Industrial-Automation

System *HIMatrix*

Engineering Manual

HIMA Paul Hildebrandt GmbH + Co KG
Industrial Automation

HI 800 101 DEA

Important Notes

For more information see the documentation on CD-ROM and on our web site www.hima.com .

More information can be requested from:

HIMA Paul Hildebrandt GmbH + Co KG
Postfach 1261
68777 Brühl

Tel: +49(6202)709 0
Fax: +49(6202)709 107

e-mail: info@hima.com

About this Manual

The safety-related HIMatrix systems as described in this manual can be used for several different purposes. The knowledge of regulations and the technically perfect transfer carried out by qualified staff are prerequisites for the safe installation, start-up and for the safety during operation and maintenance of the HIMatrix Automation Devices.

In case of unqualified interventions into the automation devices, de-activating or bypassing safety functions, or if advices of this manual are neglected (causing disturbances or impairments of safety functions), severe personal injuries, property or environmental damage may occur for which HIMA cannot take liability.

HIMatrix Automation Devices are developed, manufactured and tested according to the relevant safety standards. They must only be used for the applications described in the instructions and with specified environmental conditions, and only in connection with approved external devices.

The HIMatrix system family includes not only a modular controller but also a comprehensive range of compact small controllers and remote I/O modules. The HIMatrix components are designed for versatile applications to provide solutions for safety-related tasks.

Intended Readership

This manual is intended for project engineers, programmers and maintenance staff with general knowledge in the area of automation devices.

P. O. Box 1261
D - 68777 Bruehl near Mannheim

Phone +49 6202 709-0

Fax +49 6202 709-107

E-mail info@hima.com

Internet http://www.hima.com

Additional System Documentation

The following documentation is also available for configuring HIMatrix systems:

Name	Contents	Document no. D = German E = English	Part no.
HIMatrix Safety Manual*	Safety functions of HIMatrix systems	HI 800 022 (D) HI 800 023 (E)	pdf file
HIMatrix System Manual Compact Systems	Hardware descriptions of compact systems with specifications	HI 800 140 (D) HI 800 141 (E)	pdf file
HIMatrix System Manual Modular System F60	Hardware description of the modular system F60 with specifications	HI 800 190 (D) HI 800 191 (E)	pdf file
HIMatrix Manual First Steps	Introduction to ***ELOP II Factory***	HI 800 005 (D) HI 800 006 (E)	96 9000013 96 9000014 pdf file

* Only supplied with a HIMatrix system

Terminology

Term	Definition
AI	Analog Input
AIO	Analog Input/Output
AO	Analog Output
COM	Communication Module
CPU	Central Processing Unit
DI	Digital Input
DIO	Digital Input/Output
DO	Digital Output
EMC	Electromagnetic Compatibility
FB	Field Bus
FBD	Function Block Diagram
FTZ	Fault Tolerance Time
IEC	International Electrotechnical Commission
LC	Line Control
MEZ	Multiple fault occurrence time
NSP	Non-Safety-related Protocol
OLE	Object Linking and Embedding
OPC	OLE for Process Control
PADT (PC)	Programming and Debugging Tool (according IEC 61131-3)
PES	Programmable Electronic System
R	Read
R/W	Read/Write
RC	Requirement Class
SFC	Sequential Function Chart
SIL	Safety Integrity Level (according to IEC 61508)
SNTP	Simple Network Time Protocol (RFC 1769)
TMO	Timeout
W	Write
WD	Watchdog
WDZ	Watchdog time

HIMatrix Product Overview

Compact devices

For detailed descriptions of the devices listed below and their specifications see the corresponding **Data sheets** and the **System Manual** of the **Compact Systems**.

Compact device	Properties	Interfaces
F20 part no. 98 2200417	8 digital channels, configurable as inputs or outputs 4 pulsed outputs for Line Control	2 Ethernet ports, integrated switch 2 Field bus terminals
F30 part no. 98 2200415	20 digital inputs, 8 digital outputs, configurable as pulsed outputs for Line Control	4 Ethernet ports, integrated switch 3 Field bus terminals
F31 01 part no. 98 2200403	20 digital inputs, 8 digital outputs, configurable as pulsed outputs for Line Control	2 Ethernet ports, integrated switch
F31 02 part no. 98 2200420	20 digital inputs, 8 digital outputs, configurable as pulsed outputs for Line Control	4 Ethernet ports, integrated switch
F35 part no. 98 2200416	2 counters, 8 analog inputs 0-10 V or 0/4-20 mA, 24 digital inputs, 8 digital outputs	4 Ethernet ports, integrated switch 3 Field bus terminals
F1 DI 16 01 part no. 98 2200405	Remote I/O module 16 digital inputs 4 pulsed outputs for Line Control	2 Ethernet ports, integrated switch
F2 DO 4 01 part no. 98 2200408	Remote output module 4 digital power outputs up to 5 A	2 Ethernet ports, integrated switch
F2 DO 8 01 part no. 98 2200407	Remote output module 8 relay outputs up to 250 VAC	2 Ethernet ports, integrated switch
F2 DO 16 01 part no. 98 2200406	Remote output module 8 digital outputs up to 2 A, 8 digital outputs up to 1 A	2 Ethernet ports, integrated switch
F2 DO 16 02 part no. 98 2200422	Remote output module 16 relay outputs up to 30 VAC	2 Ethernet ports, integrated switch
F3 DIO 8/8 01 part no. 96 9000114	Remote output module 8 digital inputs 8 digital L+ switching outputs 2 digital L- switching outputs 2 pulsed outputs	2 Ethernet ports, integrated switch
F3 DIO 16/8 01 part no. 96 9000112	Remote output module 16 digital inputs 8 two-pole digital outputs 2 pulsed outputs	2 Ethernet ports, integrated switch
F3 AIO 8/4 01 part no. 98 2200409	Remote I/O module 8 analog inputs 0-10 V or 0/4-20 mA, 4 analog outputs 0/4-20 mA	2 Ethernet ports, integrated switch
F3 DIO 20/8 01 part no. 98 2200402	Remote I/O module 20 digital inputs, 8 digital outputs, configurable as pulsed outputs for Line Control	2 Ethernet ports, integrated switch multimaster-capable
F3 DIO 20/8 02 part no. 98 2200404	Remote I/O module 20 digital inputs, 8 digital outputs, configurable as pulsed outputs for Line Control	2 Ethernet ports, integrated switch

Modular device F60
For a detailed description of the hardware of the F60 and all applicable modules see the corresponding **Data sheets** and the **System Manual Modular System F60**.

Modular device	Properties	Interfaces
F60, GEH 01 part no. 98 2200103	Modular system housing, freely selectable I/O modules	on CPU 01 module

Module	Properties	I/O range
AI 8 01 part no. 98 2200214	Analog input module	8 unipolar inputs 0...10 V, 4 bipolar inputs -10...+10 V, with shunt 0/4...20 mA
AO 8 01 part no. 98 2200215	Analog output module	8 outputs 0...±10 V / 0/4...20 mA
CIO 2/4 01 part no. 98 2200099	Counter module	2 counter to 1 MHz, 4 digital outputs
DI 24 01 part no. 98 2200113	Digital input module for high voltages	24 inputs 110 VDC, 127 VAC
DI 32 01 part no. 98 2200114	Digital input module, configurable with Line Control	32 digital inputs 24 VDC
DIO 24/16 01 part no. 98 2200100	Digital input/output module outputs configurable as pulsed outputs for Line Control	24 digital inputs 24 VDC, 16 digital outputs 24 VDC
DO 8 01 part no. 98 2200112	Digital output module with relay outputs	8 relay contact outputs 110 VDC, 230 VAC
MI 24 01 part no. 98 2200115	Multi-input module	24 analog inputs 0/4...20 mA, or 24 digital inputs for contacts (with resistors) or initiators
PS 01 part no. 98 2200096	Power supply unit F60	
CPU 01 part no. 98 2200126	Central module, integrated 4 port switch 100 Base-Tx with safe**ethernet**	4 Ethernet-Ports, integrated switch 2 Field bus terminals

Contents

1 Certification

The safety-related HIMA HIMatrix programmable controllers (Programmable Electronic Systems, PES) are tested and certified by TÜV for functional safety in accordance to CE and the standards listed below:

TÜV Anlagentechnik GmbH
Automation, software and information technology
Am Grauen Stein
51105 Köln

Certificate and test report No. 968/EZ 128.04/03
Safety-related automation devices
HIMatrix F20, F30, F31, F35,
F1 DI 16 01, F2 DO 4 01, F2 DO 8 01, F2 DO 16 01,
F3 AIO 8/4 01, F3 DIO 20/8 01, F3 DIO 20/8 02
HIMatrix F60

International standards:

EC 61508, parts 1-7: 2000	up to SIL 3
EN 954-1: 1996	up to category 4
EN 298: 1994	
NFPA 8501: 1997	
NFPA 8502: 1999	
EN 61131-2: 1994 and A11: 1996, A12: 2000	
EN 61000-6-2: 2000, EN 50082-2: 1996, EN 50081-2: 1993	
F 60 and F35: EN 54-2: 1997, NFPA 72: 1999	

National standards:

DIN V VDE 0801: 1990 and A1: 1994	
DIN V 19250: 1994	up to RC 6
DIN VDE 0116: 1989, prEN 50156-1: CDV 2000	

Chapter **9 Operating Conditions** contains a detailed listing of all applied environment and EMC tests.

All devices are labelled with the CE sign.

To program of the HIMatrix devices, a PADT (programmer unit, PC) running the programming tool

ELOP II Factory

and the program languages Function Block Diagram (FBD) and Sequential Function Chart (SFC) in accordance to IEC 61131-3 is used. This software assists the user in creating safety-related programs and operation of the PES.

2 Notes for Danger and Use

This manual contains specially highlighted advices that indicate safety requirements:

2.1 Notes for Danger

Important information regarding situations or operations. Failure to observe these instructions could cause personal injury and/or damage to property.

These notes

- indicate danger,
- help you avoid danger,
- make you aware of the consequences.

2.2 Notes for Use

Note	Special instructions to aid understanding and correct use.

These instructions will help you operate the controller correctly and provide you with better understanding of the system.

3 Installation of HIMatrix Devices

The safety-related HIMatrix controller systems can be installed on mounting bases, and also in closed cases such as control stations, terminal boxes and control racks. They have been developed in compliance with applicable standards for EMC, climate and environmental requirements. These standards are to be found in Chapter **9 Operating Conditions** and also in the manuals for the HIMatrix systems and must be observed.

The protection class of the HIMatrix devices (IP 20) can be increased by installation in a suitable housing in accordance to the specific requirements. However, the heat dissipation (see Chapter 3.3) must be checked.

3.1 Mechanical

The modular HIMatrix F60 controller has two perpendicular mounting links each of which has two slotted holes for fastening. They must be installed on a flat base.

When installing the F60 make sure that it is fastened in place with no mechanical distortion.

The screws and the selected base must be suitable to hold the weight of the F60 controller of max. 10 kg.

The HIMatrix compact devices are mounted on a rail and not directly on a base. This makes it impossible to bend the bottom of the case.

3.2 Installation of Controllers

3.2.1 Installation

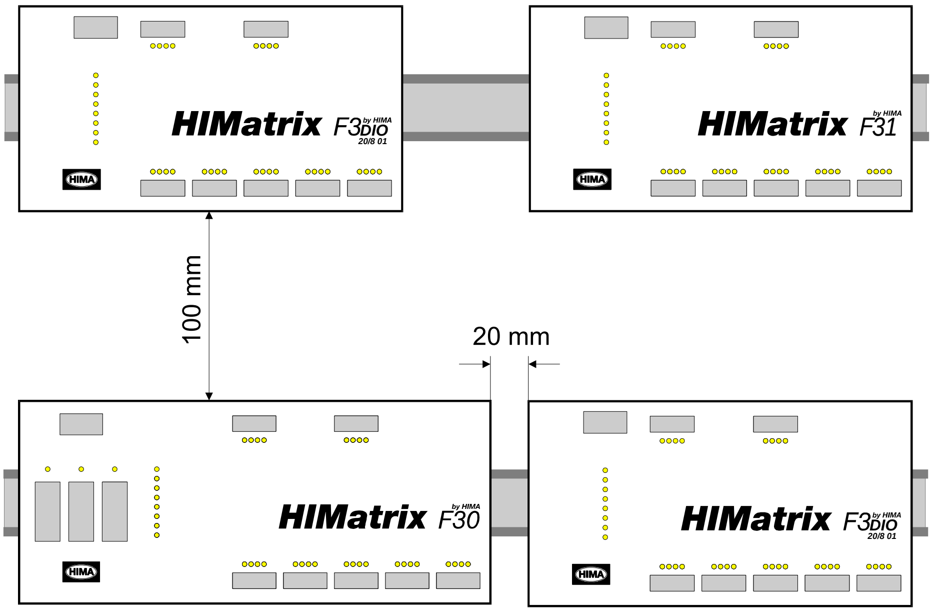
All devices must be mounted in a horizontal position (with reference to the inscription on the front plate) to ensure sufficient ventilation. Mounting in a vertical position requires additional measures to ensure sufficient ventilation.

See the relevant manuals for the dimensions of the various devices.

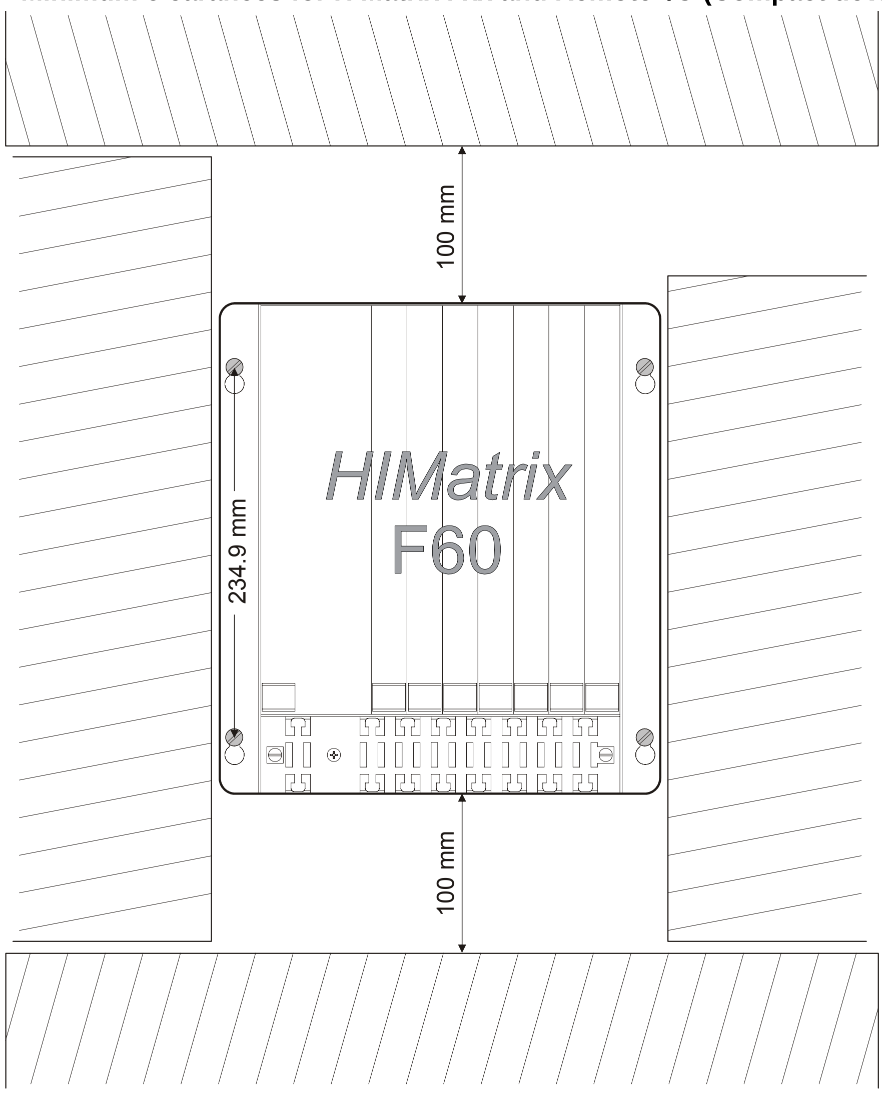
The minimum distances between HIMatrix devices, to devices from other manufacturers also as to cabinet walls are as follows

- **vertical** minimum **100 mm,**
- **horizontal** approx. **20 mm** (set by the fastening straps with the F60).

The installation space (rack heights) must also be considered for attaching connectors for the inputs and outputs and for communication (see Chapter 3.2.3 Assembly heights).



Minimum clearances for HIMatrix Fxx and Remote I/O (Compact devices)



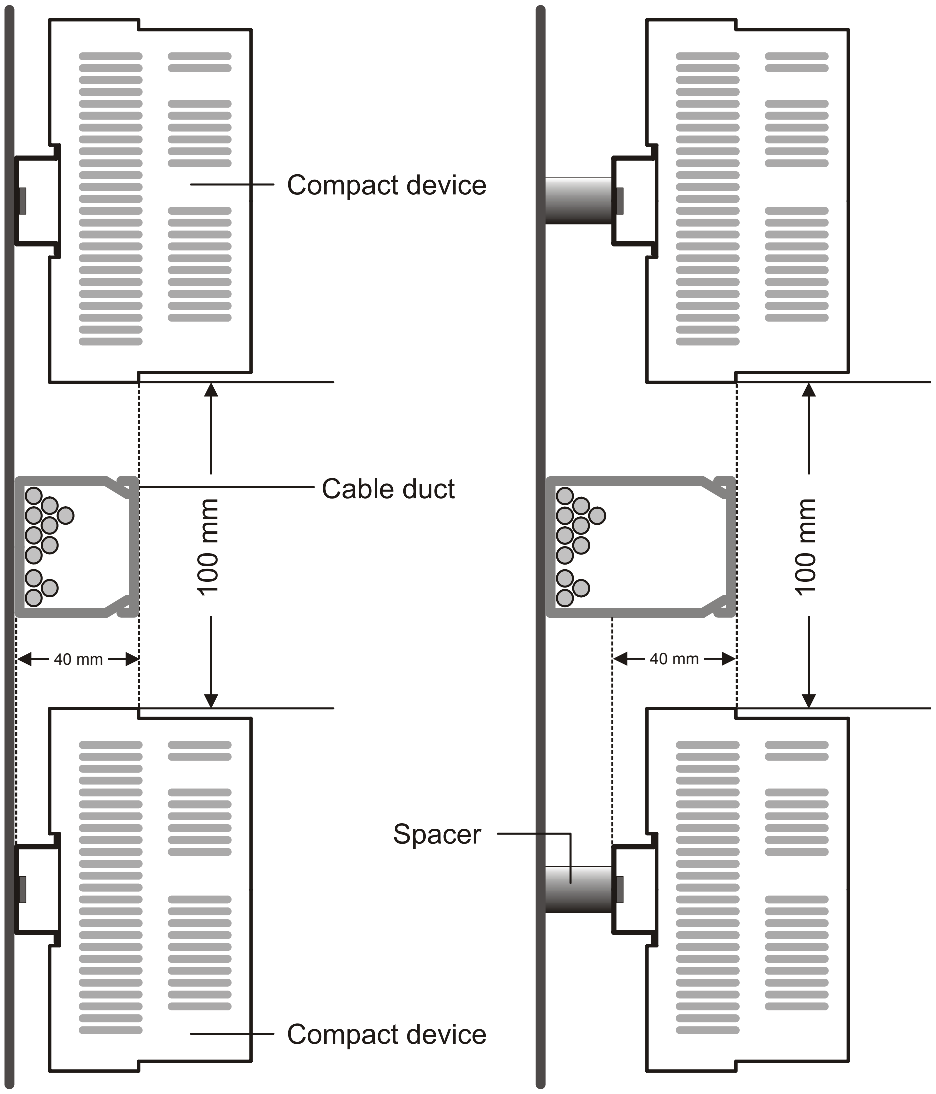
Minimum clearances for HIMatrix F60

Figure 1: Minimum clearances at installation

Notes	The following installation is required so that • HIMatrix devices are not subject to heat from other equipment with high heat dissipation, • devices with high EMC interference do not interfere with HIMatrix devices. Note the information provided by the manufacturer.

3.2.2 Air Circulation

The ventilation slots in the case may not be obstructed. When mounting compact devices and cable ducts at the same level the height of the cable ducts must be no more than 40 mm. If the cable ducts are higher, the mounting rails must be placed on spacers:



Use of cable ducts
with horizontal mounting of compact devices on rails

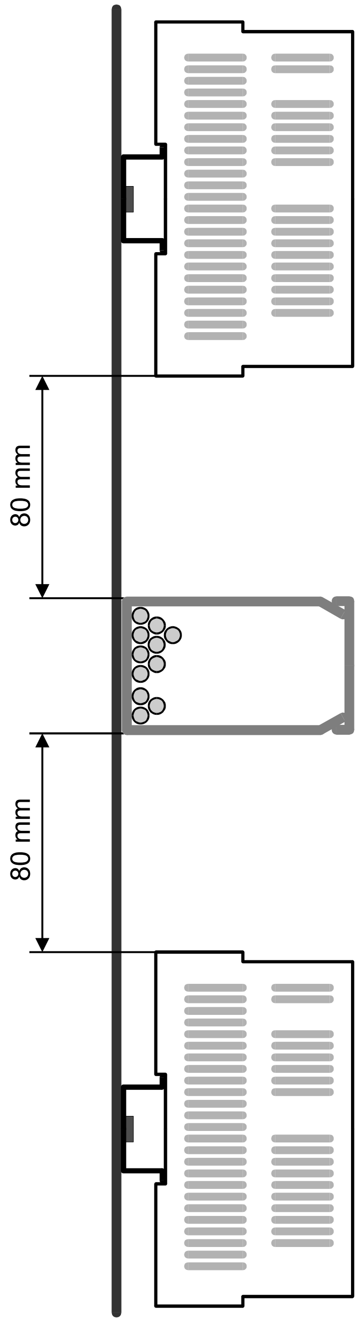
Figure 2: Use of cable ducts and spacers

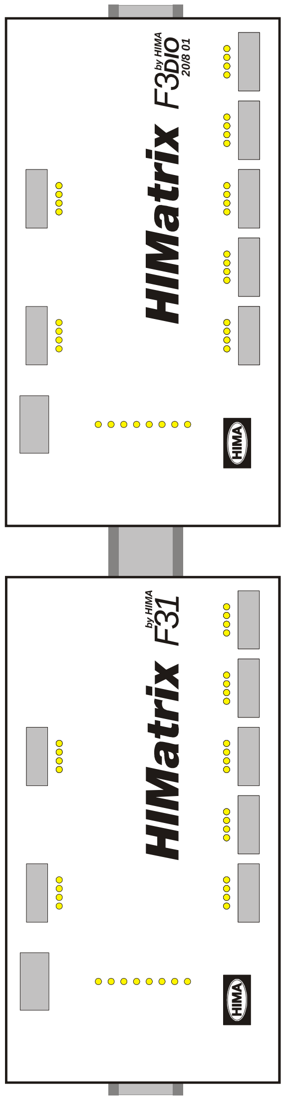
The length l of the required spacer is calculated as follows:

l = height of the cable duct – 40 mm

If **more** than two HIMatrix devices (even when the minimum vertical clearance of 100 mm is retained) are installed one above the other, additional measures for ventilation are required to ensure even temperature distribution.

The illustration below left shows the minimum clearances if no spacers are used for the rails:





Note
HIMatrix devices can only be mounted vertically with sufficient ventilation!

Clearances for mounting without spacers

Vertical mounting of HIMatrix devices

Figure 3: Mounting without spacers and vertical mounting

On open mounting surfaces there are no problems with maintaining the maximum operating temperature if the minimum clearances are retained and the air can circulate without obstruction.

3.2.3 Assembly Heights

Because of the connectors for communication and I/O level the HIMatrix devices require the assembly heights shown in the table below. With compact devices they apply from the fixing rail:

HIMatrix device		Assembly height
F60		270 mm
F1 DI 16 01		100 mm
F2 DO 4 01		100 mm
F2 DO 8 01		120 mm
F2 DO 16 01		100 mm
F2 DO 16 02		120 mm
F3 DIO 8/8 01		100 mm
F3 DIO 16/8 01		100 mm
F3 DIO 20/8 01		100 mm
F3 DIO 20/8 02		100 mm
F3 AIO 8/4 01		100 mm
F20	with Profibus connector* without Profibus connector	----* mm 100 mm
F30	with Profibus connector* without Profibus connector	----* mm 100 mm
F31		100 mm
F35	with Profibus connector* without Profibus connector	----* mm 100 mm

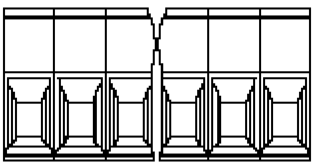
Table 1: Assembly heights

*Assembly height = height HIMatrix + height of Profibus connector
Right connector : 100 mm + 50 mm
45º connector : 100 mm + 40 mm
90º connector : 100 mm + 35 mm

3.2.4 Pluggable Cable Dimensions

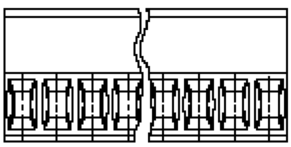
At the terminals and plugs of the HIMatrix Compact Systems and the Modular System F60 the following cable dimensions with wire ends are pluggable:

Power supply



up to 2.5 mm^2

Terminal



up to 1.5 mm^2

3.3 Heat Contemplation

The increasing integration of electronic components results in increasing heat dissipation. The amount of heat depends on the external load on the HIMatrix devices. Therefore, depending on the design of the installation, the devices and the air distribution are significant.

It is important to comply with the approved environmental conditions when installing the devices. A reduced operating temperature extends the service life and reliability of the installed components.

3.3.1 Heat Dissipation

An enclosed case must be designed to allow the heat generated inside it to be dissipated from its surface.

The type and site of installation must be selected to allow heat dissipation.

The heat output of the installed components determines the design of the ventilation components. An even distribution of the heat load is assumed (see chapter 3.3.1.3).

3.3.1.1 Definitions

P_V [W]	heat output (heat dissipation) of the electronic components installed in the case
A [m^2]	effective surface area of case (see below)
k [W/m^2 K]	heat transfer coefficient of case, Steel sheet: ~ 5.5 W/m^2 K

3.3.1.2 Installation Type

The effective case surface area A is calculated as follows depending on the mounting or installation type:

Case installation according to VDE 0660 part 5		Calculation of A [m^2]
	Single case free on all sides	A = 1.8 x H x (W + D) + 1.4 x W x D
	Single case for wall mounting	A = 1.4 x W x (H + D) + 1.8 x H x D
	End case free-standing	A = 1.4 x D x (W + H) + 1.8 x W x H
	End case for wall mounting	A = 1.4 x H x (W + D) + 1.4 x W x D
	Centre case free-standing	A = 1.8 x W x H + 1.4 x W x D + H x D
	Centre case for wall mounting	A = 1.4 x W x (H + D) + H x D
	Centre case for wall mounting, top surface covered	A = 1.4 x W x H + 0.7 x W x D + H x D

Table 2: Installation type

3.3.1.3 Internal Convection

With internal convection the heat is dissipated outside through the walls of the case. This requires the ambient temperature to be lower than the temperature inside the case.

The maximum temperature increase $(\Delta T)_{max}$ of all electronic devices in the case is calculated as follows:

$$(\Delta T)_{max} = \frac{P_V}{k \cdot A}$$

The power dissipation P_V can be calculated from the electrical power values of the controller and its inputs and outputs.

Example: Calculation of power dissipation P_V for controller F35

- Idle current consumption of the controller: 0.75 A at 24 V
- 8 outputs with current consumption of each 1 A at 2 V
- The current consumption of the digital inputs, analog outputs and counters can be neglected.

Hence a maximum thermal power dissipation P_V of approx. 34 W results.

3.3.1.4 Temperature State/Operating Temperature

The controllers are designed for operation up to a maximum temperature of 60 °C. The temperature states of the single modules or the controllers are evaluated by the CPU module (at F60) or the respectively installed CPU (compact systems) in the controller.

The temperature state of the particular module or the controller is measured by one temperature sensor in a relevant temperature location. This sensor monitors automatically and continuously the temperature state of the device.

The temperature state signals the measured temperatures in the following temperature ranges:

Temperature state	Temperature range	Signal value [BYTE] ***Temperature State***
< 60 °C	Normal	0x00
60 °C to 70 °C	High temperature	0x01
> 70 °C	Very high temperature	0x03
Return to 64 °C to 54 °C	High temperature	0x01
Return to < 54 °C	Normal	0x00

Table 3: Temperature state

If the temperature at a temperature sensor rises above a temperature threshold, the temperature state changes.

The temperature states can be evaluated using the ***Temperature State*** system signal on a programming unit running ***ELOP II Factory***.

The display of the temperature state is carried out with a temperature hysteresis of 6 K.

3.3.1.5 Standard

The temperature in a case can also be calculated in accordance to VDE 0660 Part 507 (HD 528 S2).

Note For heat contemplation **all** components in a housing have to be regarded!

3.4 Operating Voltage

Before connecting the operating voltage of 24 VDC check that the polarity is correct (see also Chapter 4.1), otherwise the devices may be damaged.

The terminals L+ and L- may not be reversed!
A pre-fuse prevents damages in case of wrong polarity!
Damage may also be caused by connection with other terminals of the PES.

3.5 Earth and Shield

3.5.1 Earthing the System Voltage 24 VDC

All devices of the HIMatrix family must be operated with power supply units that comply with the SELV (Safety Extra Low Voltage) or PELV (Protective Extra Low Voltage) requirements. A function earth is provided to improve the electromagnetic compatibility (EMC).

All HIMatrix systems can be operated non-earthed or with earthed reference pole L-.

3.5.1.1 Non-earthed Operation

Non-earthed operation offers some advantages in relation to EMC performance.

Some applications make own demands on the non-earthed operation of controllers, e.g. according to the standard VDE 0116 an earth fault monitor is required for non-earthed operation.

3.5.1.2 Earthed Operation

The earth must be designed in accordance to the standard and must have a separate earth contact through which no power dependent interference current flows. Only the negative pole (L-) may be earthed. The positive pole (L+) may not be earthed because every earth fault on the sensor line would mean that the sensor is short-circuited.

The L- must only be earthed at one point inside the system. The L- is usually earthed directly behind the power supply unit (e.g. on a bus bar). The earth must be easily accessible and disconnectable. The earth resistance must be ≤ 2 Ohm.

3.5.2 Earth Connections

All HIMatrix devices have labelled screws for earthing. The core cross section for the connection to the screw is 2.5 mm^2. The earth wires must be as short as possible.

If HIMatrix compact devices are mounted on the rail this is already sufficient earth connection, as long as the rail itself is earthed in accordance to the standard.

These measures will give a reliable earth and will also meet the requirements of the applicable EMC regulations for HIMatrix systems.

3.5.3 Shields

Sensor or actuator lines for analog inputs and outputs of HIMatrix systems with shrouds (F3 AIO 8/4 01, F35 und F60) must be installed as shielded cables. The shield must be earthed at one end at the device side, and the case of the sensor or actuator must be connected over a wide area to the cable shield to create a Faraday cage.

The F3 AIO 8/4 01, F35 and F60 have rails at the front conductively connected with the case potential to earth the cable shield. The cable shield is connected there to the rail with a clamp.

In all other devices the shield must be positioned in the controller case, terminal cabinet, control cabinet etc.

The shield clamp may not be used as a strain relief for the connected cable.

3.5.4 EMC Protection

Windows in the case in which the device is installed are permitted.

Increased EMC interferences outside the standard limit values require appropriate measures.

3.5.5 ESD Protection

Only personnel who have the knowledge of ESD protective measures are permitted to carry out system modifications/upgrades to the system wiring.

An electrostatic discharge can damage the built-in electronic components.

- Touch an earthed object to discharge any static in your body.
- When carrying out the work, make sure to use an ESD protected working area and wear an earthing strip.
- When the module is not in use, ensure it is protected from electrostatic discharges, e.g. keep it in its packaging.

4 Configuring the Hardware

4.1 Supply Voltage

The HIMatrix system is a single voltage system. The required operating voltage is defined as follows in accordance to IEC/EN 61131-2:

Supply voltage	
Nominal value	24 VDC, -15...+20 %, 20.4 V...28.8 V
Max. permissible function limits in continuous operation	18.5 V...30.2 V (including ripple)
Maximum peak value	35 V for 0.1 s
Allowable ripple	w < 5 % as r.m.s. value w_{ss} < 15 % as value peak-to-peak
Reference potential	L- (negative pole) Earthing the reference potential is permitted (see chapter 3.5.1)

Table 4: Supply voltage

The HIMatrix controllers must be powered by power supply units that meet the requirements of SELV (Safety Extra Low Voltage) or PELV (Protective Extra Low Voltage).

The controller will function correctly when the permitted voltage limits are maintained.

The specified SELV/PELV power supply units ensure secure operation.

4.2 Deenergize to Trip Mode / Energize to Trip Mode

The programmable controllers are designed for the deenergize to trip mode.

The HIMatrix systems are certificated for process controllers, safety systems, burner systems and machine controllers.

A system operating according to the deenergize to trip mode does not need energy to perform its safety function.

In the event of a fault, the input and output signals revert to voltage-free or current-free states to ensure safe operation.

The HIMatrix controllers can also be used in energize to trip mode applications.

A system operating according to the energize to trip mode needs energy, for example electrical or pneumatic energy, to perform its safety function.

Therefore the HIMatrix F60, F35 and F3 AIO 8/4 01 were tested and certificated according to EN54 and NFPA72 for use in fire alarm systems and fire extinguish systems. In these systems it is necessary that on demand the active state is used for controlling the danger (further details see chapter 4.5).

4.3 Short-Circuit Characteristics of the Output Channels

In the event of a short-circuit in one output channel the HIMatrix automation devices switch off the affected channel. In the event of multiple short-circuits the channels are switched off individually in accordance to their power consumption.

If the maximally permitted current for all outputs is exceeded, *all* outputs are shut down and cyclically reconnected.

The terminals for output circuits may not be plugged with load connected. With existing short-circuits the resulting high current may damage the terminals.

4.4 Using the F35 Controller in the Zone 2 (EG guideline 94/9/EG, ATEX)

The F35 controller is suitable for installation in zone 2. The corresponding declaration of conformity can be found in the **Data sheet HIMatrix F35**.

For this mounting the following mentioned special conditions have to be regarded.

Special conditions X

1. The controller **HIMatrix F35** must be mounted in an enclosure, which fulfills the requirements of the EN 60079-15 with the type of protection at least IP 54, according to EN 60529. This enclosure must be labeled with

   "Working permitted only in the de-energized state"

   Exception:
   If it is assured that there exists no explosive atmosphere working under voltage is also permitted.

2. The used enclosure must be able to dissipate safely the generated heat. The power dissipation of the controller **HIMatrix F35** is between **15 W** and **29 W** depending on the output load and the power supply voltage.

3. The controller **HIMatrix F35** must be fused with a time-lag fuse of 10 A.

   The voltage supply 24 VDC of the controller **HIMatrix F35** is admissible only from a power supply unit with safe isolation. Only PELV or SELV power supply types may be used.

4. The following items of the standards

   VDE 0170/0171 part 16, DIN EN 60079-15: 2004-5

   VDE 0165 part 1, DIN EN 60079-14: 1998-08

   must be regarded:

   DIN EN 60079-15:
   Chapter 5 Design
   Chapter 6 Terminals and cabling
   Chapter 7 Air and creeping distances
   Chapter 14 Connectors

   DIN EN 60079-14:
   Chapter 5.2.3 Equipment for use in zone 2
   Chapter 9.3 Cabling for zones 1 and 2
   Chapter 12.2 Equipment for zones 1 and 2

The controller additionally has the following label:

HIMA	**Paul Hildebrandt GmbH + Co KG** **A.-Bassermann-Straße 28, D-68782 Brühl**
HIMatrix	**Ex II 3 G EEx nA II T4 X**
F35	**0 °C ≤ Ta ≤ 60 °C** **Special conditions X must be regarded!**

4.5 Use in Central Fire Alarm Systems

All HIMatrix systems with analog inputs can be used for central fire alarm systems in accordance with DIN EN 54-2 and NFPA 72.

The application program must fulfil the functions laid down for central fire alarm systems according to the cited standards.

The required maximum cycle time of 10 seconds (DIN EN 54-2) for central fire alarm systems can easily be achieved with the systems as the cycle times of these systems can be measured in milliseconds. Similarly, the required 1 second safety time (if necessary) can also be easily achieved (error response time).

According to EN 54-2 the fire alarm system has to be in the fault report state within 100 seconds after the HIMatrix system has received the fault report.

The fire alarms are connected using the energize to trip principle with line monitoring for the detection of short-circuits and breaks. The digital and analog inputs can be used with F35, the analog inputs with F3 AIO 8/4 01 and the AI 8 01 analog input module with F60.

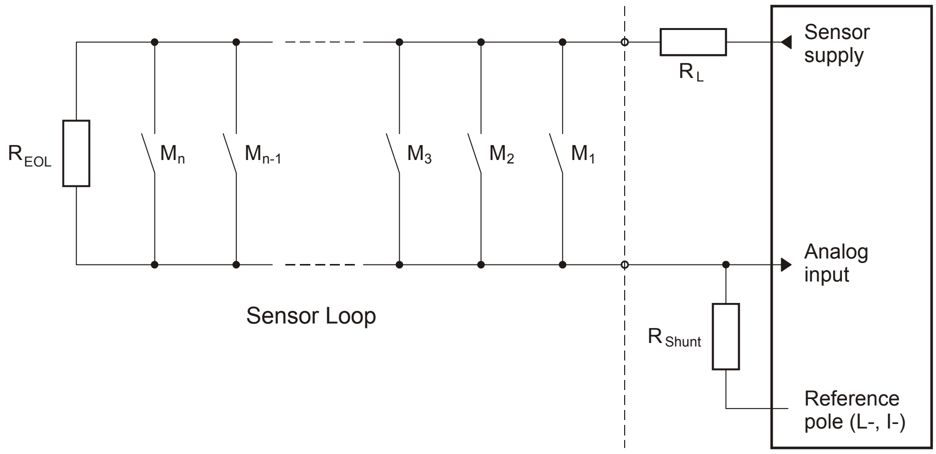


Figure 4: Wiring of fire alarms

M	Fire alarm
R_{EOL}	Terminating resistor on the last sensor in the loop
R_L	Limitation of the maximum permitted current in the loop
R_{Shunt}	Measuring resistor

For the application, the resistance of R_{EOL}, R_L and R_{Shunt} should be calculated depending on the sensors being used and the number of sensors per alarm loop. The required data is contained in the relevant data sheet from the sensor manufacturer.

The alarm outputs, used for activating lamps, sirens, horns, etc, are operated using the energize to trip principle. These outputs must be monitored for line breaks and short-circuits. Feeding back the output signals directly from the actuator to the inputs can do this.

The current in the actuator circuit should preferably be monitored via an analog input with an appropriate shunt. A series connection of zener diode and series protects the input against overvoltage in case of short-circuit.

For an explicit line break monitoring (at de-energized outputs DO) a transmitter supply additionally to the analog inputs is necessary (see scheme below):

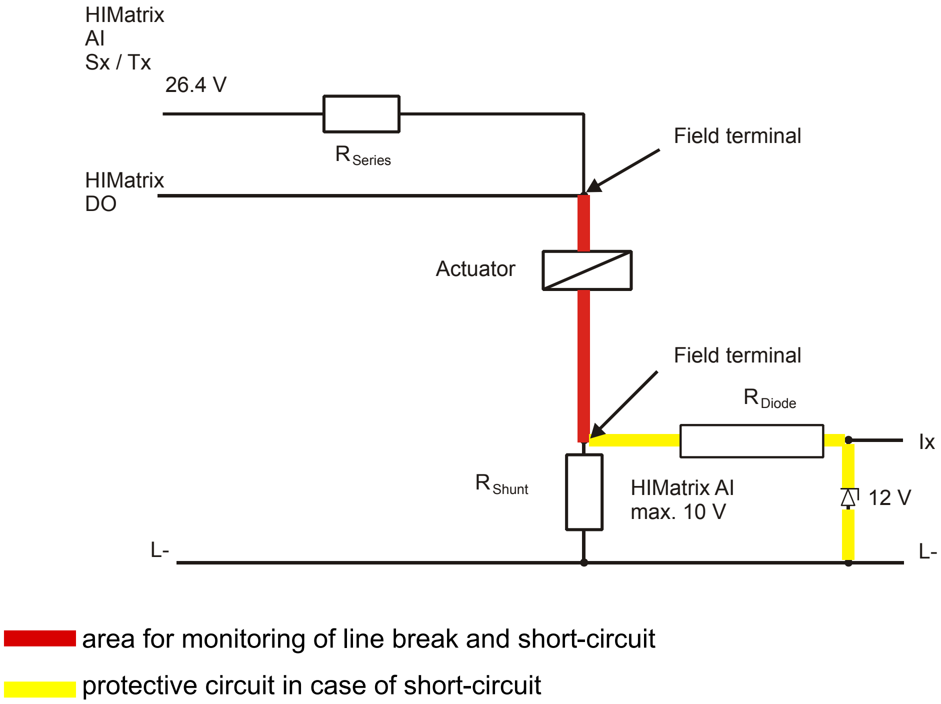


Figure 5: Example for line break and short-circuit monitoring of digital outputs (actuator circuit)

In chapter "Line Monitoring" at HIMatrix F35 you will find an example for monitoring of line break and short-circuit of actors via analog inputs.

Visual display systems, indicator light panels, LED displays, alphanumeric displays, audible alarms, etc. can all be controlled using an appropriate application program.

The routing of fault signals via input and output modules or to routing equipment must be carried out using the deenergize to trip mode.

Fire alarms can be transmitted from one HIMatrix system to another using the Ethernet communications (OPC) standard available. Any breakdown in communications must be signaled.

HIMatrix systems that are used as central fire alarm systems must have a redundant power supply. Precautions must also be taken against the power supply failing, i.e. using a battery-powered horn. There must be no interruption in operation when switching between the mains supply and the back-up supply. Voltage dips of up to 10 ms are permitted.

When there is a fault in the system, the system signals specified in the application program are written by the operating system. This enables error signaling to be programmed to signal errors detected by the system. In the event of an error, safety-related inputs and outputs are switched off, i.e. 0-signals are applied to all the channels of faulty inputs and all the channels of faulty outputs are switched off.

5 Communication

5.1 Options for Communication at HIMatrix Systems

Depending on the controller at HIMatrix systems different communication options can be activated:

1. Unlocking only per software (SW) code
2. Installation of the module ex works and unlocking the function with delivered SW code and later unlocking of other functions per SW code.

Other communication interfaces (protocols) are already installed in the controller and do not need a SW code for unlocking of functions.

Protocols	F20	F30	F31 01	F31 02	F35	F60
Safe**ethernet**	X	X	X		X	X
HOPCS	X	X	X		X	X
Modbus master Eth	SW code	SW code	SW code		SW code	SW code
Modbus slave Eth	SW code	SW code	SW code		SW code	SW code
Send/Receive TCP	SW code	SW code	SW code		SW code	SW code
Ethernet/IP	SW code	SW code	SW code		SW code	SW code
Modbus master RS485	option	option	-		option	option
Modbus slave RS485	option	option	-		option	option
Profibus master	option	option	-		option	option
Profibus slave	option	option	-		option	option
Interbus	option	option	-		option	option
Total number of field bus interfaces	2	3	0		3	2

Table 5: Communication options at HIMatrix systems

<u>Explanations for the table:</u>

X: equipped, without SW code

SW code: Unlocking of the interface via software license

F20: FB2 for Modbus, FB1 freely pluggable

F3x: FB3 for Modbus, FB1 and FB2 freely pluggable

F60: FB1 and FB2 freely pluggable

Each master or slave (Modbus/Profibus/Interbus) is only single usable over all interfaces (unlocking via SW code).
The field bus interfaces of the F20 (FB2), F30 (FB3) and F35(FB3) are already equipped with an RS485 module, which can be used either for Modbus master or Modbus slave depending on the acquired unlocking code (SW code).

After buying a license you can get a new unlocking code via the homepage http://himatrix.hima.com. For further informations please contact the HIMA support:
Phone: +49 6202 709 185 or –424 or via E-mail: support@hima.com

Composition of the part number

98.22**xy**.....
x: Option for first slot
y: Option for second slot

Options for **x** and **y**:

0: Interface is not used
1: RS485 (Modbus master or slave, unlocked by the license code)
2: Profibus master
3: Profibus slave
4: Interbus master

Examples:

F60:	98.22**12**126 ...	Slot 1: RS485,	Slot 2:Profibus Master
F30:	98.22**32**415 ...	Slot 1: Profibus Slave,	Slot 2:Profibus Master
F20:	98.22**10**417 ...	Slot 1: RS485	
F35:	98.22**42**416 ...	Slot 1: Interbus Master,	Slot 2:Profibus Master

5.2 Ethernet Communication

5.2.1 Communication via Switches

The switch integrated into each system for safe**ethernet** or Ethernet communication can be seen on the block diagrams.

- In contrast to a hub, a switch is able to store data packets for a short period of time in order to establish a temporary connection between two communication partners (transmitter/receiver) for the transfer of data. In this way, collisions (typical of a hub) can be avoided and the load on the network is reduced. For controlled data transfer every switch needs an address/port relation table. This table will be automatically generated in a self-learning process. Each port in the switch is correlated to defined MAC addresses. According to this table incoming data packages are directly switched to the corresponding port.
- The switch automatically switches between the transfer rates of 10 and 100 Mbit/s and between full and half duplex connections. This makes the full bandwidth available (full duplex operation) in both directions.
- A switch controls the communication between different devices. The switch can address up to 1000 absolute MAC addresses.
- Autocrossing recognizes that cables with crossed wires have been connected, and the switch adjusts accordingly.

Note When configuring the safety-related communication in accordance to the HIMatrix manual, the information contained in the Safety Manual must be regarded.

5.2.2 Safeethernet

In the field of automation central themes are requirements like determinism, reliability, changeability, enlargement and over all safety.

Safe**ethernet** provides a transfer protocol for transmitting safety-related data up to SIL 3 on base of the Ethernet technology.

Safe**ethernet** implements mechanism that can detect and react safety-related on the following faults:

- Corruptions of the transmitted data (duplicate, lost, changed bits)
- Wrong addresses of messages (transmitter, receiver)
- Wrong sequence of data (repetition, lost, change)
- Wrong timing (delay, echo)

Safe**ethernet** is based on the standard Ethernet or FastEthernet according to IEEE802.3.

The transmission of the safety-related data uses the protocol frame of the standard Ethernet.

According to the Black Channel Approach in Safe**ethernet** "insecure transmission channels" (Ethernet) are used and controlled by safety-related protocol mechanism at transmitter and receiver.

In this way normal Ethernet network components like hubs, switches, routers and PCs supplied with network interfaces can be used within a safety-related network.

The significant difference to standard Ethernet is determinism, the real-time ability, of safe**ethernet**. A special protocol mechanism guarantees deterministic behaviour even in case of faults or new entries of communication participants. New components are automatically integrated in the running system. All components of the network could be changed while the system is running. With the use of switches transmission times can be clearly defined. In this way Ethernet works in real-time.

The possible transfer speed up to 100 Mbit/s for safety-related data is higher then the speed normally used. For example copper lines as well as fiber optic cables can be used as transmission media.

The integration of firm intranets as well as connections to the Internet can be realized with safe**ethernet** technology. The terms for safety-related communication according to the HIMatrix Safety Manual have to be considered. Therefore only one network for safety and non-safety data transfer is necessary.

Safe**ethernet** can be fitted to existing Ethernet networks with adjustable network profiles.

With safe**ethernet** one can built-up flexible system structures for the decentral automation with defined reaction times. According to the requirements the intelligence can be centralized or distributed in a decentral way to the participants within the network. There is no limit in the number of safe participants of the network and the amount of transferred safe data to get the needed reaction times. A central controller and the built-up of parallel structures is therefore superfluous.

The transmission of safe data is integrated in the existing Ethernet network. A separate safety bus can be saved. The switches in the HIMatrix controllers overtake tasks for which normally network switches are needed.

The configuration of safe**ethernet** is described in System Manual Compact Systems.

5.2.3 Ethernet/IP

Ethernet/IP (Ethernet Industrial Protocol) is an open industrial communication standard for exchange of process data via Ethernet.

For further informations see also http://www.odva.org (ODVA = **O**pen **D**eviceNet **V**endor **A**ssociation).

Via Ethernet/IP *HIMatrix* controllers can communicate with other Ethernet/IP devices (e.g. PLC, sensors, actuators and industrial robots).

The physical connection of Ethernet/IP runs over Ethernet interfaces with 10/100 Mbit/s.

In Hardware Management of ELOP II Factory the Ethernet/IP protocol can be configured for *HIMatrix* controllers (with layout 2, hardware revision 2).

A *HIMatrix* controller can be configured as Ethernet/IP scanner and/or as Ethernet/IP target.

Further details about Ethernet/IP communication you will find in online help of ***ELOP II Factory***.

5.2.4 TCP S/R (Send/Receive over TCP)

TCP S/R is a manufacturer-independent, non safety-related protocol for cyclic and acyclic data exchange and does not require a specific protocol except for TCP/IP.

With the TCP S/R protocol the HIMatrix controllers support almost every third-party system and also PCs with an available socket interface (e.g. winsock.dll) to TCP/IP.

Note	In the first place the non safety-related TCP S/R protocol is an additional interface to communicate with systems from other manufacturers. For the communication between HIMatrix controllers via Ethernet the safety-related HIMA peer-to-peer protocol should be used.

Further informations about the TCP S/R protocol you will find in the corresponding manual and/or in the online help of ***ELOP II Factory***.

5.2.5 SNTP

Using the SNTP Protocol (**s**imple **n**etwork **t**ime **p**rotocol), the time of the HIMA resources can be synchronized via Ethernet.

The current time can be polled in defined time intervals via the Ethernet from a HIMA resource or a PC, which are configured as an SNTP Server.

HIMA resources having a COM operating system version 6.x and newer can be configured and can operate as an SNTP server and/or an SNTP Client. The communication of the SNTP server with the SNTP client runs via the non safety UPD protocol on port 123.

Further informations about the SNTP protocol you will find in the online help of ***ELOP II Factory***.

5.2.6 Modbus TCP

The HIMA notation for the Modbus TCP protocol is: Modbus Master/Slave Eth.

The field bus protocols Modbus master/slave can communicate with the protocol Modbus TCP via the Ethernet interfaces of the HIMatrix controllers.

At a standard Modbus communication the slave address and a CRC checksum is transferred additionally to the instruction code and the data. At Modbus TCP the subordinate TCP protocol handles this function.

Further informations about the Modbus TCP protocol you will find in the corresponding manual Modbus master/slave and/or in the online help of ***ELOP II Factory***.

5.2.7 Operating Parameters of the Ethernet Interfaces

Up to COM OS Version 8.32:

All Ethernet ports of the integrated Ethernet switches have the same settings Autoneg / Autoneg for Speed Mode and Flow-Control Mode. Other settings are not possible or are rejected by the controller during loading of configuration.

The Ethernet interfaces 10/100 BaseT of the HIMatrix devices have the following parameters:

Operating parameters	
Speed Mode	Autoneg
Flow-Control Mode	Autoneg

Other devices combined with HIMatrix devices must have the following network settings:

Admissible settings of other devices	
Speed Mode Flow-Control Mode	Autoneg Autoneg
or	
Speed Mode Flow-Control Mode	Autoneg Half-Duplex
or	
Speed Mode Flow-Control Mode	10 Mbit/s or 100 Mbit/s Half-Duplex

Non-admissible settings of other devices	
Speed Mode Flow-Control Mode	Autoneg or 10 Mbit/s or 100 Mbit/s Full-Duplex

From COM OS Version > 8.32 and ELOP II Hardware Management Version 7.56.10:

For each Ethernet port of the integrated Ethernet switch the parameters could be set individually (see chapter 5.2.8).

5.2.8 Configuration of the Ethernet Interfaces

For HIMatrix devices in the register "Extended“ the parameters “Speed Mode” and “Flow-Control Mode” must be set to “Autoneg”. The option “Activate Extended Settings” must be set in order that the parameters are activated (see Figure 6: Properties of the COM).

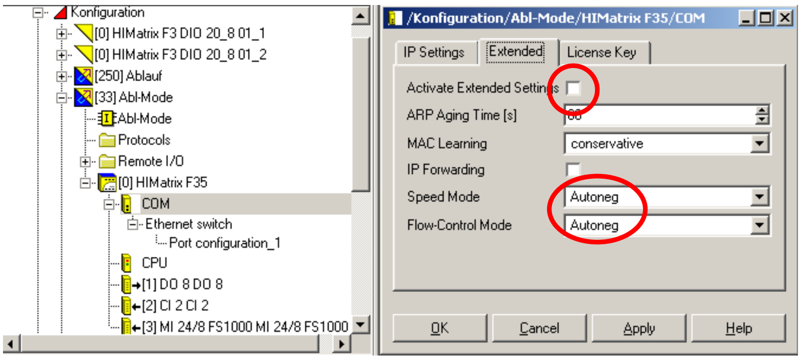


Figure 6: Properties of the COM

The parameters ARP, MAC Learning, IP Forwarding, Speed Mode and Flow-Control Mode are explained in detail in the online help of ***ELOP II Factory***.

The port settings of the integrated switch of a HIMatrix resource can be parameterized individually ***from COM OS Version > 8.32 and ELOP II Hardware Management Version 7.56.10 on***. Via the menu option *Ethernet switch -> New -> Port configuration* a configuration menu can be established for each switch port.

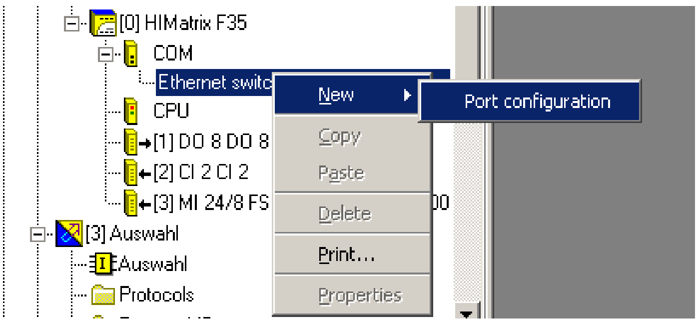


Figure 7: Setting a port configuration

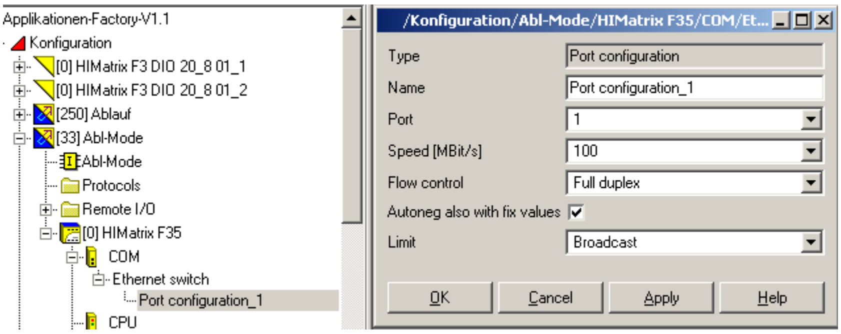


Figure 8: Parameter of a port configuration

Name	Description
Port	Number of port as on device; per port only one configuration is possible. Value range: 1..n, depending on the resource
Speed [Mbit/s]	10 MBit/s: Data rate 10 MBit/s 100 MBit/s: Data rate 100 MBit/s Autoneg (10/100): Automatic setting of the baud rate Default: Autoneg
Flow-Control	Full duplex: Communication in both directions at the same time Half duplex: Communication in one direction at the same time Autoneg: Automatic control of communication Default: Autoneg
Limit	Limit incoming Multicast and/or Broadcast packages. Off: no limit Broadcast: limit Broadcast (128 kbit/s) Multicast and Broadcast: limit Multicast and Broadcast (1024 kbit/s) Default: Broadcast
Option: Autoneg also with fix values The "Advertising" (transfer of the properties of Speed und Flow-Control) is made also at fix values of the parameters “Speed” and “Flow-Control”. Thereby other devices, whose port settings are ”Autoneg“, can recognize how the ports of the HIMatrix are set.	

Table 6: Parameters of the port configuration

The parameters are set in the configuration of the COM of the HIMatrix controller by pushing the button *Apply.* The entries in the properties of the COM and of the Ethernet switches (configuration) must be compiled anew with the application program and transferred in the controller before the entries can become active for the communication of the HIMatrix. The properties of the COM and the Ethernet switches can also be changed directly online via the Control Panel. These settings become active at once, but are not transferred into the application program.

5.2.9 Connections for safeethernet, Ethernet/Networking Example

For the networking via safe**ethernet** or Ethernet the devices are equipped – depending on the design – with two or four connections arranged on the lower and upper side panels of the case or on the front side (e.g. F60).

Safeethernet Networking example:

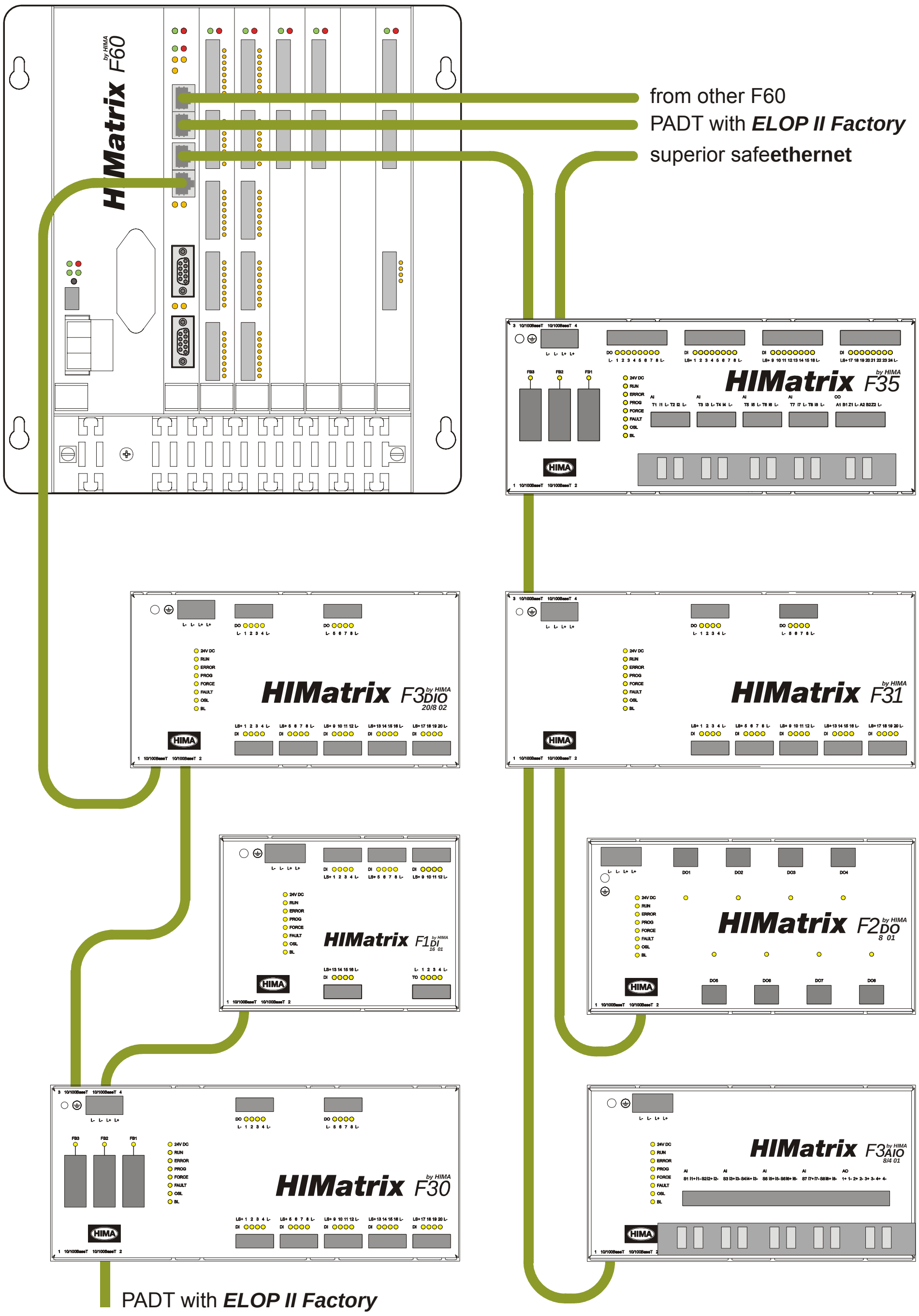


Figure 9: Safeethernet Networking example

The various systems can be networked together as required via Ethernet (star or line configuration). A programming unit (PADT) can also be connected wherever required.

Note	Make sure that no network rings are formed when connecting systems together. A system must receive data packets on only *one* path.

5.3 Field Bus Communication

The controllers F20, F30, F35 and the CPU of the modular system can be equipped with modules for field bus communication (Modbus, Profibus, Interbus).

Four intern pluggable communication modules are available. These supplement the existing field bus interface with the following functions:

- HIMA CM-PROFIBUS-DP master
- HIMA CM-PROFIBUS-DP slave
- HIMA CM-RS485 (as MODBUS master or MODBUS slave configurable)
- HIMA CM-INTERBUS master

With the mentioned communication modules the field bus interfaces of FB1 and FB2 of the HIMatrix controllers F30, F35, F60, at F20 only FB1, can be equipped. Without communication module the field bus interfaces FB1 and FB2 are not functional.

Note	The mounting of the communication modules is only permitted by HIMA, otherwise the guarantee of the controller will be nullified.

No unlock code is necessary for unlocking a communication module at Profibus and Interbus.

For Modbus you need a license and get the unlocking code via homepage.

5.3.1 Restrictions for simultaneous Operation of Protocols

- PROFIBUS-DP master or slave can only be used on one field bus interface, i.e. two Profibus master or slaves at one time in one resource are not supported and will not function.
- MODBUS master/slave RS485 will only run on one field bus interface. An operation via RS485 and Ethernet simultaneously however is possible.
- An INTERBUS master will only run on one field bus interface.

Note	Safety-related communication is not possible with the field bus interfaces.

The communication unit with the field bus interfaces is connected to the safe microprocessor system via a Dual-Port RAM. Only devices with a safe electrical isolation may be connected to the interfaces.

Note	The communication modules CM-PROFIBUS-DP master and CM-INTERBUS can be used on controllers F20, F30, F35 or F60 as of hardware revision 02.

5.3.2 Mounting of HIMA Field Bus Communication Modules

5.3.2.1 System Requirements

Only controllers with hardware reversion 02 can be equipped with communication module CM-PROFIBUS-DP master or CM-INTERBUS master. The modules CM-PROFIBUS-DP slave and CM-RS485 can be used on controllers with previous revisions. An update of the COM operating system is necessary in this case. The revision (HW-REV.) and the revision of the COM operating system (FW-REV.) at the delivery state you can see on the type label of the controller (see Figure 10: Type label of a HIMatrix F35 controller).

Figure 10: Type label of a HIMatrix F35 controller

The revision of the COM operating system comes in first place, the revision of the CPU operating system comes in second place of the firmware revision number.

5.3.2.2 Display of the actual Versions of the Operating Systems

The actual versions of the COM and CPU operating system can be displayed via the Control Panel. The actual versions of the operating systems, loaded on the controller, are listed in the register OS with the corresponding versions of the loaders and the CRC.

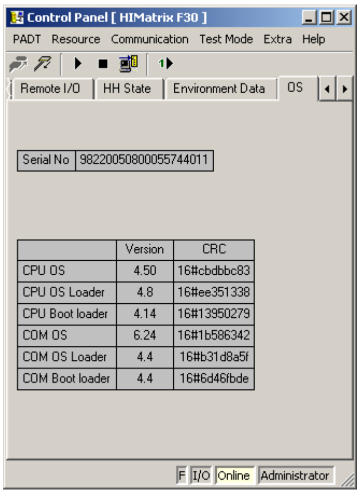


Figure 11: Display of actual versions of operating systems

5.4 Wiring

5.4.1 Safeethernet, Ethernet

Industrial standard cables can be subjected to extreme mechanical stresses. For Ethernet communication Cat 5 cable (twisted pair or star-quad cable) or better is used.

The controllers communicate at 100 Mbit/s (Fast Ethernet) in full-duplex mode. They have "auto cross-over" function and can be operated with a 1:1 cable as well as with a cross-over cable.

The **shield** of an Ethernet cable must be earthed at both ends. If an RJ 45 connector is used, it automatically connects the shield to the device case.

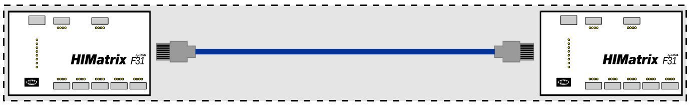
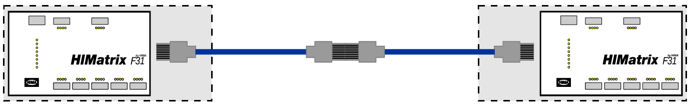
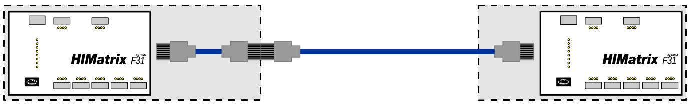
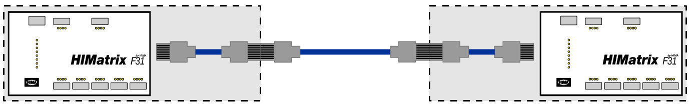
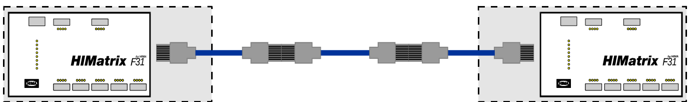
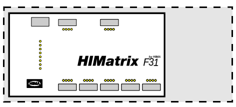
Wiring example	Number of plug connector pairs	Maximum cable distance between two devices
	2	100 m
	2	100 m
	3	100 m
	3	100 m
	4	100 m
	4	100 m
Legend:  Device in case  Connector  Coupling (plug + socket)		

Table 7: Wiring examples safeethernet, Ethernet

When using specified cables and plug connectors approved to 100 MHz the maximum cable distance is 100 m between two devices with a maximum of four connector pairs. A combination of plug and socket is considered one pair.

Use optical fibre cables for greater distances. The total dimension of the network (several devices) can be longer than the connection between two devices.

Configuring a network with switches ("Switched Ethernet") has the following advantages:

- Very fast packet transfer between the collision areas,
- Significant increase of data throughput with full-duplex mode,
- Prevention of collisions allows deterministic operation.

5.4.1.1 Interface Elements

When connecting a controller to the Ethernet communication, interface elements, such as the

FL CAT5 TERMINAL BOX (manufacturer Phoenix Contact®)

type, can be used in the control cabinet. They are mounted on an earthed EN mounting rail. The conductors of the field cable are attached to the interface terminals in the control cabinet. It is important to make sure that the cable shield is also connected via the strain relief.

Prefabricated patch cables are used to connect the interface element and the HIMatrix controller.

In the case of the interface element mounting it on the rail is sufficient for earth connection, as long as the rail itself is earthed in accordance to the standard.

5.4.1.2 Specified Cables

The cables are identified by category as follows depending on their transmission and high-frequency properties:

Category	Specification	Approved
1	–	–
2	up to 1 MHz	–
3	up to 16 MHz	–
4	up to 20 MHz	–
5	up to 100 MHz	●
6	up to 250 MHz	●
7	up to 600 MHz	●

Table 8: Specified cables safeethernet, Ethernet

The channel as a point-to-point transmission path is defined as follows:

Class	Specification	Approved
A	up to 0.1 MHz	–
B	up to 1 MHz	–
C	up to 16 MHz	–
D	up to 100 MHz	●
E	up to 250 MHz	●
F	up to 600 MHz	●

Table 9: Specifications on the transmission path

The higher the letter the greater the demand on the transmission channel. For Ethernet communication in HIMatrix systems at 100 MHz Category 5 (or better) cables and at least Class D capacity are required.

5.4.1.3 RJ 45 Connector

For direct Ethernet plug connections without interface elements connectors such as the

IP 20 Data Plug (manufacturer Harting®)

can be used. The cable can be assembled quickly by crimping the conductors; special tools are not required.

5.4.1.4 Switches

To span distances of more than 100 m with Ethernet communication for example the

rail switches of the RS2-... series (manufacturer Hirschmann®)

can be used with optical fibre ports.

5.4.2 Field Buses

5.4.2.1 Fundamentals of RS-485 Transfer Mode System

The protocols for Profibus-DP, Modbus and Interbus communicate via the RS-485 transfer mode system. The following table shows an overview over the basic physical features of RS-485 transfer mode system:

Scope	Feature	Comment
Network topology	Linear bus, active bus termination on both ends	Branch lines should be avoided
Medium	Shielded twisted cable	Shielding can be not applied dependent of the environment conditions
Number of Stations	32 stations in each segment without repeater	With repeater expandable up to 126 stations
Connector	9-pole MIN-D connector	

Table 10: Basic features of the RS-485 transfer mode system

5.4.2.2 PROFIBUS DP

According to IEC 61158 two bus lines are noted. Wire type A can be used for transfer rates up to 12 Mbit/s. Wire type B is out-dated and should not be used.

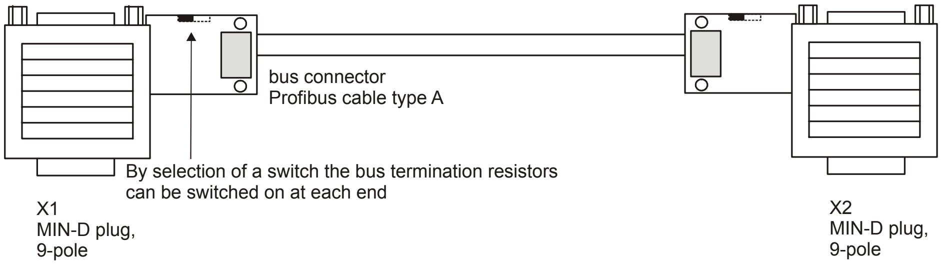


Figure 12: Wiring and bus termination for PROFIBUS-DP

As option to the shown 90º bus connectors, also straight and 45º offset connectors are available from HIMA.

Wiring and bus termination

The incoming and outgoing data cable is connected within the bus connector. Branch lines are avoided and the connector can be plugged off from a controller without interruption of data line.

The PROFIBUS-DP bus termination has a resistor combination with which a defined zero potential can be adjusted on the bus line. The resistor combination is integrated in the PROFIBUS-DP bus connector and can be activated via bridges or switches. To guarantee an even signal level the terminating resistors must be hooked up at the beginning and the end of a segment.

Stations at the end of the bus should have a 5 V voltage at pin 6.

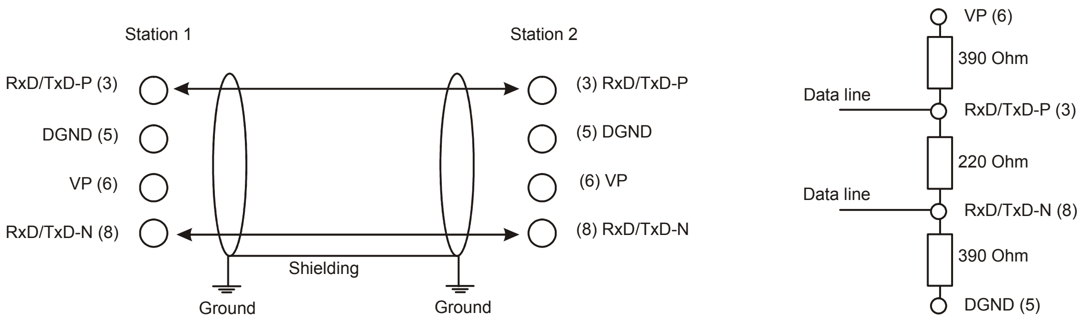


Figure 13: Pin assignment of the field bus interface

Line length depending on the baud rate with PROFIBUS-DP bus cable

Baud rate	Range per segment
9.6 kBit/s	1200 m
19.2 kBit/s	1200 m
93.75 kBit/s	1200 m
187.5 kBit/s	1000 m
500 kBit/s	400 m
1500 kBit/s	200 m
3000/6000/12000 kBit/s	100 m

Table 11: Range depending on the baud rate

The data corresponding to the range refer to the cable type A with the following parameters:

Impedance	:	135 to 165 Ω
Capacitance per unit length	:	< 30 pF/m
Loop resistance	:	110 Ω/km
Core diameter	:	0.64 mm
Core cross section	:	< 0.34 mm^2

Note A prolongation of the line length can be achieved via bidirectional repeater. Up to three repeaters can be set between two devices. In this way a line length of 4.8 km in total is possible.

At time-critical applications no more than 32 devices should be connected. In non-time-critical applications up to 126 devices (with repeater) are possible.

Further informations you will find in **Manual HIMA PROFIBUS-DP maste**r (HI 800 008).

5.4.2.3 MODBUS Master/Slave Communication

The total length of a bus at MODBUS can be up to 1200 m. Repeaters are needed for greater distances. In total three repeaters are applicable for a maximum range of 4800 m.

Further informations you will find in **Manual HIMA MODBUS master/slave** (HI 800 002).

5.4.2.4 INTERBUS

INTERBUS has been designed as fast sensor / actuator bus for transmitting process data in industrial environments.

The INTERBUS is a single master system, i.e. all participants of an INTERBUS ring are controlled by one INTERBUS master (controller board).

The INTERBUS uses in principle a ring structure as bus topology.

The signal way of the INTERBUS begins at the controller board and leads through all INTERBUS participants ending at the controller board again.

Further details about INTERBUS communication you will find in online help of ***ELOP II Factory***.

6 Labelling

6.1.1 Equipment Identification

The equipment is identified and labelled in accordance to the standards, such as DIN 6779.

7 Configuration of the Software

7.1 Line Control

Line Control is a line short-circuit and line break monitoring system, such as EMERGENCY OFF inputs in accordance to Cat. 4 in compliance with EN 954-1, which can be configured with the F1 DI 16 01, F3 DIO 8/8 01, F3 DIO 16/8 01, F3 DIO 20/8, F20, F30, F31 and F60 systems.

The digital outputs DO of the system are connected to the digital inputs DI of the same system as shown below (example):

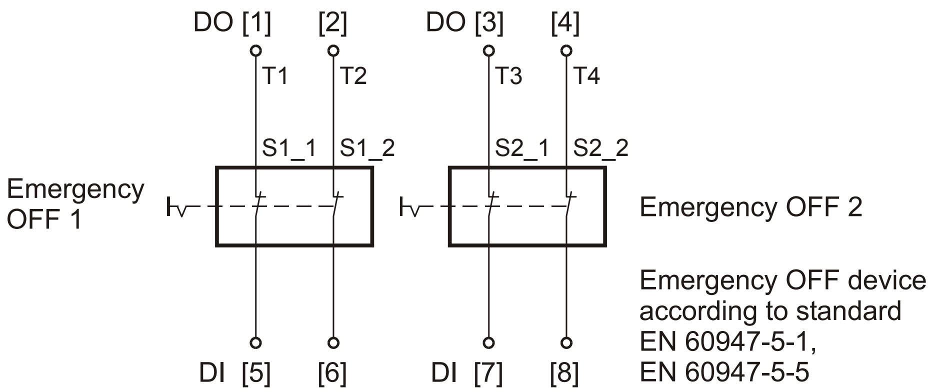


Figure 14: Line Control

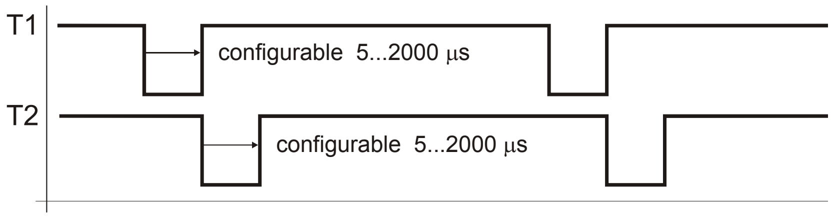


Figure 15: Pulsed signals

The digital outputs DO are pulsed (briefly set to Low) and so the lines to the digital inputs are monitored. The time basis of the test pulse can be configured in the range 5...2000 µs (default value 400 µs).

The FAULT LED on the front panel of the controller flashes, the inputs are set to 0-signal and an (analyzable) error code is generated if the following errors occur:

- Cross connection between two parallel lines,
- Change of two lines DO to DI, connection against the preset configuration in the software, e.g. DO 2 → DI 7 (configured), DO 2 → DI 6 (wired),
- Earth fault of one of the conductors (with earthed reference pole only),
- Line break or opening of contacts, i.e. the LED "FAULT" also flashes and the error code is generated if one of the above EMERGENCY OFF switches is actuated.

Note	If multiple errors are existing at the same time, the error code is the sum of the codes of the individual errors.

The pulse delay for the Line Control is the time between writing the pulsed outputs to FALSE and the latest possible reading of the signal at the relevant input. The default value is set to 400 µs. It may be necessary to increase this with longer cables. The maximum value is 2000 µs.

The minimum time for reading all inputs results in pulse delay x number of pulses.

The pulsed outputs are permanently set to TRUE. In each cycle the pulsed outputs will be set successively to FALSE for the duration of the pulse delay.

7.1.1 Required Signals

The following signals must be set up in the ***ELOP II Factory Hardware Management***:

Signal name	Type	Description	Initial value	Remarks
Sum_Pulse	USINT	Number of pulsed outputs	4	1...8, as required
Board_POS_Pulse	UDINT	Slot of module with the pulsed outputs	2	In the compact devices the DOs are in slot 1,2 or 3 (see Table 14). In the F60 the slot (1...6) is specified.
Pulse_delay	UINT	Pulse delay	400	Value in µs Maximum value: 2000 µs
P1 P2 ... P8	USINT USINT ... USINT	Pulse 1 Pulse 2 ... Pulse 8	1 2 ... 8	Pulse 1 to pulse 8, as required, must match the number of pulsed outputs
Pulse_ON	BOOL	Initialization value for the pulsed outputs	TRUE	Activation of pulsed outputs

Table 12: Signals for Line Control

The signal names can be freely selected; the names used here are examples. All signals have the attribute "Const".

The following table contains the used switch signals of the example:

Signal name	Type	Description	Initial value	Remarks
Switch_1_1pulsed Switch_1_2pulsed	BOOL BOOL	Value Value		Switch 1 first and second contact
Switch_2_1pulsed Switch_2_2pulsed	BOOL BOOL	Value Value		Switch 2 first and second contact
Switch_1_1_EC Switch_1_2_EC	BYTE BYTE	Error code Error code		Error Codes Switch 1 first and second contact
Switch_2_1_EC Switch_2_2_EC	BYTE BYTE	Error code Error code		Error Codes Switch 2 first and second contact

Table 13: Switch signals for Line Control

Slot of the modules with pulsed outputs within remote I/O or compact system:

Controller	Signal value *DI Pulse Slot*
F1 D1 16 01	**1**
F3 DIO 8/8 01	**3**
F3 DIO 16/8 01	**3**
F3 DIO 20/8 01, F3 DIO 20/8 02	**2**
F20	**2**
F30	**2**
F31	**2**

Table 14: Slot of module with the pulsed outputs

7.1.2 Configuration for Pulsed Outputs

The pulsed outputs must begin at DO[01] and must be directly sequential:

Outputs	Examples for admissible configurations ...				... for non-admissible	
DO[01].Value	A1	Pulse_ON	Pulse_ON	Pulse_ON	A1	*Pulse_ON*
DO[02].Value	A2	Pulse_ON	Pulse_ON	Pulse_ON	*Pulse_ON*	*Pulse_ON*
DO[03].Value	A3	Pulse_ON	Pulse_ON	Pulse_ON	*Pulse_ON*	A3
DO[04].Value	A4	A4	Pulse_ON	Pulse_ON	*Pulse_ON*	*Pulse_ON*
DO[05].Value	A5	A5	A5	Pulse_ON	*Pulse_ON*	*Pulse_ON*
DO[06].Value	A6	A6	A6	Pulse_ON	A6	*Pulse_ON*
DO[07].Value	A7	A7	A7	A7	A7	A7
DO[08].Value	A8	A8	A8	A8	A8	A8

Table 15: Configuration for pulsed outputs

The relevant inputs can be selected as desired, i.e. two sequential pulsed outputs need not be assigned to two adjacent inputs.

Restriction

Two directly adjacent inputs may not be supplied from the same pulse; this will prevent crosstalk.

7.1.3 Configuration Example

7.1.3.1 Principle Method of Signal Assignment

With the use of the software ***ELOP II Factory*** the previously via signal editor defined signals (hardware management) could be assigned to the single existing hardware inputs and outputs.

Follow the further steps in ***ELOP II Factory Hardware Management***:

- ❑ Open Signal Editor in menu *Signals.*
- ❑ Right-click on the HIMatrix I/O module and select *Connect Signals* in the context menu.
- ❑ A new window opens for allocating the logic signals of the Signal Editor to the existing hardware signals, i.e. the inputs and outputs (different registers).

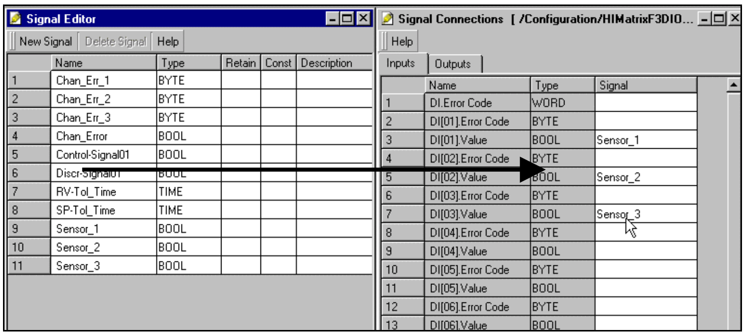


Figure 16: Drag & drop allocating of signals to the inputs (principle scheme)

- For better overview you can tile both windows of Signal Editor and Signal Connections side by side.
- In the Signal Editor click on a signal name and drag the signal into the "Signal" column (used channel, input) of the "Signal Connections" window.
- For signal connection of the outputs change the register to "Outputs" and do in the same way as for the inputs.

In the following configuration example the list of the signal editor in 6.1.1 is used practicing the method described above.

7.1.3.2 Configuring the Pulsed Outputs and Assignment to the Inputs

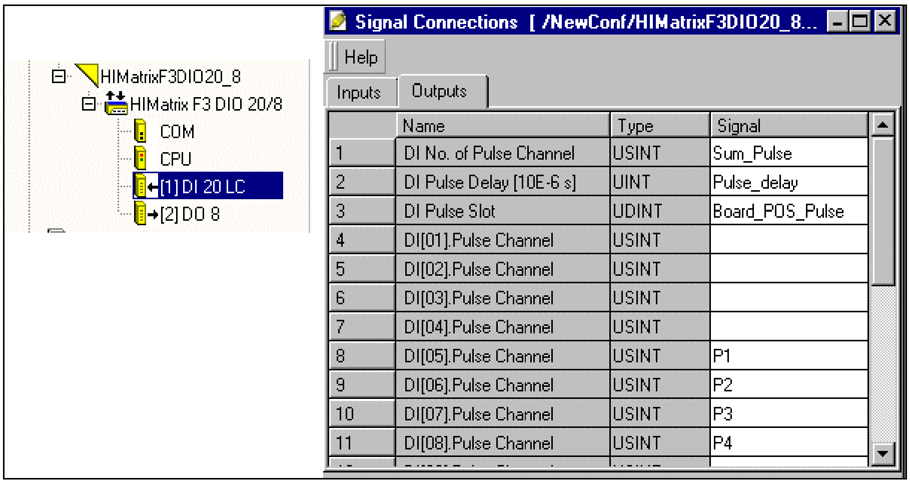


Figure 17: Configuring the pulsed outputs and assignment to the inputs

The assignment of the digital inputs (pulse channels) to the pulsed output channels is arbitrary.

DI [07] could have used T1 and DI [08] correspondingly T2.

The allocation depends on the hardware configuration.

7.1.3.3 Assignment of the Signals to the Inputs and their Error Codes

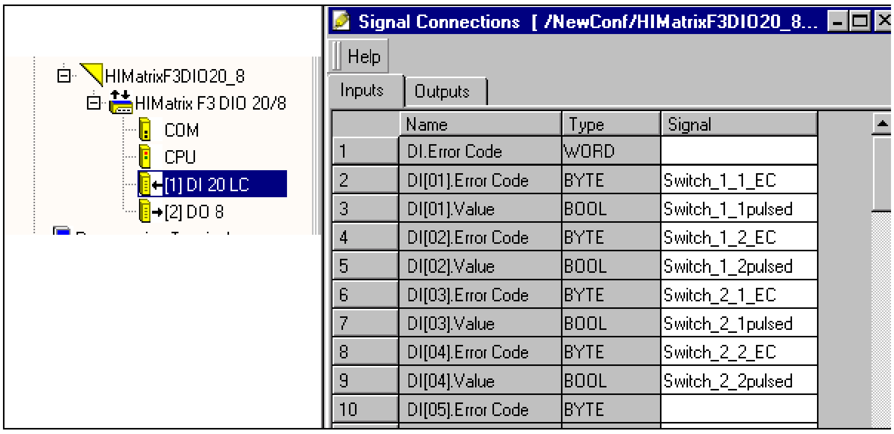


Figure 18: Assignment of the Signals to the Inputs and their Error Codes

The relevant error code must also be evaluated for every usable signal DI[xx].Value.

7.1.3.4 Activation of the Pulsed Outputs

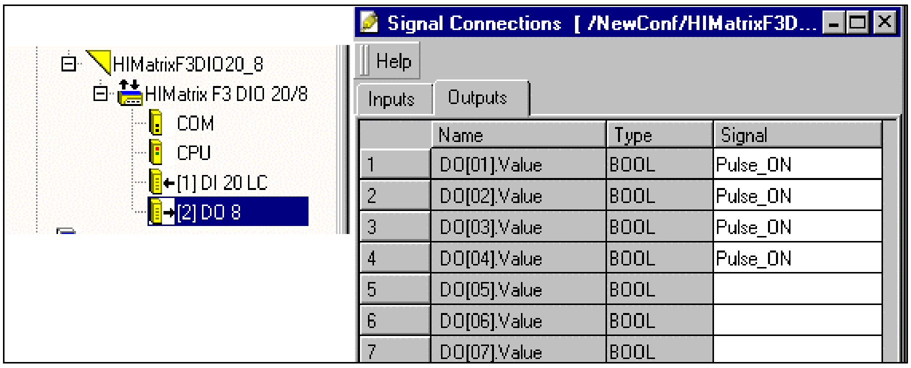


Figure 19: Activation of the pulsed outputs

The logical value of the signal Pulse_ON is TRUE. This keeps the pulsed outputs continuously activated and they are only set to FALSE for the duration of the pulse actuation.

7.2 Line monitoring (F3 DIO 16/8 01)

7.2.1 Parameterization of Line Monitoring at 2-Pole Connection

Note For all corresponding system signals of line monitoring initial values have to be set.

Therefore all needed or wanted configurations of system signals (see Table 16) must be set first in ***ELOP II Factory***, then the application program must be compiled and at last the program must be transferred to the controller.
A change of the settings for the system signals of line monitoring is not possible during operation!

Signal name	Type	Description	Default value
DO.LSLB period	WORD	Period in which LSLB monitoring is carried out in [s], range 1…100 s in steps of 1	-
DO.LSLB time	UINT	Monitoring time for LSLB monitoring in [ms], range 0…50 ms in steps of 1ms, default: 0 ms	0 ms
DO[01].2-pole	BOOL	Parameterization whether channel1 is used 2-pole 1 = channel is used 2-pole 0 = channel is used 1-pole	0
DO[02].2-pole	BOOL	Parameterization whether channel2 is used 2-pole 1 = channel is used 2-pole 0 = channel is used 1-pole	0
DO[01].LSLB monitoring	BOOL	Parameterization of the line monitoring channel1 1 = LSLB monitoring is carried out 0 = LSLB monitoring is not carried out	0
DO[02].LSLB monitoring	BOOL	Parameterization of the line monitoring channel2 1 = LSLB monitoring is carried out 0 = LSLB monitoring is not carried out	0
DO[01].+Value	BOOL	Output value for DO channel1 (DO+), 2-pole, identically to DO- (Value: 0 or 1)	
DO[01].-Value	BOOL	Output value for DO channel1 (DO-), 2-pole, identically to DO+ (Value: 0 or 1)	0
DO[02].+Value	BOOL	Output value for DO channel2 (DO+), 2-pole, identically to DO- (Value: 0 or 1)	0
DO[02].-Value	BOOL	Output value for DO channel2 (DO-), 2-pole, identically to DO+ (Value: 0 or 1)	0
DO.Error Code	WORD	Error code of all digital outputs	-
DO[01].+Error Code	WORD	Error code of digital output DO+ in channel1	-
DO[01].-Error Code	WORD	Error code of digital output DO- in channel1	-
DO[02].+Error Code	WORD	Error code of digital output DO+ in channel2	-
DO[02].-Error Code	WORD	Error code of digital output DO- in channel2	-

Signal name	Type	Description	Default value
DO[01][02].in pairs	BOOL	Couple of common reference (DO- outputs build common reference potential) Couple 1 = Channel 1 [01] and channel 2 [02] DO[01][02].in pairs=1	0
DO[01].LS monitoring with reduced voltage	BOOL	Line monitoring with reduced voltage channel1 1 = reduced signal voltage level 0 = normal signal voltage level (reduced signal voltage level only active with signal DO[xx].LSLB Monitoring =1!)	0
DO[02].LS monitoring with reduced voltage	BOOL	Line monitoring with reduced voltage channel2 1 = reduced signal voltage level 0 = normal signal voltage level (reduced signal voltage level only active with signal DO[xx].LSLB Monitoring =1!)	0

Table 16: Signals for line monitoring 2-pole

The system signals listed above (software) must be defined at first in the Signal Editor and then assigned to the hardware channels of the digital outputs (register "inputs" and register "outputs"). The principle method of signal assignment is described in chapter 7.1.3.1. During assignment you have to regard the identical data types of signal and hardware channel.

In the following scheme the principle wiring possibility of a 2-pole connection is shown:

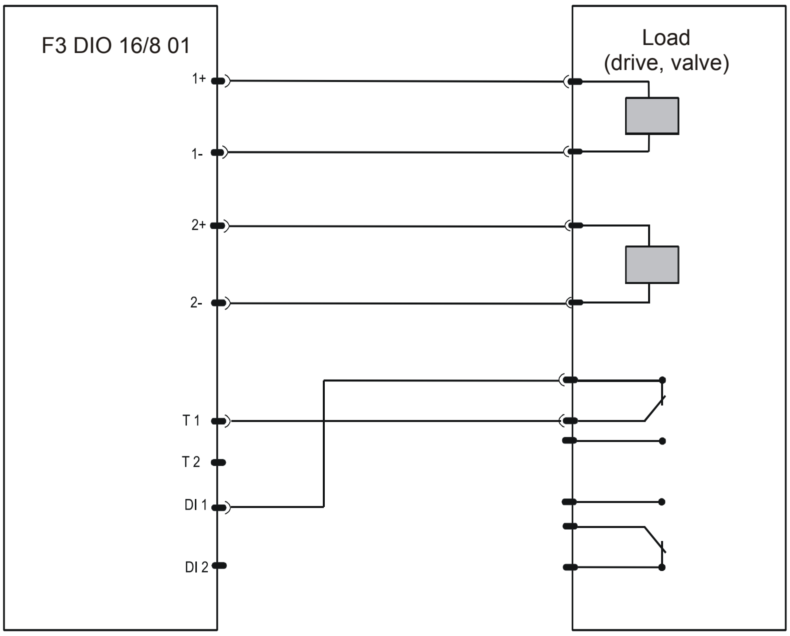


Figure 20: 2-pole connection of digital outputs with Line Control of digital inputs

Beside the line monitoring of the digital outputs switching contacts can be monitored for short-circuit and line break by pulsing the digital inputs (Line Control, see chapter 7.1).

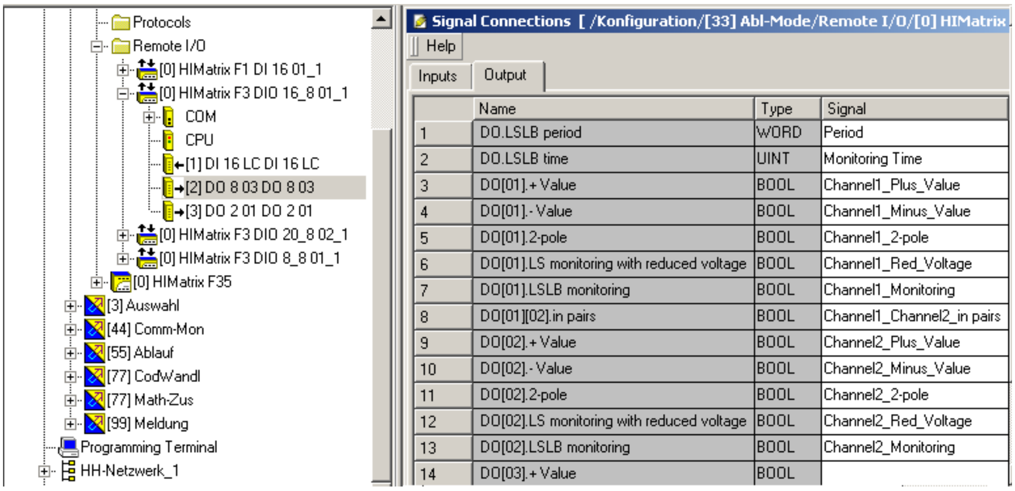


Figure 21: Setting the parameters for line monitoring (Outputs F3 DIO 16/8 01)

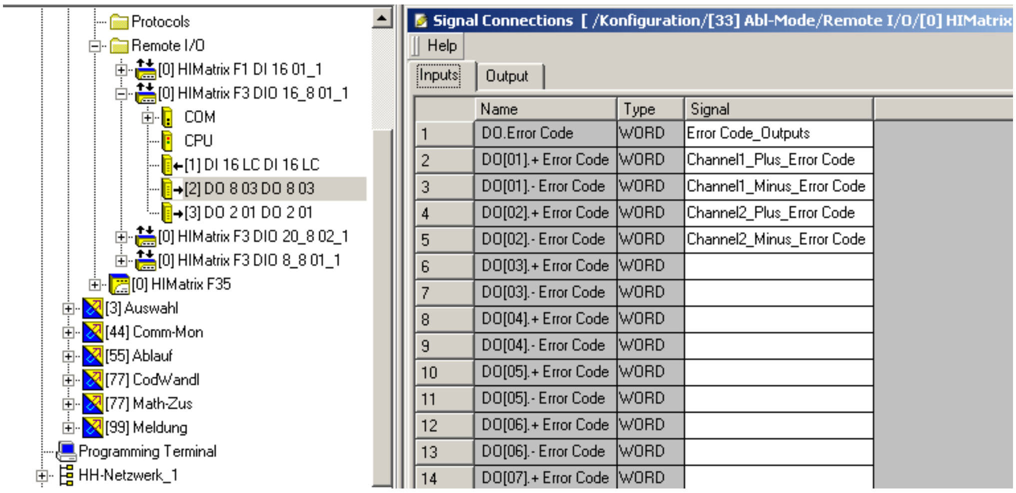


Figure 22: Setting the error codes for the outputs (Inputs F3 DIO 16/8 01)

For monitoring the outputs for each channel two error codes (DO+ and DO- output, DO[xx].+Error Code and DO[xx].-Error Code) can be evaluated. The whole output module is monitored via the signal DO.Error Code.

7.2.1.1 Line Monitoring for Lamp Loads and Inductive Loads

For short-circuit detection a 24 V impulse with a duration of 500µs is switched in the output circuit. Afterwards a 10 V signal is set for the duration of the monitoring time to detect a line break.

For configuration of line monitoring the following signals must be set in ***ELOP II Factory Hardware Management***:

DO.LSLB period	*Value adjustable (1 to 100 seconds)*
DO.LSLB time	*Value adjustable (0 to 50 ms, default: 0 ms)*
DO[xx].2-pole	***set on TRUE***
DO[xx].LSLB monitoring	***set on TRUE***
DO[xx].LS monitoring with reduced voltage	***set on FALSE***

7.2.1.2 Line Monitoring with Reduced Voltage for Resistive, Capacitive Loads

For line monitoring a 10 V signal is switched on in the output circuit for the duration of the monitoring time. This kind of line monitoring is designed for resistive or resistive capacitive loads. At inductive loads or lamp loads there can be error messages concerning short-circuit.

For configuration of line monitoring the following signals must be set in ***ELOP II Factory Hardware Management***:

DO.LSLB period	*Value adjustable (1 to 100 seconds)*
DO.LSLB time	*Value adjustable (0 to 50 ms, default: 0 ms)*
DO[xx].2-pole	***set on TRUE***
DO[xx].LSLB monitoring	***set on TRUE***
DO[xx].LS monitoring with reduced voltage	***set on TRUE***

7.2.1.3 2-Pole Connection with Common Reference Pole (3-Pole Connection)

Two 2-pole channels are connected to a common reference pole to realize a line monitoring at motor drives (2 coils), valves etc.. Therefore the system signal ***DO[xx][xx].in pairs*** for each pair (2 channels) must be parameterized (further configurations see also Table 17: Configuration possibilities of digital outputs). If line monitoring is set on both channels with ***DO[xx].LSLB monitoring*** **= TRUE**, the line monitoring is carried out on both 2-pole channels in pairs (channel 1 and 2, channel 3 and 4, channel 5 and 6, channel 7 and 8). During line monitoring on first channel the second channel will be switched off to prevent any falsification of the line monitoring.

A short-circuit between the both DO+ lines is not checked.

A detected line fault is reported by a system signal (***DO[xx].+Error Code or DO[xx].-Error Code***).

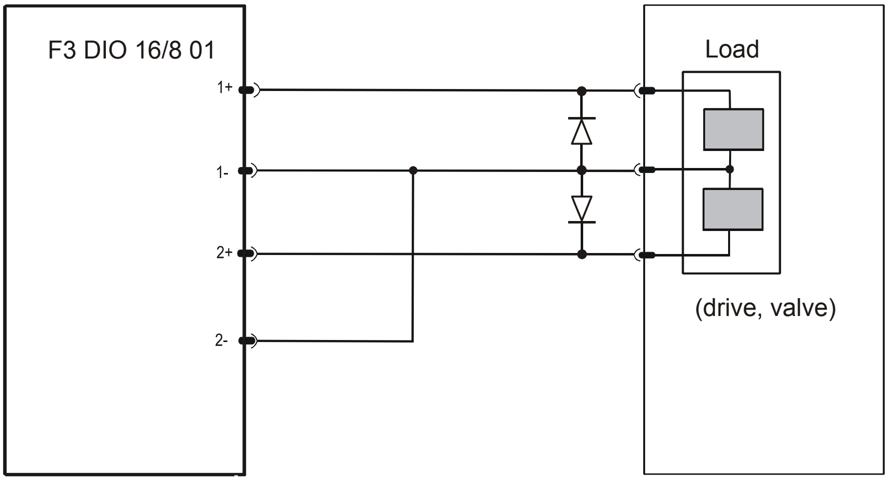


Figure 1: 2-pole connection with common reference pole (3-pole connection)

Inductive loads must be connected with a protection diode on the load.

7.2.2 Table of Configurations for Digital Outputs

All permissible configurations for digital outputs accepted by ***ELOP II Factory*** are listed in the following table. Additional system signals have no influence on further variations (e.g. signal ***DO[xx].LS with reduced voltage***). At wrong parameterization an entry “IOA wrong initial data“ is set in the diagnosis. At the same time the parameterization is displayed. With the following table the error can be located.

Configuration possibilities of digital outputs					
Appli-cation	**Channel1 2-pole**	**Channel2 2-pole**	**Channel1 LSLB**	**Channel2 LSLB**	**common reference pole**
1-pole	0	0	0	0	0
2-pole	0	1	0	0	0
	0	1	0	1	0
	1	0	0	0	0
	1	0	1	0	0
	1	1	0	0	0
	1	1	0	1	0
	1	1	1	0	0
	1	1	1	1	0
3-pole	1	1	0	1	1
	1	1	0	0	1
	1	1	1	0	1
	1	1	1	1	1

Table 17: Configuration possibilities of digital outputs

Explanations for the table:

0 = Option is not set
1 = Option is set
LSLB: short-circuit and line break detection (line monitoring)

8 Commissioning, Maintenance, Repairs

This chapter must be read carefully before doing any commissioning, maintenance, modifications and repairs in order not to affect or endanger the safety of HIMatrix systems and their functions.

Only personnel who have the knowledge of ESD protective measures are permitted to carry out system modifications/upgrades to the system wiring.

An electrostatic discharge can damage the built-in electronic components.

- Touch an earthed object to discharge any static in your body.
- When carrying out the work, make sure to use an ESD protected working area and wear an earthing strip.
- When the module is not in use, ensure it is protected from electrostatic discharges, e. g. keep it in its packaging.

8.1 Testing the Inputs and Outputs for Interference Voltage and Earth Faults

Inadmissible interference voltage can be measured with a universal tester. We recommend testing every single terminal for unapproved interference voltage.

When testing the external cables for insulation resistance, short-circuit and line break the cables may not be connected at both ends to prevent defects or destruction of the HIMatrix devices caused by excessive voltages.

Earth faults are tested before connecting the field cable to the devices. The feed voltage to the sensors and from the negative pole to the actuators must be disconnected. If the negative pole is earthed during operation, the earth connection must be disconnected while testing for earth faults. This also applies for the earth connection of an existing earth fault tester.

Every terminal can only be tested against earth with a resistance tester or a similar test instrument.

In this status of the system only testing the insulation of single or a group of wires against earth is admissible, but not two wires mutual each other. Otherwise defects may occur. A test with high voltage is also not admissible.

The guideline for measuring circuit voltage and the insulation resistance is EN 50178 (VDE 0160).

8.2 Modifications

Great care must be taken when handling plug connectors with compact devices and modules of the HIMatrix systems.

When pulling out or plugging in the connectors the undefinable I/O signals of the controller can trigger unexpected responses in the system and endanger the safety functions.

We strongly recommend switching off the power supply at all times when working on the system.

Note Plug connectors must never be reversed or inserted incorrectly. To prevent errors the I/O plug connectors of the HIMatrix systems are numbered sequentially and connectors for the power supply are labelled with L+/L-.

Note Make sure that the wires have the required cross sections.

8.3 Replacement of Modules

A module in the F60 can only be replaced with the power switched off, i.e. the relevant system components must be shut down.

The replacement of an existing or installation of a new module is described in the chapter **Handling modules** in the HIMatrix **System Manual Modular System F60**.

The positions of the DIP switches must be noted with the analog output module AO 8 01 in the F60. They can be used to configure every channel as voltage or current output (see the module datasheet for more information).

8.4 Maintenance

The HIMatrix systems are designed for industrial operation. All HIMatrix components have a very high availability and comply with the requirements of IEC 61508 for PFD and PFH in accordance to SIL 3. For more information see the HIMatrix **Safety Manual**.

With relay modules the maximum number of operating cycles in accordance to the specifications must be noted. They must be tested at the specified test intervals.

Note For all safety-related uses the modules must be generally overhauled in periodical time intervals (Off-line Proof Test every 3 years for relay output modules, every 10 years for other modules, see IEC/EN 61508-4, paragraph 3.8.5).

8.5 Replacement of Back-up Batteries

The HIMatrix devices with hardware revision 01 (see type label at the back) have a back-up battery to save data in the event of failure of the 24 VDC power supply. The back-up battery must be replaced every four years. In all actual HIMatrix devices with hardware revision 02 a goldcap is integrated.

The relevant system manual contains a description of the replacement procedure.

A change of the buffer battery must only be executed by the HIMA service. If the customer opens the device this will nullify the guarantee and the certification.

Only personnel familiar with ESD protection precautions is qualified to replace back-up batteries.

8.6 Repair of Controllers and Modules

The operator may not repair controllers and modules in HIMatrix systems. Defective devices must be returned to HIMA for repair after being tested by the operator with a brief description of the fault.

Equipment that has a safety certificate is safety-relevant. The validity of the certificate will expire if unauthorized repairs are made on safety-related controllers and modules of the HIMatrix system.

We are not responsible for repairs made without our authorization and this will cancel all warranties.

8.7 Supply of Internal Documentation

Internal documentation such as internal circuit diagrams, component mounting diagrams and parts lists of HIMatrix controllers are not part of the general system documentation. For this reason they are not provided.

9 Operating Conditions

The devices were developed in compliance with the requirements of the following standards for EMC, climate and environment:

IEC/EN 61131-2	Programmable Controllers, Part 2 Equipment Requirement and Tests
IEC/EN 61000-6-2	EMC Generic Standards, Part 6-2 Immunity for Industrial Environments
IEC/EN 61000-6-4	EMC Generic Emission Standard Industrial Environment

For the use of the safety-related HIMatrix controller systems the following common conditions have to be met:

Protection class	Protection class II according to IEC/EN 61131-2
Pollution	Pollution degree II
Altitude	< 2000 m
Enclosure	Standard: IP 20 If requested by the relevant application standards (e.g. EN 60204, EN 954-1), the device must be installed in a required enclosure (e.g. IP 54).

9.1 Climatic Conditions

The most important tests and limit values for climatic conditions are listed in the following table:

IEC/EN 61131-2 Chapter 6.3.4	**Climatic Tests**
	Temperature, operating: 0...60 °C (Test limits -10...+70 °C)
	Storage Temperature: -40...85 °C (with battery only -30 °C)
6.3.4.2	Dry heat and cold withstand test: 70 °C / -25 °C, 96 h, EUT power supply unconnected
6.3.4.3	Change of temperature, withstand and immunity test: -25 °C / 70 °C and 0 °C / 55 °C, EUT power supply unconnected
6.3.4.4	Cyclic damp heat withstand test: 25 °C / 55 °C, 95 % relative humidity, EUT power supply unconnected

9.2 Mechanical Conditions

The most important tests and limit values for mechanical conditions are listed in the following table:

IEC/EN 61131-2 Chapter 6.3.5	**Mechanical Tests**
	Vibration test, operating: 5...9 Hz / 3.5 mm 9...150 Hz / 1 g
6.3.5.1	Immunity vibration test: 10...150 Hz, 1 g, EUT operating, 10 cycles per axis
6.3.5.2	Immunity shock test: 15 g, 11 ms, EUT operating, 2 cycles per axis

9.3 EMC Conditions

The most important tests and limit values for EMC conditions are listed in the following tables:

IEC/EN 61131-2 Chapter 6.3.6.2	**Noise Immunity Tests**
6.3.6.2.1 IEC/EN 61000-4-2	ESD test: 4 kV contact / 8 kV air discharge
6.3.6.2.2 IEC/EN 61000-4-3	RFI test (10 V/m): 26 MHz...1 GHz, 80 % AM
6.3.6.2.3 IEC/EN 61000-4-4	Burst test: 2 kV power supply / 1 kV signal lines
6.3.6.2.4 IEC/EN 61000-4-12	Damped oscillatory wave immunity test: 1 kV

IEC/EN 61000-6-2	**Noise Immunity Tests**
IEC/EN 61000-4-6	Radio frequency common mode: 10 V, 150 kHz...80 MHz, AM
IEC/EN 61000-4-3	900 MHz pulses
IEC/EN 61000-4-5	Surge: 1 kV, 0.5 kV

IEC/EN 61000-6-4	**Noise Emission Tests**
EN 50011 Class A	Emission test: radiated, conducted

9.4 Voltage Supply

The most important tests and limit values for the voltage supply of the equipment are listed in the following table:

IEC/EN 61131-2 Chapter 6.3.7	**Verification of DC Power Supply Characteristics**
	The power supply must meet alternatively the following standards: IEC/EN 61131-2 or SELV (Safety Extra Low Voltage) or PELV (Protective Extra Low Voltage)
	The fusing of the HIMatrix devices must be in accordance to the statements of this manual
6.3.7.1.1	Voltage range test: 24 VDC, -20 %...+25 % (19.2 V...30.0 V)
6.3.7.2.1	Momentary interruption immunity test: DC, PS 2: 10 ms
6.3.7.4.1	Reversal of DC power supply polarity test: application note in the according chapter of the system manual or in the data sheet of power supply module
6.3.7.5.1	Backup duration withstand test: Test B, 1000 h, Lithium battery is used for backup

HIMA
...the safe decision.

HIMA Paul Hildebrandt GmbH + Co KG
Industrial Automation
Postfach 1261 • D - 68777 Bruehl
Phone: (+49) 6202 709-0 • Fax: (+49) 6202 709-107
E-mail: info@hima.com • Internet: www.hima.com

(0548)