

# LION SYSTEM

## INSTALLATION AND COMMISSIONING INSTRUCTIONS

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# Safety Information

## General Safety Information

- ▶ When performing any work (installation, mounting, start-up), all instructions given by the manufacturer and in particular the safety instructions provided in these Installation and Commissioning Instructions are to be observed.
- ▶ The LION System (including the CLLIONLC01, I/O modules, manual disconnect modules, and the auxiliary terminal package) may be installed and mounted only by authorized and trained personnel.
- ▶ Rules regarding electrostatic discharge should be followed.
- ▶ If the LION System is modified in any way, except by the manufacturer, all warranties concerning operation and safety are invalidated.
- ▶ Make sure that the local standards and regulations are observed at all times. Examples of such regulations are VDE 0800 and VDE 0100 or EN 60204-1 for earth grounding.
- ▶ Use only accessory equipment which comes from or has been approved by Centraline.
- ▶ It is recommended that devices are to be kept at room temperature for at least 24 hours before applying power. This is to allow any condensation resulting from low shipping/storage temperatures to evaporate.
- ▶ The LION System must be installed in such a manner (e.g., in a lockable cabinet) as to ensure that uncertified persons have no access to the terminals.

## Safety Information as per EN60730-1:2005-12

### Purpose

The LION System is an independently mounted electronic control system with fixed wiring.

It is used for the purpose of building HVAC control and is suitable for use only in non-safety controls for installation on or in appliances.

<b>Pollution degree</b>	Pollution Degree 2, suitable for use in residential controls, commercial controls, in a clean environment.
<b>Overvoltage category</b>	Category II for mains-powered (16A) controls Category I for 24 V powered controls
<b>Rated impulse voltage</b>	2500 VAC
<b>Automatic action</b>	Type 1.C (micro-interruption for the relay outputs)
<b>Software class</b>	Class A
<b>Ball-pressure test temperature</b>	75 °C for all housing and plastic parts 125 °C in the case of devices applied with voltage-carrying parts and connectors
<b>Electromagnetic interference</b>	Tested at 230 VAC, with the modules in normal condition.
<b>System transformer</b>	Europe: safety isolating transformers according to IEC61558-2-6 U.S.A. and Canada: NEC Class-2 transformers

Table 1 System data as per EN60730-1:2005-12

# System Overview

## System Architecture

An LION System consists of the CLLIONLC01 Controller and various I/O modules. The CLLIONLC01 Controller provides interface connections, which allow connection to external systems. Auxiliary parts enable special features.

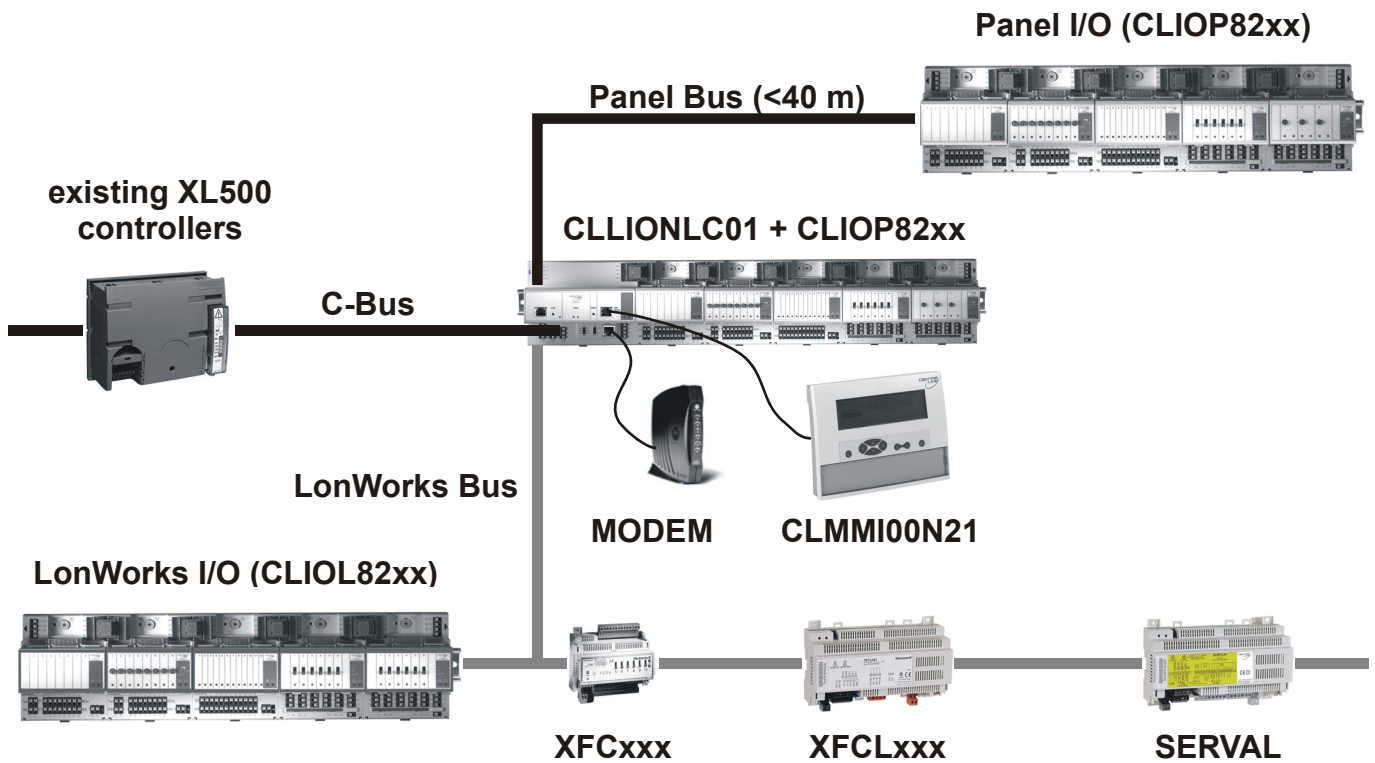


Fig. 1 LION System architecture

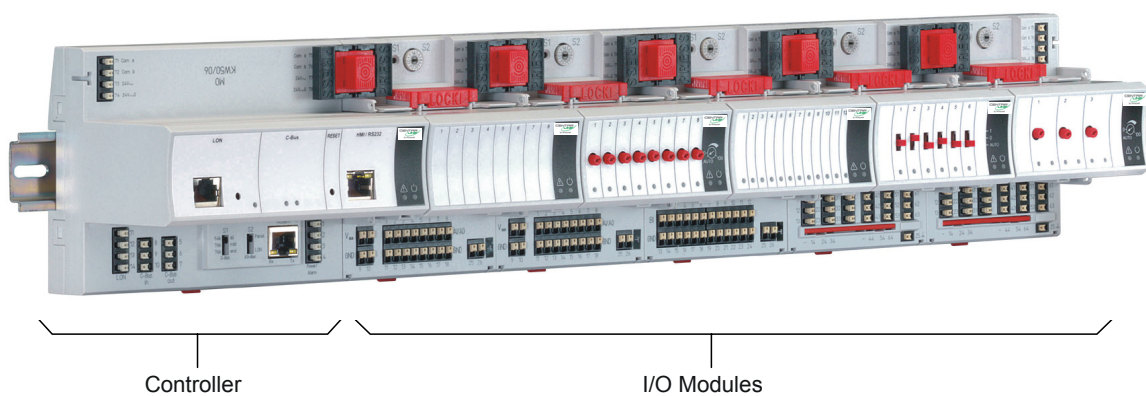


Fig. 2 CLLIONLC01 Controller and I/O modules

## I/O Modules

### Variants of I/O Modules

There are 2 variants of I/O modules:

- Panel Bus I/O modules with communication via Panel Bus (light gray housings)  
Modules are automatically commissioned (with firmware download) by the CLLIONLC01 Controller
- LONWORKS Bus I/O modules (dark gray housings) with communication via LONWORKS (FTT10-A, link power compatible) for easy integration and use with 3<sup>rd</sup>-party controllers

### Terminal Sockets

I/O modules are mounted on the appropriate terminal sockets. Panel Bus I/O modules and LONWORKS Bus I/O modules use the same terminal sockets.

### Color Coding

To distinguish modules and components, the following color coding is used:

Color	Part
Red	All of the user-accessible adjustable mechanical parts (i.e., bridge connectors and locking mechanism) and operating controls (manual overrides, etc.)
Light-gray	Panel Bus I/O modules
Dark-gray	LONWORKS Bus I/O modules

Table 2 Color coding of LION Modules

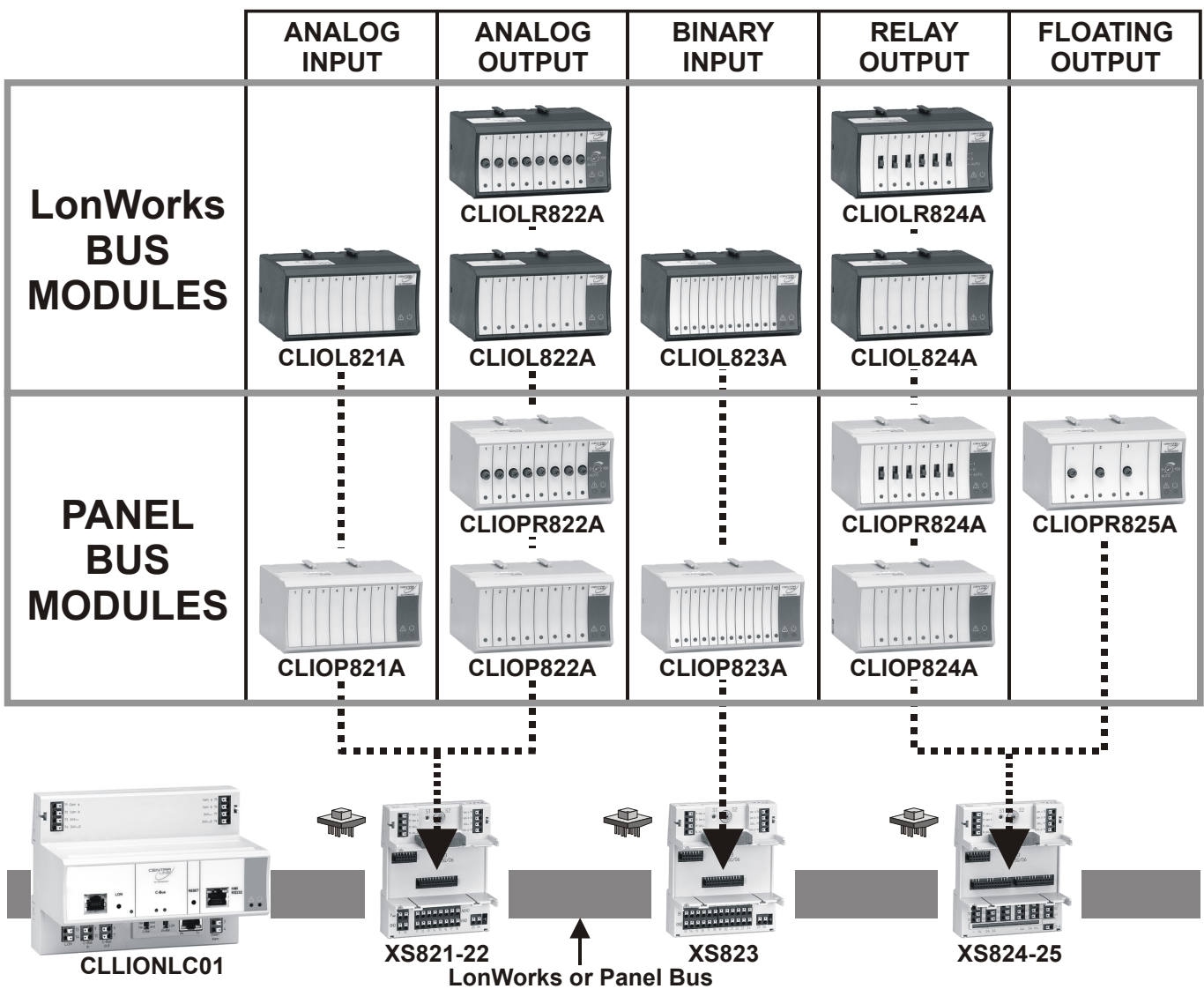


Fig. 3 Overview of I/O modules and terminal sockets

**I/O Module Overview**

Panel Bus module	LONWORKS Bus module	Description	Inputs	Outputs	Manual controls	LEDs <sup>1)</sup>
CLIOP821A	CLIOL821A	Analog input module	8	–	–	–
CLIOP822A	CLIOL822A	Analog output module	–	8	–	8 status LEDs
CLIOPR822A	CLIOLR822A	Analog output module	–	8	8 Manual overrides	8 status LEDs
CLIOP823A	CLIOL823A	Binary input module	12	–	–	12 status LEDs
CLIOP824A	CLIOL824A	Relay output module	–	6 <sup>2)</sup>	–	6 status LEDs
CLIOPR824A	CLIOLR824A	Relay output module	–	6 <sup>2)</sup>	6 Manual overrides	6 status LEDs
CLIOPR825A	–	Floating output module	–	3	3 Manual overrides	3 pairs of status LEDs

<sup>1)</sup> In addition to the power LED and service LED

<sup>2)</sup> Changeover outputs

Table 3 Overview of I/O modules

**Corresponding Terminal Sockets**

I/O module CLIOP/CLIOL...	Socket	Scope of delivery
...821	XS821-22	1 terminal socket, 1 bridge connector 1 swivel label holder
...822		
...823	XS823	1 terminal socket, 1 bridge connector 1 swivel label holder
...824	XS824-25	1 terminal socket, 1 bridge connector 1 swivel label holder 1 long cross connector
...825		

Table 4 I/O modules and corresponding terminal sockets

**Note**

In the following e.g., ...822 is used to summarize all analog output modules (Panel Bus/LONWORKS Bus, with/without manual overrides)

## Auxiliary Parts

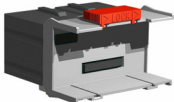
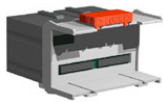


Module	Type	Figure	Corresponding I/O modules CLIOP/CLIOL...	Information
Manual disconnect modules	XS812		...821 ...822 ...823	Module allows disconnection of individual I/O signals
	XS812RO		...824 ...825	Module allows disconnection of individual I/O signals For 24 V applications only
Auxiliary terminal package	XS814		All LION I/O modules	2 rows of 7 terminals connected to each other for redistributing voltage
Cross connectors, short (yellow)	XS817		...824 ...825	Connects 3 relay commons, required in case of line voltage and low voltage in the same I/O module

Table 5 Auxiliary parts

## Spare Parts


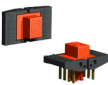

Module	Type	Figure	Corresponding I/O modules CLIOP/CLIOL...	Information
Cross connectors, long (red)	XS815		...824 ...825	Connects 6 relay commons
Connector bridge	XS816		All LION I/O modules	Connects CLLIONLC01 and I/O modules
Swivel label holder	XAL10		All LION I/O modules	Can be plugged into socket, for attaching label generated by CARE

Table 6 Spare parts



## Interfaces and Bus Connections

The LION System can be connected to the following devices and systems:

### Panel Bus

- For communication with up to 16 Panel Bus I/O modules
- Polarity-insensitive

### LONWORKS Bus

- For communication with other LONWORKS Bus devices within the building
- FTT10, link power compatible
- Polarity-insensitive

### C-Bus

- For communication with other controllers, e.g., existing Excel 500 Controllers

### HMI

- For connecting an operator interface, e.g., CLMMI00N21 or a laptop, e.g., for CARE

### Modem

- For connecting a modem or an ISDN terminal adapter

## Technical Data

### System Data

Operating voltage	24 VAC, $\pm 20\%$ , 21 ... 30 VDC
Max. number of C-Bus participants	30
Power consumption	Max. 3.57 A (1 CLLIONLC01 Controller + 16 I/O modules)
Push-in terminals	1.5 mm <sup>2</sup>
Overvoltage protection	All inputs and outputs are protected against 24 VAC and 40 VDC overvoltage as well as against short-circuiting.
Calculated lifetime of weakest component	MTBF $\geq 13.7$ years

Table 7 System data

## Standards

Protection class	IP20
Product standard EMC	EN 60730-2-9:2005-10
Testing electrical components	IEC68
Certification	CE
System transformer	The system transformer(s) must be safety isolating transformers according to IEC 61558-2-6. In the U.S.A. and Canada, NEC Class 2 transformers must be used.
Low-Voltage Device Safety Assessment	EN 60730-1:2005-12, EN 60730-2-9:2005-10

Table 8 Standards

## Operational Environment

Ambient operating temperature	0 ... 50 °C (32 ... 122 °F)
Ambient operating humidity	5 ... 93 % rel. humidity (non condensing)
Ambient storage temperature	-20 ... 70 °C (-4 ... +158 °F)
Ambient storage humidity	5 ... 95 % rel. humidity (non condensing)
Vibration under operation	0.024" double amplitude (2 ... 30 Hz), 0.6 g (30 ... 300 Hz)
Dust, vibration	According to EN60730-1:2005-12
RFI, EMI	According to EN60730-1:2005-12

Table 9 Operational environment

# Planning

## Overview

### Engineering with CARE

During CARE engineering, the type of I/O modules, terminal assignment and module configuration are defined depending on the application.

### Planning

In this step, the following has to be defined, if applicable:

- Power supply
- Fusing
- Earth grounding
- Lightning protection
- Panel Bus wiring
- Design of a LONWORKS network
- Design of a C-Bus network
- Useful accessories
- Cable selection

## Transformer Selection

### Note

*In Europe the system transformer(s) must be safety isolating transformers according to IEC61558-2-6.*

*In the U.S.A. and Canada, NEC Class-2 transformers must be used.*

### Power Consumption

When selecting the appropriate transformer, take into account the number of individual modules, accessories, and field devices in determining the total power consumption.

Devices powered	Power consumption	
	24 VAC	24 VDC
CLLIONLC01 with CLMMI00N21 (backlight ON) and with watchdog load (max. 500 mA)	690 mA	640 mA
CLLIONLC01 with CLMMI00N21 (backlight ON) but without watchdog load	190 mA	140 mA
...821	130 mA	80mA
...822	160 mA	90 mA
...823	180 mA	130 mA
...824	140 mA	90 mA
...825	140 mA	90 mA

Table 10 Power consumption of LION System components depending on power supply

## Connectable Power Supplies

### CentralLine CRT Series (Europe)

Transformer	Primary side	Secondary side
CRT 2	220/230 VAC	24 VAC, 50 VA, 2 A
CRT 6	220/230 VAC	24 VAC, 150 VA, 6 A
CRT 12	220/230 VAC	24 VAC, 300 VA, 12 A

Table 11 CentralLine CRT series transformers data

### CentraLine 1450 Series (North America)

- 50/60 Hz AC
- Insulated accessory outputs
- Built-in fuses
- Line transient /surge protection
- AC convenience outlet
- NEC Class-2

Part number 1450 7287	Primary side	Secondary side
-001	120 VAC	24 VAC, 50 VA
-002	120 VAC	2 x 24 VAC, 40 VA, and 100 VA from separate transformer
-003	120 VAC	24 VAC, 100 VA, and 24 VDC; 600 mA
-004	240/220 VAC	24 VAC, 50 VA
-005	240/220 VAC	2 x 24 VAC, 40 VA, and 100 VA from separate transformer
-006	240/220 VAC	24 VAC, 100 VA, and 24 VDC, 600 mA

Table 12 CentraLine 1450 series transformers data

### Standard Transformers (Europe, North America)

Standard commercially available transformers used to supply power to LION Systems must fulfill the following specifications:

Output voltage	Impedance	AC current
24.5 VAC to 25.5 VAC	$\leq 1.15 \Omega$	max. 2 A
24.5 VAC to 25.5 VAC	$\leq 0.40 \Omega$	max. 6 A
24.5 VAC to 25.5 VAC	$\leq 0.17 \Omega$	max. 12 A

Table 13 Requirements for standard transformers

### RIN-APU24 Uninterruptable Power Supply

The RIN-APU24 Uninterruptable Power Supply can be wired to power LION Systems.

See also RIN-APU24 Uninterruptable Power Supply – Mounting Instructions (MU1B-0258GE51) for detailed wiring diagrams.

### Power Supply of Field Devices

Depending upon the power consumption of the field devices used, it is possible to use either a single transformer to power both the CLLIONLC01 and attached field devices, or it may be necessary to employ an additional transformer. See also section "Field Device Cables" on page 14 and connection examples on page 29.

### Fusing Specifications

For connection examples see description of the I/O modules on page 39 and following.

#### F1 (Fusing for CLLIONLC01 and I/O Modules)

Rating: 4 A, time-lag fuse (slo-blo)

For example:

Manufacturer: Littelfuse

Type: 218004

#### F2 (Fusing for Active Field Devices)

Depends upon loads in use.

### System Protective Earth Grounding

LION Systems comply with SELV (Safety Extra-Low Voltage). Earth grounding is therefore not recommended.

However, if compliance with EN60204-1 is required, see Appendix 1.

### Lightning Protection

Please contact your local CentralLine representative for information on lightning protection.

### Panel Bus Topologies

- Up to 16 Panel Bus I/O modules can be controlled by a single CLLIONLC01.
- Panel Bus I/O modules must be addressed using the HEX switch on the terminal socket.
- Maximum distance between controller and Panel Bus I/O module: 40 m.
- No bus termination
- Polarity-insensitive

## LONWORKS Bus Topologies

The LONWORKS Bus is a 78-kilobit serial link that uses transformer isolation so that the bus wiring does not have a polarity. I.e. it is not important which of the two LONWORKS Bus terminals are connected to each wire of the twisted pair.

The LONWORKS Bus does not need to be shielded on the controller module side.

The LONWORKS Bus can be wired in daisy chain, star, loop or any combination thereof as long as the maximum wire length requirements are met.

### Configuration

The recommended configuration is a daisy chain with two bus terminations. This layout allows for max. LONWORKS Bus lengths, and its simple structure presents the least number of possible problems, particularly when adding on to an existing bus.

See also "LONWORKS Mechanisms", Product Literature no.: EN0B-0270GE51.

## C-Bus Topologies

Via the C-Bus up to 30 C-Bus devices (e.g., controllers, etc.) can communicate with one another and a PC central. The C-Bus must be connected via the individual controllers (open ring).

### Note

Star connection is not allowed because uncontrollable line reflections may occur.

Instead of an LION Controllers, other C-Bus controllers (e.g., the Excel 500, Excel 100, PANTHER) can also be connected.

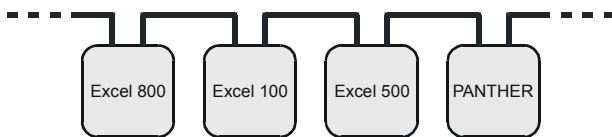


Fig. 4 C-Bus topology Excel 5000

## Accessories

Besides the auxiliary parts of Table 5 on page 8, the following accessories are available.

### Preconfigured Connection Cables

Type	Connecting CLLIONLC01 with	Features
XW882	CLMMI00N21 Operator Interface	5 m, shielded, RJ45 plug with clip
XW582 + XW586	CLMMI00N21 Operator Interface	–
XW884	Adapter cable for Excel 500/600 Controllers	0.2 m, shielded, RJ45 – 9 pin sub-D
XW885	Laptops	3 m, shielded, RJ45 plug with clip
XW585 + XW586	Laptops	–
XW586	Modems	1.8 m, RJ45 – 9 pin sub-D

Table 14 Preconfigured connection cables

### XW882 Cable Details

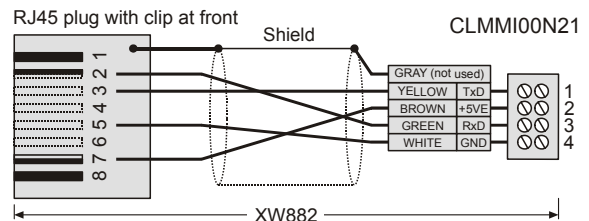


Fig. 5 CLLIONLC01/CLMMI00N21 cable details

### XW884 Cable Details

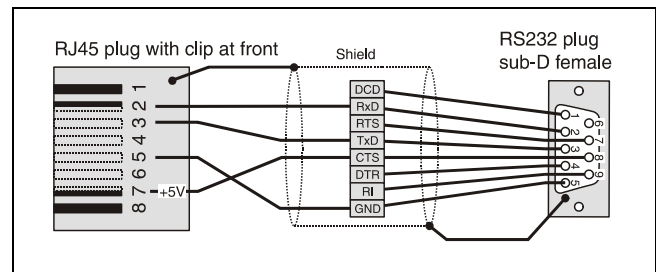


Fig. 6 CLLIONLC01/Excel 500/600 cable details

**XW885 Cable Details**

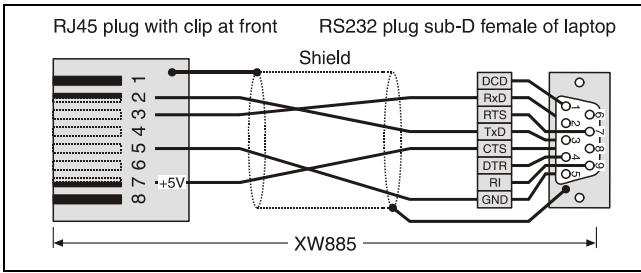


Fig. 7 CLLIONLC01/laptop cable details

**XW582 Cable Details**

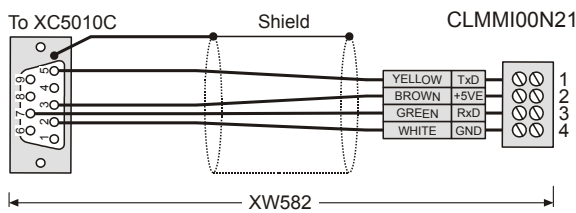


Fig. 8 XW582 cable details

**XW585 Cable Details**

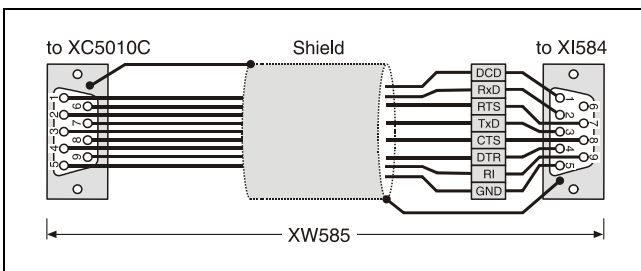


Fig. 9 XW585 cable details

**XW586 Cable Details**

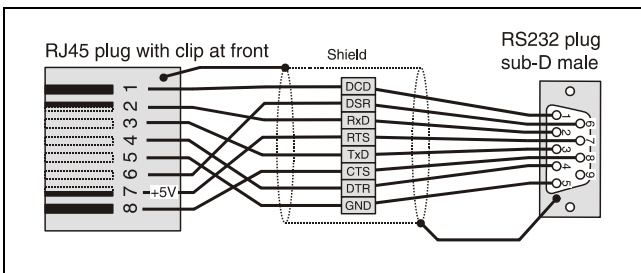


Fig. 10 XW586 cable details

**LONWORKS Bus Termination Modules**

Type	Description
209541	LONWORKS Bus termination module
XAL-Term	LONWORKS connection and termination module, which can be mounted on DIN rails and in fuse boxes

Table 15 LONWORKS Bus termination modules

**C-Bus Extension by Using Repeaters**

The C-Bus length can be extended by using repeaters. Each repeater extends the bus length by 1200 m (4000 ft). For the US the repeater is available either with or without housing. In Europe, only the version with housing is allowed.

Repeater	US order No.	European order no.
Without housing	14507324-001	–
With housing	14507324-002	XD509

Table 16 Order no. for repeaters

**Cable Specifications**

**Power Supply Cables**

When checking the length of the power supply cable, the connection cables to all I/O modules must be taken into account.

<b>Max. length</b>	3 m (per side of the controller), see Fig. 32 on page 25
<b>Cross section</b>	min. 0.75 mm <sup>2</sup> (AWG 18)

Table 17 Power supply cables specification

**Panel Bus Cables**

<b>Max. length</b>	40 m
<b>Cable type</b>	twisted pair, e.g., J-Y-Y 2 x 2 x 0.8

Table 18 Panel Bus cables specification

## LONWORKS Bus Cables

Cable type	Max. bus length
Belden 85102 (plenum)	2700 m (8900 ft)
Belden 8471 (non-plenum)	2700 m (8900 ft)
Level IV, 22 AWG	1400 m (4600 ft)
JY (St) Y 2 x 2 x 0.8	900 m (3000 ft)
TIA568A Cat. 5 24AWG, twisted pair	900 m (3000 ft)

Table 19 Doubly-terminated bus specifications

### Notes

- The cable types listed above are as recommended by Echelon in their FTT-10A User Guide.
- The cable recommended by CentraLine is the level IV, 22 AWG, solid core, non-shielded cable.
- Belden part numbers are 9H2201504 (plenum) and 9D220150 (non-plenum).

### FTT Specification

The FTT specification includes two components that must be met for proper system operation:

- The distance from each transceiver to all other transceivers and to the termination must not exceed the max. node-to-node distance.
- If multiple paths exist, the maximum total wire length is the total amount of wire used.

Cable type	Max. node-to-node distance	Max. total wire length
Belden 85102	500 m (1650 ft)	500 m (1650 ft)
Belden 8471	400 m (1300 ft)	500 m (1650 ft)
Level IV, 22AWG	400 m (1300 ft)	500 m (1650 ft)
JY (St) Y 2 x 2 x 0.8	320 m (1050 ft)	500 m (1650 ft)
TIA568A Cat. 5 24AWG, twisted pair	250 m (825 ft)	450 m (1500 ft)

Table 20 Free topology (singly-terminated) specifications

## NOTICE

### Unpredictable reflections on the bus due to step change in line impedance characteristics!

- ▶ Do not use different wire types or gauges on the same LONWORKS network segment.

### Note

In the event that the limit on the total wire length is exceeded, the FTT physical layer repeaters (FTT 10A) can be added to interconnect segments. This increases the overall length by an amount equal to the original specification for that cable type and bus type for each repeater used.

For example, adding repeaters for a doubly-terminated bus using JY (St) Y 2 x 2 x 0.8 cable increases the maximum length 900 m (3000 ft) for each repeater.

## Field Device Cables

Type of signal	Cross-sectional area	
	≤ 100 m (300 ft) (Fig. 39 on p. 29) one transformer	≤ 400 m (1300 ft) (Fig. 40 on p. 29) separate transformers
24 VAC power	1.5 mm <sup>2</sup> (16 AWG)	not allowed for > 100 m (300 ft)
0...10 V signals	0.24 – 1.5 mm <sup>2</sup> (24 – 16 AWG)	

Table 21 Cable sizing for connection of field devices

For wiring field devices see page 29.

## C-Bus Cables

### Note

Observe national regulations for C-Bus cables!

- For Europe only shielded cable is permitted.
- For the U.S. shielded or unshielded cable can be used.

Cable type	Description	Recommended for
J-Y-(ST)Y 2 x 2 x 0.8	shielded, twisted pair	Europe, inside cabinet
A-Y-(ST)Y 2 x 2 x 0.8	shielded, twisted pair	Europe, outside cabinet
AK 3702	unshielded, twisted pair	US not approved for Europe
AK 3740A	shielded	US (low-cost) not approved for Europe
Belden 9842	twisted pair	Europe, US also possible
Belden 9841	shielded	US
AK 3702	unshielded, twisted pair	US not approved for Europe
AK 3740A	shielded	US (low-cost) not approved for Europe

Table 22 C-Bus cable types

### Maximum Cable Length

The maximum C-Bus cable length is 1200 m (4000 ft).

See section "C-Bus Topologies" on page 12.

## Dimensions

### Controller Module

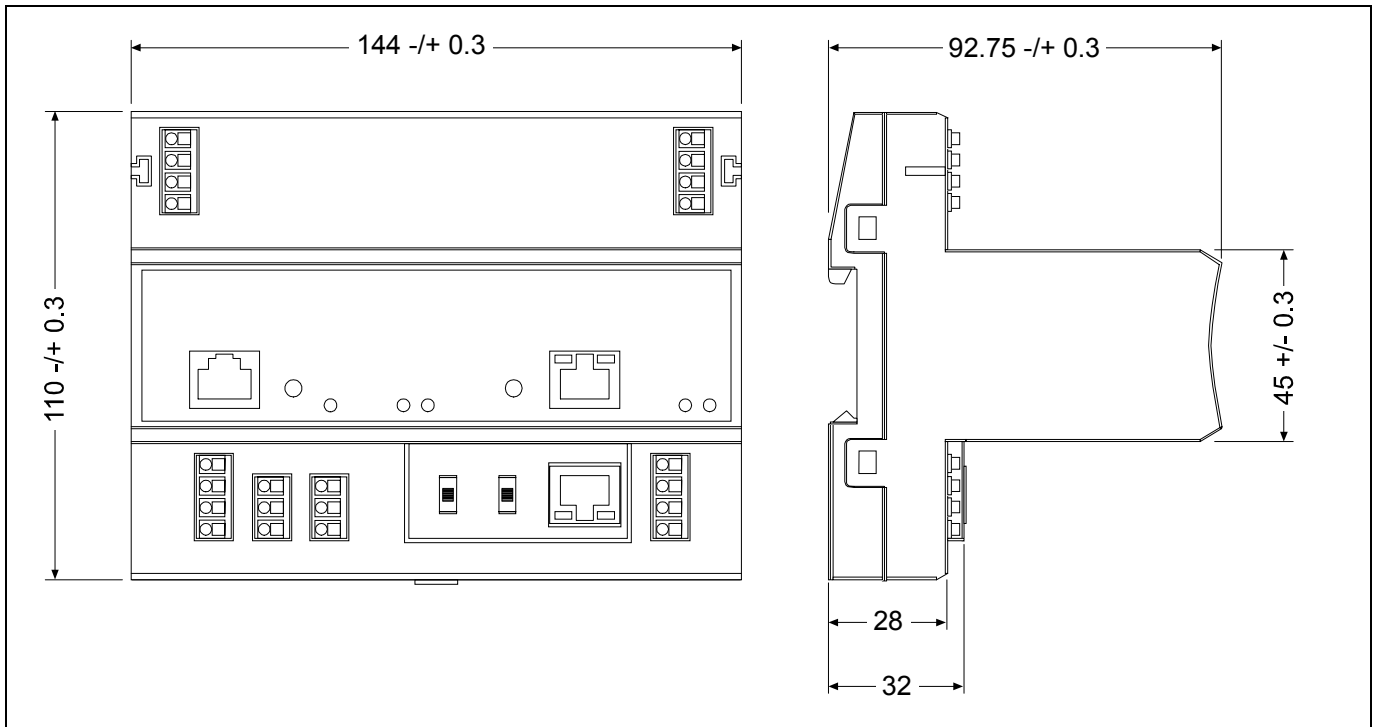


Fig. 11 Controller module, outside dimensions (in mm)

### I/O Modules

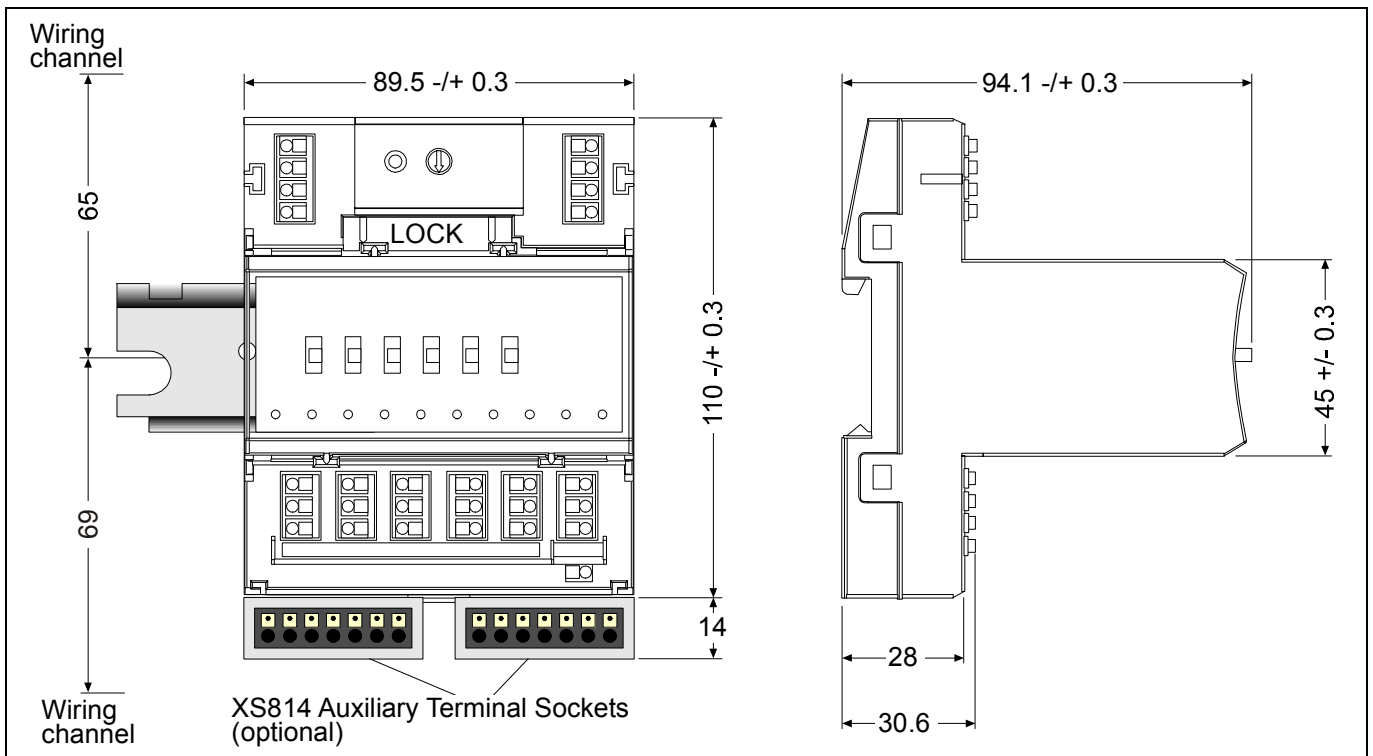


Fig. 12 I/O modules (example shows manual overrides), including terminal socket, outside dimensions (in mm)



# How to Mount/Dismount Modules

## ⚠ WARNING

- Risk of electric shock or equipment damage!**
- ▶ Do not touch any live parts in the cabinet.
  - ▶ Disconnect the power supply before you start to install the LION System.  
More than one disconnect switch may be required to de-energize the system.
  - ▶ Do not reconnect the power supply until you have completed the installation.

**Note**

The terminal socket of each I/O module can be mounted and wired before inserting and locking the corresponding electronic module.

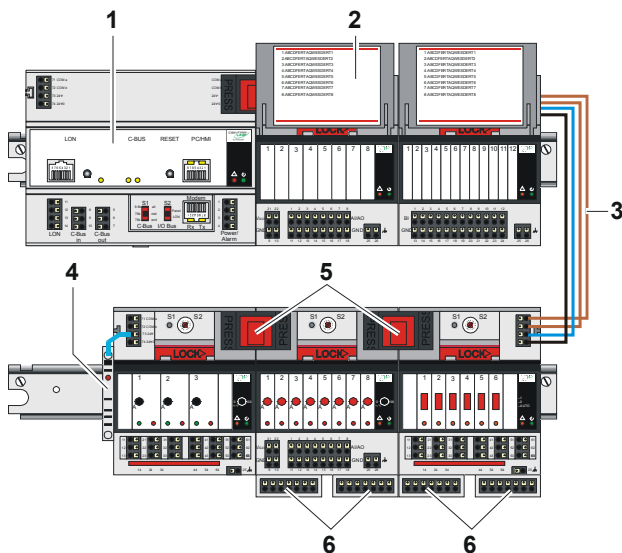


Fig. 13 CLLIONLC01 and I/O modules mounted on multiple DIN rails

**Legend**

- 1 CLLIONLC01
- 2 Swivel label holder
- 3 Cable connection
- 4 Stopper
- 5 Bridge connectors
- 6 Auxiliary terminal package

## How to Mount/Dismount Controller/Sockets

### How to Mount Sockets

**Notes**

- When using both Panel Bus and LONWORKS Bus I/O modules in an LION System, group both Panel Bus modules (light gray) and LONWORKS Bus I/O modules (dark gray), e.g., on different rails.
- Up to 10 Panel Bus I/O modules can be mounted to one side of the controller. In total, up to 16 Panel Bus I/O modules can be mounted to one controller.
- The CLLIONLC01 is mounted on the DIN rail in the same way as a terminal socket.

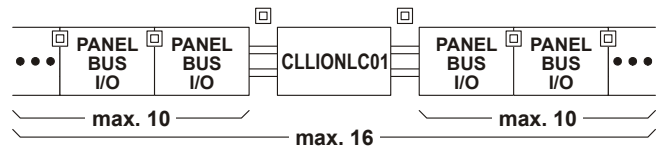


Fig. 14 Max. number of Panel Bus I/O modules

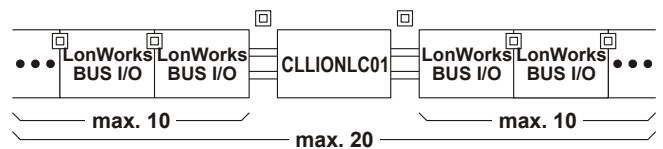


Fig. 15 Max. number of LONWORKS Bus I/O modules with power supply via CLLIONLC01

- ▶ Angle the terminal socket at the upper edge of the DIN rail until it snaps in.
- ▶ Swing the terminal socket down and apply gentle force until it snaps into position with an audible "click".
- ▶ Position controller module and terminal sockets flush with one another along the rail.
- ▶ If desired, mount stoppers at the ends of the rail to prevent sliding.

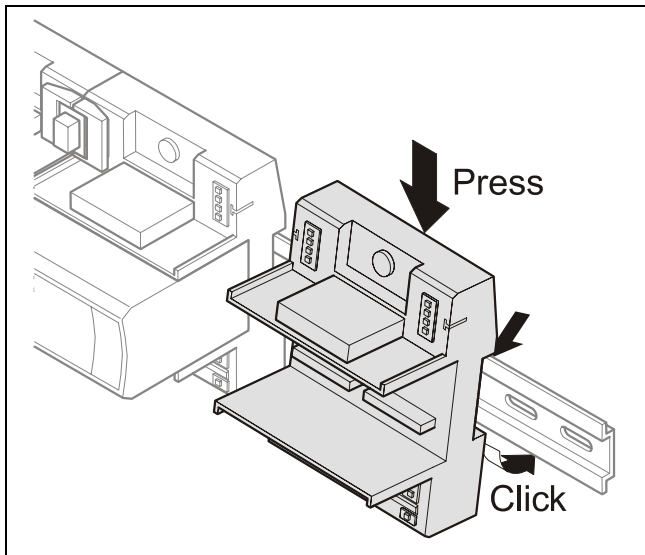


Fig. 16 Mounting terminal sockets

**Note**

Take care to not bend the Omega clamp, which serves to establish the electrical contact with the DIN rail and which is located on the back of the terminal socket.

**How to Connect Sockets**

Controller and terminal sockets on the same DIN rail can be connected mechanically and electrically with bridge connectors.

Controller and terminal sockets on different DIN rails must be connected using cables, see Fig. 13 and page 24.

**NOTICE**

**Risk of malfunction!**

- ▶ Wire Panel Bus I/O modules and LONWORKS Bus I/O modules separately.
- ▶ When using both Panel Bus and LONWORKS Bus I/O modules in an LION System, LONWORKS Bus I/O modules must be connected to the controller via LON terminals 11 ... 14.

Position the bridge connector on terminals 71 ... 74 of the right hand terminal socket or controller and on terminals 75 ... 78 of the left hand terminal socket or controller. Then press the bridge connector down.

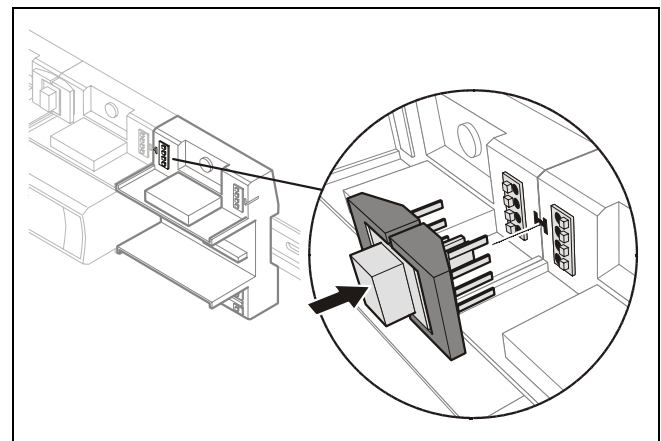


Fig. 17 Connecting terminal sockets with bridge connector

**Notes**

- Bridge connectors transmit both communication signals and power supply between modules.
- Removing bridge connectors will interrupt the transmission of both communication signals and power supply between the modules.

## How to Dismount Sockets

### How to Disconnect Sockets

Release all bridge connectors before removing the controller module and/or the terminal sockets from the DIN rail.

- ▶ Press down at the same time both the gray side wings next to the red button and then pull the bridge connector out of the module.

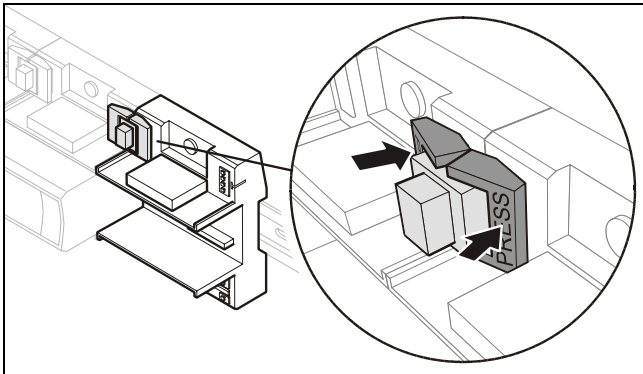


Fig. 18 Releasing bridge connectors

### Dismounting Controller/Terminal Sockets

- ▶ Insert a screwdriver into the latch on the underside of the module and lever the red latch 2–3 mm downwards. The module can then be swung away from the rail.

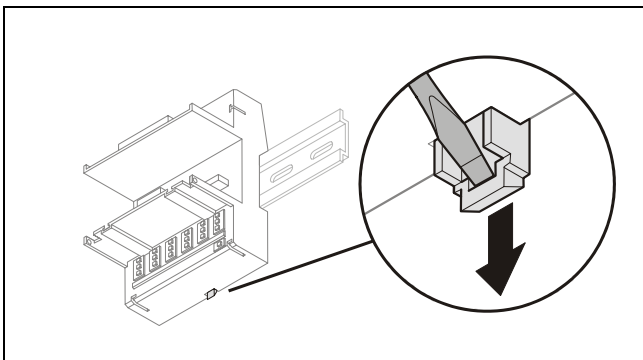


Fig. 19 Releasing latch

## How to Mount/Dismount Electronic Modules

### How to Mount Electronic Modules

#### Note

Electronic modules can be removed from the socket or inserted into the sockets without switching off the power supply. The behavior of connected field devices must be taken into consideration.

- ▶ Make sure that terminal socket and I/O module match, see Table 4 on page 7.
- ▶ Make sure that the red locking mechanism is in the open, i.e., left, position.
- ▶ Gently push the electronic module onto the terminal socket until snug.

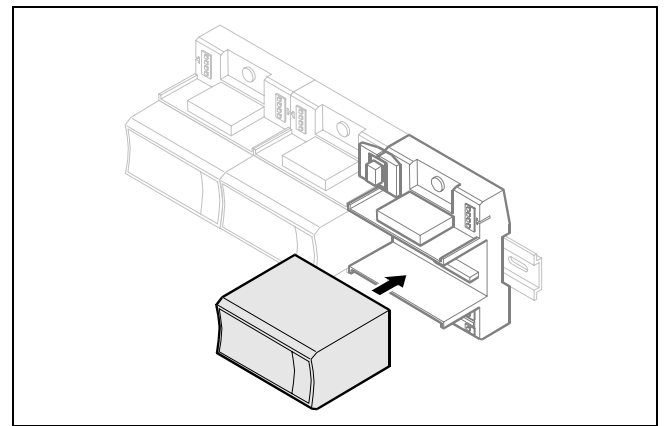


Fig. 20 Inserting the electronic module

- ▶ Lock the red locking mechanism by sliding it to the right.

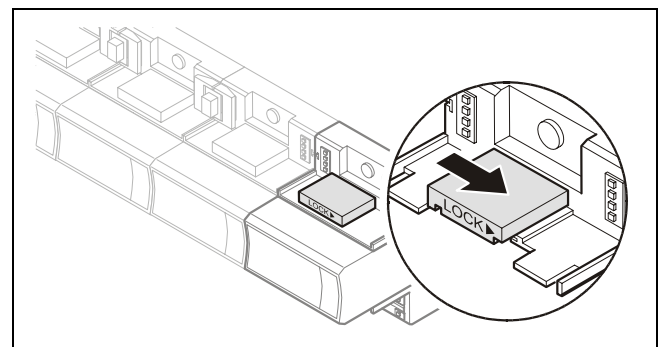


Fig. 21 Locking the electronic module

#### Note

The red locking mechanism will not close if the electronic module is not properly mounted.

## How to Dismount Electronic Modules

### Note

Electronic modules can be removed from the socket or inserted into the sockets without switching off the power supply. The behavior of connected field devices must be taken into consideration.

- ▶ Open the red locking mechanism by sliding it to the left and then gently pull the electronic module out of the terminal socket.

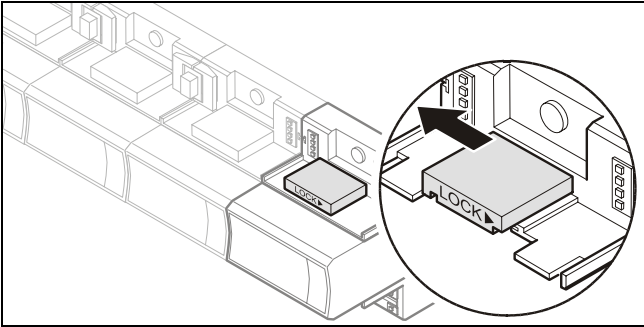


Fig. 22 Dismounting the electronic module

## How to Mount/Dismount Manual Disconnect Modules

XS812 and XS812RO Manual Disconnect Modules are mounted on the terminal socket appropriate for the electronic module, see Table 4 on page 7. The electronic module is mounted onto the manual disconnect module.

### ⚠ WARNING

**Risk of electric shock or equipment damage!**  
The XS812RO Manual Disconnect Module is designed for 24 V applications only!

- ▶ Never use the XS812RO Manual Disconnect Module with line voltage.

### How to Mount Manual Disconnect Modules

- ▶ Make sure that manual disconnect module, electronic module and terminal socket match, see Table 4 on page 7.
- ▶ Make sure that the red locking mechanism is in the open, i.e., left, position.
- ▶ Gently push the manual disconnect module onto the terminal socket until snug.
- ▶ Lock the red locking mechanism by sliding it to the right.

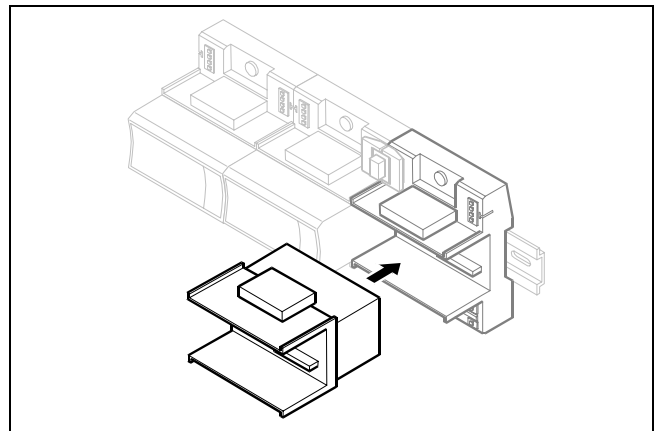


Fig. 23 Mounting the manual disconnect modules

### How to Operate the Individual Switches

- Use a screwdriver to open/close the appropriate disconnect switches of the manual disconnect modules.

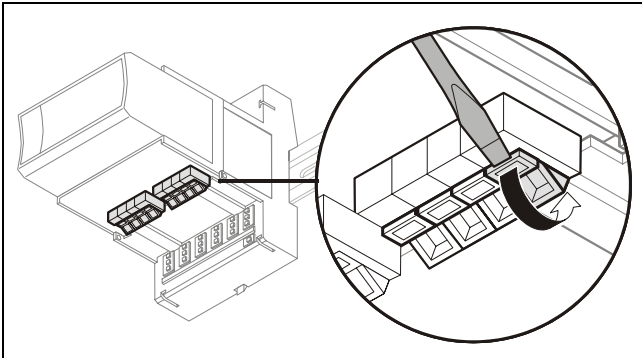


Fig. 24 Operating the disconnect switches

### How to Dismount Manual Disconnect Modules

- Open the red lock mechanism by sliding it to the left and then gently pull the electronic module out of the terminal socket.

### How to Mount/Dismount Auxiliary Terminal Packages

#### How to Mount Auxiliary Terminal Packages

- Push the auxiliary terminal package onto the grooves of the corresponding terminal socket.

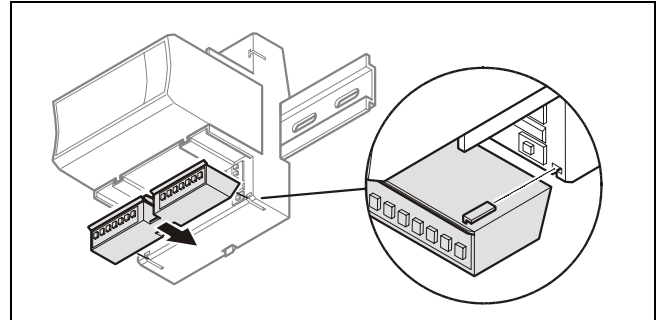


Fig. 25 Mounting the auxiliary terminal package onto the terminal socket

#### How to Dismount Auxiliary Terminal Packages

- Push down the catch of the auxiliary terminal package and pull it out of the grooves of the terminal socket.

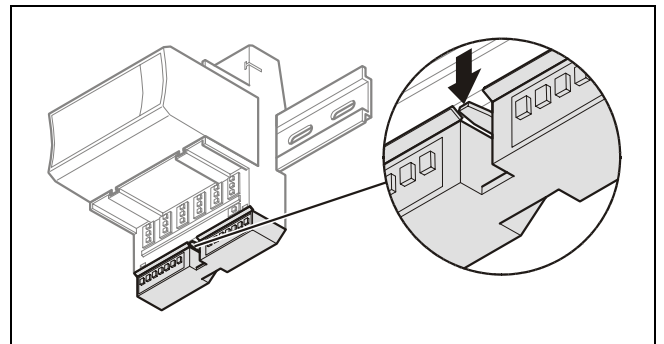


Fig. 26 Dismounting the auxiliary terminal package from the terminal socket

## How to Mount/Dismount Cross Connectors

**Note**

The long cross connector is already mounted to each of the relay output or floating actuator output I/O modules. It can be removed and, if desired, replaced with 1 or 2 short connectors (optional accessory, see Table 5 on page 8).

- ▶ Insert a screwdriver on one end of the cross connector and swivel it to the right and to the left.
- ▶ Insert a screwdriver on the other end of the cross connector and swivel it to the right and to left until the cross connector is released.
- ▶ If desired, insert another cross connector.

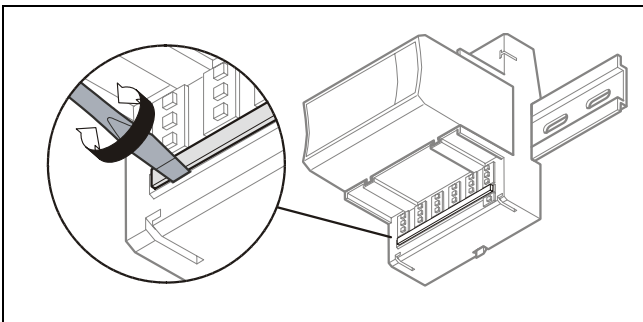


Fig. 27 Dismounting the cross connectors (long cross connector shown here)

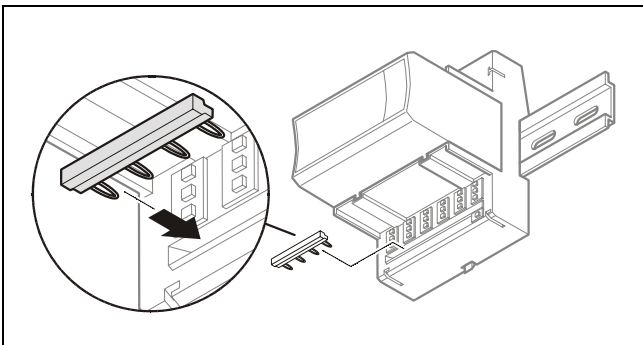


Fig. 28 Mounting the cross connectors (short cross connector shown here)

## How to Mount/Dismount Swivel Label Holders

**Note**

A swivel label holder is included in the scope of delivery of each module.

### How to Mount Swivel Label Holders

- ▶ Snap the swivel label holder onto the terminal socket hinges.
- ▶ Apply self-adhesive labels to the holders.

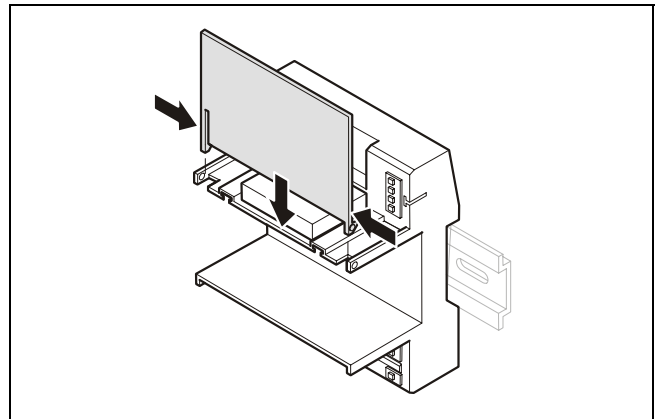


Fig. 29 Mounting the swivel label holder

### How to Dismount Swivel Label Holders

- ▶ Press the hinges together and remove the swivel label holder.

# How to Wire and Set Up the System

## General Safety Considerations

- When connecting the CLLIONLC01 or LION I/O modules, both VDE, National Electric Code (NEC) or equivalent, and any local regulations concerning grounding and zero voltage must be observed.
- Electrical work should be carried out by a qualified electrician.
- The electrical connections must be made at the terminal blocks. The corresponding connection diagrams are located on the individual controller module and I/O modules.
- For Europe only: To comply with CE requirements, devices with a voltage in the range of 50 ... 1000 VAC or 75 ... 1500 VDC, which are not provided with a supply cord and plug or with other means for disconnection from the supply having a contact separation of at least 3 mm in all poles, must have the means for disconnection incorporated in the fixed wiring.



### WARNING

#### Risk of electric shock or equipment damage!

- ▶ Do not touch any live parts in the cabinet.
  - ▶ Disconnect the power supply before making connections to or removing connections from terminals of controller or I/O modules.
  - ▶ Do not use spare terminals as wiring support points.
  - ▶ Do not reconnect the power supply until you have completed the installation.
- 
- ▶ Observe precautions for handling electrostatic sensitive devices.



## How to Wire Push-in Terminals

The LION System is equipped with push-in terminals for easy wiring.

For correct wiring, cables must fulfill the following specifications according to IEC664-1 / VDE 0110 (4.97):

<b>Max. plug gauge</b>	0.14 ... 1.50 mm <sup>2</sup>
<b>Solid conductor H05(07) V-U</b>	0.25 ... 1.50 mm <sup>2</sup>
<b>Stranded conductor H05(07) V-K</b>	0.25 ... 1.50 mm <sup>2</sup>
<b>Stranded conductor with wire end ferrules (without plastic collar)</b>	0.25 ... 1.50 mm <sup>2</sup>
<b>Stripping length</b>	8.0 +1.0 mm

Table 23 Push-in terminals wiring specifications

## How to Connect Power Supply

The LION System can be powered by one or more external transformers.

### Note

The maximum length for the power supply cable from a transformer is 3 m. This also includes the length of the modules and the connection cables between the rails.

Referring to Fig. 30 the following conditions must be fulfilled:

$$A + B \leq 3 \text{ m and } A + C \leq 3 \text{ m}$$

## How to Connect a Single or the First Transformer

- ▶ Connect the transformer to terminals 1 and 2 of the CLLIONLC01 Controller.

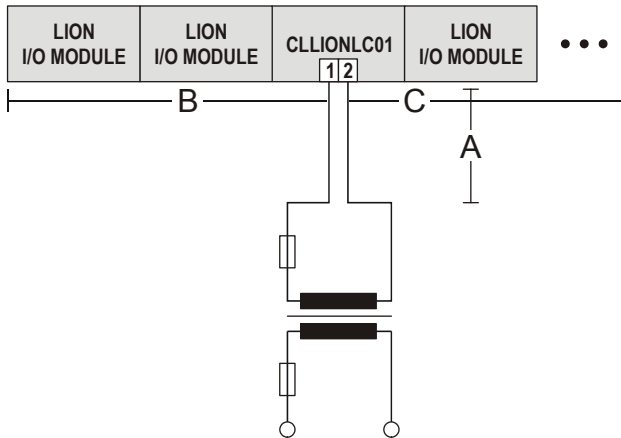
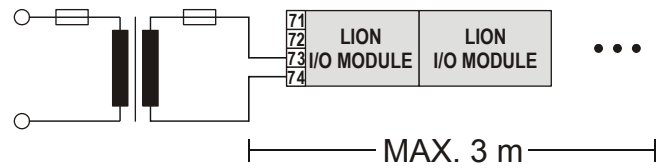


Fig. 30 Wiring power supply from the (first) transformer to the controller module

## How to Connect an Additional Transformer

- ▶ Connect the additional transformer in a second room or cabinet to terminals 73 and 74 or 77 and 78 of an I/O module.



### TRANSFORMER 2

Fig. 31 Wiring the power supply from a second transformer

## NOTICE

### Equipment damage!

- ▶ Do not use bridge connectors to connect modules powered by different transformers.
- ▶ When connecting modules powered by different transformers using cables, be sure to not connect terminals 73 and 77.



## How to Connect Single Bus Controller Systems

This section describes how to connect a controller system which uses **Panel Bus I/O modules only** or **LonWORKS Bus I/O modules only**.

### How to Connect Controller and I/O Modules on a Single Rail

- ▶ Connect controller and I/O modules using the bridge connectors.

This provides power supply and communication connection. No further wiring is necessary.

### How to Connect Controller and I/O Modules on Several Rails in a Single Cabinet

The rails of a controller system are connected in series.

- ▶ Connect the rail ends as follows:
  - **Power supply**  
via power supply terminals 73, 74 or 77, 78
  - **Communication**  
via communication terminals 71, 72 or 75, 76

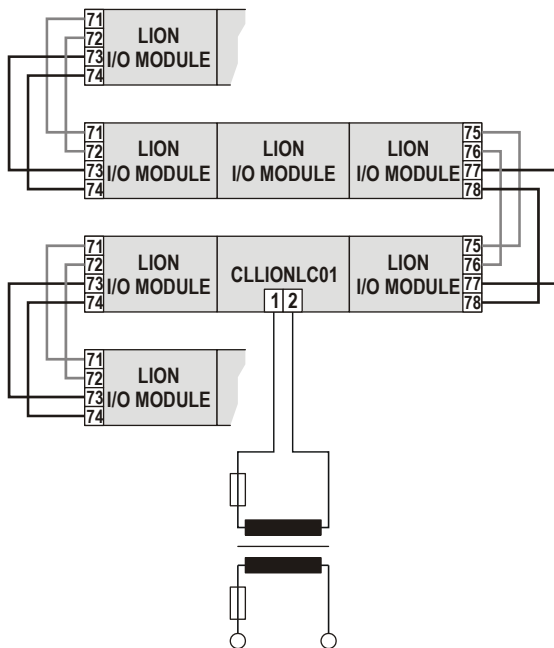


Fig. 32 Wiring the power supply and the communication lines to the I/O modules

### Maximum Power Cable Length

The maximum length for power supply cable per side is 3 m. This also includes the connection cables between the rails, the lengths of the modules, and the cable from the transformer.

## How to Connect Panel Bus I/O Modules in Separate Rooms

In this scenario, communication and reference voltage (24 V0) must be connected between the rooms.

- ▶ Connect the last module of room 1 to the first module of room 2:
  - **Reference voltage**  
via power supply terminals 74 or 78  
terminals 73 and 77 must not be connected
  - **Communication**  
via communication terminals 71, 72 or 75, 76

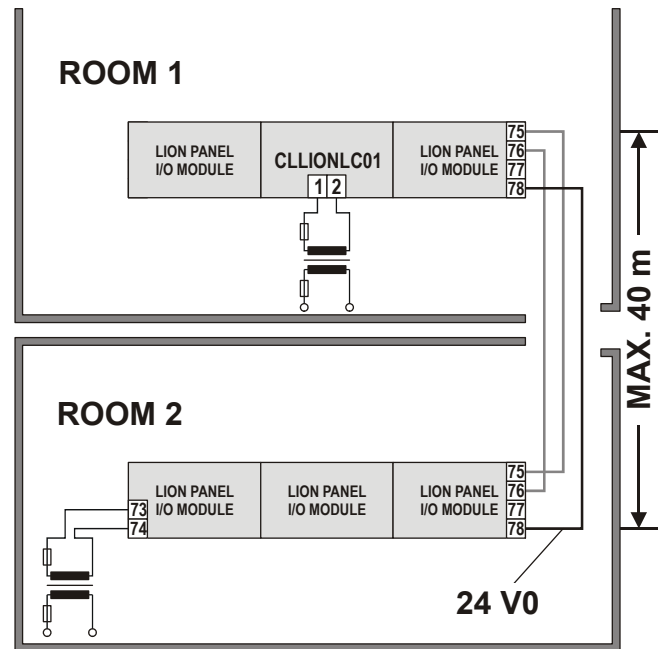


Fig. 33 Wiring the Panel Bus I/O modules in separate rooms

### Maximum Cable Length

The maximum cable length for connecting room 1 and room 2 is 40 m.

## How to Connect LonWorks Bus I/O Modules in Separate Rooms

In this scenario, only communication lines must be connected between the rooms.

- ▶ Connect the last module of room 1 to the first module of room 2:
  - via communication terminals 71, 72 or 75, 76

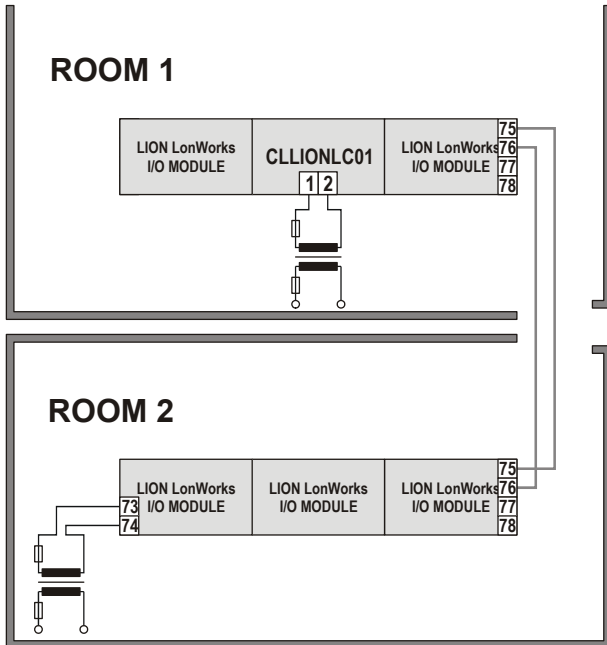


Fig. 34 Wiring the LONWORKS Bus I/O modules in separate rooms

### Maximum Cable Length

For maximum cable lengths and cable specifications of the communication lines, see Table 19 and Table 20 on page 14.

## How to Connect Panel Bus and LONWORKS Bus Mixed Controller Systems

### How to Connect I/O Modules

For connecting the I/O modules with each other ones, proceed as described for single bus controller systems on page 24.

### How to Connect I/O Modules to the Controller

#### Panel Bus I/O Modules

- ▶ Connect communication terminals 71 ...74 or 75... 78 of Panel Bus I/O modules to communication terminals 71 ...74 or 75... 78 of the controller module using either
  - Bridge connectors for flush mounting on a single DIN rail or
  - Cables for separate mounting, e.g., on multiple rails, separate cabinets, etc.

#### LONWORKS Bus I/O Modules

- ▶ Connect communication terminals 71 ... 74 or 75 ... 78 of LONWORKS Bus I/O modules to LONWORKS terminals 11 ... 14 of the controller module using cables.

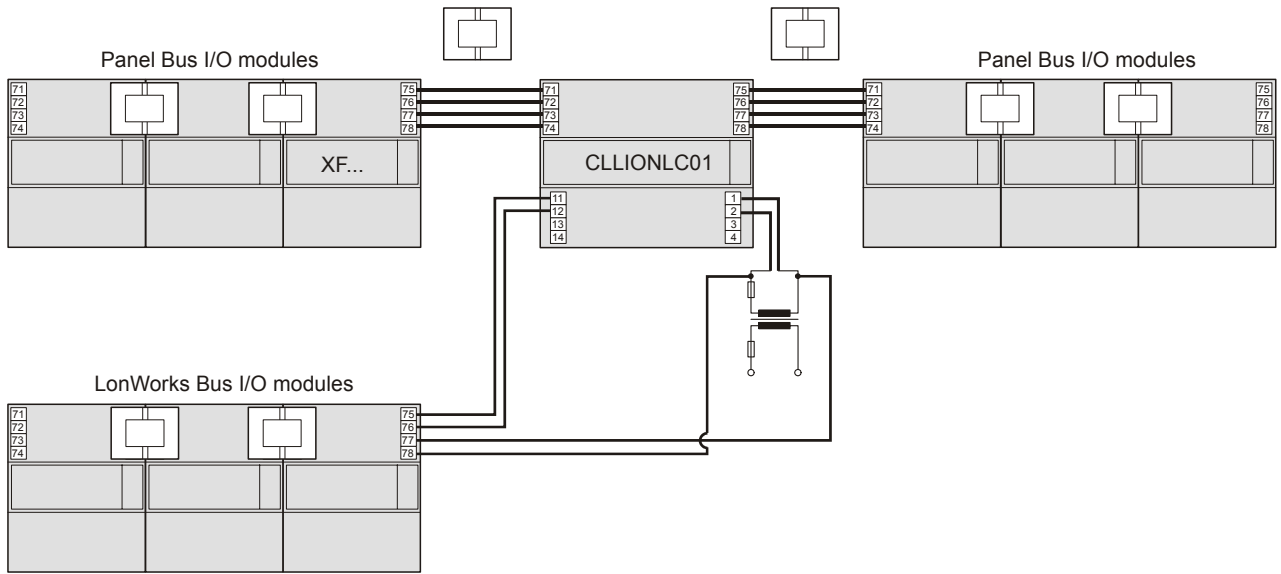


Fig. 35 Mixed bus system – correct wiring

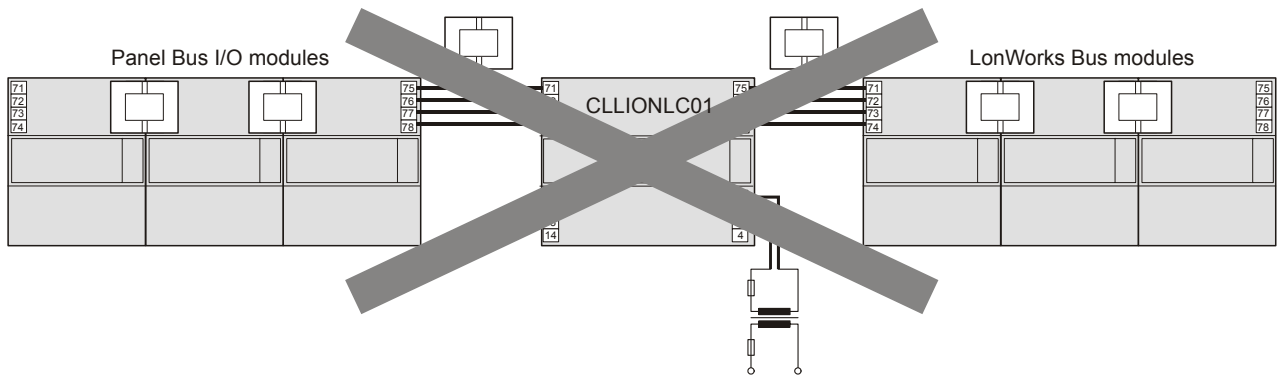


Fig. 36 Mixed bus system – incorrect wiring

## How to Set the Address of Panel Bus I/O Modules

During CARE engineering, each Panel Bus I/O module is assigned its own unique address. For the sake of clarity for maintenance personnel, it is recommended that you address the Panel Bus I/O modules in ascending order 0 through F.

Hex switch	0	1	2	3	4	5	6	7
Address	01	02	03	04	05	06	07	08

Hex switch	8	9	A	B	C	D	E	F
Address	09	10	11	12	13	14	15	16

Table 24 HEX switch settings and addresses

- Use the rotary HEX switch to set the address to the one already defined in CARE.

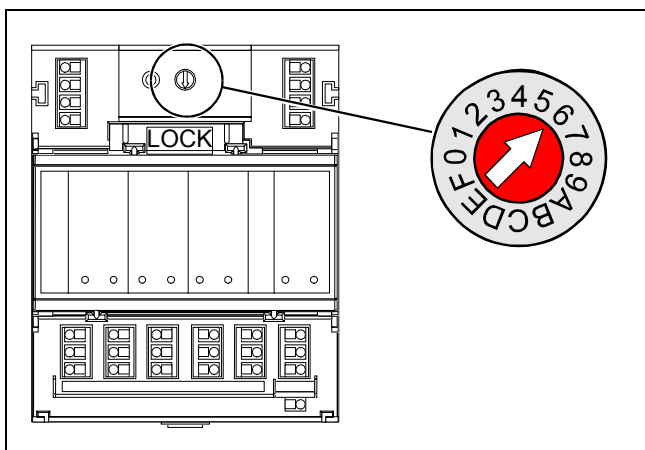


Fig. 37 HEX switch location

### Notes

- If the HEX switch is changed, the Panel Bus I/O module will revert to its default configuration.
- With LONWORKS Bus I/O modules, the HEX switch is without function.

## How to Set I/O Bus Switch

- Set the I/O Bus switch S2 of the CLLIONLC01 depending on the modules connected to terminals 71 ... 78 and the desired communication as follows:

Communication	S2 setting	Terminals
LONWORKS Bus only	LON	71 ... 74 LONWORKS Bus 75 ... 78 LONWORKS Bus 11 ... 14 LONWORKS Bus
Panel Bus and LONWORKS Bus	Panel	71 ... 74 Panel Bus 75 ... 78 Panel Bus 11 ... 14 LONWORKS Bus

Table 25 I/O Bus switch settings

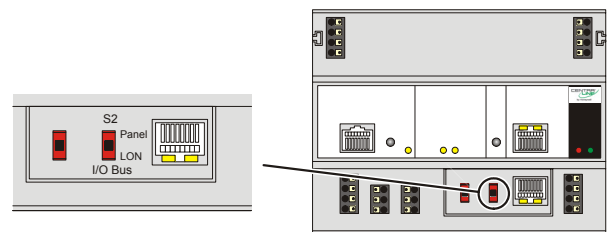


Fig. 38 S2 I/O Bus switch

## How to Connect Field Devices

### How to Connect Field Devices with Power Supply

Depending on the distance from the controller, field devices can be supplied by the controller or need a separate transformer, see Table 21 on page 14.

For fusing see section "Fusing Specifications" on page 11.

#### Example 1: Power Supply via Controller

- 24 V actuator connected to an analog output module
- Less than 100 m away from the controller

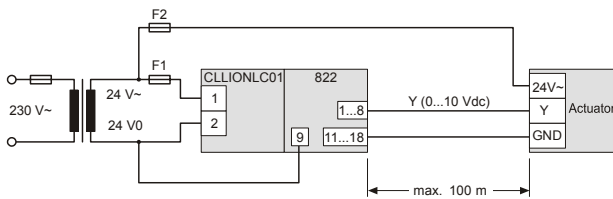


Fig. 39 Power supply of field devices via I/O module

#### Example 2: Power Supply via Separate Transformer

- 24 V actuator connected to an analog output module
- 100 ... 400 m away from the controller

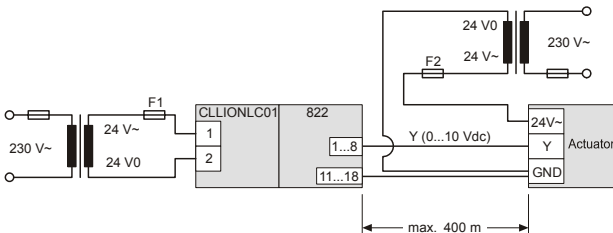


Fig. 40 Power supply of field devices via a separate transformer

## How to Cable Field Devices

### Cable Routing

Route low-voltage signal and output cables separately from mains cables.

Cable	Minimum distance
Shielded	10 mm (0.4 in.)
Unshielded	100 mm (4 in.)

Table 26 Minimum distances to power mains cables

All low-voltage signal and output cables should be regarded as communication circuits in accordance with VDE 0100 and VDE 0800 (or NEC or other equivalent).

### Cable Shielding

- If the general guidelines for cable routing are observed, it is not necessary to shield field device signal and power supply cables.
- If, for whatever reason, the routing guidelines cannot be observed, the field device signal and power supply cables must be shielded.
  - Shielding of cables leading to field devices must be grounded only at the cabinet end.
  - The shield must not be terminated at the CLLIONLC01.

## How to Commission I/O Modules

---

### How to Commission Panel Bus I/O Modules

During CARE engineering, the HEX address of the Panel I/O modules is defined.

**Note**

*With Panel Bus I/O modules it is essential that the HEX switch be set to the address assigned by CARE.*

The CLLIONLC01 Controller automatically commissions all Panel Bus I/O modules.

### How to Commission LONWORKS Bus I/O Modules

Commissioning is done using CARE.

## How to Update Software

---

CARE is used to update the CLLIONLC01 Controller.

### How to Update Software with Panel Bus I/O Modules

The CLLIONLC01 Controller automatically updates all Panel Bus I/O modules.

### How to Update Software with LONWORKS Bus I/O Modules

You can update the LONWORKS I/O modules using CARE or EXCELON.

# How to Connect to External Systems or Interfaces

**WARNING**

**Risk of electric shock or equipment damage!**

- ▶ Do not touch any live parts in the cabinet!
- ▶ Disconnect the power supply before making connections to or removing connections from terminals of controller or I/O modules.
- ▶ Do not reconnect the power supply until you have completed installation.
- ▶ Observe the rules regarding electrostatic discharge.

## How to Connect via LONWORKS Bus

Via a LONWORKS Bus, an LION System can be connected to other controller systems, to additional LONWORKS Bus I/O modules, or to laptops and HMIs.

### LONWORKS Bus Termination

Depending upon the configuration, either 1 or 2 termination modules are required for terminating a LONWORKS bus with FTT devices on it.

The following 2 different LONWORKS termination units are available for this purpose:

- 209541 LONWORKS Bus Termination Module and
- XAL-Term LONWORKS Connection and Termination Module, which can be mounted on DIN rails and in fuse boxes

### Termination Examples

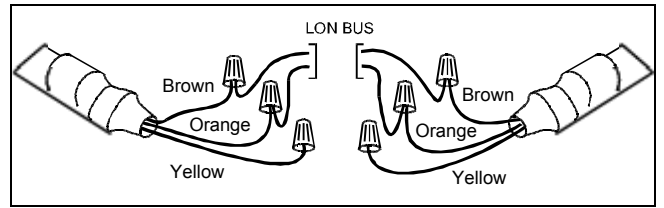


Fig. 41 Termination Module 209541 connections for a doubly-terminated FTT network

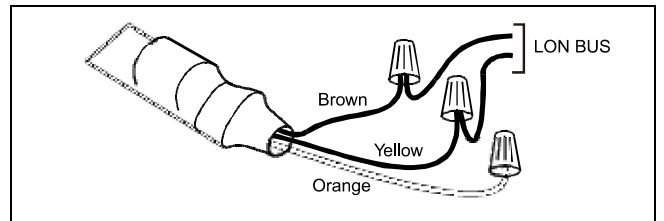


Fig. 42 Termination Module 209541 connections for a singly-terminated FTT network

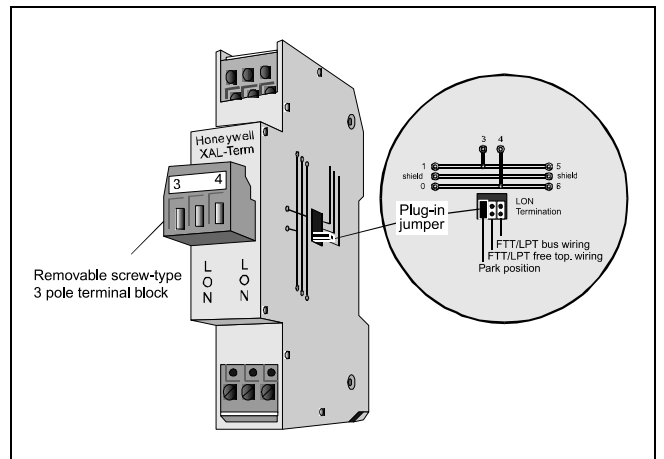


Fig. 43 XAL-Term Connection and Termination Module

## How to Connect via C-Bus

Via C-Bus an LION Controller can be connected to other controller systems to form a network.

### How to Connect to the Controller

- ▶ Connect the C-Bus to the CLLIONLC01 as follows:
  - Input to C-Bus terminals 8 and 9
  - Output to C-Bus terminals 5 and 6
  - Do not connect the C-Bus to the cabinet earth or any other earth ground points

### How to Set C-Bus Termination Switch

- ▶ Set the C-Bus termination switch S1 appropriately.

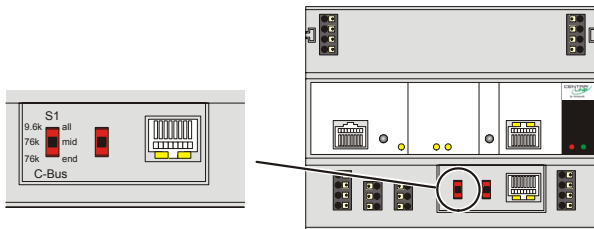


Fig. 44 C-Bus termination switch S1

Switch setting S1	Baud rate
9.6k all	Up to <b>9600 baud</b> (default setting)
76k mid	Up to 76800 baud without bus termination
76k end	Up to 76800 baud with bus termination

Table 27 CLLIONLC01 C-Bus termination switch settings

### How to Shield

In principle, data transmitting cables should be shielded in case of RFI.

- ▶ On the controller side, connect the shield to terminals 7 and 10.
- ▶ On the side of the device, connect the shield to the respective terminals.  
Do not connect it to the cabinet ground or any other ground points.

## How to Connect HMIs or Laptops

Laptops or HMIs, e.g., CLMMI00N21, can either be connected via the HMI interface of the CLLIONLC01 or via the LONWORKS interface.

### How to Connect the CLMMI00N21 Operator Interface

- ▶ Connect the CLMMI00N21 Operator Interface to the HMI interface or LONWORKS interface of the CLLIONLC01 by means of
  - the XW882 cable or
  - the XW582 cable connected with an XW586 cable.

For mounting details refer to the CLMMI00N21 Installation Instructions (Product Literature no.: EN2B-0126GE51).

For cable details refer to section "Preconfigured Connection Cables" on page 12.

### How to Connect Laptops (XL-Online/CARE)

- ▶ Connect a laptop (on which e.g., XL-Online or CARE has been installed) to the HMI interface or LONWORKS interface of the CLLIONLC01 by means of
  - the XW885 cable or
  - the XW585 cable connected with an XW586 Cable.

For cable details refer to section "Preconfigured Connection Cables" on page 12.

## How to Connect Modems

An LION System can be connected to a modem or an ISDN terminal adapter via the Modem Interface of the CLLIONLC01 by means of the XW786 Cable.

- ▶ Connect the RJ45 female connector of the XW586 cable to the modem interface of the CLLIONLC01 Controller.
- ▶ Connect the 9-pin sub-D connector to the modem.

For cable details refer to section "Preconfigured Connection Cables" on page 12.

Refer to Appendix 2 for details regarding remote communication.



# Description of the CLLIONLC01

## Overview

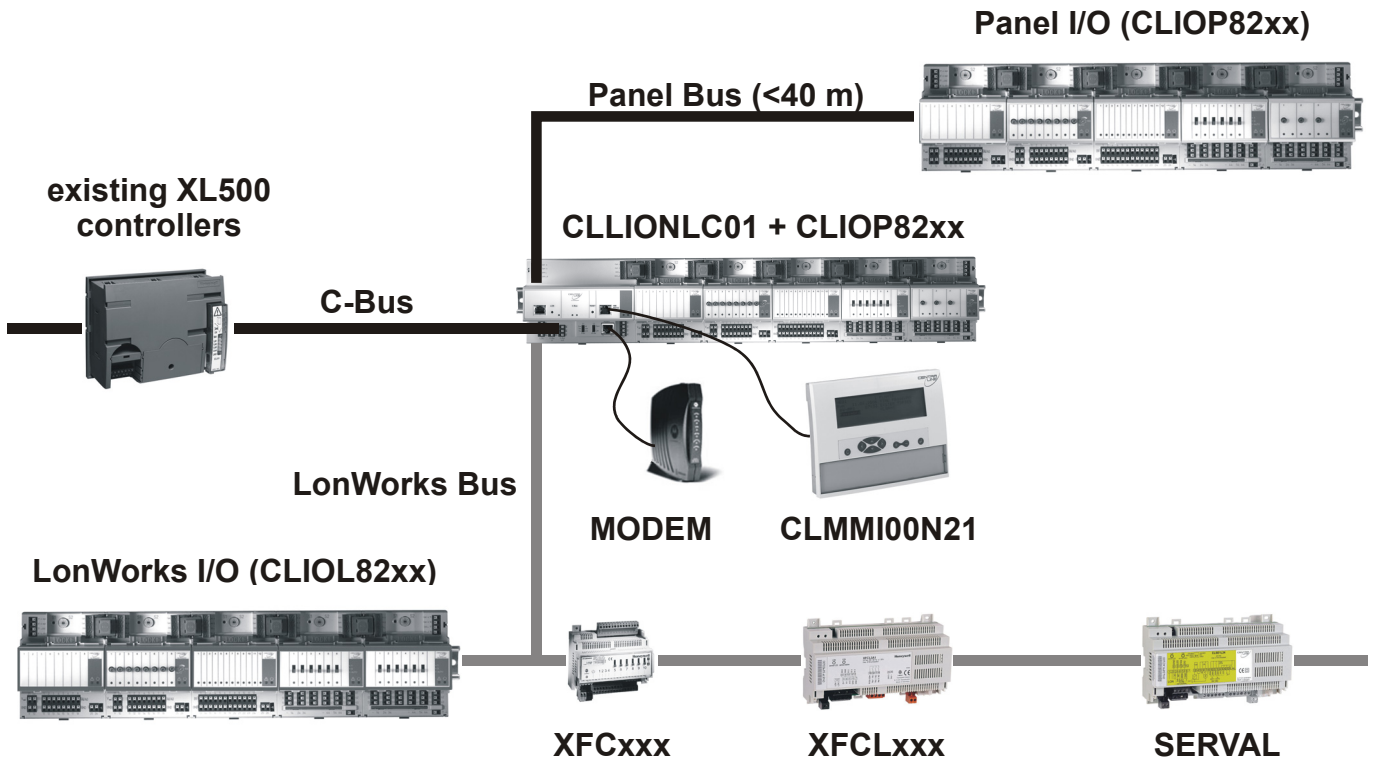


Fig. 45 Connections to the CLLIONLC01 Controller

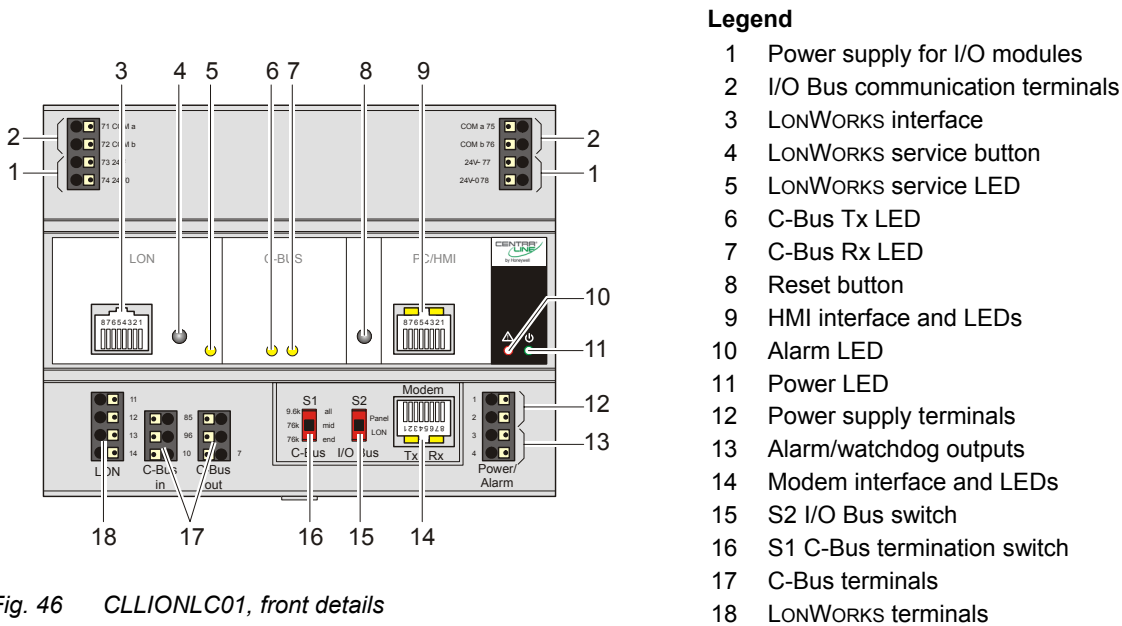


Fig. 46 CLLIONLC01, front details

### CLLIONLC01 Terminals

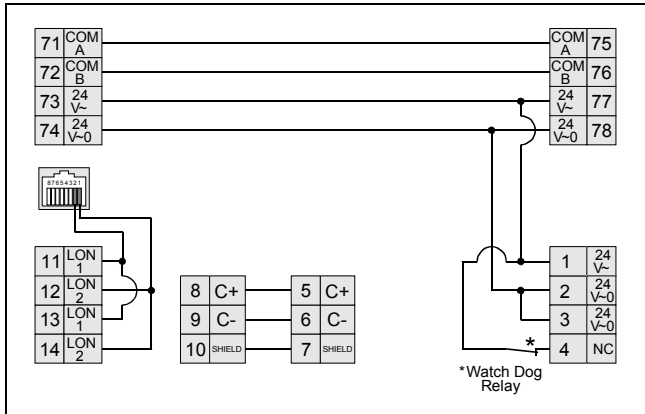


Fig. 47 Terminal assignment and internal connections of the CLLIONLC01

Ter- minal	Signal	Comment
71, 75	COM a	2-wire communication bus (LON/Panel Bus)
72, 76	COM b	2-wire communication bus (LON/Panel Bus)
73, 77	24 V~	Power supply for I/O modules
74, 78	24 V~0	Power supply for I/O modules
1	24 V~	Power supply from transformer
2	24 V~0	Power supply from transformer
3	24 V~0	Alarm/watchdog output
4	NC	Alarm/watchdog output
5, 8	C+	C-Bus
6, 9	C-	C-Bus
7, 10	Shield	C-Bus shield
11, 12	LON	LONWORKS IN
13, 14	LON	LONWORKS OUT

Table 28 Description of CLLIONLC01 terminals

### Features

#### LONWORKS Interface and Terminals

The CLLIONLC01 Controller Module features

- An RJ45 socket serving as an interface to connect laptops or HMIs to the LONWORKS Bus
- LONWORKS terminals 11, 12, 13, and 14 to connect LONWORKS Bus I/O modules or other LONWORKS devices to the CLLIONLC01 Controller or other LONWORKS controllers.

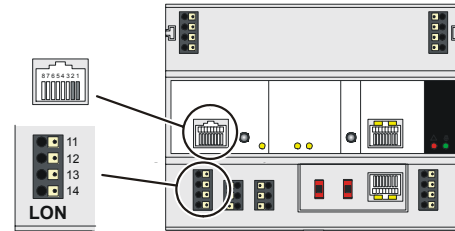


Fig. 48 LONWORKS interface and LONWORKS terminals

#### LONWORKS Interface Signals on RJ45 Socket

Pin	Signal type
1	Connection to LONWORKS Bus
2	Connection to LONWORKS Bus
3 ... 8	Not used

Table 29 Signals of LONWORKS interface

#### LONWORKS Service LED and Button

The CLLIONLC01 is equipped with a LONWORKS service button and corresponding LONWORKS Service LED (status: yellow/OFF).

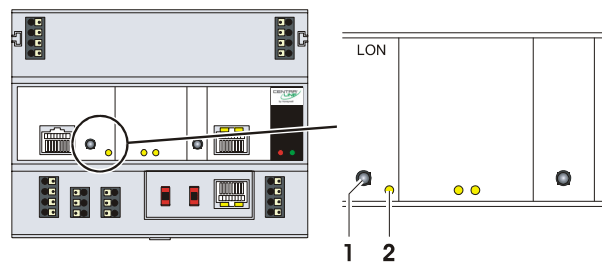


Fig. 49 LONWORKS service button (1) and service LED (2)

See also section "Troubleshooting" on page 67.

### C-Bus Tx LED and Rx LED

The CLLIONLC01 is equipped with a Tx LED (status: yellow/OFF) and an Rx LED (status: yellow/OFF).

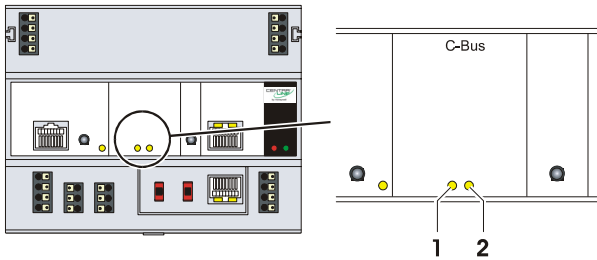


Fig. 50 C-Bus Tx LED (1) and Rx LED (2)

### C-Bus LEDs

<b>Tx (1) flickering</b>	The controller is sending data onto the C-Bus
<b>Rx (2) flickering</b>	The controller is receiving data from the C-Bus

Table 30 Controller C-Bus LEDs

### Reset Button

The CLLIONLC01 is equipped with a reset button.

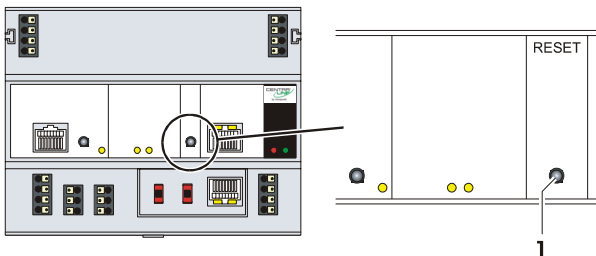


Fig. 51 Reset button (1)

Pushing the reset button (1), e.g. using a paperclip, will cause the CLLIONLC01 to reset.

### Note

*In the event of a reset, all non-volatile memory contents are permanently deleted, though the clock will not be set to zero.*

*In order to avoid problems, we therefore recommend that you always save your application changes (e.g., time program changes) to FLASH memory.*

### HMI Interface

The controller module is equipped with an HMI Interface for the connection of HMIs, e.g., CLMMI00N21 Operator Interface or a laptop (with XL-Online/CARE).

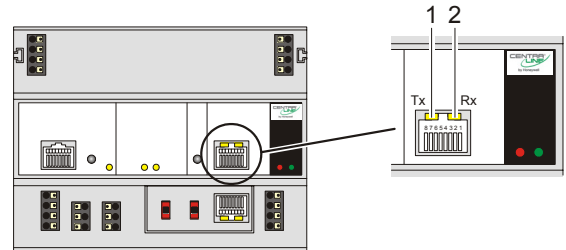


Fig. 52 HMI interface, Tx LED (1) and Rx LED (2)

### HMI interface LEDs on RJ45 socket

<b>Tx (1) flickering</b>	The controller is transmitting data to the HMI
<b>Rx (2) flickering</b>	The controller is receiving data from the HMI

Table 31 HMI interface LEDs

### HMI interface Signals on RJ45 socket

Pin	Signal type
1	-
2	Receive
3	Transmit
4	-
5	Signal ground
6	-
7	5 V
8	-

Table 32 Signals of the HMI interface

### NOTICE

#### Equipment damage!

- ▶ Make sure that the controller is not connected to earth ground.
- ▶ If nonetheless earth grounding is required, make sure that only terminal 2 is connected to earth ground. Terminal 1 must not be connected to earth ground. See also Appendix 1.

## Alarm and Power LEDs

The CLLIONLC01 is equipped with an alarm LED and a power LED.

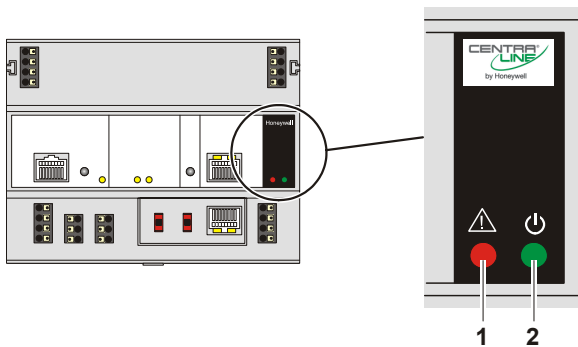


Fig. 53 Alarm LED (1) and power LED (2)

### Alarm LED (1, red)

<b>Off</b>	Normal operation
<b>On</b>	<p>Watchdog alarm output is powered</p> <ul style="list-style-type: none"> <li>The controller has encountered a hardware problem</li> <li>The application has a fault</li> <li>The controller has been powered up without an application or the operator has manually stopped the application, e.g., using XL-Online. In this case, the LED will light up 13 minutes after power-up without application</li> </ul>
<b>Flashing</b>	<p>The watchdog alarm output has not yet been powered, although the controller has encountered a problem.</p> <p>The controller performs a warm start.</p> <p>If the problem persists, the LED will become lit constantly, see above.</p> <p>See section "Troubleshooting" on page 67.</p>

Table 33 Controller alarm LED

### Power LED (2, green)

<b>On</b>	Normal operation
<b>Flashing</b>	<p>One or more of the internal voltage supplies are outside of the permissible ranges.</p> <p>The controller stops operation.</p> <ul style="list-style-type: none"> <li>Check wiring or see section "Troubleshooting" on page 67.</li> </ul>
<b>Goes out briefly</b>	<ul style="list-style-type: none"> <li>The operator has activated the reset button</li> <li>The controller is performing a warm start</li> </ul>

Table 34 Controller power LED

## Watchdog

### Watchdog status

Status	Signal on terminal 4
Failure (= alarm)	24 V
Normal operation	0 V

Table 35 Watchdog status 4

### Permissible Load of Normally Closed Contact (Terminal 4)

	Max. load	Min. current
<b>Per normally closed contact (terminal 4)</b>	<p><b>19...29 VAC</b> current at <math>\cos \varphi \geq 0.95</math>: 0.5 A, current at <math>\cos \varphi \geq 0.6</math>: 0.5 A</p> <p><b>19...29 VDC</b> 0.5 A resistive or inductive</p>	10 mA

Table 36 Permissible load of terminal 4

### Modem Interface

The controller module is equipped with a modem interface for the connection of a modem or an ISDN terminal adapter.

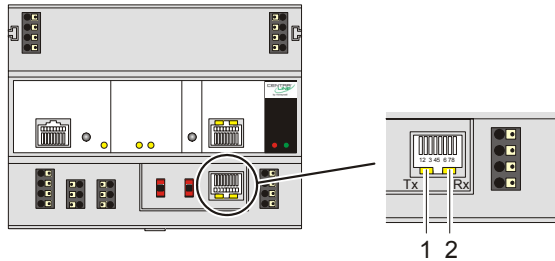


Fig. 54 Modem interface, Tx LED (1) and Rx LED (2)

### Modem LEDs on RJ45 socket

<b>Tx (1) flickering</b>	The controller is transmitting data to the HMI, e.g., CLMMI00N21
<b>Rx (2) flickering</b>	The controller is receiving data from the HMI

Table 37 HMI interface LEDs

### Modem Signals on RJ45 socket

Pin	Signal type
1	Carrier detect
2	Receive
3	Transmit
4	Data terminal ready
5	Signal ground
6	-
7	5 V
8	Clear to send

Table 38 Signals of the modem interface

### Communication Speed

Default setting: **9600 baud**

The communication speed can be set to as high as 38.4 Kbaud, e.g., using the XI852 HMI or a Laptop with XL-Online, see Appendix 2.

### I/O Bus Switch S2

The CLLIONLC01 features a 2-position I/O Bus switch S2. I/O Bus switch S2 must be set in accordance with the kind of I/O modules connected to communication terminals 71, 72 and 75, 76 of the controller module.

Terminals 71, 72 and 75, 76 must be all connected either to Panel Bus I/O modules or to LONWORKS Bus I/O modules.

The **default** setting is **Panel**.

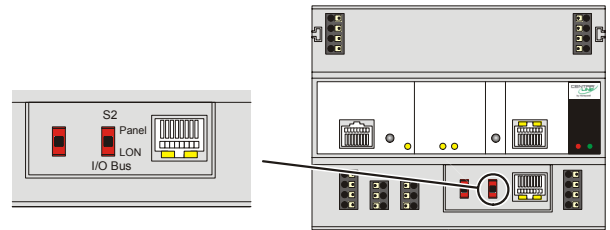


Fig. 55 I/O Bus switch S2

Communication	S2 setting
LONWORKS Bus only	LON
Panel Bus and LONWORKS Bus LONWORKS BUS modules connected to terminals 11 .... 14 of the controller	Panel
Panel Bus connected to terminals 71, 72 or 75, 76 of the controller	Panel

Table 39 I/O Bus switch settings

## C-Bus Termination Switch S1

The CLLIONLC01 features a 3-position C-Bus termination switch S1.

This switch must be set in accordance with the given C-Bus configuration.

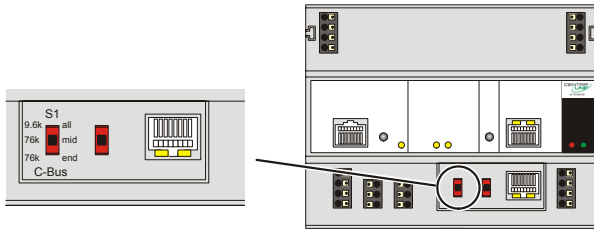


Fig. 56 C-Bus termination switch

Switch setting S1	Baud rate
9.6k all	Up to 9600 baud (default setting)
76k mid	Up to 76800 baud without bus termination
76k end	Up to 76800 baud with bus termination controller at the end of the C-Bus

Table 40 CLLIONLC01 C-Bus termination switch S1 settings

## Memory

Memory	Size	Usage
SRAM	512 KB	For controller application, modem trend and firmware RACL application: 128 KB Total application: 192 KB
Flash	2 MB	Firmware (1 MB) and application (1 MB) storage
EPROM	128 KB	For bootstrap loader

Table 41 CLLIONLC01 memory

### Note

The CLLIONLC01 does not contain a battery. RAM (data and realtime clocktime) is buffered for 3 days by a super capacitor.

## Description of the I/O Modules

### Common Features

#### Switches located on the Terminal Socket

Feature	Function
Service button S1	<ul style="list-style-type: none"> <li>LED test, see section "Troubleshooting" on page 67</li> <li>LONWORKS service button functionality for LONWORKS Bus I/O modules</li> </ul>
Hex switch S2	<ul style="list-style-type: none"> <li>Module addressing for Panel Bus I/O modules</li> </ul>

#### LEDs located on the I/O Module

Feature	Function
Service LED (yellow)	<ul style="list-style-type: none"> <li>Service information, see section "Troubleshooting" on page 67</li> </ul>
Power LED (green)	<ul style="list-style-type: none"> <li>Information on power supply, see section "Troubleshooting" on page 67</li> </ul>

For the location of these elements, see figures of the relative modules.

### Analog Input Modules

#### Types of Analog Input Modules and Terminal Socket

Type	Description	Housing
CLIOP821	Panel Bus analog input module	Light gray
CLIOL821	LONWORKS Bus analog input module	Dark gray
XS821-822	Terminal socket	Light gray

Table 42 LION Analog Input Modules

#### Features

- 8 analog inputs
- Sensor-break and short-circuit detection, see section "Troubleshooting" on page 67.

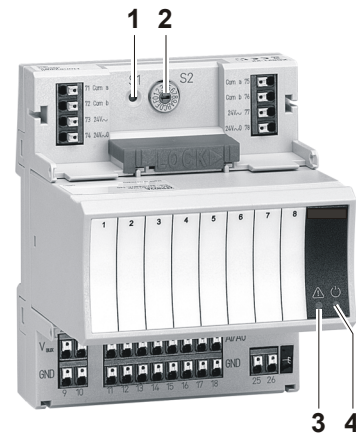


Fig. 57 CLIOP821A Analog Input Module with terminal socket

#### Legend

- Service button S1
- Hex switch S2
- Service LED
- Power LED

Functionality of service LED and power LED: see Table 75 to Table 77 on page 71 and following.

**Terminals**

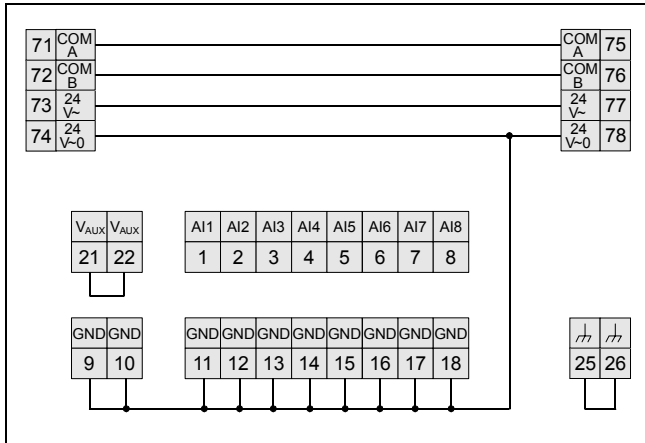


Fig. 58 Terminal assignment and internal connections of analog input modules

Ter- mi- nal	SIGNAL	Comment
71, 75	COM a	2-wire communication bus (LON/Panel Bus)
72, 76	COM b	2-wire communication bus (LON/Panel Bus)
73, 77	24 V~	Power supply
74, 78	24 V~0	Power supply
1...8	AI1 ... AI8	Analog inputs 1...8
9...18	GND	Ground. All grounds are connected internally to each other
21, 22	10 VDC/ 5 mA, ±2 %	Auxiliary voltage signal (used e.g. for supplying setpoint potentiometers)
25, 26		Shield connection (functional earth), internally connected to the DIN rail

Table 43 Description of analog input module terminals

**Notes**

- Shield connection to be used for shielded I/O cables only. It is not allowed to connect a LONWORKS shield, since LONWORKS requires a resistor and a capacitor.
- If additional shield terminals are needed, the XS814 Auxiliary Terminal Package can be installed.

**Technical Data**

<b>Input</b>	<ul style="list-style-type: none"> <li>• 0(2) ... 10 VDC</li> <li>• 0(4) ... 20 mA (via external 499 Ω/0.25 % resistor)</li> <li>• NTC20k (-50...+150 °C; default)</li> <li>• PT1000-1 (-50...+150 °C)</li> <li>• PT1000-2 (0...+400 °C)</li> <li>• PT3000 (-50...+150 °C)</li> <li>• BALCO500 (-30...+120 °C)</li> <li>• Slow binary input</li> </ul>
<b>Protection</b>	Protected against failure voltage (24 VAC, 40 VDC)
<b>Resolution</b>	16-bit resolution
<b>Accuracy</b>	±75 mV (0 ... 10 V), without sensor

Table 44 Analog input modules data

Range	Measurement error (without sensor tolerance)				
	PT1000-1	PT1000-2	Balco500 *	PT3000	NTC20k (default)
-50 ... -20 °C (-58 ... -4 °F)	≤ 1.2 K	-	≤ 1.2 K	≤ 1.2 K	≤ 5.0 K
-20 ... 0 °C (-4 ... +32 °F)	≤ 0.7 K	-	≤ 0.7 K	≤ 0.7 K	≤ 1.0 K
0 ... 30 °C (32 ... 86 °F)	≤ 0.5 K	≤ 0.5 K	≤ 0.5 K	≤ 0.5 K	≤ 0.3 K
30 ... 70 °C (86 ... 158 °F)	≤ 0.7 K	≤ 0.7 K	≤ 0.7 K	≤ 0.7 K	≤ 0.5 K
70 ... 100 °C (158 ... 212 °F)	≤ 1.2 K	≤ 1.2 K	≤ 1.2 K	≤ 1.2 K	≤ 1.0 K
100 ... 130 °C (212 ... 266 °F)	≤ 1.2 K	≤ 1.2 K	≤ 1.2 K	≤ 1.2 K	≤ 3.0 K
130 ... 150 °C (266 ... 302 °F)	≤ 1.2 K	≤ 1.2 K	-	≤ 1.2 K	≤ 5.5 K
150 ... 400 °C (302 ... 752 °F)	-	≤ 1.2 K*	-	-	-

\* Balco specified for -30 °C ... +120 °C only

Table 45 Accuracy of analog input sensors

**Note**

The accuracy of the sensor itself is not included in this table.



**Internal Impedance when Connecting Sensors**

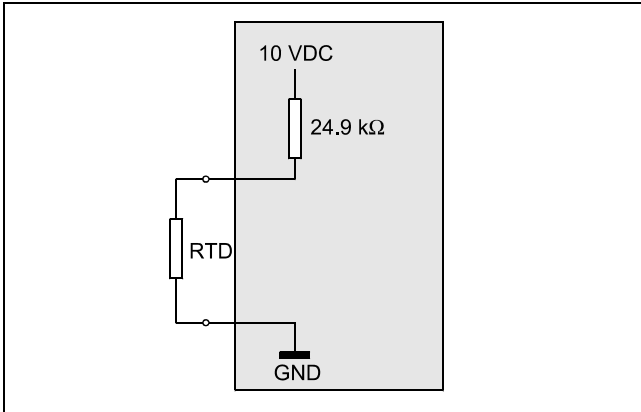


Fig. 59 Analog input low impedance (input circuit for PT1000, Balco, PT3000, slow binary input)

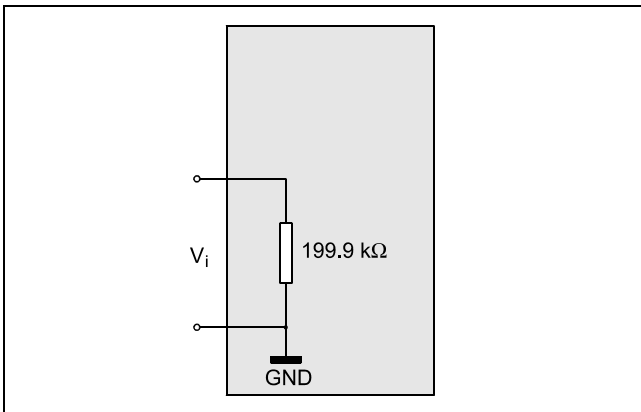


Fig. 60 Analog input high impedance (input circuit for voltage input for active sensors)

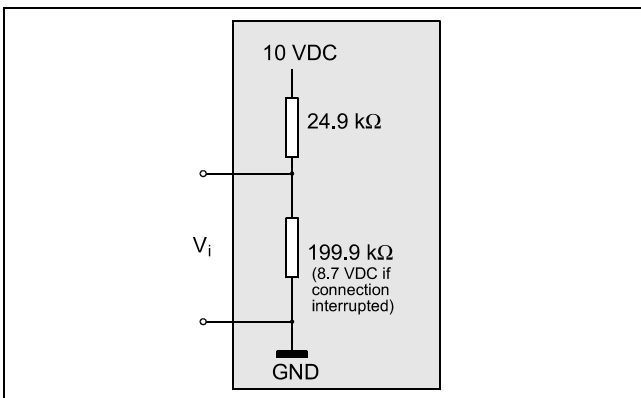


Fig. 61 Analog input impedance set-point (input circuit for NTC20k, wall module setpoint)

### Connection Examples

#### Active Sensor and Potentiometer

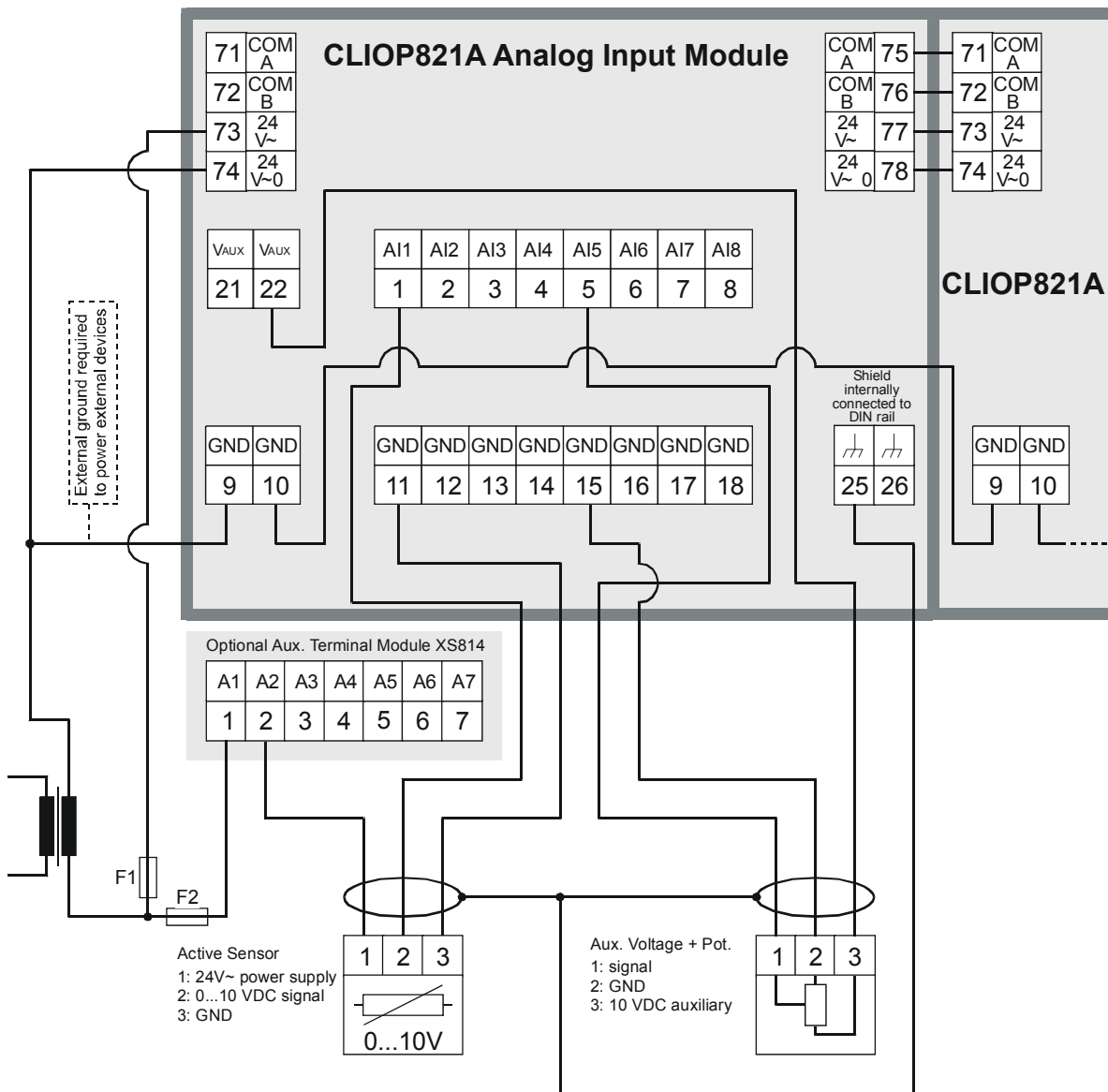


Fig. 62 Analog input module, wiring example 1

For fusing specifications see section "Fusing Specifications" on page 11.

Passive Sensor and 0 (4) ... 20 mA Signal

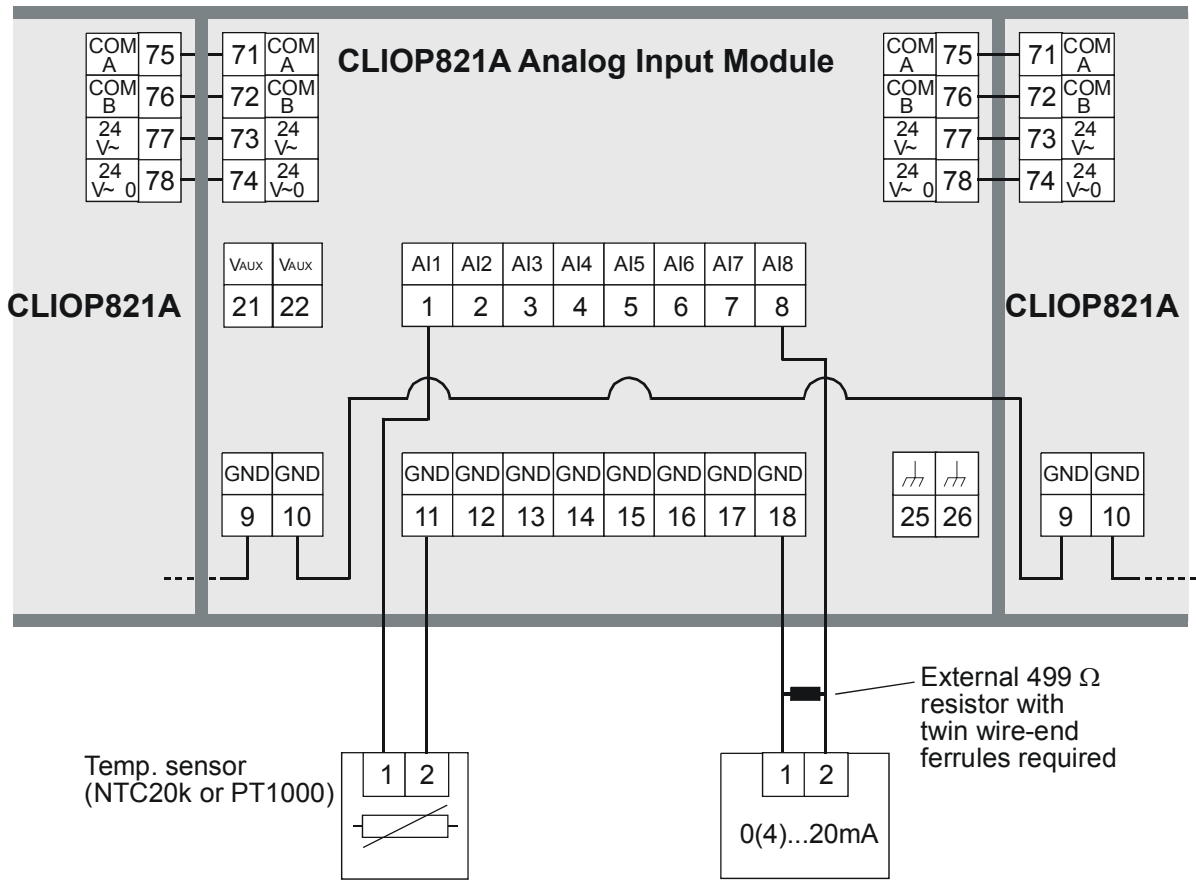


Fig. 63 Analog input module, wiring example 2

## Analog Output Modules

### Types of Analog Output Modules and Terminal Socket

Type	Description	Housing
CLiop822	Panel Bus analog output module	Light gray
CLiOPR822	Panel Bus analog output module with manual overrides	Light gray
CLiOL822	LONWORKS Bus analog output module	Dark gray
CLiOLR822	LONWORKS Bus analog output module with manual overrides	Dark gray
XS821-22	Terminal socket	Light gray

Table 46 LION Analog Output Modules

### Features

- 8 analog outputs; can also be configured per output as binary outputs (0 ... 10 V, 2 ... 10 V, ON/OFF, or floating)
- Corresponding output status LEDs (red)
- ...R822: 8 manual overrides, see figure below

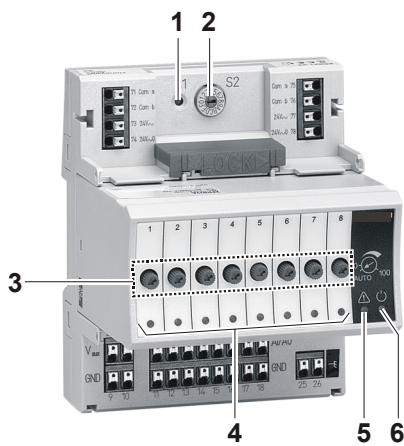


Fig. 64 CLiOP822A Analog Output Module with terminal socket

### Legend

- 1 Service button S1
- 2 Hex switch S2
- 3 Manual overrides
- 4 Output LEDs

- 5 Service LED
- 6 Power LED

Functionality of service LED and power LED: see Table 75 to Table 77 on page 71 and following.

In the event of communication problems, the analog outputs will move to the safety positions you have configured in CARE, see analog output point description in the CARE – User Guide, 74-5587/EN2B-0182GE51.

### Terminals

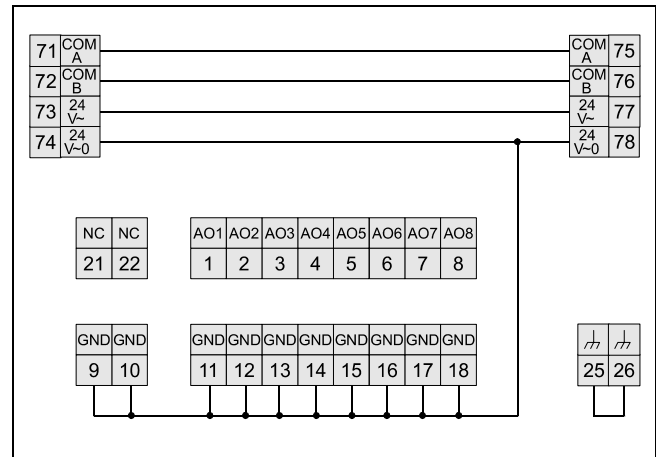


Fig. 65 Terminal assignment and internal connections of the analog output modules

Ter- mi- nal	Signal	COMMENT
71, 75	COM a	2-wire communication bus (LON/Panel Bus)
72, 76	COM b	2-wire communication bus (LON/Panel Bus)
73, 77	24 V~	Power supply
74, 78	24 V~0	Power supply
1...8	AO1...AO8	Analog outputs 1...8
9...18	GND	Ground. All grounds are connected internally to each other
21, 22	N.C.	Do not use!
25, 26		Shield connection (functional earth), internally connected to the DIN rail

Table 47 Description of the analog output module terminals

### Notes

- Shield connection to be used for shielded I/O cables only. It is not allowed to connect a LONWORKS shield, since LONWORKS requires a resistor and a capacitor.
- If additional shield terminals are needed, the XS814 Auxiliary Terminal Package can be installed.

## Technical Data

<b>Voltage rating</b>	0(2)...11 V (default)
<b>Current rating</b>	max. $\pm 1$ mA
<b>Resolution</b>	8 bit
<b>Accuracy</b>	$\pm 150$ mV
<b>Zero output voltage</b>	< 200 mV
<b>Protection</b>	Short-circuit protected; protected against failure voltage (24 VAC, 40 VDC)
<b>Feedback signal</b>	Auto/manual mode and output value

Table 48 Analog output modules data

### Output status LEDs behavior

<b>Automatic mode</b>	Brightness follows the commanded output signal
<b>Override mode</b>	Flashes

Table 49 Analog output status LED behavior

## Modules with Manual Overrides

The CLIOPR822A/CLIOLR822A Analog Output Modules are equipped with manual overrides: one rotary knob for each analog output.

The manual overrides can be set manually to either "auto" or "0...110 %" (infinitely adjustable).

---

## NOTICE

---

### Damage to the electronic module!

- ▶ Do not use a tool to adjust the rotary knobs.
  - ▶ Do not use excessive force. Adjust only by hand.
- 

## Analog Outputs Configured as Binary Outputs

Using CARE, the analog outputs can be configured individually as binary outputs. The voltage output is then 0 V or 10 V, depending upon the signal from the controller.

Connection example

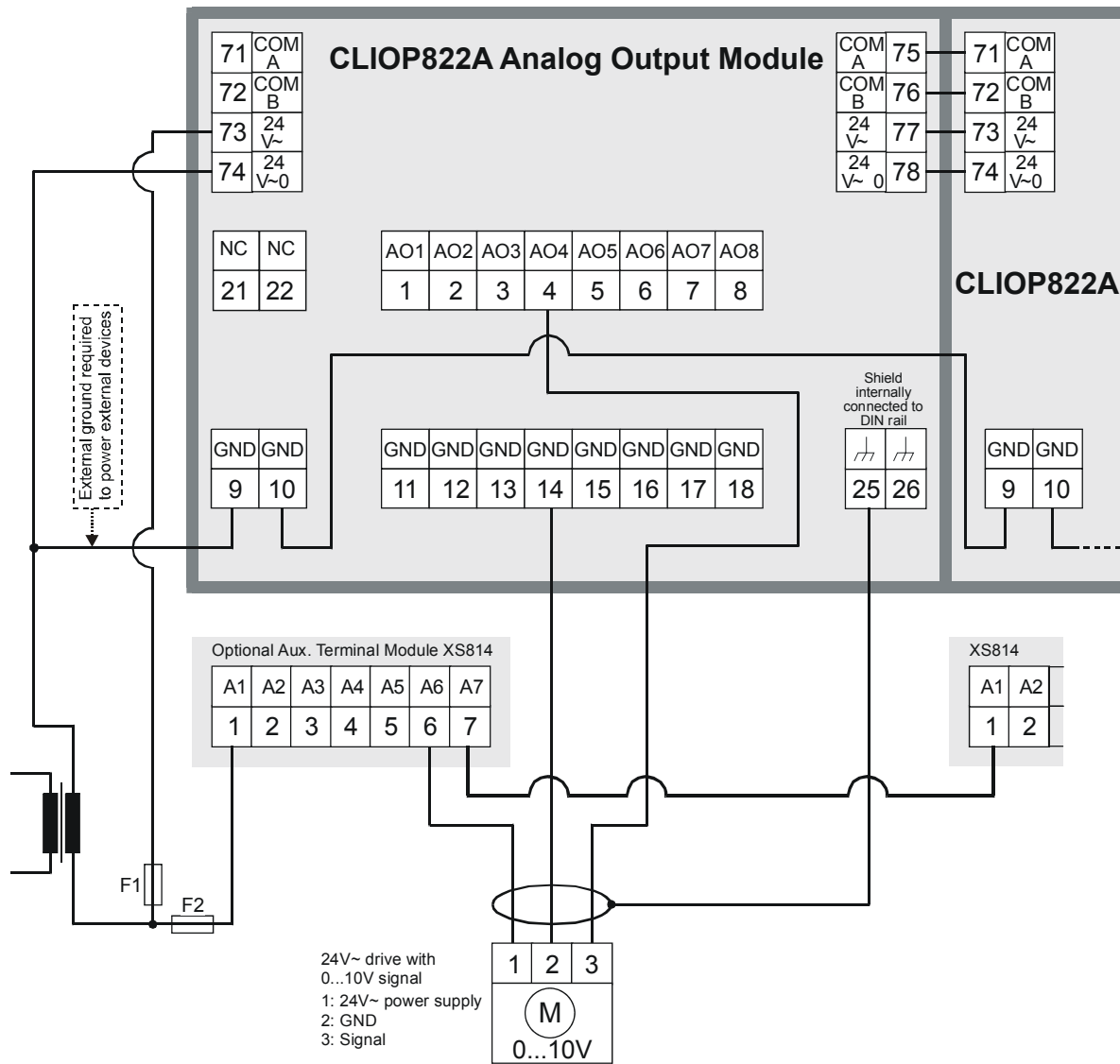


Fig. 66 Analog output connection example

For fusing specifications see section "Fusing Specifications" on page 11.

### Synchronization Behavior of Analog Output Module Configured as Floating Output

In order to regularly update the real actuator position with the calculated position and thus ensure that the actuator definitely reaches its end position, a synchronization process is performed by the analog output module.

During the synchronization process, the analog output module will continue running for the configured runtime once it reaches the calculated end position.

This updating (synchronization) is performed:

- If the calculated position of the actuator < lower synchronization threshold (2 %) = synchronization towards 0 %
- If the calculated position of the actuator > upper synchronization threshold (98 %) = synchronization towards 100 %
- Following any power-up or any reset

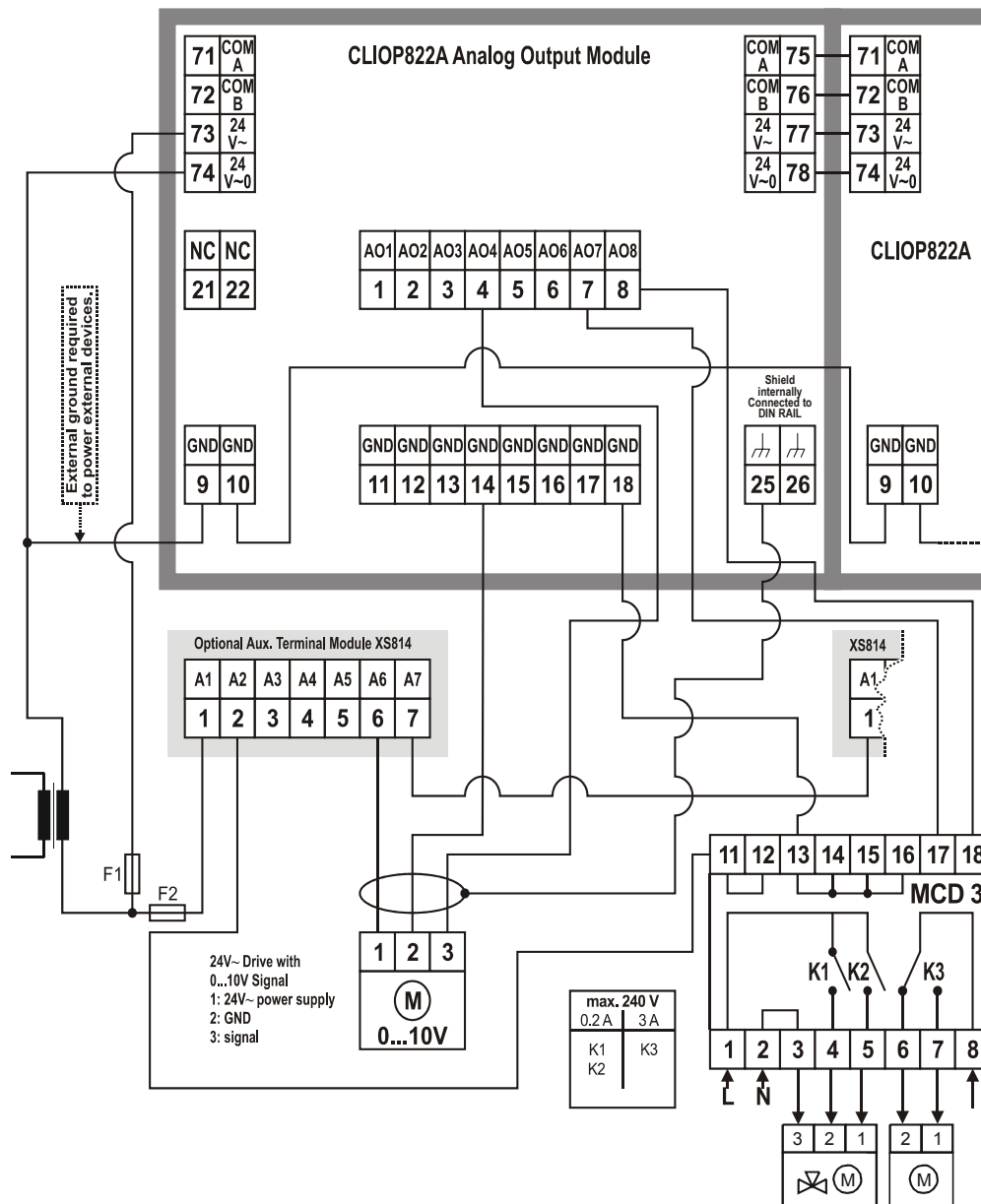


Fig. 67 Connection example with Relay Module MCD 3

- The relay module facilitates the control of peripheral devices with high load via the analog outputs.
  - Input terminal 17 controls of MCD3 controls changeover contact K3.
  - Relay terminal 18 of MCD3 controls the N.O. contacts (floating outputs) K1, K2.
- For fusing specifications, see section "Fusing Specifications" on page 11.

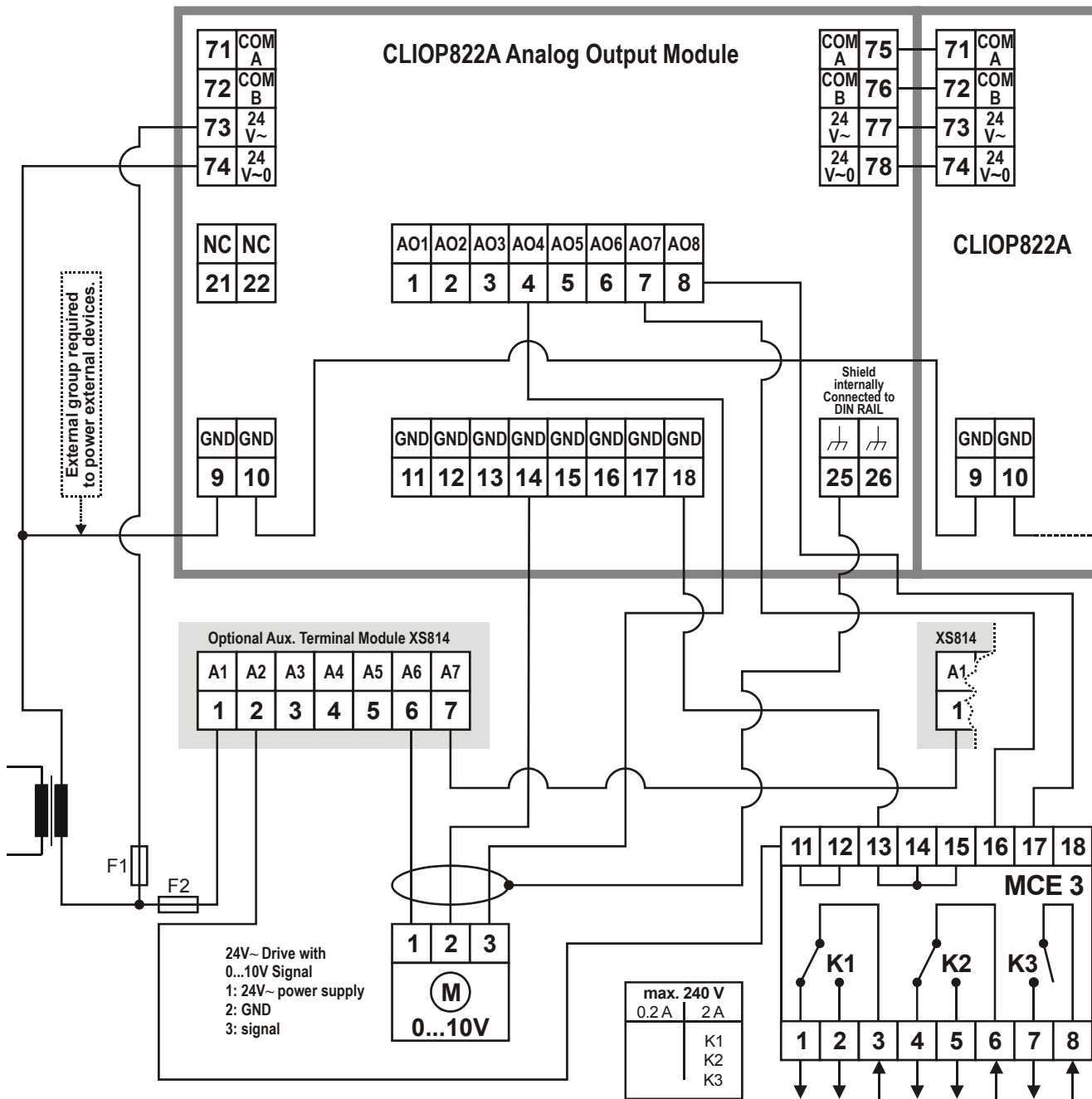


Fig. 68 Connection example with Relay Module MCE 3

The relay module facilitates the control of peripheral devices with high load via the analog outputs.

- Input terminal 16 of MCE3 controls the N.O. contact K3.
- Input terminal 17 of MCE3 controls the changeover contact K2.
- Input terminal 18 of MCE3 controls the changeover contact K1.

For fusing specifications, see section "Fusing Specifications" on page 11.



## Binary Input Modules

### Types of Binary Input Modules and Terminal Socket

Type	Description	Housing
CLIOP823	Panel Bus binary input module	Light gray
CLIOL823	LONWORKS Bus binary input module	Dark gray
XS823	Terminal socket	Light gray

Table 50 LION Binary Input Modules

### Features

- 12 binary inputs
- 12 configurable status LEDs (green/red, yellow/OFF)
- Binary inputs can be used as
  - Static digital inputs as dry-contacts (default)
  - Fast totalizers (up to 20 Hz)

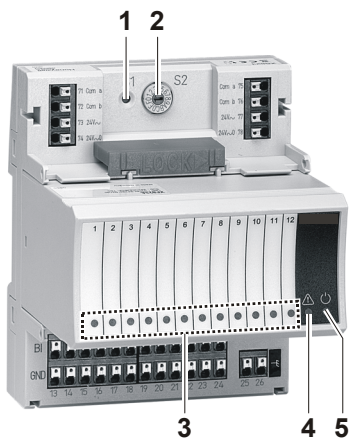


Fig. 69 CLIOP823A Binary Input Module with terminal socket

### Legend

- 1 Service button S1
- 2 Hex switch S2
- 3 Input LEDs
- 4 Service LED
- 5 Power LED

Functionality of service LED and power LED: see Table 75 to Table 77 on page 71 and following.

### Terminals

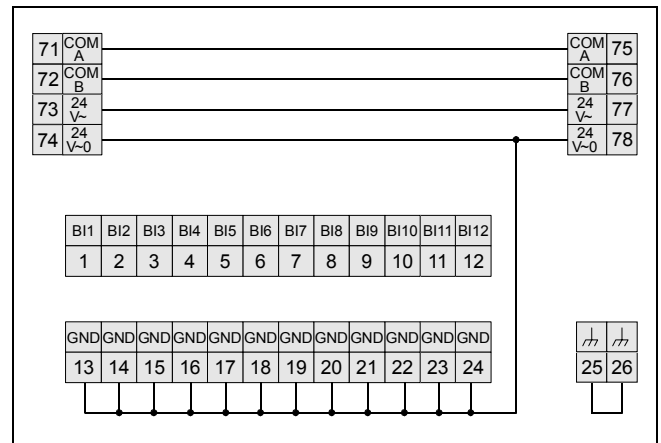


Fig. 70 Terminal assignment and internal connections of binary input modules

Ter-minal	Signal	COMMENT
71, 75	COM a	2-wire communication bus (LON/Panel Bus)
72, 76	COM b	2-wire communication bus (LON/Panel Bus)
73, 77	24 V~	Power supply
74, 78	24 V~0	Power supply
1...12	BI1...BI12	Binary inputs 1...12
13...24	GND	Ground. All grounds are connected internally to each other.
25, 26		Shield connection (functional earth), internally connected to the DIN rail.

Table 51 Description of binary input module terminals

### Notes

- Shield connection to be used for shielded I/O cables only. It is not allowed to connect a LONWORKS shield, since LONWORKS requires a resistor and capacitor.
- If additional shield terminals are needed, the XS814 Auxiliary Terminal Package can be installed.

## Technical Data

<b>Input type</b>	Dry-contact or open collector
<b>Current rating (closed input)</b>	2 mA
<b>Open contact voltage</b>	16...22 VDC
<b>Protection</b>	Protected against failure voltage (24 VAC, 40 VDC)

## Status LEDs

Using CARE, the status LEDs can be configured individually for use as either alarm LEDs (red/green) or as status LEDs (yellow/OFF [default]).

Given a state of "logical ON," the LED will be lit (yellow or red).

## Configuration as Fast Totalizer

Using CARE, the binary inputs can be configured as fast totalizers for operation in conjunction with devices equipped with an open collector output.

<b>Frequency</b>	max. 20 Hz
<b>Pulse ON</b>	min. 25 ms
<b>Pulse OFF</b>	min. 25 ms
<b>Bounce</b>	max. 5 ms

Table 52 Binary inputs used as fast totalizers

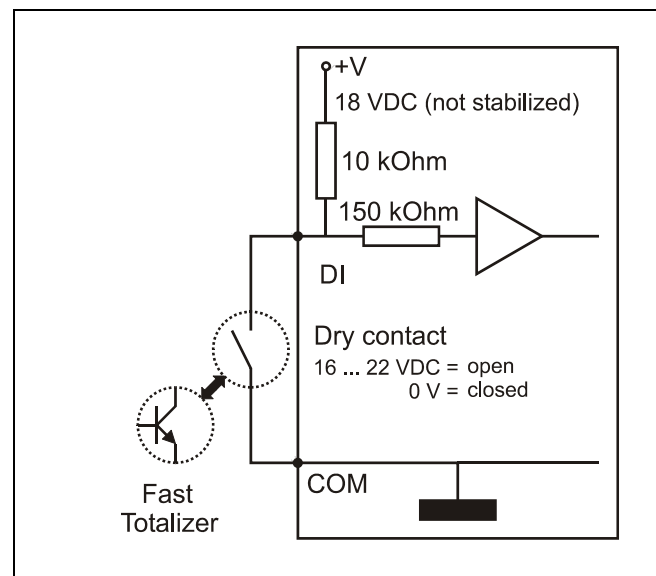


Fig. 71 Configuration of binary input as fast totalizer

Connection example

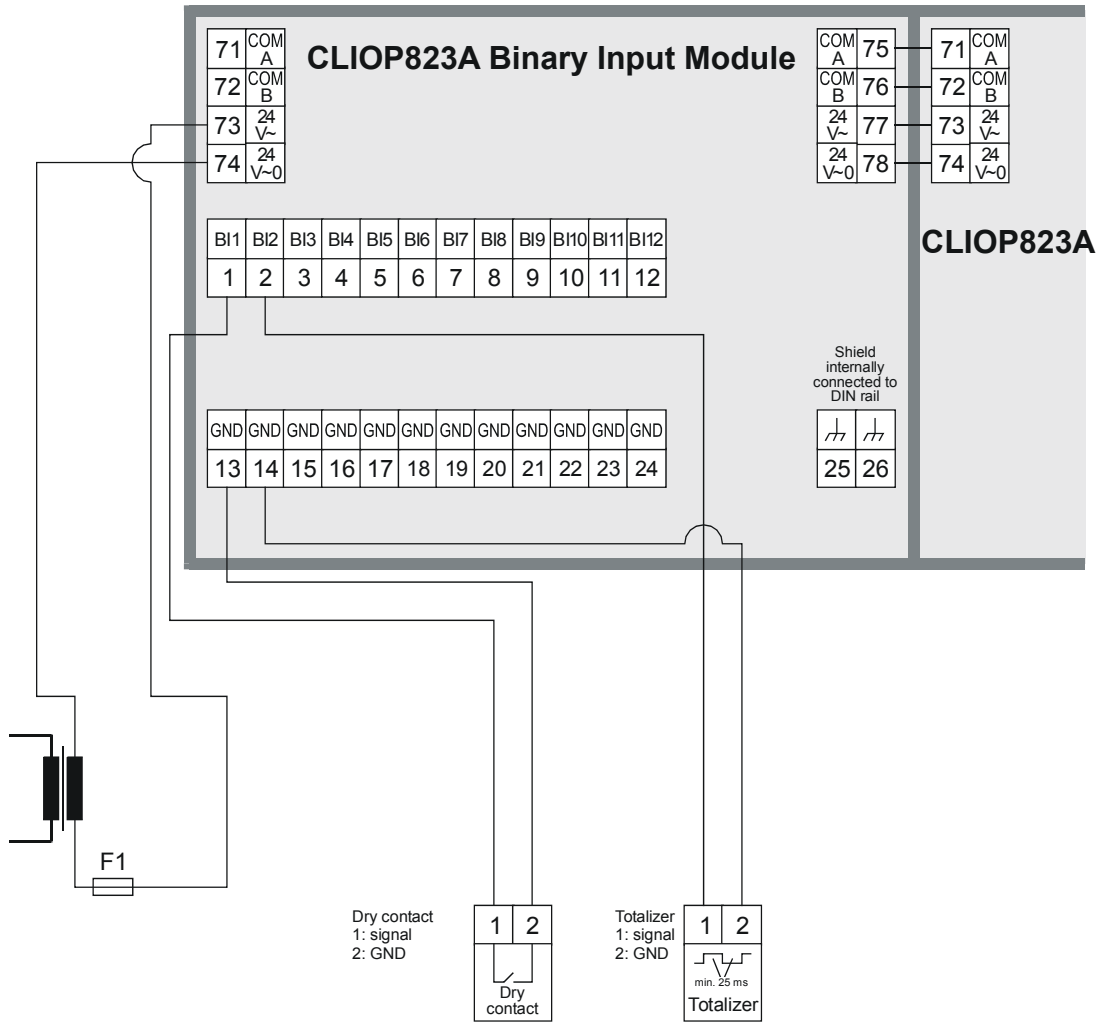


Fig. 72 CLIOP823A connection examples

For fusing specifications, see section "Fusing Specifications" on page 11.

## Relay Output Modules

### Types of Relay Output Modules and Terminal Socket

Type	Description	Housing
CLIOP824	Panel Bus relay output module	Light gray
CLIOPR824	Panel Bus relay output module with manual overrides	Light gray
CLIOL824	LONWORKS Bus relay output module	Dark gray
CLIOLR824	LONWORKS Bus relay output module with manual overrides	Dark gray
XS824-25	Terminal socket, delivered with long (red) cross connector installed	Light gray

Table 53 LION Relay Output Modules

### Features

- 6 relays (changeover contacts), arranged in two blocks
- ...R824: 6 manual overrides
- Low and line voltage allowed, see WARNING.

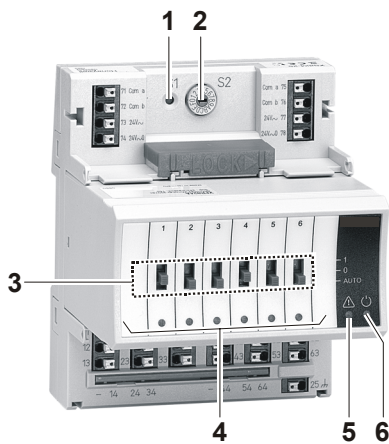


Fig. 73 CLIOP824A Relay Output Module with terminal socket

### Legend

- 1 Service button S1
- 2 Hex switch S2
- 3 Manual overrides
- 4 Status LEDs
- 5 Service LED
- 6 Power LED

Functionality of service LED and power LED: see Table 75 to Table 77 on page 71 and following.

In the event of communication problems, the relay outputs will move to the safety positions you have configured in CARE, see relay output point description in the CARE – User Guide, 74-5587/EN2B-0182GE51.

### WARNING

**Risk of electric shock or equipment damage!**  
**Low voltage and line voltage must not be wired within the same relay block.**

- ▶ Wire low voltage e.g., to relay block 1 and line voltage to relay block 2 or vice versa. In this case the short cross connectors must be used, see Table 5 on page 8.

### NOTICE

#### Risk of malfunction!

**Cross connectors may only be used if the same voltage is used on all relays they connect.**

- ▶ Do not use a cross connector if different voltages are used on the relays.  
 E.g., use a short cross connector for relay block 1 with line voltage and no cross connector for relay block 2 with 12 V low voltage for relay 4 and 24 V low voltage for relays 5 and 6.

**Terminals**

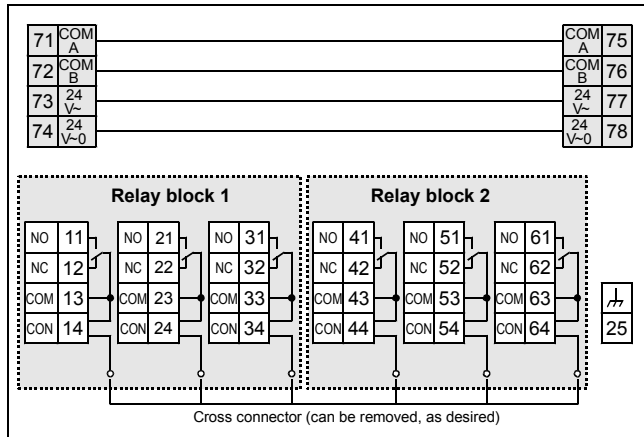


Fig. 74 Terminal assignment and internal connections of relay output modules

Terminal	Signal	Comment	
71, 75	COM a	2-wire communication bus (LON/Panel Bus)	
72, 76	COM b	2-wire communication bus (LON/Panel Bus)	
73, 77	24 V~	Power supply	
74, 78	24 V-0	Power supply	
RELAY BLOCK 1	11	REL1 N.O.	Relay 1 N.O. contact
	12	REL1 N.C.	Relay 1 N.C. contact
	13	R1 COM	relay 1 common contact
	14	R1 COM	For connection of relay 1 common via cross connector*
	21	REL2 N.O.	Relay 2 N.O. contact
	22	REL2 N.C.	Relay 2 N.C. contact
	23	R2 COM	Relay 2 common contact
	24	R2 COM	For connection of relay 2 common via cross connector*
	31	REL3 N.O.	Relay 3 N.O. contact
	32	REL3 N.C.	Relay 3 N.C. contact
	33	R3 COM	Relay 3 common contact
	34	R3 COM	For connection of relay 3 common via cross connector*
RELAY BLOCK 2	41	REL4 N.O.	Relay 4 N.O. contact
	42	REL4 N.C.	Relay 4 N.C. contact
	43	R4 COM	Relay 4 common contact
	44	R4 COM	For connection of relay 4 common via cross connector*
	51	REL5 N.O.	Relay 5 N.O. contact
	52	REL5 N.C.	Relay 5 N.C. contact
	53	R5 COM	Relay 5 common contact
	54	R5 COM	For connection of relay 5 common via cross connector*
	61	REL6 N.O.	Relay 6 N.O. contact
	62	REL6 N.C.	Relay 6 N.C. contact
	63	R6 COM	Relay 6 common contact
	64	R6 COM	For connection of relay 6 common via cross connector*
25	⏏	Shield connection (functional earth), internally connected to the DIN rail	

\* Do not connect by wire!

Table 54 Description of relay output module terminals

**Permissible Loads**

	Max. load	Min. load
<b>Per relay output module (total)</b>	<b>19...250 VAC</b> current at $\cos \varphi \geq 0.6$ : 12 A <b>1...29 VDC</b> 12 A resistive, 3 A inductive	—
<b>Per normally open contact</b>	<b>19...250 VAC</b> current at $\cos \varphi \geq 0.6$ : 4 A <b>1...29 VDC</b> 4 A resistive, 1 A inductive	50 mW
<b>Per normally closed contact</b>	<b>19...250 VAC</b> current at $\cos \varphi \geq 0.95$ : 2 A, current at $\cos \varphi \geq 0.6$ : 1 A <b>1...29 VDC</b> 4 A resistive, 1 A inductive	50 mW

Table 55 Permissible loads of relay output modules

**Notes**

- In the case of voltages above 30 VAC/DC and if inductive components are to be connected to relays switching more often than once every 2 minutes, these components must be prevented from causing harmful interference to radio or television reception (conformance with EN 55014).
- Max. voltage for UL 864-compliant applications is 24 V.

**Status LEDs with Manual Overrides**

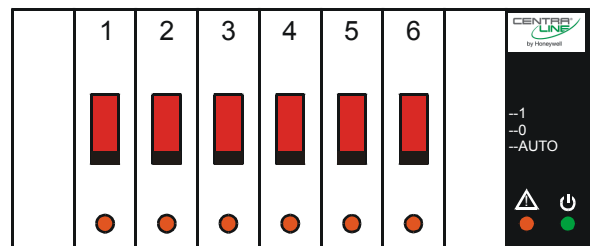


Fig. 75 Manual overrides (sliding switches)

The ...R824A Relay Output Modules are equipped with manual overrides: one for each relay output. These sliding switches can manually be set to either "auto" or "0" or "1".

**Output status LEDs behavior and relay output behavior**

Mode	LED	N.O.* (direct)	N.C.* (reverse)
Automatic mode, state "logical ON"	ON	ON	OFF
Automatic mode, state "logical OFF"	OFF	OFF	ON
Override mode (setting "0")	Flashes	OFF	ON
Override mode (setting "1")	Flashes	ON	OFF

\*As configured using CARE.

Table 56 Relay output status LED behavior

Connection Example

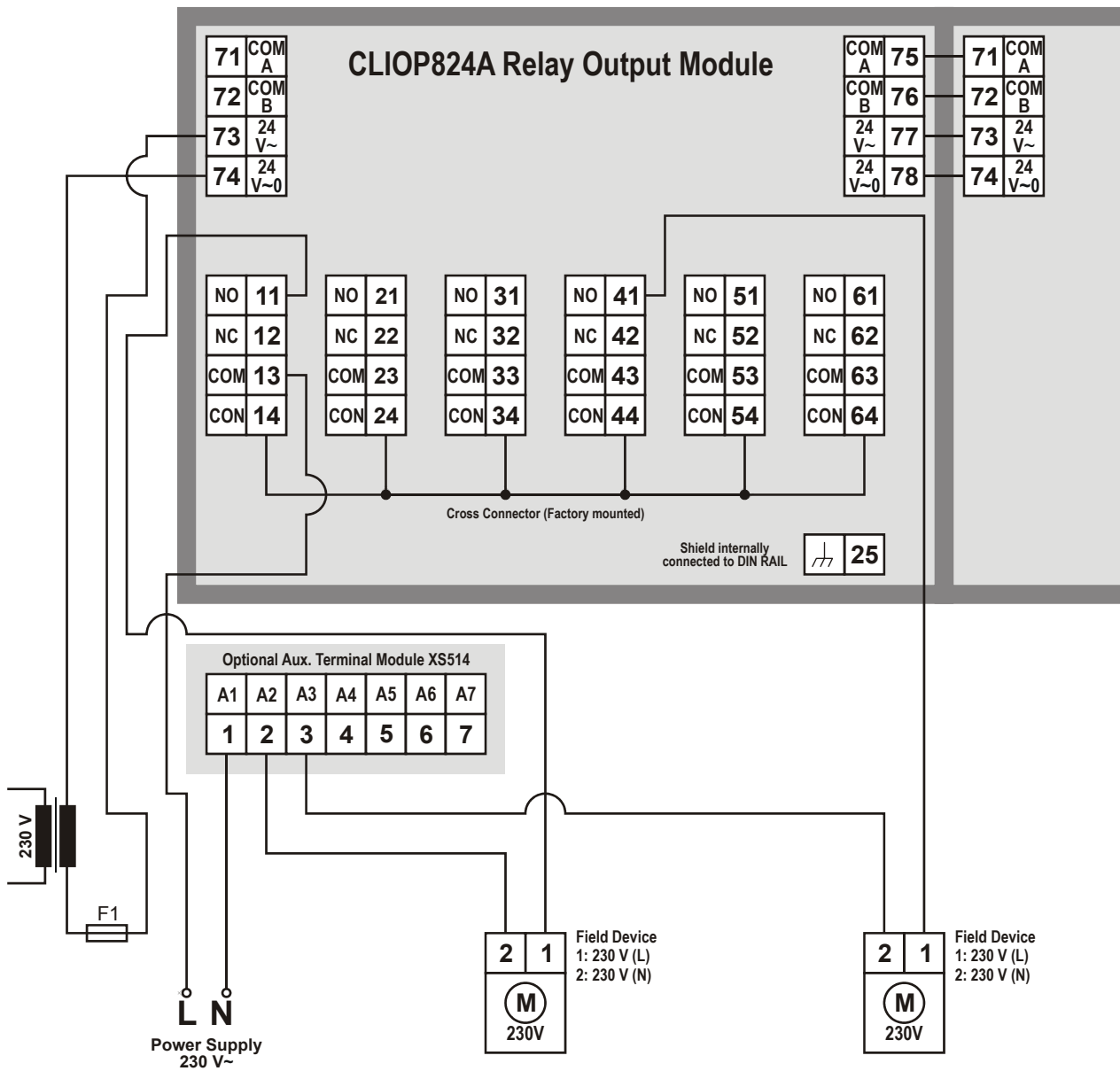


Fig. 76 CLIO824A connection example (both relay blocks with line voltage)

For fusing specifications see section "Fusing Specifications" on page 11.

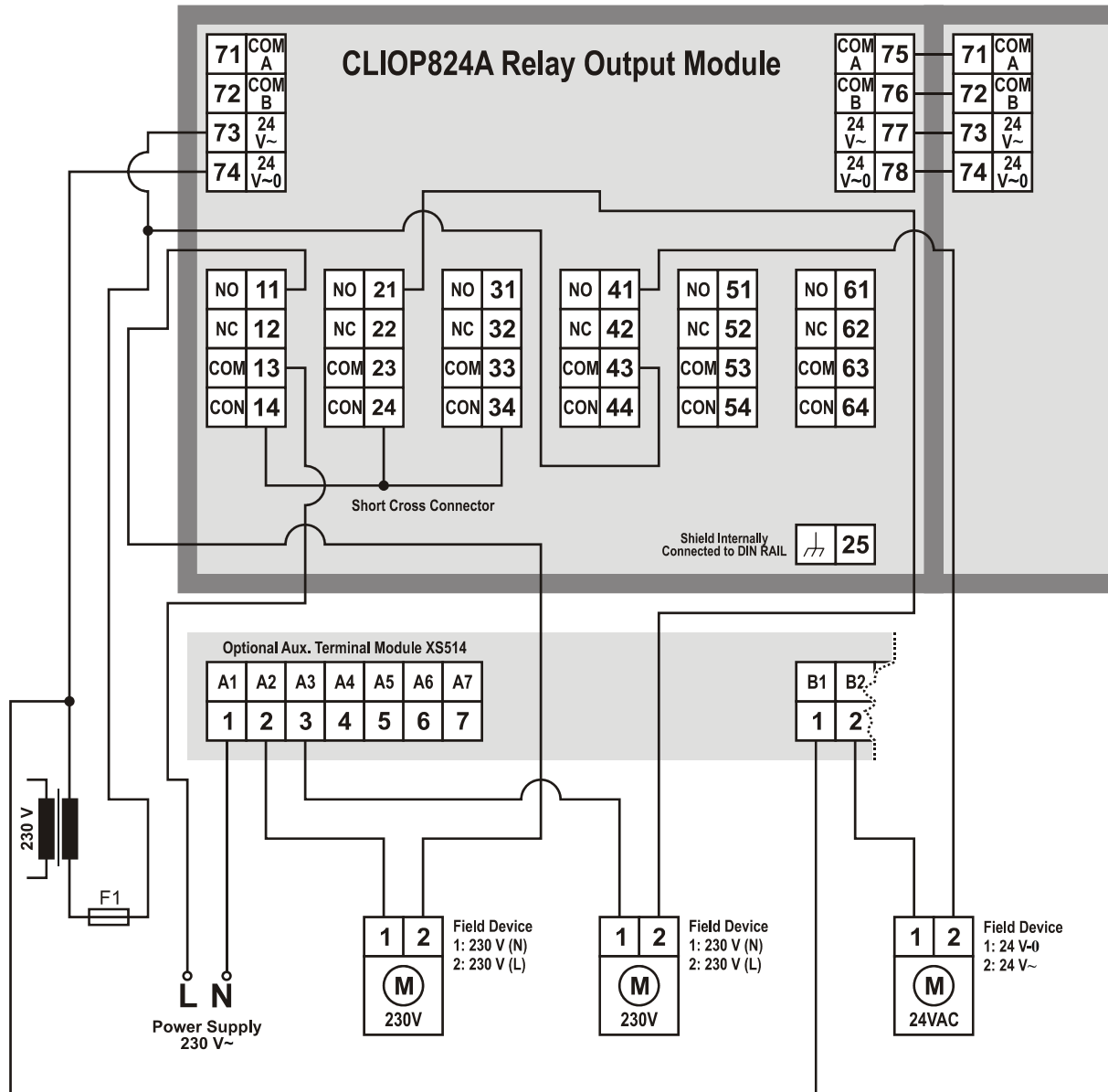


Fig. 77 CLIOP824A connection example (relay blocks with low and line voltage)

For fusing specifications see section "Fusing Specifications" on page 11.

## Floating Output Module

### Features

- Type: CLIOPR825A Floating Output Module
- Housing: light gray
- Floating outputs sufficient for driving up to 3 floating actuators
- Manual overrides and 3 corresponding pairs of status LEDs

In the event of communication problems, the 3 floating outputs will move to the safety positions you have configured in CARE, see floating output point description in the CARE – User Guide, 74-5587/EN2B-0182GE51.

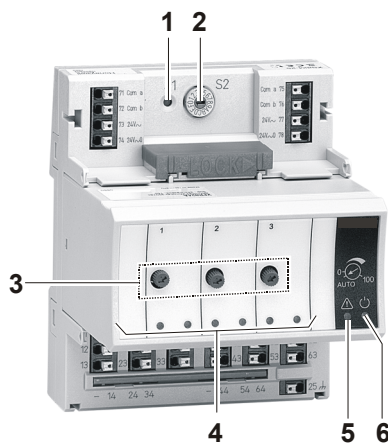


Fig. 78 CLIOPR825A Floating Output Module with terminal socket

### Legend

- 1 Service button S1
- 2 Hex switch S2
- 3 Manual overrides
- 4 Status LEDs
- 4 Service LED
- 5 Power LED

Functionality of service LED and power LED: see Table 75 to Table 77 on page 71 and following.

### ⚠ WARNING

**Risk of electric shock or equipment damage!**  
**Low voltage and line voltage must not be wired within the same relay block.**

- ▶ Wire low voltage e.g., to relay block 1 and line voltage to relay block 2 or vice versa. In this case the short cross connectors must be used, see Table 5 on page 8.

### NOTICE

**Risk of malfunction!**  
**Cross connectors may only be used if the same voltage is used on all relays they connected.**

- ▶ Do not use a cross connector if different voltages are used on the relays.  
 E.g., use a short cross connector for relay block 1 with line voltage and no cross connector for relay block 2 with 12 V low voltage for relay 4 and 24 V low voltage for relays 5 and 6.

### Permissible loads

	Max. load	Min. load
<b>Per relay output module (total)</b>	<b>19...250 VAC</b> current at $\cos \varphi \geq 0.6$ : 12 A <b>1...29 VDC</b> 12 A resistive, 3 A inductive	–
<b>Per normally open contact</b>	<b>19...250 VAC</b> current at $\cos \varphi \geq 0.6$ : 4 A) <b>1...29 VDC</b> 4 A resistive, 1 A inductive	50 mW
<b>Per normally closed contact</b>	<b>19...250 VAC</b> current at $\cos \varphi \geq 0.95$ : 2 A, current at $\cos \varphi \geq 0.6$ : 1 A <b>1...29 VDC</b> 4 A resistive, 1 A inductive	50 mW

Table 57 Permissible loads of floating output modules

### Notes

- In the case of voltages above 30 VAC/DC and if inductive components are to be connected to relays switching more often than once every 2 minutes, these components must be prevented from causing harmful interference to radio or television reception (conformance with EN 55014).
- Max. voltage for UL 864-compliant applications is 24 V.



**Terminals**

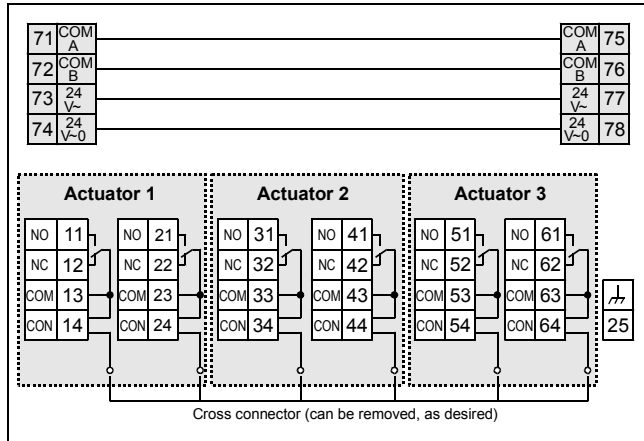


Fig. 79 Terminal assignment and internal connections of floating output module

Ter-minal	Signal	Comment
71, 75	COM a	2-wire communication bus (LON/Panel Bus)
72, 76	COM b	2-wire communication bus (LON/Panel Bus)
73, 77	24 V~	Power supply
74, 78	24 V~0	Power supply
ACTUATOR 1	11	REL1 N.O. Floating relay 1 N.O. contact
	12	REL1 N.C. Floating relay 1 N.C. contact
	13	R1 COM Floating relay 1 common contact
	14	R1 COM For connection of floating relay 1 common via cross connector*
ACTUATOR 2	21	REL2 N.O. Floating relay 2 N.O. contact
	22	REL2 N.C. Floating relay 2 N.C. contact
	23	R2 COM Floating relay 2 common contact
	24	R2 COM For connection of floating relay 2 common via cross connector*
ACTUATOR 3	31	REL3 N.O. Floating relay 3 N.O. contact
	32	REL3 N.C. Floating relay 3 N.C. contact
	33	R3 COM Floating relay 3 common contact
	34	R3 COM For connection of floating relay 3 common via cross connector*
ACTUATOR 4	41	REL4 N.O. Floating relay 4 N.O. contact
	42	REL4 N.C. Floating relay 4 N.C. contact
	43	R4 COM Floating relay 4 common contact
	44	R4 COM For connection of floating relay 4 common via cross connector*
ACTUATOR 5	51	REL5 N.O. Floating relay 5 N.O. contact
	52	REL5 N.C. Floating relay 5 N.C. contact
	53	R5 COM Floating relay 5 common contact
	54	R5 COM For connection of floating relay 5 common via cross connector*
ACTUATOR 6	61	REL6 N.O. Floating relay 6 N.O. contact
	62	REL6 N.C. Floating relay 6 N.C. contact
	63	R6 COM Floating relay 6 common contact
	64	R6 COM For connection of floating relay 6 common via cross connector*
25	Shield connection (functional earth), internally connected to the DIN rail	

Table 58 Description of floating output module terminals

\* Do not connect by wire!

**Manual Overrides**

The floating output module is equipped with manual overrides: one rotary knob for each floating output. These manual overrides can manually be set to either "Auto" or "0 ... 100 %" (infinitely adjustable).

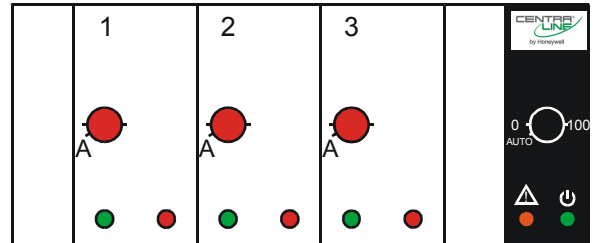


Fig. 80 Manual overrides (rotary knobs)

**NOTICE**

**Damage to the electronic module!**

- ▶ Do not use a tool to adjust the rotary knobs.
- ▶ Do not use excessive force. Adjust only by hand.

**Auto**

In this setting, the signal provided by the respective floating output (R1 + R2 or R3 + R4 or R5 + R6) and the condition (ON/OFF) of the respective pair of status LEDs both follow the commanded output signal.

**Override (0...100 %)**

When a manual override is set to values in the range of "0...100 %", the respective floating output will drive to the set position. The runtime depends upon the actuator runtime configured in CARE an on the actual position.

**Status LEDs**

The respective pair of status LEDs will display the following:

Mode	LED	Actuator 1		
		Closing	Opening	Not moving
Auto	Green LED	ON	OFF	OFF
	Red LED	OFF	ON	OFF
Override	Green LED	Flashing	OFF	Flashing
	Red LED	OFF	Flashing	Flashing

Table 59 LED behavior (for e.g., floating output 1)

Connection Example

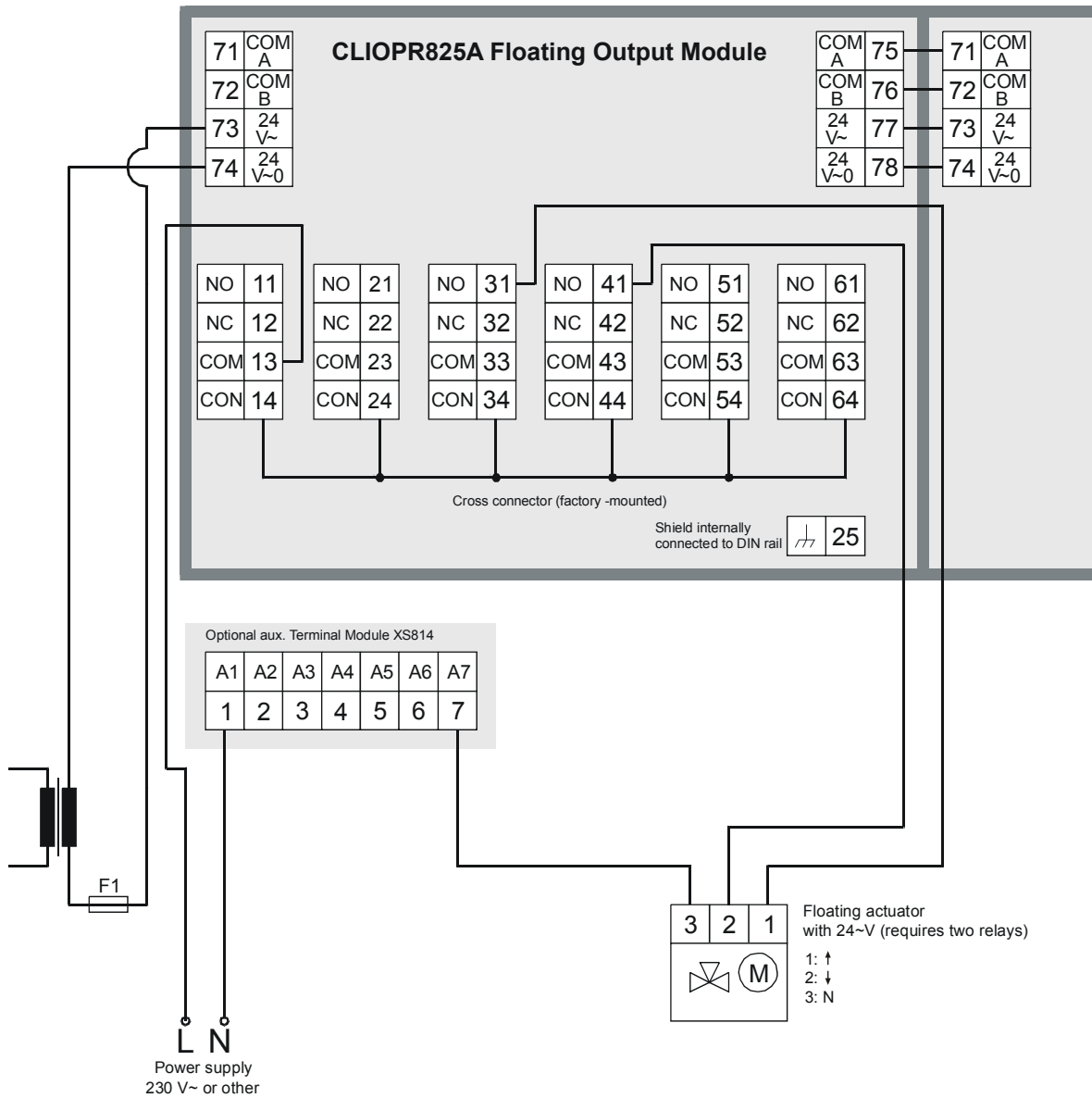


Fig. 81 CLIOPR825A Connection example (floating actuator)

For fusing specifications see section "Fusing Specifications" on page 11.

# Description of Extra Parts

## Manual Disconnect Modules

### Types

Manual disconnect module	Corresponding I/O modules CLIOP/CLIOL...
<b>XS812</b>	...821 ...822 ...823
<b>XS812RO</b>	...824 ...825

Table 60 Manual disconnect modules

For mounting the manual disconnect modules, see Fig. 23 on page 20.

### **WARNING**

**Risk of electric shock or equipment damage due to improper use of XS812RO manual disconnect module!**

- ▶ Do not connect line voltage to the XS812RO.

### Features

- Disconnecter switches are used to manually disconnect individual terminals of the corresponding electronic module.
- Useful for troubleshooting and installation.

### Diagrams

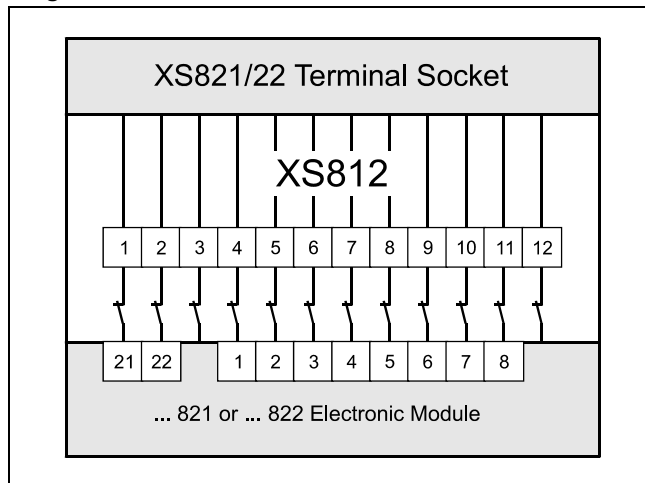


Fig. 82 XS812 and analog input/analog output modules

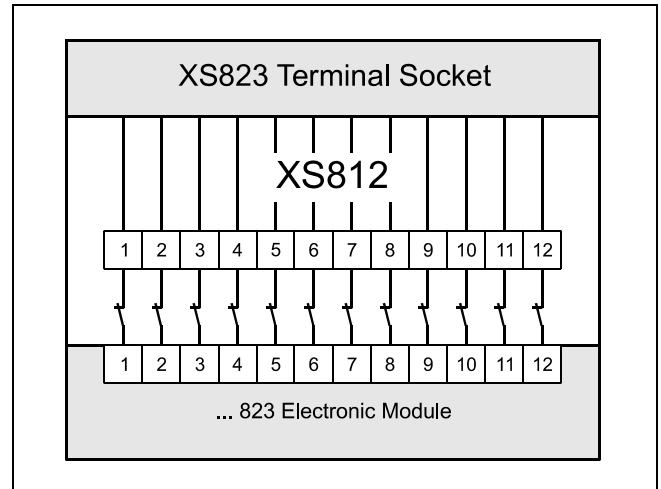


Fig. 83 XS812 and binary input modules

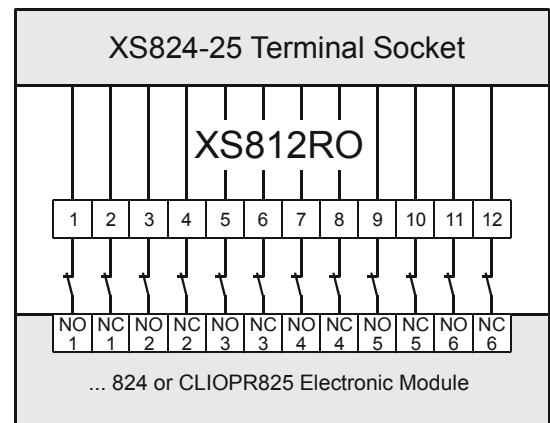


Fig. 84 XS812RO and relay modules/floating module

## XS814 Auxiliary Terminal Package

### Features

- Type: XS814 Auxiliary Terminal Package
- For mounting onto already installed I/O modules in order to equip them with additional terminals.
- Each unit consists of 2 terminal blocks (the "A" block and the "B" block), each with 7 terminals with a maximum load of 12 A.

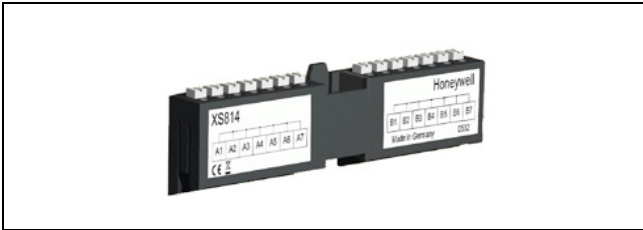


Fig. 85 XS814 Auxiliary Terminal Package

### Terminal Assignment

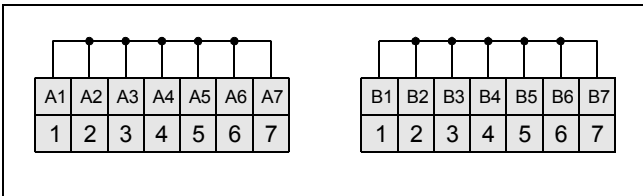


Fig. 86 Terminal assignment and internal connections of XS814 Auxiliary Terminal Package

## Cross Connectors

### XS815 Cross Connector Features

- For connecting the common terminals of all 6 relays. This is permitted when all terminal blocks carry the same voltage
- Long, red
- Supplied with the terminal socket

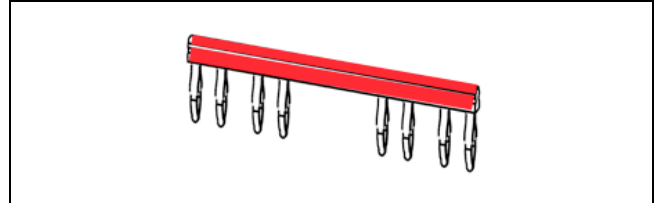


Fig. 87 XS815 Cross Connector

### XS817 Cross Connector Features

- For connecting the common terminals of only relays 1–3 or of relays 4–6
- Short, yellow
- Must be ordered separately

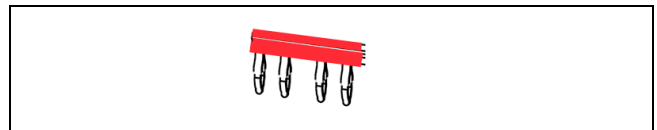


Fig. 88 XS817 Cross Connector

## XAL10 Swivel Label Holders

- Type: XAL10 Swivel Label Holder
- For applying self-adhesive labels with application information generated using CARE
- For use with standard commercially-available labels, e.g., AVERY ZWECKFORM 3669
- Supplied with the terminal socket

## XS816 Bridge Connectors

- Type: XS816 Bridge Connectors
- Bridge connectors transmit both communication signals and power supply between modules
- Supplied with the terminal socket

# LON Software Interface Description

## Overview

### LonTalk Protocol

LION LONWORKS Bus I/O Modules use a LONTALK protocol communication with other nodes on the LONWORKS network, with commissioning tools und supervisory devices.

### Features

- Network variables for communications between nodes, but no explicit messages
- Configuration network variables
- LONMARK FPT protocol for downloading an LION LONWORKS Bus I/O Module firmware via LON: loadable apbG file (supported by CARE and EXCELON)

### Addressing, binding, and commissioning

LION LONWORKS Bus I/O Modules are addressed, bound, and commissioned using CARE or any other standard LONWORKS commissioning tool based on LNS 2.0 and higher, e.g., LonMaker for Windows.

### Configuration

LION LONWORKS Bus I/O Modules are configured using CARE.

## CLIOL821A Analog Input Module

For the CLIOL821A Analog Input Module the LONMARK Profile 520 "Analog Input" has been assigned per input.

Each input object has its own configuration properties, except for heartbeat configuration, which will be shared among all objects.

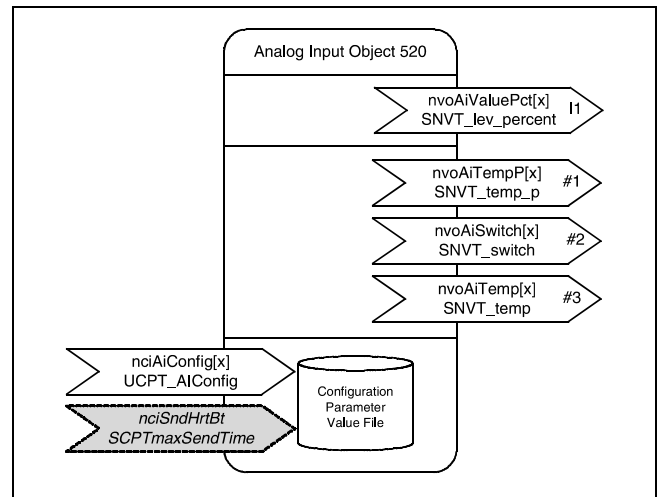


Fig. 89 LONMARK analog input object

### Input types and corresponding NVs

Input type	NV used
NTC PT1000-1 PT3000 BALCO500	nvoAiTempP
PT1000-2	nvoAiTemp
0(2)...10V	nvoAiValuePct
Slow binary input	nvoAiSwitch
Other Sensors	INVALID
Sensor break/short circuit	

Table 61 Input types and corresponding NVs

### Transmission/Updates

These variables are transmitted immediately when their value has been changed by a higher rate than the configured "send on delta" (default: 0.3 K).

These variables are also transmitted as heartbeat output (default: 60 sec) on a regular basis as dictated by the maximum send time (nciSndHrtBt) configuration variable.

**Default Service Type**

The default service type of these variables is unacknowledged.

**Analog Sensor Output – nvoAiValuePct[ ]**

This network variable output represents the percentage level for the appropriate input, if configured for voltage input.

**Valid Ranges for 0 ... 10 V Input**

Value	Representation
< 0 V	0 %
0 V ... 10 V	0 ... 100 %
> 10 V	100 %

Table 62 Analog input values: 0 ... 10 V

**Valid Ranges for 2 ... 10 V Input**

Value	Representation
< 1.5 V	Sensor break/short circuit
1.5 V ... 2 V	0 %
2 V ... 10 V	0 ... 100 %
> 10 V	100 %

Table 63 Analog input values: 2 ... 10 V

**Default Value**

The default value is set after power-up or reset and remains until the module has measured a valid value.

nvoAiValuePct = INVALID = 0x7FFF (=163.835 %)

The sensor failure behavior can be configured for 2 ... 10 V.

**Temperature Sensor Output – nvoAiTempP[ ]**

This network variable output represents the temperature for the appropriate input, if configured for temperature sensor, except PT1000-2.

Range: see Table 44 and Table 45 on page 40.

**Default Value**

The default value is set after power-up or reset and remains until the module has measured a valid value.

nvoAiTempP = INVALID = 0x7FFF (= 327.67 °C)

**Slow Digital Input – nvoAiSwitch[ ]**

This network variable output represents a slow digital input connected to the universal input terminals.

**Valid Range**

Sensor	Value	State
Enabled	100 %	1
Disabled	0 %	0
Not configured	0 %	-1

Table 64 Slow digital input values

**Temperature#2 Sensor Output – nvoAiTemp[ ]**

This network variable output represents the temperature for the appropriate input, if configured for temperature sensor if configured for PT1000-2 sensor.

Range: see Table 44 and Table 45 on page 40.

**Default Value**

The default value is set after power-up or reset and remains until the module has measured a valid value.

nvoAiTemp = INVALID = 0xFFFF (= 6279.5 °C)

## CLIOL(R)822A Analog Output Module

For the CLIOL822A/CLIOLR822A Analog Output Module, the LONMARK open-loop actuator object has been assigned per output.

Each analog output object has its own configuration properties, except for heartbeat configuration and nciAoConfig, which will be shared among all objects.

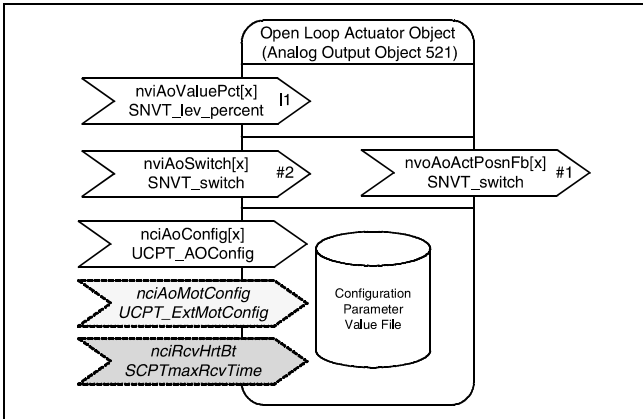


Fig. 90 LONMARK analog output object

### Receive Heartbeat

The default configuration for “Receive Heartbeat” is 300 sec. If no nvi update is received during this time, the actuators will go to their configured safety positions.

### Start-up Behavior

At start-up, i.e., power-up or reset, all nvi's will be initialized with INVALID, and after 1 minute, the actuators will go to their configured safety positions.

## Analog Output Control Level – nviAoValuePct[ ]

This network variable is used to drive the analog output to 0 ... 100 %.

If both nviAoSwitch[ ] and nviAoValuePct[ ] receive valid values, nviAoValuePct[ ] will have priority.

### Valid Ranges

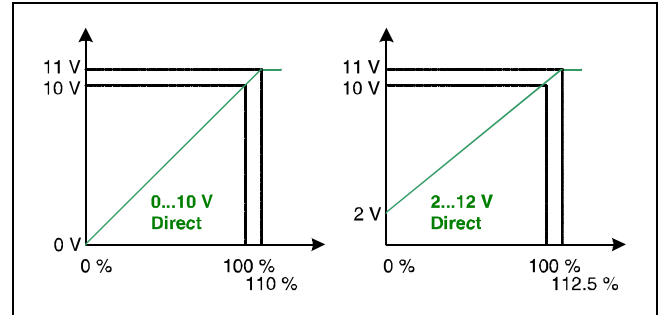


Fig. 91 Analog output control levels – direct actuator

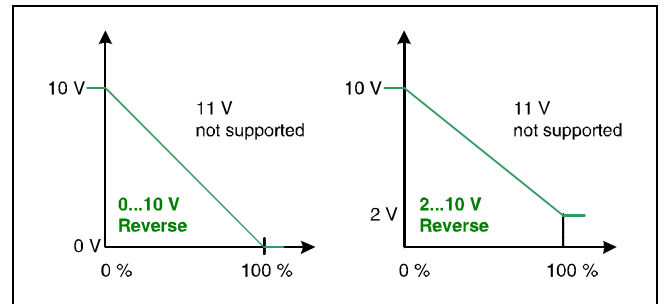


Fig. 92 Analog output control levels – reverse actuator

### Default Value

nvoAoValuePct = INVALID = 0x7FFF (=163.835 %)

This will cause the actuator to adopt a predefined position defined for failure behavior.

### Analog Output Feedback – nvoAoPosnFb[ ]

This value represents the current status of the analog output including feedback related to manual override initiated from the manual override.

This is typically used for monitoring purposes at a supervisory station or for diagnostic purposes.

#### Valid Range

Value	State	Current analog output position
0.5 ... 100 %	1	Analog output position due to normal control by nviAoSwitch or nviAoValuePct
0 % (OFF)	0	
0 ... 100 %	-1	Manual override position via the manual override panel
0xFF	-1	Current position unknown or synchronization active, analog output not configured

Table 65 Analog output feedback range

#### Transmission

This variable is transmitted immediately when the corresponding network input variable has changed more than 1 % or immediately as an answer to an nviAoValuePct[ ] or nviAoSwitch[ ] update.

#### Default Service Type

The default service type is unacknowledged.

### Analog Output Command – nviAoSwitch[ ]

This network variable is used to drive the analog output to 0 ... 100 %.

It is typically bound to a LONWORKS control device issuing an output level 0 ... 100 %.

If both nviAoSwitch[ ] and nviAoValuePct[ ] receive valid values, nviAoValuePct[ ] will have priority.

#### Default Value

Value = 0

State = -1



## CLIOL823A Binary Input Module

One instance of the LONMARK open-loop sensor object has been assigned per input of the CLIOL823A Binary Input Module.

Each digital input object has its own configuration properties, except for heartbeat configuration, which will be shared among all objects.

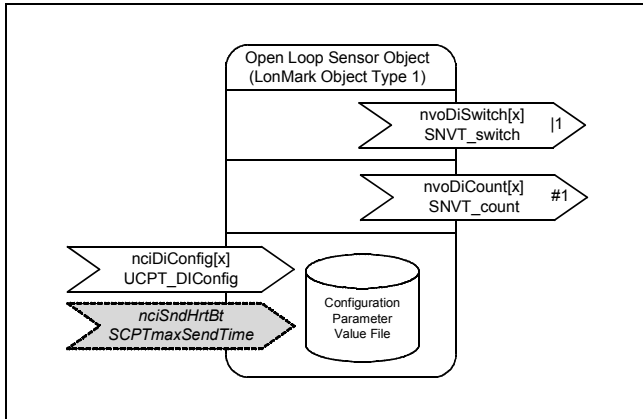


Fig. 93 LONMARK digital input object

### Transmission

These variables are transmitted immediately when its value has been changed by a higher rate than the configured "send on delta" (in the case of the totalizer, "send on delta" has a default value of 5 counts).

These variables are also transmitted as a heartbeat output on a regular basis as dictated by the maximum send time (nciSndHrtBt) (default = 0 = disabled) configuration variable.

### Default Service Type

The default service type of these variables is unacknowledged.

## Fast Binary Input – nvoDiSwitch[ ]

This network variable output represents the logical state of a fast binary input connected to the binary input terminals.

### Valid Range

Logical input state	Value	State
ON	100 %	1
OFF	0 %	0
Not configured	0 %	-1

Table 66 Slow digital input values

### Default Value

The default value is set after power-up or reset and remains until the module has measured a valid value.

Value = 0

State = -1

## Totalizer Count – nvoDiCount[ ]

This network variable output indicates the total number of transitions from 0 to 1 since the last reset due to power-up or network reset.

### Valid Range

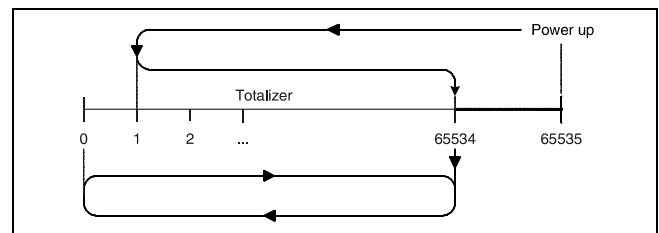


Fig. 94 Totalizer

State	Value
For totalizer counts	0 ... 65534
For power-up/reset	65535

Table 67 Totalizer counts

### Power-up/Reset

After power-up and reset, the value 0xFFFF = 65535 will be sent to the network to indicate that previous count values have been lost due to a reset.

## CLIOL(R)824A Relay Output Module

One instance of the LONMARK open-loop sensor object has been assigned per input of the CLIOL824A/CLIOLR824A Relay Output Module.

Each output object has its own configuration properties, except for heartbeat configuration, which will be shared among all objects.

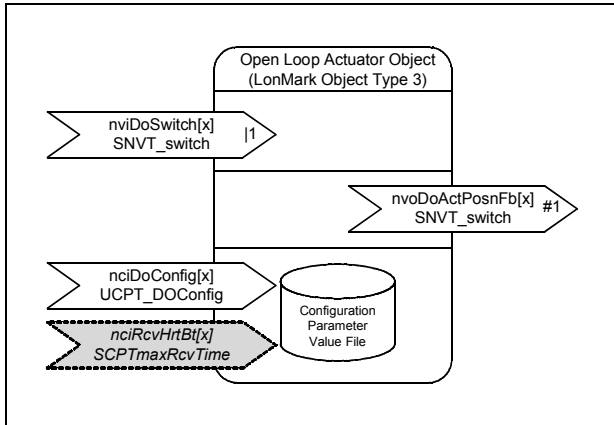


Fig. 95 LONMARK output object

## Relay Output Command – nviDoSwitch[ ]

This network variable is used to drive the relay output.

It is typically bound to a LONWORKS control device issuing an output level ON/OFF, respectively 0 ... 100 %.

### Valid Range

Value	State	Action
N/a	0	OFF
0	1	OFF
0.5 ... 100 %	1	Outputs are switched according to actual output type configuration
N/a	-1	INVALID: as defined for failure behavior

Table 68 Relay output command values

### Default Value

Value = 0

State = -1

### Start-up Behavior

At start-up, i.e., power-up or reset, all nvi's will be initialized with INVALID, leading the actuator to drive to the configured safety position after 1 minute.

### Receive Heartbeat

The default configuration for "Receive Heartbeat" is 300 sec. If no nvi update is received during this time, the field devices will go to their configured safety positions.

# Troubleshooting

## Testing Wiring Connections

The push-in terminals feature small holes (1 mm in diameter) which can be used to measure the signals.

- ▶ Insert a probe (1) as shown on the right.

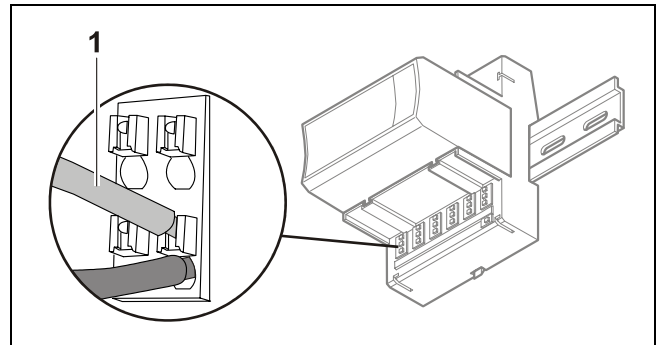


Fig. 96 Testing wiring connections

## Troubleshooting on the CLLIONLC01 Controller

The following LEDs of the CLLIONLC01 Controller can be used for troubleshooting purposes:

- Power LED (green)
- Alarm LED (red)
- LONWORKS service LED
- C-Bus Tx and Rx LEDs
- HMI Tx and Rx LEDs
- Modem Interface Tx and Rx LEDs

### Power LED (green)

case	Power LED	Meaning	Remedy
1	<b>ON</b>	Normal operation	No action necessary
2	<b>Flashing</b>	One or more of the internal voltage supplies are outside of the permissible ranges. The controller stops operation.	<ul style="list-style-type: none"> <li>▶ Check power</li> <li>▶ Check wiring</li> <li>▶ If the problem persists, replace hardware</li> </ul>
3	<b>Goes out briefly</b>	<ul style="list-style-type: none"> <li>• The operator has activated the reset button</li> <li>• The controller is performing a warm start</li> </ul>	No action necessary

Table 69 CLLIONLC01 power LED

**Alarm LED (red)**

Case	Alarm LED	Meaning	Remedy
1	OFF	Normal operation	No action necessary
2	ON	<p>Watchdog alarm output is powered</p> <ul style="list-style-type: none"> <li>- The controller has encountered a hardware problem</li> <li>- or -</li> <li>- The application has a fault</li> <li>- or -</li> <li>- The controller has been powered up without an application or the operator has manually stopped the application, e.g., using XL-Online.</li> </ul> <p>In this case, the LED will light up 13 minutes after power-up without application</p>	<ul style="list-style-type: none"> <li>▶ Try powering down and then powering up the CLLIONLC01.</li> <li>▶ If the problem persists, check and – if necessary – reload the application.</li> <li>▶ If the problem still persists, replace hardware</li> </ul>
3	Flashing	<p>Although the controller has encountered a problem, the watchdog alarm output has not yet been powered.</p> <p>If the problem persists, the LED will become lit constantly, see case #2.</p> <p>The controller performs a warm start.</p>	<p>If it happens only once, the controller has performed a restart</p> <p>If, however, it happens multiple times, then there is an application or hardware problem (see case #2)</p>

Table 70 CLLIONLC01 alarm LED

### LONWORKS Service LED

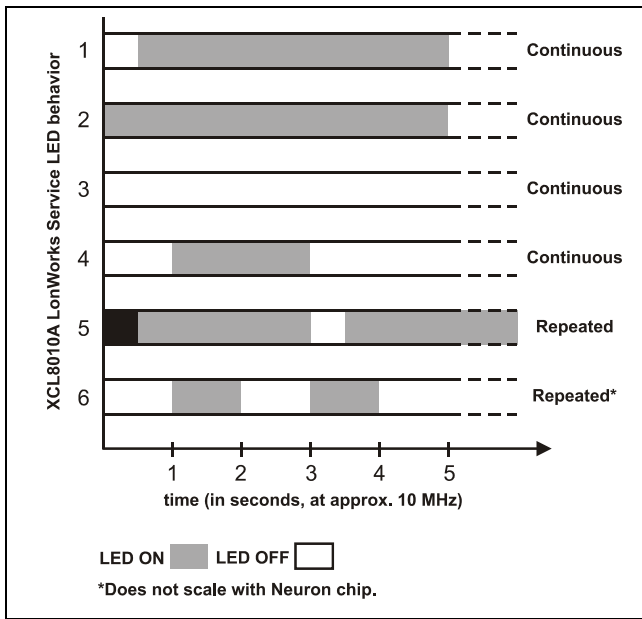


Fig. 97 Flashing pattern of the LONWORKS service LED

The LONWORKS service LED of the controller module displays the following flashing patterns indicating possible failure modes:

case	When can it occur?	Meaning	Remedy
1	Anytime	Node is configured and running normally	No action necessary
2	Power up of controller	Bad node hardware	► Replace hardware
3	Power up of controller	Bad node hardware	► Replace hardware
4	Power up / reset	Node lacks application. May be caused by neuron chip firmware when a mismatch occurs on application checksum	► Using EXCELON, set module to “configured online” ► If the problem persists, the MIP software on LW interface has been erased due to wrong setting performed using ECHELON tool: Replace hardware
5	Anytime	Watchdog timer resets occurring. Possible corrupt EEPROM and bootstrap mode	► Download firmware
6	Anytime	Node is unconfigured but has an application	► Proceed with commissioning

Table 71 CLLIONLC01 LONWORKS service LED

### C-Bus Tx and Rx LEDs

case	C-Bus LEDs	Meaning	Remedy
1	Both LEDs are flashing	If the C-bus is functioning properly, then the CLLIONLC01 Controller is functioning properly	No action necessary
		If the C-bus is not functioning properly, then the termination can be wrong	▶ Check C-bus termination switch S1 (location: see Fig. 46 on page 33)
2	Both LEDs are OFF	No C-bus communication	▶ Check C-bus settings
3	Both LEDs are flashing synchronously	No C-bus communication	▶ Check C-bus wiring

Table 72 CLLIONLC01 C-Bus Tx and Rx LEDs

### HMI Tx and Rx LEDs

case	HMI LEDs	Meaning	Remedy
1	Both LEDs are flashing	If the HMI Interface is functioning properly, then the CLLIONLC01 Controller is functioning properly	No action necessary
2	Both LEDs are OFF	No HMI Interface communication	▶ Check HMI Interface connection and proper earthing of connected hardware

Table 73 CLLIONLC01 HMI Tx and Rx LEDs

### Modem Tx and Rx LEDs

case	Modem LEDs	Meaning	Remedy
1	Both LEDs are flashing	If the Modem Interface is functioning properly, then the CLLIONLC01 Controller is functioning properly	No action necessary
2	Both LEDs are OFF	No Modem Interface communication	▶ Check Modem Interface connection

Table 74 CLLIONLC01 modem Tx and Rx LEDs

## I/O Modules Troubleshooting

- ▶ Check if the power supply voltage level is OK and that there is no high voltage (> 24 VAC or > 40 VDC) connected to the inputs/outputs of the ...821, ...822, ...823 I/O modules.
- ▶ Replace the problem I/O module with another module of the same kind.
  - If the problem persists, this is an indication that the problem is caused by the application or incorrect wiring.
  - If the problem is solved, this is an indication that the I/O module was defective.

For troubleshooting purposes on all I/O modules the following features can be used:

- Power LED
- Service LED
- Service button

In addition, a module-specific troubleshooting may be necessary.

### Power LED of I/O Modules

case	Power LED	Meaning	Remedy
1	ON	I/O module is powered	No action necessary
2	OFF	No power	▶ Check power supply
3	Flashing continuously	If the I/O module's service LED is likewise flashing, the I/O module is in the boot mode	▶ Wait until rebooting (firmware download) has been completed

Table 75 Power LED of I/O modules

**Service LED of I/O Modules**

case	Service LED	Meaning	Remedy
1	LED remains OFF after power-up	If the power LED is also OFF, then <ul style="list-style-type: none"> <li>– Defective device hardware</li> <li>– Possible power supply problems, clock problems, or defective processor</li> </ul>	▶ Replace hardware
2	LED is lit continuously after first power-up	<ul style="list-style-type: none"> <li>• LONWORKS Bus I/O modules:                             <ul style="list-style-type: none"> <li>– Defective hardware</li> </ul> </li> <li>• Panel Bus I/O modules:                             <ul style="list-style-type: none"> <li>– I/O module has not yet been configured by CLLIONLC01</li> <li>– Boot loader is active</li> <li>– Failure during last firmware download</li> <li>– Checksum error</li> </ul> </li> </ul>	LONWORKS Bus I/O modules: <ul style="list-style-type: none"> <li>▶ Replace hardware</li> </ul> Panel Bus I/O modules: <ul style="list-style-type: none"> <li>▶ Allow CLLIONLC01 to configure I/O module</li> <li>▶ Unplug and replug the module</li> <li>▶ If the Problem persists, replace hardware</li> </ul>
3	Alternating flash between service LED and power LED	Panel Bus I/O modules, only: Download error or application checksum error. Boot loader is running	▶ Panel Bus I/O modules, only: Wait until rebooting (firmware download) has been completed
4	LED flashes at power up, goes OFF, and then is lit continuously	LONWORKS Bus I/O modules, only: The LONWORKS Bus I/O module lacks application	▶ Download application
5	LED repeatedly blinks ON for 1 sec and OFF for 1 sec	LONWORKS Bus I/O modules, only: The LONWORKS Bus I/O module is unconfigured, but has an application	▶ Set module to configured mode
6	LED remains OFF after a short ON duration	I/O module is configured and running normally	No action necessary
7	LED flashes continuously in following pattern: 4 x ON/OFF followed by pause	Sensor failure of analog input module (in the case of LONWORKS Bus I/O modules, this behavior can occur only if the appropriate NV has been bound)	<ul style="list-style-type: none"> <li>▶ Check sensor or connection</li> <li>▶ Check sensor configuration</li> </ul>
8	LED flashes continuously in following pattern: 5 x ON/OFF followed by pause	LONWORKS Bus I/O modules, only: LONWORKS I/O Bus module has received the wink command from network, physical outputs are unaffected	No action necessary
9	LED flashes continuously in following pattern: 6 x ON/OFF followed by pause	Boot loader problem or hardware defect	▶ Replace hardware
10	LED flashes continuously in following pattern: 7 x ON/OFF followed by pause	Communications failure	<ul style="list-style-type: none"> <li>▶ Check bus wiring</li> <li>▶ Check I/O Bus switch S2 of CLLIONLC01 Controller</li> <li>▶ Ensure that LONWORKS Bus I/O modules and Panel Bus I/O modules are not sharing the same bus</li> <li>▶ In case of Panel Bus I/O modules, only: Check for incorrect HEX addresses (2 Panel Bus I/O modules using the same HEX address)</li> <li>▶ In case of LONWORKS Bus I/O modules, only: Check heartbeat</li> </ul>

Table 76 Service LED of I/O modules



## LED Test for I/O Modules

- ▶ Press the service button S1 of the I/O module, e.g. using a paperclip.
  - The service LED and all other LEDs of that Panel Bus I/O module light up for as long as the service button is pressed.

LED	Correct behavior
Power LED	ON continuously (if it flashes, check the 24 VAC power supply)
Service LED	ON continuously
Analog output module status LEDs	ON continuously
Relay output module status LEDs	ON continuously
Digital input module status LEDs	Red -> green -> yellow -> red -> green -> yellow, cyclically every 0.5 sec

Table 77 Effects of pressing and holding down service button of I/O modules

An LED is defective if it is not lit as shown above.

## Analog Input Modules Troubleshooting

case	Problem	Possible causes	Remedy
1	Incorrect sensor measurement	Wrong sensor configuration	▶ Reconfigure sensor
		Incorrect wiring	▶ Rewire
		Sensor failure	▶ Replace sensor
		Negative voltage on at least one channel	▶ Check polarity of active sensor inputs.
2	Unstable sensor measurements	Incorrect grounding of active sensors	▶ Ground active sensors individually (see Fig. 62 and Fig. 63 on page 42 and following)
3	a voltage of about 8.88 V(*) is measured (with an external voltmeter) at an open analog input configured for: NTC20k or Pt1000-1/-2 or Pt3000 or Balco 500.	Sensor is not connected	▶ Connect the configured sensor
4	a voltage of about 8.88 V(*) is measured (with an external voltmeter) at an open analog input configured for: 0...10V with pull-up or slow Digital Input	Normal value for open input that is configured to listed types	▶ No action necessary
(*) : voltage may differ slightly depending on the input impedance of the used voltmeter			

Table 78 Failure modes of analog input modules

### Analog Output Modules Troubleshooting

case	Problem	Possible causes	Remedy
1	All outputs always have zero voltage	Manual override settings	▶ Check manual override settings
		Outputs are in safety position	▶ Check communication
		Software problem	▶ Power down and then power up ▶ If the problem persists, replace hardware
		Internal undervoltage detection has been activated	▶ Replace hardware
2	Unstable output voltage	Incorrect grounding of actuators	▶ Ground actuators individually (see Fig. 66 on page 46)

Table 79 Failure modes of analog output modules

### Binary Input Modules Troubleshooting

case	Problem	Possible causes	Remedy
1	Unexpectedly, all status LEDs are always OFF	Internal overload protection has been activated	▶ Power down and then power up

Table 80 Failure modes of binary input modules

### Relay Output Modules Troubleshooting

case	Problem	Possible causes	Remedy
1	Unexpectedly, all outputs are in unpowered position	Improper manual override settings	▶ Check manual override settings
		Outputs are in safety position	▶ Check communication
		Software problem	▶ Power down and then power up ▶ If the problem persists, replace hardware
		Internal undervoltage detection has been activated	▶ Replace hardware

Table 81 Failure modes of relay output modules

### Floating Output Modules Troubleshooting

case	Problem	Possible causes	Remedy
1	Unexpectedly, all outputs are in unpowered position	Improper manual override settings	▶ Check manual override settings to check outputs
		Outputs are in safety position	▶ Check communication
		Software problem	▶ Power down and then power up ▶ If the problem persists, replace hardware
		Internal undervoltage detection has been activated	▶ Replace hardware

Table 82 Failure modes of floating output modules

# Appendix 1: System Protective Earth Grounding

## LION Systems and SELV

In order to avoid distribution of noise or earth ground potential differences over networks or other connections, the CLLIONLC01 is designed to be in compliance with SELV (Safety Extra-Low Voltage).

Furthermore, SELV offers the greatest possible safety against electrical impact.

To support SELV, all CentraLine external (CRT series) or internal transformers comply with standard EN60742.

Earth grounding is therefore not recommended.

## LION Systems and Standard EN60204-1

However, if compliance with EN60204-1 is required, note the following:

### General Information about EN60204-1

EN60204-1 defines electrical safety for a complete application/machine including controllers, sensors, actuators and any connected/controlled electrical device.

EN60204-1 requires controllers to be powered by PELV (Protective Extra-Low Voltage) and earth grounding of the secondary side of the used transformers or earth grounding of the system ground.

Earth grounding is prescribed to prevent unexpected start-up of connected rotating/moving machines due to an insulation fault and double earth grounding somewhere in the plant.

The use of an earth leakage monitor is also possible to fulfill PELV if earth grounding is prohibited.

### When is EN60204-1 Applicable to LION Systems?

- **Safety against electrical impact**  
EN60204-1 is not mandatory; this is because electrical safety is provided by the use of SELV and transformers according to standard EN60742.
- **Safety against unexpected start-up of rotating/moving machines**
  - If the application/plant does not contain machines that can be harmful to the operator due to an unexpected start-up, the standard EN60204-1 is not applicable.

If such machines are encountered, then EN60204-1 must be followed. Grounding is required.

## Earth Grounding of EN60204-1 Applicable Systems

- ▶ If system protective earth grounding is planned, use a cable as short as possible for grounding: min. 1.5 mm<sup>2</sup> (16 AWG).
- ▶ For connection details refer to the following examples.

### Example 1

Connecting a single transformer with multiple LION Systems earth-grounded as per EN60204-1

- ▶ Connect earth ground to terminal 1 of the CLLIONLC01 Controllers

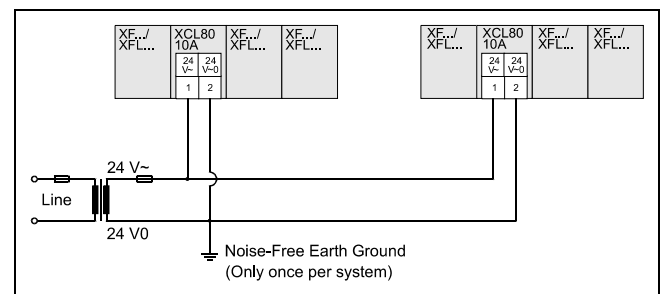


Fig. 98 Connecting and earth grounding multiple CLLIONLC01s (single transformer)

**Example 2**

Connecting an LION System together with other controllers earth-grounded as per EN60204-1

**Notes**

- Use a noise-free earth ground inside the cabinet.
- Use one star-point to split power for controllers and field devices.
- If the transformer is used for several controllers, each controller ground has to be wired separately to the star-point.
- If a field device that prohibits earth grounding is connected to the system ground, an isolation monitoring device must be used instead of earth grounding.
- If the field device transformer is physically far away from the controller, earth grounding must still be performed for the controller.

- ▶ Connect earth ground to the respective terminal of the controllers, see figure below.

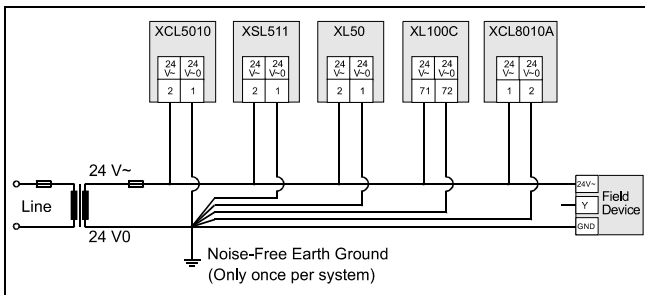


Fig. 99 Connecting and earth grounding mixed controllers (single transformer)

**NOTICE**

**Equipment damage!**

Terminals 1 and 2 are assigned differently on the XCL5010 and CLLIONLC01 Controllers.

- ▶ Make sure that earth ground is connected to the correct terminal according to Fig. 99 and the respective connection diagrams.

The XL40, XL50, XL100C, Distributed IO, Smart IO, and the LION System can share one transformer.

The XC5010C Controller always requires its own transformer.

If EN60204-1 is applicable for the given type of controller, the system ground has the same potential as one terminal of the power supply.

**Example 3**

Connecting a C-Bus with controllers earth-grounded as per EN60204-1

**Notes**

- Use a noise-free earth ground inside the cabinet.
- Do not use the controller terminals which are normally used for C-Bus shield connection.
- Be sure to wire the shield only once per bus connection to the earth ground; this is to prevent any current draw over the shield.
- A permanent earth ground potential difference of more than 24 VAC may destroy the related controllers.

- ▶ Connect earth ground to the respective terminal of the controllers, see figure below.

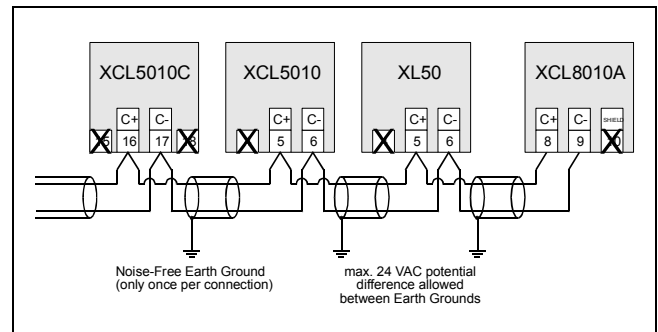


Fig. 100 Connecting C-Bus with multiple controllers earth-grounded as per EN60204-1

If a system ground of the controller is connected to the earth ground, the available terminals for shielding the C-Bus must not be used. Instead, the C-Bus shield must be connected to the earth ground, but only once per bus connection.

## Appendix 2: Remote Communications

For remote communications with up to three centrals, a modem or ISDN terminal adapter can be connected directly to the modem interface of the CLLIONLC01.

### Notes

Remote communication via modem or ISDN terminal adapter requires firmware version V2.1.0 or higher. XBSi building supervisors are not supported for remote communication.

### Approved Modems

The following modems have been approved for use with the LION:

Type	Model	Comment
Standard modem	Westermo TD-33	
GSM modem	Siemens MC45	Successor to Siemens M20
	Siemens M20	Phased out in 2005

Table 83 Approved modems

### Note

Siemens has phased out the M20. We therefore recommend that you instead use the MC45 and adopt the same settings as for the M20.

Additional information about the MC45 terminal may be found at the following web site:

[www.mc-technologies.net](http://www.mc-technologies.net)

### Modem or ISDN Terminal Adapter Connection

The modem interface of the CLLIONLC01 accepts a standard modem cable with a female 9-pin connector.

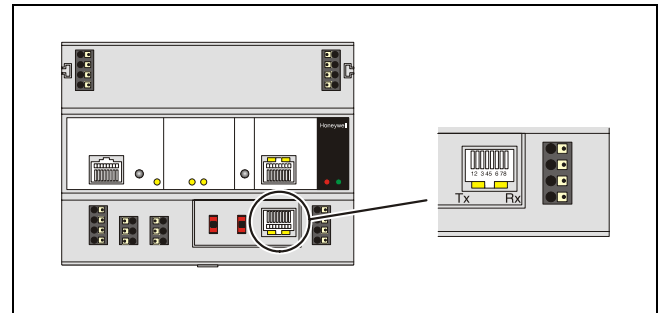


Fig. 101 Modem interface

- ▶ Connect the cable that is supplied with the modem/ISDN terminal adapter to the modem interface of the CLLIONLC01 Controller.

### Modem Requirements

Modems to be connected to CLLIONLC01 must support the following requirements:

- Hayes compatible command set (not V150 or V151 = Microsoft command set)
- Alpha-numeric return codes
- Modem must follow serial baud rate of the controller CPU
- Auto-bauding (baud rate fall-back)
- When carrier detect (connect) is reported, the carrier must be on simultaneously at both modems (on controller CPU side and on side of the central) ⇒ use same modem
- After a switch-ON of the DTR line by the CPU or the central, the modem must accept a dial command after 3 seconds
- Modem must answer AT commands in less than 3 seconds

## Modem Set-up

### Standard Modem Behavior

If no special modem behavior is required, there is no need to set up or initialize the modem/ISDN terminal adapter.

The CLLIONLC01 will automatically

- detect the device (MMI or modem) attached to the modem interface,
- set the appropriate communication speed,
- adapt to alphanumeric return codes used by the modem.

This automatic detection and adjustment can take up to 5 seconds.

#### Note

*It is highly recommended to use a state-of-the-art modem and leave it in its factory settings.*

### Automatic Baudrate Synchronization

The default communication speed between the CLLIONLC01 and the local modem/ISDN terminal adapter is 9600 baud.

The communication speed between the modem and terminal adapter and the central's modems/ISDN terminal adapters is automatically synchronized by the two devices to the highest speed that both of the devices are capable of.

This feature is called auto-bauding and is a feature that all state-of-the-art-modems/ISDN terminal adapters provide when left in their factory default settings.

The communication speed between the central and its modem/ISDN terminal adapter is part of the modem set-up at the central.

### Auto / Manual Answer Detection

The CLLIONLC01 will automatically detect whether the modem/ISDN terminal adapter is initialized in auto-answer or manu-answer mode, and it will set the modem to manual answer mode (S0 = 0).

### Resetting the Modem

For those cases where it is not clear if the modem to be used is in its factory settings, the modem can be reset to its factory setting by using the RESET MODEM command in the start-up sequence or through the HW configuration part of the system info. sequence on the MMI. This will allow a quick and easy modem reset without the need to run the modem set-up software or the Windows™ terminal program.

The RESET MODEM command causes the following commands to be sent to the modem:

1. ATZ  
executes hardware reset on modem
2. AT&FX3&W  
resets modem to factory configuration settings, configures

the modem not to wait for the public phone system dial tone, and writes this to nonvolatile memory.

### Set-up for Special Modem Behavior

If special modem/ISDN terminal adapter behavior is required, the communication device should be set up according to the instructions provided with it. This typically involves running a setup program on a computer with the device connected to the computer serial port or using the Windows™ terminal program.

### Set-up for In-house Telephone Systems

A common case of special modem behavior is when the modem is connected to an in-house telephone network requiring a prefix to be dialed before the destination number to provide access to the public telephone network.

There are two important aspects of the special initialization of the modem to consider:

- Do not wait for the public network dial tone.
  - Typically the init command ATX3 will trigger the modem to dial without waiting for a public network dial tone.
  - Save this modem set-up in the modem EEPROM with the command AT&W.
  - Check the modem handbook to verify the correct commands.
  - Note that these commands are executed automatically with the RESET MODEM command.
- Add the prefix required for access to the public telephone network to the destination telephone number.
  - Depending on the in-house telephone system, a certain prefix may have to be added to the destination number in the central system configuration/site definition screen prior to sending the set-up to the remote CLLIONLC01 Controller.

### Set-up for Limited Communication Speed

The communication speed of the modem can be fixed to a lower rate in case of data transmission errors due to telephone line limitations. See the XI581/582 Buswide Operator Interface User Guide (EN2B-0126GE51) for the procedure for fixing the baud rate.

## Westermo TD-33 Setup Parameters

The Westermo TD-33 modem is the standard modem for use with the LION.

The following is the initialization string for PANTHER or Excel 100C/500 with O.S. 2.01.xx or newer and LION:

```
AT&FE0X0&D2S0=0\VO&W0
```

The ATX command should be adapted according to your telephone system. See also section "Set-up for In-house Telephone Systems" above.

The following dip switch setting is required for communication with LION:

Dip Switch	Setting	Comment
Dip switch	1 = ON	Enables internal modem watchdog
Others	0 = OFF	Default setting

Table 84 Westermo TD-33 switch settings

## Troubleshooting

In case of any problems, the handbook of the modem or ISDN terminal adapter must be consulted.

## GSM Communication (Europe, only)

For communication via the Global System for Mobile communications (GSM), a Siemens M20 or MC45 Terminal (cellular engine) is required and must be connected directly to the modem interface of the CLLIONLC01 controller. The M20T translates the Excel CPU data received in transparent mode into the GSM standard. The M20T behaves like a Hayes-compatible modem connected to the controller modem interface, and it then transmits via GSM like a cellular (mobile) phone.

### Notes

- *Communication via GSM requires firmware version V2.3.0 or higher.*
- *With the M20T, data communication is possible only in 900 MHz GSM networks. GSM networks operating at 1800 MHz or 1900 MHz are not supported.*

The maximum communication speed is determined by the current GSM standard, which is 9600 baud.

Due to a special transmission mechanism, the effective communication throughput is lower than 9600 baud – however, this can only be noticed when high data volumes are transmitted, e.g. during application downloading.

## M20T/MC45 Safety Precautions

### CAUTION

#### Illegal operation!

- ▶ Use of a Cellular Engine in an aircraft, such as for the purpose of wireless connection of an aircraft based HVAC system to a central, can endanger navigation, it interferes with the cellular network and it is illegal.
- ▶ Failure to comply with this prohibition may lead to temporary suspension or permanent cancellation of Cellular Engine services for the person who disregards this prohibition and/or to legal action against said person.
- ▶ Users are advised to NOT use the M20T/MC45 in automotive service stations.
- ▶ Users are reminded of the necessity of complying with restrictions regarding the use of radio devices in fuel depots, chemical plants and locations where explosives are ignited.

**Additional Precautions**

- ▶ When receiving calls on a public highway, such as a cooling control system of a refrigeration truck being called by a central, the M20T/MC45 is not permitted to use "warning" devices which causes the vehicle's horn to sound or the lights to flash.
- ▶ Drivers are advised not to use the handheld microphone or the telephone handset while their vehicle is in motion, except in emergencies. Use the hands-free facility to speak only if it does not divert your attention from the traffic.
- ▶ Operation of the M20T/MC45 can disrupt the operability of inadequately protected medical devices. Please address all questions to a doctor or the manufacturer of the medical device.
- ▶ The M20/MC45 Terminal shall not be used within wet environment, such as in public baths.
- ▶ If your M20/MC45 Terminal, your SIM card, or both go missing, notify your network operator immediately in order to avoid misuse.

**Required Third-Party Equipment**

The Siemens M20 Terminal (shown below) is required for GSM communication.

In addition, a 3V Mini SIM card with personal identification number (PIN) is required for the M20T.

The Mini SIM card, supplied by the GSM Network Provider, must be released for data communication at 9600 baud.

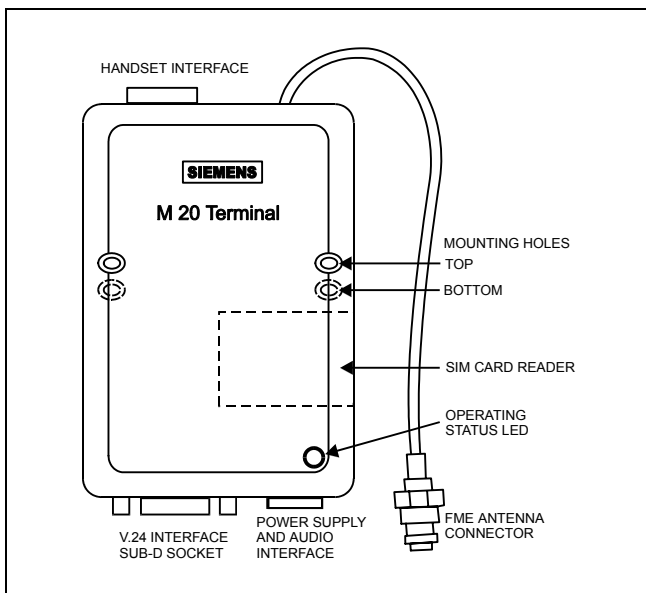


Fig. 102 Siemens MC20 Terminal

A separate telephone number is required for data communication with the same SIM card (one telephone number for voice communications and one for data).

**M20 Mechanical Characteristics**

Weight	145 g
Dimensions (max) LxWxH	107.0 x 63.5 x 31.3 mm
Temperature range	-20°C to 55°C
Protection-class	IP40
Mechanical vibrations	Amplitude 7.5 mm at 5 to 200 Hz sine
Max. pulse-acceleration	30 g pulse with 18 ms duration
Air humidity	5-98%

Table 85 M20 mechanical characteristics

**M20 Electrical Characteristics**

Operating voltage range	8 to 28.8 Vdc, ±5% ripple
Undervoltage/over-voltage protection:	0 V / 45 V
Power consumption at 12V	<200 mA speech mode, <14 mA idle mode
Max. line-in/out cable length	2 m (e.g., modified NOKIA 2110 for M20T)
Protection fuse	1 A, fast blow
Max. RF power	2 W at 900 MHz
Power supply connector	6-pin modular

Table 86 M20 electrical characteristics

**M20 CE Conformity**

- 89/336/EC (EMC guideline)
- 73/23/EC (Low voltage guideline)
- 91/263/EC (Telecommunications devices guideline)

**M20 Standards**

- EMC: ETS 300 342-1
- Safety: EN 60950
- GSM network: TBR 19, TBR 20

**Serial Cable**

For connecting the M20T to the CLLIONLC01 Controller, a standard RS232 cable (9-pin V24 sub-D sockets) is required.



### GSM Antenna Requirements

All major suppliers of GSM antennas can supply GSM900 Antennas with FME plugs to connect with the M20 Terminal for a variety of applications. Some antenna examples are shown below.

### M20 Antenna Requirements

Frequency TX	890-915 MHz
Frequency RX	935-960 MHz
Impedance	50 Ω
VSWR TX	max. 1.7:1 installed
VSWR RX	max. 1.9:1 installed
Gain	> 1.5 dB referenced to λ/2 dipole
3dB width of cone	vertical 80° horizontal 360°
Max. power	1 W (cw), 2 W peak; at ambient temperature of 55°C

Table 87 M20 antenna requirements

Depending on the application and the RF field at the local site, the GSM antenna may be mounted directly or via cable. The maximum antenna cable length is 8.0 m (including 20 cm M20 Terminal-cable).

**Note**

The maximum number of push/pull cycles shall not exceed 100.

The antenna interface connector of the M20 unit is a FME connector (of type SMR nano (male)). Hence, the connector on the GSM antenna or antenna cable has to be of type SMR nano (female, or use a double female connector in between).

### Antenna Examples

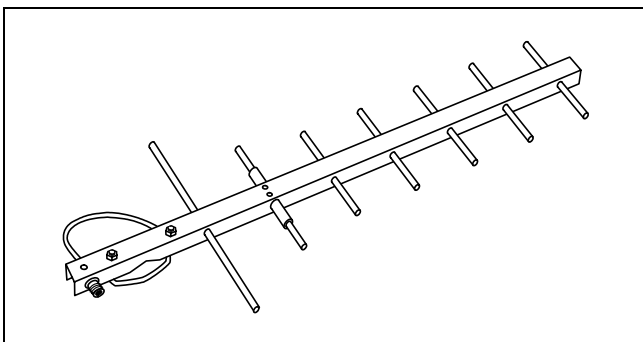


Fig. 103 Directional antenna (YAGI), 12 DBi

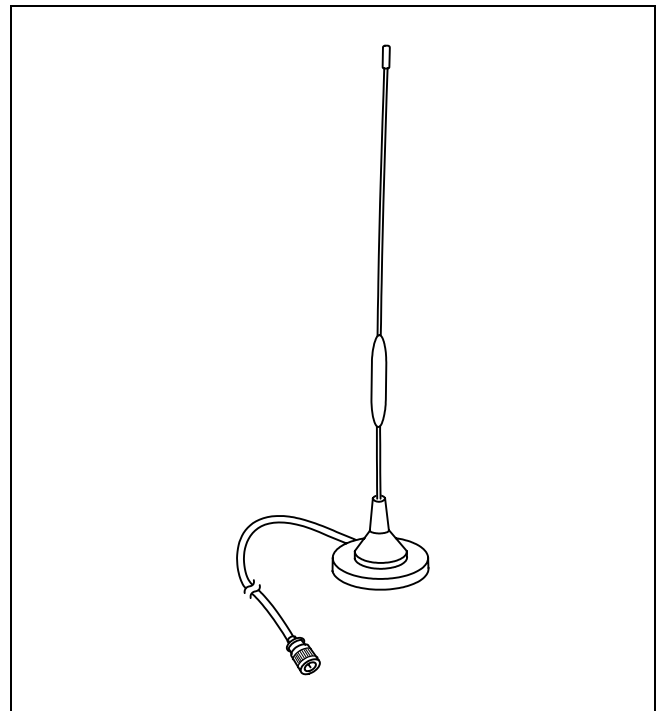


Fig. 104 Round radiation antenna, magnetic base, 5 DBi

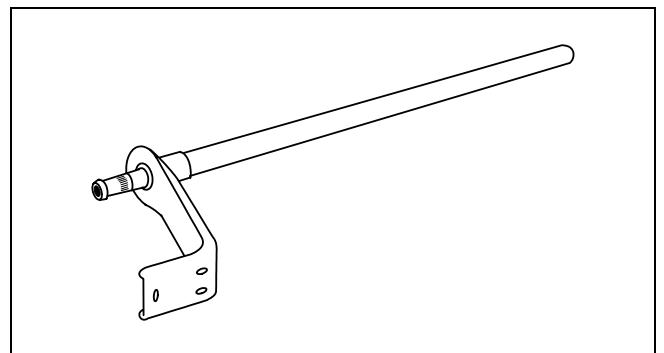


Fig. 105 Round radiation antenna, 6.5 DBi

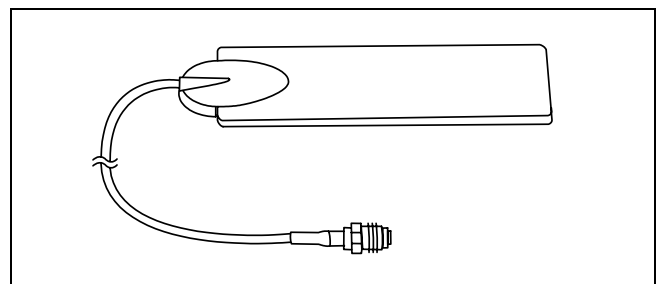


Fig. 106 Window patch antenna, 2 DBi

## GSM Antenna Installation

For GSM antenna installation, note the following:

- The maximum antenna cable length is 8.0 m (including the 20 cm M20 Terminal cable).
- Use a cable that is specified by the supplier of the GSM antenna.
- Improper cables with resistances that are too high will reduce the amplification of the antenna.
- Ideally you should know in which direction the next GSM station is located in order to position the antenna accordingly.
- Dipole antennas - e.g., antennas with a magnetic foot - must sit on metal ground to achieve the specified amplification. The larger the metal ground, the better.
- The antenna must be mounted vertically, NOT horizontally.
- Avoid barriers for the antenna signal. Ideally, within a range of approximately 3 meters there should not be any vertical barriers that would block the antenna signal, such as doors, PCs, cupboards, etc.
- Select the most suitable antenna. Location and mounting limitations may require that special antennas be used, such as antennas with higher amplification or directional antennas.
- Avoid loose contacts. All connections from the M20T to the antenna must be tight.
- Increase the distance between the antenna and Excel CPU if you experience electromagnetic interference of the antenna signal to the CPU. An indication of this might be that the functioning of the MMI of the CPU is disturbed or that the outputs behave abnormally.

## Checking Signal Quality

The easiest way to check the signal quality is to operate a cellular (mobile) phone at the very place where you want to place the antenna.

- The cellular phone must operate in the same GSM network as the M20T.
- Drop-outs in voice communication indicate that the reception is too weak.  
The data communication will never work where you have drop-outs in voice communication with the cellular phone. The preferred way is to set-up the M20T on a terminal program and check the reception with the SIEMENS AT commands – see the M20T handbook.
- An alternative way to verify the signal quality is to use the terminal program on the CD that is supplied with the M20T. You will find a special button on it that allows checking on the signal quality.

## M20 Terminal Set-up

### Notes

- *Prior to beginning the set-up, get the M20T manual (or CD-ROM, if it was delivered with one). Everything is described in it and you will need it.*
- *It is absolutely mandatory to use a serial data line monitor for the set-up of the M20T. Without such a device being connected between the serial port of the PC and the M20T, you will get no information on the set-up process.*

1. Insert the SIM card into the M20T.
2. Connect the serial cable to the M20T and a PC or laptop.
3. Connect the antenna cable and antenna to the M20T connector.
4. Start a terminal program, e.g., Windows™ HyperTerminal
5. Connect the power supply to the M20 Terminal and plug into mains.  
The M20T LED will be flashing now.
6. Set terminal program to 19200 baud.
7. Verify the correct operation of the M20T serial interface by entering: AT.  
The M20T will respond: OK.
8. Change the M20T's baud rate from 19200 (factory default) to 9600: AT+IPR=9600.
9. Set terminal program back to 9600 baud.
10. Command the M20T to cut the line whenever the DTR signal is dropped (OFF) or toggled ON/OFF: AT&D2.
11. Store setting in non-volatile memory: AT&W.
12. You may now enter the PIN number or let the Excel CPU do this. If you want to enter the PIN number now, enter the PIN with the command AT+CPIN="xxxx", where xxxx represents the PIN number.

### Notes

- *Regarding the PIN entry, the M20T shows the same behavior as a regular cellular phone, as it uses the same type of SIM card. This means, for example, that after 3 false PIN inputs, the SIM card will lock and need to be released via the "PUK" Personal Unlocking Key (Master PIN).*
  - *Repeated (more than 2) input of the wrong "PUK" will destroy the SIM card irrevocably.*
13. Once the M20 has accepted the PIN it will log into the GSM net.  
The terminal window will show "OK".  
The M20T LED will be on continuously.
  14. Disconnect the serial cable from the PC/laptop and connect it to the Excel CPU.
  15. Verify that the M20T dials out on the telephone number for data communication, otherwise, its call will not be recognized by the central. The M20T can be forced to do so by adding the letter <i>i</i> to the telephone number, e.g. <code><ATDi1234567891234</code>

**Note**

As soon as the PIN is entered into the Excel controller, the following mechanisms will take place automatically:

- Cyclical check (once per minute) for existence of the PIN number in the M20.
- Sending of PIN number to M20T, if it has lost it. This guarantees communication will resume automatically after exchange of the SIM card or after power to the M20T has been lost.
- Deletion of the PIN number or resetting the controller will stop the above mechanisms.

**Verification of the PIN**

You can verify the PIN without connecting a terminal program by following these steps:

1. Connect the CLMMI00N21.
2. Enter PIN.
3. Disconnect the CLMMI00N21.
4. Connect the M20T.
5. Reconnect the CLMMI00N21.
6. View the "PIN" field.
7. If it shows "0", the PIN was wrong.
8. If it shows "PIN", the PIN was correct.

Additional information about the M20 terminal may be found at the following website:

<http://www.siemens.de/ic/products/cd/english/index/products/cellular/m20t.html>

# Appendix 3: Sensor Characteristics

**Note**

The following sensor characteristics do not include failures due to:

- Sensor failures
- Wiring resistance or wiring failures
- Missreadings due to a meter connected to measure resistance or voltage at the input

## BALCO 500

Temp. [°C]	Resistance [Ω]	Terminal voltage [V]
-30.0	397	0.157
-29.0	399	0.158
-28.0	401	0.158
-27.0	403	0.159
-26.0	404	0.160
-25.0	406	0.160
-24.0	408	0.161
-23.0	410	0.162
-22.0	412	0.163
-21.0	413	0.163
-20.0	415	0.164
-19.0	417	0.165
-18.0	419	0.165
-17.0	421	0.166
-16.0	423	0.167
-15.0	425	0.168
-14.0	426	0.168
-13.0	428	0.169
-12.0	430	0.170
-11.0	432	0.171
-10.0	434	0.171
-9.0	436	0.172
-8.0	438	0.173
-7.0	440	0.174
-6.0	442	0.174
-5.0	444	0.175
-4.0	445	0.176
-3.0	447	0.176
-2.0	449	0.177
-1.0	451	0.178
0.0	453	0.179
1.0	455	0.179
2.0	457	0.180
3.0	459	0.181
4.0	461	0.182
5.0	463	0.183
6.0	465	0.183
7.0	467	0.184
8.0	469	0.185
9.0	471	0.186

Temp. [°C]	Resistance [Ω]	Terminal voltage [V]
10.0	473	0.186
11.0	475	0.187
12.0	477	0.188
13.0	479	0.189
14.0	481	0.190
15.0	483	0.190
16.0	485	0.191
17.0	487	0.192
18.0	489	0.193
19.0	491	0.193
20.0	493	0.194
21.0	495	0.195
22.0	497	0.196
23.0	499	0.196
24.0	501	0.197
25.0	503	0.198
26.0	506	0.199
27.0	508	0.200
28.0	510	0.201
29.0	512	0.201
30.0	514	0.202
31.0	516	0.203
32.0	518	0.204
33.0	520	0.205
34.0	522	0.205
35.0	524	0.206
36.0	527	0.207
37.0	529	0.208
38.0	531	0.209
39.0	533	0.210
40.0	535	0.210
41.0	537	0.211
42.0	539	0.212
43.0	542	0.213
44.0	544	0.214
45.0	546	0.215
46.0	548	0.215
47.0	550	0.216
48.0	553	0.217
49.0	555	0.218

Temp. [°C]	Resistance [Ω]	Terminal voltage [V]
50.0	557	0.219
51.0	559	0.220
52.0	561	0.220
53.0	564	0.221
54.0	566	0.222
55.0	568	0.223
56.0	570	0.224
57.0	572	0.225
58.0	575	0.226
59.0	577	0.226
60.0	579	0.227
61.0	581	0.228
62.0	584	0.229
63.0	586	0.230
64.0	588	0.231
65.0	590	0.231
66.0	593	0.233
67.0	595	0.233
68.0	597	0.234
69.0	600	0.235
70.0	602	0.236
71.0	604	0.237
72.0	607	0.238
73.0	609	0.239
74.0	611	0.240
75.0	614	0.241
76.0	616	0.241
77.0	618	0.242
78.0	621	0.243
79.0	623	0.244
80.0	625	0.245
81.0	628	0.246
82.0	630	0.247
83.0	632	0.248
84.0	635	0.249
85.0	637	0.249
86.0	639	0.250
87.0	642	0.251
88.0	644	0.252
89.0	647	0.253

Temp. [°C]	Resistance [Ω]	Terminal voltage [V]
90.0	649	0.254
91.0	651	0.255
92.0	654	0.256
93.0	656	0.257
94.0	659	0.258
95.0	661	0.259
96.0	664	0.260
97.0	666	0.261
98.0	668	0.261
99.0	671	0.262
100.0	673	0.263
101.0	676	0.264
102.0	678	0.265
103.0	681	0.266
104.0	683	0.267
105.0	686	0.268
106.0	688	0.269
107.0	691	0.270
108.0	693	0.271
109.0	696	0.272
110.0	698	0.273
111.0	701	0.274
112.0	703	0.275
113.0	706	0.276
114.0	708	0.276
115.0	711	0.278
116.0	713	0.278
117.0	716	0.280
118.0	718	0.280
119.0	721	0.281
120.0	724	0.283

## NTC 20 kΩ

Temp. [°C]	Resistance [kΩ]	Terminal voltage [V]
-50.0	1659	8.78
-49.0	1541	8.77
-48.0	1432	8.76
-47.0	1331	8.75
-46.0	1239	8.74
-45.0	1153	8.72
-44.0	1073	8.71
-43.0	1000	8.70
-42.0	932	8.69
-41.0	869	8.67
-40.0	811	8.66
-39.0	757	8.64
-38.0	706	8.62
-37.0	660	8.60
-36.0	617	8.58
-35.0	577	8.56
-34.0	539	8.54
-33.0	505	8.52
-32.0	473	8.49
-31.0	443	8.47
-30.0	415	8.44
-29.0	389	8.41
-28.0	364	8.38
-27.0	342	8.35
-26.0	321	8.32
-25.0	301	8.28
-24.0	283	8.25
-23.0	266	8.21
-22.0	250	8.17
-21.0	235	8.13
-20.0	221	8.08
-19.0	208	8.04
-18.0	196	7.99
-17.0	184	7.94
-16.0	174	7.89
-15.0	164	7.83
-14.0	154	7.78
-13.0	146	7.72
-12.0	137	7.66
-11.0	130	7.60
-10.0	122	7.53
-9.0	116	7.46
-8.0	109	7.39
-7.0	103	7.32
-6.0	97.6	7.25
-5.0	92.3	7.17
-4.0	87.3	7.09
-3.0	82.6	7.01
-2.0	78.2	6.93
-1.0	74.1	6.85
0.0	70.2	6.76
1.0	66.5	6.67
2.0	63.0	6.58
3.0	59.8	6.49
4.0	56.7	6.40

Temp. [°C]	Resistance [kΩ]	Terminal voltage [V]
5.0	53.8	6.30
6.0	51.1	6.20
7.0	48.5	6.10
8.0	46.0	6.00
9.0	43.7	5.90
10.0	41.6	5.80
11.0	39.5	5.70
12.0	37.6	5.59
13.0	35.7	5.49
14.0	34.0	5.38
15.0	32.3	5.28
16.0	30.8	5.17
17.0	29.3	5.07
18.0	27.9	4.96
19.0	26.6	4.85
20.0	25.3	4.75
21.0	24.2	4.64
22.0	23.0	4.53
23.0	22.0	4.43
24.0	21.0	4.32
25.0	20.0	4.22
26.0	19.1	4.12
27.0	18.2	4.01
28.0	17.4	3.91
29.0	16.6	3.81
30.0	15.9	3.71
31.0	15.2	3.62
32.0	14.5	3.52
33.0	13.9	3.43
34.0	13.3	3.33
35.0	12.7	3.24
36.0	12.1	3.15
37.0	11.6	3.06
38.0	11.1	2.97
39.0	10.7	2.89
40.0	10.2	2.81
41.0	9.78	2.72
42.0	9.37	2.64
43.0	8.98	2.57
44.0	8.61	2.49
45.0	8.26	2.42
46.0	7.92	2.34
47.0	7.60	2.27
48.0	7.29	2.20
49.0	7.00	2.14
50.0	6.72	2.07
51.0	6.45	2.01
52.0	6.19	1.94
53.0	5.95	1.88
54.0	5.72	1.82
55.0	5.49	1.77
56.0	5.28	1.71
57.0	5.08	1.66
58.0	4.88	1.61
59.0	4.69	1.56

Temp. [°C]	Resistance [kΩ]	Terminal voltage [V]
60.0	4.52	1.51
61.0	4.35	1.46
62.0	4.18	1.41
63.0	4.03	1.37
64.0	3.88	1.32
65.0	3.73	1.28
66.0	3.59	1.24
67.0	3.46	1.20
68.0	3.34	1.16
69.0	3.21	1.13
70.0	3.10	1.09
71.0	2.99	1.06
72.0	2.88	1.02
73.0	2.78	0.991
74.0	2.68	0.960
75.0	2.58	0.929
76.0	2.49	0.900
77.0	2.41	0.872
78.0	2.32	0.844
79.0	2.24	0.818
80.0	2.17	0.792
81.0	2.09	0.767
82.0	2.02	0.744
83.0	1.95	0.720
84.0	1.89	0.698
85.0	1.82	0.676
86.0	1.76	0.655
87.0	1.70	0.635
88.0	1.65	0.616
89.0	1.59	0.597
90.0	1.54	0.578
91.0	1.49	0.561
92.0	1.44	0.544
93.0	1.40	0.527
94.0	1.35	0.511
95.0	1.31	0.496
96.0	1.27	0.481
97.0	1.23	0.466
98.0	1.19	0.452
99.0	1.15	0.439
100.0	1.11	0.425
101.0	1.08	0.413
102.0	1.05	0.401
103.0	1.01	0.389
104.0	0.98	0.378
105.0	0.95	0.367
106.0	0.92	0.356
107.0	0.90	0.346
108.0	0.87	0.336
109.0	0.84	0.326
110.0	0.82	0.317
111.0	0.79	0.308
112.0	0.77	0.299
113.0	0.75	0.290
114.0	0.73	0.282

Temp. [°C]	Resistance [kΩ]	Terminal voltage [V]
115.0	0.70	0.274
116.0	0.68	0.266
117.0	0.66	0.259
118.0	0.64	0.252
119.0	0.63	0.245
120.0	0.61	0.238
121.0	0.59	0.231
122.0	0.57	0.225
123.0	0.56	0.219
124.0	0.54	0.213
125.0	0.53	0.207
126.0	0.51	0.201
127.0	0.50	0.196
128.0	0.49	0.191
129.0	0.47	0.186
130.0	0.46	0.181
131.0	0.45	0.176
132.0	0.43	0.171
133.0	0.42	0.167
134.0	0.41	0.162
135.0	0.40	0.158
136.0	0.39	0.154
137.0	0.38	0.150
138.0	0.37	0.146
139.0	0.36	0.142
140.0	0.35	0.139
141.0	0.34	0.135
142.0	0.33	0.132
143.0	0.32	0.128
144.0	0.32	0.125
145.0	0.31	0.122
146.0	0.30	0.119
147.0	0.29	0.116
148.0	0.29	0.113
149.0	0.28	0.110
150.0	0.27	0.107

**PT 1000**

Temp. [°C]	Resistance [Ω]	Terminal voltage [V]
-50.0	803	0.312
-49.0	807	0.314
-48.0	811	0.315
-47.0	815	0.317
-46.0	819	0.318
-45.0	823	0.320
-44.0	827	0.321
-43.0	831	0.323
-42.0	835	0.324
-41.0	839	0.326
-40.0	843	0.327
-39.0	847	0.329
-38.0	851	0.330
-37.0	855	0.332
-36.0	859	0.333
-35.0	862	0.335
-34.0	866	0.336
-33.0	870	0.338
-32.0	874	0.339
-31.0	878	0.341
-30.0	882	0.342
-29.0	886	0.344
-28.0	890	0.345
-27.0	894	0.347
-26.0	898	0.348
-25.0	902	0.350
-24.0	906	0.351
-23.0	910	0.353
-22.0	914	0.354
-21.0	918	0.356
-20.0	922	0.357
-19.0	926	0.359
-18.0	929	0.360
-17.0	933	0.361
-16.0	937	0.363
-15.0	941	0.364
-14.0	945	0.366
-13.0	949	0.367
-12.0	953	0.369
-11.0	957	0.370
-10.0	961	0.372
-9.0	965	0.373
-8.0	969	0.375
-7.0	973	0.376
-6.0	977	0.378
-5.0	980	0.379
-4.0	984	0.380
-3.0	988	0.382
-2.0	992	0.383
-1.0	996	0.385
0.0	1000	0.386
1.0	1004	0.388
2.0	1008	0.389
3.0	1012	0.391
4.0	1016	0.392
5.0	1020	0.394
6.0	1023	0.395
7.0	1027	0.396
8.0	1031	0.398
9.0	1035	0.399

Temp. [°C]	Resistance [Ω]	Terminal voltage [V]
10.0	1039	0.401
11.0	1043	0.402
12.0	1047	0.404
13.0	1051	0.405
14.0	1055	0.406
15.0	1058	0.408
16.0	1062	0.409
17.0	1066	0.411
18.0	1070	0.412
19.0	1074	0.413
20.0	1078	0.415
21.0	1082	0.416
22.0	1086	0.418
23.0	1090	0.419
24.0	1093	0.420
25.0	1097	0.422
26.0	1101	0.423
27.0	1105	0.425
28.0	1109	0.426
29.0	1113	0.428
30.0	1117	0.429
31.0	1121	0.431
32.0	1124	0.432
33.0	1128	0.433
34.0	1132	0.435
35.0	1136	0.436
36.0	1140	0.438
37.0	1144	0.439
38.0	1148	0.441
39.0	1152	0.442
40.0	1155	0.443
41.0	1159	0.445
42.0	1163	0.446
43.0	1167	0.448
44.0	1171	0.449
45.0	1175	0.451
46.0	1179	0.452
47.0	1182	0.453
48.0	1186	0.455
49.0	1190	0.456
50.0	1194	0.458
51.0	1198	0.459
52.0	1202	0.461
53.0	1205	0.462
54.0	1209	0.463
55.0	1213	0.465
56.0	1217	0.466
57.0	1221	0.467
58.0	1225	0.469
59.0	1229	0.470
60.0	1232	0.471
61.0	1236	0.473
62.0	1240	0.474
63.0	1244	0.476
64.0	1248	0.477
65.0	1252	0.479
66.0	1255	0.480
67.0	1259	0.481
68.0	1263	0.483
69.0	1267	0.484

Temp. [°C]	Resistance [Ω]	Terminal voltage [V]
70.0	1271	0.486
71.0	1275	0.487
72.0	1278	0.488
73.0	1282	0.490
74.0	1286	0.491
75.0	1290	0.493
76.0	1294	0.494
77.0	1297	0.495
78.0	1301	0.497
79.0	1305	0.498
80.0	1309	0.499
81.0	1313	0.501
82.0	1317	0.502
83.0	1320	0.503
84.0	1324	0.505
85.0	1328	0.506
86.0	1332	0.508
87.0	1336	0.509
88.0	1339	0.510
89.0	1343	0.512
90.0	1347	0.513
91.0	1351	0.515
92.0	1355	0.516
93.0	1358	0.517
94.0	1362	0.519
95.0	1366	0.520
96.0	1370	0.522
97.0	1374	0.523
98.0	1377	0.524
99.0	1381	0.525
100.0	1385	0.527
101.0	1389	0.528
102.0	1393	0.530
103.0	1396	0.531
104.0	1400	0.532
105.0	1404	0.534
106.0	1408	0.535
107.0	1412	0.537
108.0	1415	0.538
109.0	1419	0.539
110.0	1423	0.541
111.0	1427	0.542
112.0	1430	0.543
113.0	1434	0.545
114.0	1438	0.546
115.0	1442	0.547
116.0	1446	0.549
117.0	1449	0.550
118.0	1453	0.551
119.0	1457	0.553
120.0	1461	0.554
121.0	1464	0.555
122.0	1468	0.557
123.0	1472	0.558
124.0	1476	0.560
125.0	1479	0.561
126.0	1483	0.562
127.0	1487	0.564
128.0	1491	0.565
129.0	1494	0.566

Temp. [°C]	Resistance [Ω]	Terminal voltage [V]
130.0	1498	0.567
131.0	1502	0.569
132.0	1506	0.570
133.0	1510	0.572
134.0	1513	0.573
135.0	1517	0.574
136.0	1521	0.576
137.0	1525	0.577
138.0	1528	0.578
139.0	1532	0.580
140.0	1536	0.581
141.0	1539	0.582
142.0	1543	0.584
143.0	1547	0.585
144.0	1551	0.586
145.0	1554	0.587
146.0	1558	0.589
147.0	1562	0.590
148.0	1566	0.592
149.0	1569	0.593
150.0	1573	0.594
151.0	1577	0.596
152.0	1581	0.597
153.0	1584	0.598
154.0	1588	0.600
155.0	1592	0.601
156.0	1596	0.602
157.0	1599	0.603
158.0	1603	0.605
159.0	1607	0.606
160.0	1610	0.607
161.0	1614	0.609
162.0	1618	0.610
163.0	1622	0.612
164.0	1625	0.613
165.0	1629	0.614
166.0	1633	0.615
167.0	1636	0.617
168.0	1640	0.618
169.0	1644	0.619
170.0	1648	0.621
171.0	1651	0.622
172.0	1655	0.623
173.0	1659	0.625
174.0	1662	0.626
175.0	1666	0.627
176.0	1670	0.629
177.0	1674	0.630
178.0	1677	0.631
179.0	1681	0.632
180.0	1685	0.634
181.0	1688	0.635
182.0	1692	0.636
183.0	1696	0.638
184.0	1699	0.639
185.0	1703	0.640
186.0	1707	0.642
187.0	1711	0.643
188.0	1714	0.644
189.0	1718	0.645

Temp. [°C]	Resistance [Ω]	Terminal voltage [V]
190.0	1722	0.647
191.0	1725	0.648
192.0	1729	0.649
193.0	1733	0.651
194.0	1736	0.652
195.0	1740	0.653
196.0	1744	0.655
197.0	1747	0.656
198.0	1751	0.657
199.0	1755	0.658
200.0	1758	0.659
201.0	1762	0.661
202.0	1766	0.662
203.0	1769	0.663
204.0	1773	0.665
205.0	1777	0.666
206.0	1780	0.667
207.0	1784	0.669
208.0	1788	0.670
209.0	1791	0.671
210.0	1795	0.672
211.0	1799	0.674
212.0	1802	0.675
213.0	1806	0.676
214.0	1810	0.678
215.0	1813	0.679
216.0	1817	0.680
217.0	1821	0.681
218.0	1824	0.683
219.0	1828	0.684
220.0	1832	0.685
221.0	1835	0.686
222.0	1839	0.688
223.0	1843	0.689
224.0	1846	0.690
225.0	1850	0.692
226.0	1854	0.693
227.0	1857	0.694
228.0	1861	0.695
229.0	1865	0.697
230.0	1868	0.698
231.0	1872	0.699
232.0	1875	0.700
233.0	1879	0.702
234.0	1883	0.703
235.0	1886	0.704
236.0	1890	0.705
237.0	1894	0.707
238.0	1897	0.708
239.0	1901	0.709
240.0	1905	0.711
241.0	1908	0.712
242.0	1912	0.713
243.0	1915	0.714
244.0	1919	0.716
245.0	1923	0.717
246.0	1926	0.718
247.0	1930	0.719
248.0	1934	0.721
249.0	1937	0.722

Temp. [°C]	Resistance [Ω]	Terminal voltage [V]
250.0	1941	0.723
251.0	1944	0.724
252.0	1948	0.726
253.0	1952	0.727
254.0	1955	0.728
255.0	1959	0.729
256.0	1962	0.730
257.0	1966	0.732
258.0	1970	0.733
259.0	1973	0.734
260.0	1977	0.736
261.0	1980	0.737
262.0	1984	0.738
263.0	1988	0.739
264.0	1991	0.740
265.0	1995	0.742
266.0	1998	0.743
267.0	2002	0.744
268.0	2006	0.746
269.0	2009	0.747
270.0	2013	0.748
271.0	2016	0.749
272.0	2020	0.750
273.0	2024	0.752
274.0	2027	0.753
275.0	2031	0.754
276.0	2034	0.755
277.0	2038	0.757
278.0	2042	0.758
279.0	2045	0.759
280.0	2049	0.760
281.0	2052	0.761
282.0	2056	0.763
283.0	2060	0.764
284.0	2063	0.765
285.0	2067	0.766
286.0	2070	0.768
287.0	2074	0.769
288.0	2077	0.770
289.0	2081	0.771
290.0	2085	0.773
291.0	2088	0.774
292.0	2092	0.775
293.0	2095	0.776
294.0	2099	0.777
295.0	2102	0.778
296.0	2106	0.780
297.0	2110	0.781
298.0	2113	0.782
299.0	2117	0.784
300.0	2120	0.785
301.0	2124	0.786
302.0	2127	0.787
303.0	2131	0.788
304.0	2134	0.789
305.0	2138	0.791
306.0	2142	0.792
307.0	2145	0.793
308.0	2149	0.794
309.0	2152	0.796

Temp. [°C]	Resistance [Ω]	Terminal voltage [V]
310.0	2156	0.797
311.0	2159	0.798
312.0	2163	0.799
313.0	2166	0.800
314.0	2170	0.802
315.0	2173	0.803
316.0	2177	0.804
317.0	2181	0.805
318.0	2184	0.806
319.0	2188	0.808
320.0	2191	0.809
321.0	2195	0.810
322.0	2198	0.811
323.0	2202	0.812
324.0	2205	0.814
325.0	2209	0.815
326.0	2212	0.816
327.0	2216	0.817
328.0	2219	0.818
329.0	2223	0.820
330.0	2226	0.821
331.0	2230	0.822
332.0	2234	0.823
333.0	2237	0.824
334.0	2241	0.826
335.0	2244	0.827
336.0	2248	0.828
337.0	2251	0.829
338.0	2255	0.830
339.0	2258	0.831
340.0	2262	0.833
341.0	2265	0.834
342.0	2269	0.835
343.0	2272	0.836
344.0	2276	0.838
345.0	2279	0.839
346.0	2283	0.840
347.0	2286	0.841
348.0	2290	0.842
349.0	2293	0.843
350.0	2297	0.845
351.0	2300	0.846
352.0	2304	0.847
353.0	2307	0.848
354.0	2311	0.849
355.0	2314	0.850
356.0	2318	0.852
357.0	2321	0.853
358.0	2325	0.854
359.0	2328	0.855
360.0	2332	0.856
361.0	2335	0.857
362.0	2339	0.859
363.0	2342	0.860
364.0	2346	0.861
365.0	2349	0.862
366.0	2353	0.863
367.0	2356	0.864
368.0	2360	0.866
369.0	2363	0.867

Temp. [°C]	Resistance [Ω]	Terminal voltage [V]
370.0	2367	0.868
371.0	2370	0.869
372.0	2373	0.870
373.0	2377	0.871
374.0	2380	0.872
375.0	2384	0.874
376.0	2387	0.875
377.0	2391	0.876
378.0	2394	0.877
379.0	2398	0.878
380.0	2401	0.879
381.0	2405	0.881
382.0	2408	0.882
383.0	2412	0.883
384.0	2415	0.884
385.0	2419	0.885
386.0	2422	0.886
387.0	2426	0.888
388.0	2429	0.889
389.0	2432	0.890
390.0	2436	0.891
391.0	2439	0.892
392.0	2443	0.893
393.0	2446	0.894
394.0	2450	0.896
395.0	2453	0.897
396.0	2457	0.898
397.0	2460	0.899
398.0	2463	0.900
399.0	2467	0.901
400.0	2470	0.902

## PT 3000

Temp. [°C]	Resistance [kΩ]	Terminal voltage [V]
-50	2.823	1.018
-45	2.868	1.033
-40	2.913	1.047
-35	2.957	1.061
-30	3.002	1.076
-25	3.046	1.090
-20	3.090	1.104
-15	3.134	1.118
-10	3.178	1.132
-5	3.222	1.146

Temp. [°C]	Resistance [kΩ]	Terminal voltage [V]
0	3.266	1.160
5	3.310	1.173
10	3.353	1.187
15	3.397	1.200
20	3.440	1.214
25	3.484	1.227
30	3.527	1.241
35	3.570	1.254
40	3.613	1.267
45	3.656	1.280

Temp. [°C]	Resistance [kΩ]	Terminal voltage [V]
50	3.699	1.293
55	3.742	1.306
60	3.784	1.319
65	3.827	1.332
70	3.869	1.345
75	3.912	1.358
80	3.954	1.370
85	3.996	1.383
90	4.038	1.395
95	4.080	1.408

Temp. [°C]	Resistance [kΩ]	Terminal voltage [V]
100	4.122	1.420
105	4.164	1.433
110	4.206	1.445
115	4.247	1.457
120	4.289	1.469
125	4.330	1.481
130	4.371	1.493
135	4.413	1.505
140	4.454	1.517
145	4.495	1.529
150	4.536	1.541

Manufactured for and on behalf of the Environmental and Combustion Controls Division of Honeywell Technologies Sàrl, Ecublens, Route du Bois 37, Switzerland by its Authorized Representative:

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Printed in Germany.  
Subject to change  
without notice.  
EN1Z-0921GE51 R0507

DIN EN ISO  
9001/14001

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