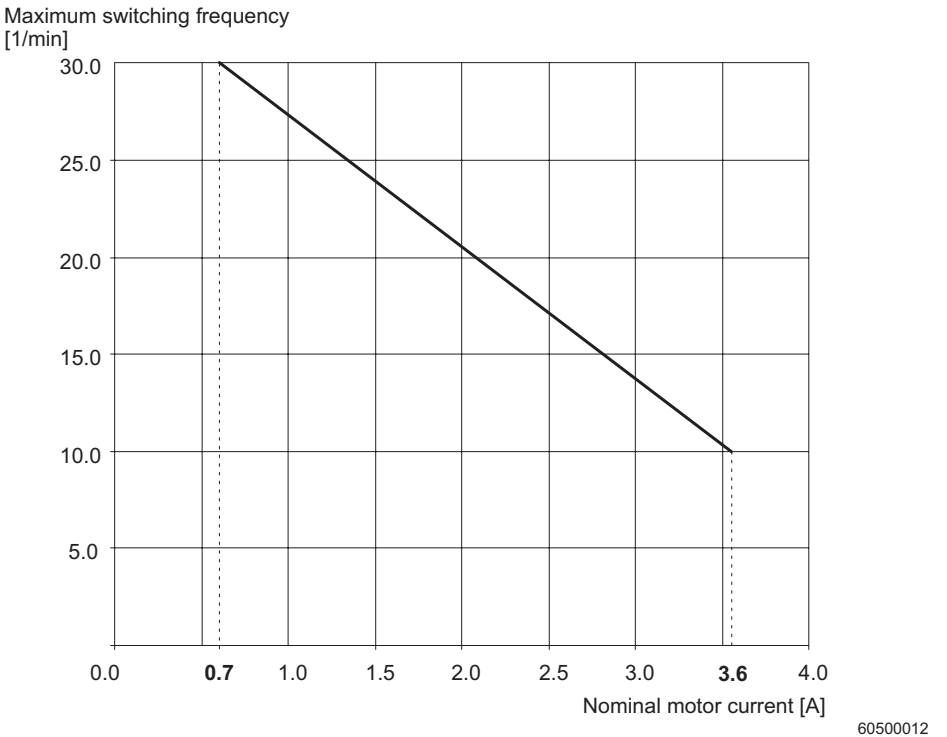
Interface	
INTERBUS interface	Through data routing

Power Consumption	
Communications power U_L	7.5 V
Current consumption at U_L	45 mA, maximum
Power consumption at U_L	0.34 W, maximum
Segment supply voltage U_S	24 V DC (nominal value)
Nominal current consumption at U_S	50 mA, maximum
Total internal power consumption	1.2 W, maximum

Supply of the Module Electronics and the I/O Through the Bus Terminal Module/ Power Terminal (U_L, U_M, U_S)	
Connection method	Through potential routing

Line Connection	
Connection method	Power connector or power bridge
Terminal strip	X11 and X12
Number of pins	5 L1, L2, L3, N, PE (not leading)
Permissible cable cross-section	Up to 2.5 mm^2 (14 AWG)
Nominal voltage $U_{operation}$ (conductor voltage)	400 V AC
Voltage range	187 V AC to 440 V AC + 0%, minimum, with safe isolation between line and SELV
Tolerances outside the voltage range are not permitted.	
Frequency	50 Hz or 60 Hz
The supply of the line voltage through a frequency inverter is not permitted.	
Current load (incoming line)	20 A, maximum
Observe the motor starting currents.	
Wiring	TSE wiring Varistor 460 V AC

Power-Level Terminal	
Switches	Electronic hybrid switches, two phase switching. Connection and disconnection is carried out using thyristors that are jumpered by relays in the conductive state.
Operating voltage $U_{operation}$ (conductor voltage)	187 V AC to 440 V AC + 0%, minimum
Power frequency	50 Hz or 60 Hz
Nominal current range	0.2 A to 3.6 A
Minimum current	100 mA
Power	1.5 kW for AC 3 operation (4-pos. asynchronous motor)
Usage category	According to AC 3
Switching frequency	30 switching operations per minute, maximum Observe derating



Power-Level Terminal (Continued)	
Figure 17 Switching frequency depending on the nominal motor current at ambient temperatures of 25°C (77°F) and 55°C (131°F)	
Switch-on time	1 s, minimum
Switch-off time	1 s, minimum
Phase angle	cos $\varphi \geq 0.3$
Motor starting time	0.5 s, maximum
Observe the minimum motor current The minimum permissible motor current of 0.1 A per phase must be maintained in the operating state "Motor ON via INTERBUS". Otherwise, the error message 10_{bin} "Power level cannot be controlled" will be displayed in the diagnostic code.	
Internal protection	Fuse 6.3 x 32 10 AT in the switched phases
Working on the terminal is not permitted The fuses inside the terminal protect the operating personnel and the entire system where the terminal has been installed. If these fuses blow, for example, in the event of a short-circuit at the motor output, the terminal must be replaced. Repairs must only be carried out by Phoenix Contact. Otherwise, you may endanger the safety of the operating personnel and of your system.	
Control voltage for the power-level terminal	24 V segment voltage (U_S) (when the segment voltage is switched off the power-level terminal cannot be switched on (motor OFF))
When the segment voltage is switched off the motor is not disconnected.	
If thermal damage occurs to the power level, the motor cannot be switched off. This error state is indicated in the status byte (error message 10_{bin} in the diagnostic code). In this case, the user must ensure that the system is switched off by a mechanical switch (see also Figure 16 on page 29).	

Motor Output	
Dangerous voltage Switch off the line voltage before working on the power-level terminal or on the motor.	
Avoid damage to the electronics Avoid a motor output short-circuit, as this may damage the electronics.	
Connection method	HV-COMBICON
Number of motor outputs	1 (3 phases), short-circuit-proof with external fuse 16 A (total range protection for semiconductor type gR)
Terminal strip	X10
Number of pins	4 T1, T2, T3, ⏚
Conductor cross-section	1 mm^2 (18 AWG), minimum, to 2.5 mm^2 (14 AWG), maximum
Degree of protection	Protection against direct touch
Wiring	Varistor 460 V AC
Observe the minimum motor current The minimum permissible motor current of 0.1 A per phase must be maintained in the operating state "Motor ON via INTERBUS". Otherwise, the error message 10_{bin} "Power level cannot be controlled" will be displayed in the diagnostic code.	
Nominal load	Three-phase asynchronous motors (see "Motor power ranges")
Motor power ranges (subject to change)	
Motor voltage	400 V
Number of motor poles	4
Motor power	0.18 kW to 1.5 kW
The selection of appropriate motors depends on the nominal motor current ranging from 0.2 A to 3.6 A.	

Motor Protection	
Parameterization of the motor current	Through INTERBUS
Parameterization range	0.2 A to 3.6 A
A motor protection relay is inserted using a single-phase current measurement in unconnected phase T1.	
The motor current is measured in the T1 phase.	
Trip class	According to Class 10A of IEC 60947-4:1990
Quick shutdown	≥ 20.3 A after 300 ms

Motor Protection

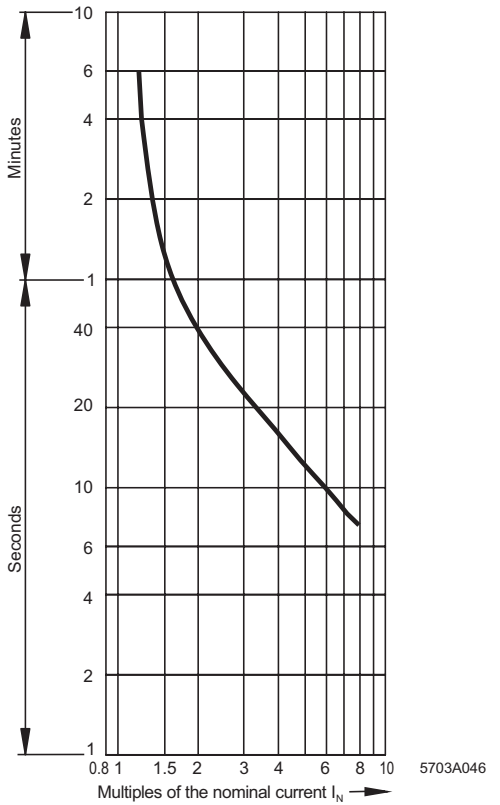


Figure 18 Typical response behavior of the motor protection

Current	1.5 x I_N	7.2 x I_N
Release Time	T_P < 120 s	2 s < T_P < 10 s

If the circuit is disconnected due to an overcurrent, wait for at least **60 seconds** to ensure successful acknowledgment of the error.

Current Monitoring	
Monitored phase	T1
Measuring range	0 A to 25 A
Resolution	14 mA
Supply of the current detection	From the 7.5 V communications power

Manual Mode Input	
Number	1
Terminal strip	X32
Number of pins	4
Conductor cross-section	1.5 mm^2 (16 AWG), maximum
Input current	Approximately 5 mA at U_S = 24 V
Filter time	0.2 ms, typical
Potential	Potential of the supply voltage U_S

Diagnostic Messages	
Module error after error in selftest	Message to the master (controller board)
Overcurrent	Error message in diagnostic code (bus) and display by means of the ERR LED on the power-level terminal.
Power level cannot be controlled	

Brake Module (External; See Also Module-Specific Data Sheet)	
Connection method	HV-COMBICON terminal strip (X8); 3-pos.
Brake	HV-COMBICON terminal strip (X9 of the brake module); 2-pos.
Contact type	Semiconductor
Further data	See module-specific data sheets

If data transmission via INTERBUS fails for ≥ 640 ms, the motor output and the brake switch are reset (motor is decelerated).

Conformance with EMC Directive 89/336/EEC		
Noise Immunity Test According to EN 50082-2:1995		
Electrostatic discharge (ESD)	EN 61000-4-2:1995/ IEC 61000-4-2	6 kV contact discharge, Criterion B 8 kV air discharge, Criterion B
Electromagnetic fields	EN 61000-4-3:1993/ IEC 61000-4-3	Criterion A Field strength: 3 V/m
Fast transients (burst)	EN 61000-4-4:1995/ IEC 61000-4-4	Criterion B Supply lines: 2 kV Signal/data lines: 2 kV
Surge voltage	EN 61000-4-5:1995/ IEC 61000-4-5	Criterion B DC supply lines: 0.5 kV/0.5 kV (symmetrical/asymmetrical) Criterion B AC supply lines: 2 kV/4 kV (symmetrical/asymmetrical)
Conducted interference	EN 61000-4-6:1993/ IEC 61000-4-6	Criterion A Test voltage 10 V
Noise emission test according to EN 50081-2:1993		
Noise emission of housing	EN 55011:1991	Class A
Ensure that the power-level terminal is not operated close to strong or medium-range electromagnetic fields. The use of portable radio transmission systems with a transmission power > 2 W at a distance of ≤ 2 m and the installation of strong radio transmitters and ISM devices close to the power-level terminal may have an adverse effect on operation.		

Electrical Isolation	
Safe isolation between line and SELV according to EN 50178:1998	
Supply voltage U_S/400 V level	1.2 kV AC, 1 minute, 50 Hz
Supply voltage U_S/brake switch	1.2 kV AC, 1 minute, 50 Hz
Supply voltage U_L/400 V level	1.2 kV AC, 1 minute, 50 Hz
Supply voltage U_L/brake switch	1.2 kV AC, 1 minute, 50 Hz
Remote bus/400 V level	1.2 kV AC, 1 minute, 50 Hz
Remote bus/brake switch	1.2 kV AC, 1 minute, 50 Hz

Mechanical Capability		
Shock	IEC 60068-2-27:1987	10g, Criterion 1
Vibration (operation)	IEC 60068-2-6:1982	2g, Criterion 1

10 Ordering Data

Description	Order Designation	Order No.
INTERBUS Inline power-level terminal as direct starter up to 1.5 kW	IB IL 400 ELR 1-3A	27 27 35 2
Motor circuit connector pack of 10	GMVSTBW 2,5 HV/ 4-ST-7,62 NZIL	18 93 95 7
Power connector pack of 1	IB IL 400 CN-PWR-IN	28 36 07 8
Power bridge pack of 1	IB IL 400 CN-BRG	28 36 08 1
Optional Accessories:		
Brake module	IB IL 400 BR	27 27 39 4
Brake module	IB IL 24 BR/DC	27 42 03 6
Operator Hand Panel	IBS HVO	28 36 05 2
For direct mode: MINI-COMBICON vertical connector	MCVW 1,5/4-ST-3,81	18 26 99 5
Thermistor terminal	IB IL 24 TC	27 27 41 7
For the thermistor terminal: I/O connector with eight terminals, spring-clamp connection (green, w/o color print); pack of 10	IB IL SCN-8	27 26 33 7

Description	Order Designation	Order No.
Documentation		
INTERBUS Inline System Manual	IB IL SYS PRO UM E	27 43 04 8
Data sheet for the thermistor terminal	DB GB IB IL 24 TC	90 02 02 4
Data sheet for the brake module	DB GB IB IL 400 BR	90 06 75 4
Data sheet for the brake module	DB GB IB IL 24 BR/DC	90 06 75 6

All the INTERBUS documentation can be found on the Internet at **http://www.phoenix-contact.com** under the heading "InfoService".

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