Electronics

Valve terminal with direct fieldbus connection
Fieldbus protocol:
- DeviceNet

CDVI-DN type
Contents and general safety instructions
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Contents and general safety instructions

Intended use

The CDVI valve terminal with direct fieldbus connection described in this manual is intended exclusively for use as station on the DeviceNet fieldbus.

This CDVI valve terminal has been certified by the ODVA.

DeviceNet

The valve terminal may be used only as follows:

- As intended in an industrial environment
- In original condition without unauthorized alterations. Only the conversions or modifications described in the documentation supplied with the product are permitted.
- In perfect technical condition

The limit values specified for pressures, temperatures, electrical data, torques etc. should be observed.

If conventional accessory components such as sensors and actuators are connected, the specified limits for pressures, temperatures, electrical data, torques etc. should be observed.

Comply with the regulations of the trade associations and the German Technical Control Board (TÜV) and the VDE conditions or corresponding national conditions.

Observe the measures in section 1.4.4 when implementing an emergency stop function.
Warning
If the valve terminal is to be used as explosion-proof equipment, make sure:

- Electrical connections are not disconnected under voltage.
- The completely installed valve terminal with all the plugs, adapters and protective caps used complies at least with protection class IP65.

Target group
This manual is intended exclusively for technicians trained in control and automation technology who have experience in installing, commissioning, programming and diagnosing stations on the DeviceNet.

Service
Please consult your local Festo repair service if you have any technical problems.

Notes on this manual
This manual contains specific information on installing, commissioning, programming and diagnosing CDVI valve terminals with direct connection for DeviceNet.

Information on the pneumatics can be found in the “Pneumatics manual, P.BE-CDV...”
Important user instructions

Danger categories

This manual contains instructions on the possible dangers which may occur if the product is incorrectly used. These instructions are indicated with a signal word (Warning, Caution etc), printed on a shaded background and additionally indicated with a pictogram. A distinction is made between the following danger warnings:

**Warning**

... means that failure to observe this instruction may result in serious personal injury or material damage.

**Caution**

... means that failure to observe this instruction may result in personal injury or material damage.

**Note**

... means that failure to observe this instruction may result in material damage.

Electrostatically sensitive devices: inappropriate handling can cause damage to components.
Identification of specific information

The following pictograms indicate text passages which contain specific information.

**Pictograms**

Information:
Recommendations, tips and references to other sources of information

Accessories:
Details on necessary or useful accessories for the product

Environment:
Information on the environment-friendly usage of the products

**Text designations**

- The bullet point indicates activities which may be carried out in any sequence.

1. Digits indicate activities which must be carried out in the specified sequence.
   - Arrowheads indicate general lists.
Contents and general safety instructions

The following product-specific terms and abbreviations are used in this manual:

<table>
<thead>
<tr>
<th>Term/abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDVI-DN</td>
<td>Clean design valve terminal with direct fieldbus connection for DeviceNet</td>
</tr>
<tr>
<td>CP</td>
<td>Compact performance</td>
</tr>
<tr>
<td>CP cable</td>
<td>Special cable for coupling the various CP modules</td>
</tr>
<tr>
<td>CP connection</td>
<td>Socket or plug on the CP modules which enable the modules to be connected with the CP cable</td>
</tr>
<tr>
<td>CP modules</td>
<td>Collective term for the various modules that can be integrated in a CP system.</td>
</tr>
<tr>
<td>CP system</td>
<td>System consisting of CDVI-DN and CP modules</td>
</tr>
<tr>
<td>Dual expansion block</td>
<td>Expansion block which helps control two solenoid coils per valve position</td>
</tr>
<tr>
<td>I</td>
<td>Digital input</td>
</tr>
<tr>
<td>I/Os</td>
<td>Digital inputs and outputs</td>
</tr>
<tr>
<td>I/O modules</td>
<td>Collective term for the CP modules which provide digital inputs and outputs (CP input modules and CP output modules)</td>
</tr>
<tr>
<td>Load voltage</td>
<td>Power supply of the valves</td>
</tr>
<tr>
<td>Manifold block</td>
<td>Block with 4 or 8 valve positions. Each CDVI-DN has exactly one manifold block.</td>
</tr>
<tr>
<td>Mono expansion block</td>
<td>Expansion block which helps control one solenoid coil per valve position</td>
</tr>
<tr>
<td>O</td>
<td>Digital output</td>
</tr>
<tr>
<td>Operating voltage</td>
<td>Power supply for the electronics</td>
</tr>
<tr>
<td>PLC/IPC</td>
<td>Programmable logic controller/industrial PC</td>
</tr>
</tbody>
</table>

Tab. 0/1: Terms and abbreviations
1. Installation

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1. Installation

1.1 General installation instructions

**Warning**
Uncontrolled movements of the connected actuators and uncontrolled movements of loose tubing may cause personal injury or material damage.
- Before any conversion work on the CDVI-DN, switch off the following:
  - Compressed air supply
  - Power supply
- Make sure no control signals from the higher-order controller are present at the solenoid coils.

**Note**
Observe the CDVI assembly instructions in the “CDVI pneumatics manual” (CP.BE-CDVI-...) in chapter 2.
The CDVI-DN contains electrostatically sensitive devices.
- Do not therefore touch any electronic components.
- Observe the handling specifications for electrostatically sensitive devices.
They will help you avoid damage to the electronics.
1. Installation

Electrical connections

1. Power supply (plug, M12)
2. CP extension (M9)
3. Fieldbus input (plug, M12)
4. Fieldbus output (socket, M12)
5. Auxiliary power supply on expansion block (plug, M12)

Fig. 1/1: Electrical connections of the CDVI-DN
1. Installation

1.2 Setting the CDVI-DN

1.2.1 Removing and mounting the left-hand end plate

Note
The CDVI-DN contains electrostatically sensitive devices.
- Do not therefore touch any electronic components.
- Observe the handling specifications for electrostatically sensitive devices.
They will help you avoid damage to the electronics.

You must remove the left-hand end plate in order to set the CDVI-DN.

3.5 Nm (... 4 Nm)

Fig. 1/2: Removing/mounting the left-hand end plate
1. **Installation**

**Removing**
1. Switch off all power supplies (electric voltage, compressed air).
2. Loosen each of the two mounting screws on the left-hand end plate by approximately one turn.
3. Now unscrew the two mounting screws completely to avoid twisting or squeezing the separator plate (seal).
4. Pull off the left end plate.

**Mounting**
1. Place the separator plate (seal) on the manifold block. The separator plate must be fitted correctly on the guide sleeves of the manifold block.
2. Position the left end plate too.
3. Tighten the two mounting screws alternately. Torque: 3.5 Nm (... 4 Nm)

**Note**
- Make sure the separator plate (seal) is not squeezed on one side as a result of uneven tightening of the cover screws.
- The requirements of the IP protection class cannot be fulfilled if a seal is squeezed.
1. Installation

1.2.2 Setting the DIL switches

You will see several DIL switches after removing the left end plate in accordance with chapter 1.2.1:

Fig. 1/3: DIL switches

You can set the following parameters with the DIL switches:

1. Extension of the CP system
2. Setting the address assignment
3. Setting the baud rate
4. Setting the station number (slave address)
1. Installation

Setting: extension of the CP system

Further CP modules can be connected to the CDVI-DN. You can set the extension of the CP system with the switch elements 1 and 2 of the dual DIL switch in accordance with the following table.

<table>
<thead>
<tr>
<th>Extension</th>
<th>Outputs</th>
<th>Inputs</th>
<th>DIL switch positions</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDVI-DN with 4 / 8 valve positions (+ expansion blocks) <strong>without</strong> CP extension</td>
<td>8 / 16 / 24 O</td>
<td>8 I (status byte)</td>
<td></td>
</tr>
<tr>
<td>CDVI-DN with:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>– CP input module</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CDVI-DN with:</td>
<td>8 / 16 / 24 O</td>
<td>8 I (status byte)</td>
<td></td>
</tr>
<tr>
<td>– CP valve terminal or</td>
<td>+ 16 O</td>
<td>+ 16 I</td>
<td></td>
</tr>
<tr>
<td>– CP output module</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CDVI-DN with:</td>
<td>8 / 16 / 24 O</td>
<td>8 I (status byte)</td>
<td></td>
</tr>
<tr>
<td>– CP valve terminal /</td>
<td>+ 16 O</td>
<td>+ 16 I</td>
<td></td>
</tr>
<tr>
<td>– CP output module and</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>– CP input module</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Tab. 1/1: Setting the extension of the CP system

The CP system occupies a different number of inputs and outputs or station numbers, depending on the extension set. Additional information can be found in section 1.5.
1. Installation

**Note: Expansion blocks**

A Manifold block
B Single or double expansion blocks

If you extend the manifold block (with 4 or 8 valve positions) by single or double extension blocks, these extension blocks will be automatically identified.

**Setting the address assignment**

Set the address assignment as illustrated in the following:

<table>
<thead>
<tr>
<th>Address assignment</th>
<th>DIL switch positions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automatic address assignment of the CDVI (modular EDS)</td>
<td><img src="image1" alt="Switch Positions" /></td>
</tr>
<tr>
<td>Addressing to maximum expansion of the CDVI</td>
<td><img src="image2" alt="Switch Positions" /></td>
</tr>
</tbody>
</table>

Tab. 1/2: Setting the address assignment
Setting the baud rate

Set the baud rate as illustrated in the following:

<table>
<thead>
<tr>
<th>125 kBaud</th>
<th>250 kBaud</th>
<th>500 kBaud</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Setting baud rate" /></td>
<td><img src="image" alt="Setting baud rate" /></td>
<td><img src="image" alt="Setting baud rate" /></td>
</tr>
</tbody>
</table>

Tab. 1/3: Setting the baud rate

Criteria for selecting the permitted baud rate can be found in section 1.3.2.

Setting the station number (slave address)

You can set the fieldbus station number (binary coded) with the eightfold DIL switch.

![Setting the station number](image)

Fig. 1/4: Setting the station number (eightfold DIL switch)

Note

Station numbers may be assigned only once per fieldbus line.
1. Installation

The following station numbers are permitted:

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Address designation</th>
<th>Permissible station numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>DeviceNet</td>
<td>Station number</td>
<td>0; ...; 63</td>
</tr>
</tbody>
</table>

Tab. 1/4: Examples of set station numbers

Recommendation:
Assign the station numbers in ascending order. Assign the station numbers in accordance with the machine structure of your system.
### 1. Installation

Overview for the setting of station numbers:

<table>
<thead>
<tr>
<th>Station no.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
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<tbody>
<tr>
<td>0</td>
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</tbody>
</table>

Tab. 1/5: Setting of station numbers 0-31: position of the DIL switch elements
### 1. Installation

<table>
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<tr>
<th>Station no.</th>
<th>1</th>
<th>2</th>
<th>3</th>
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<thead>
<tr>
<th>Station no.</th>
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<td></td>
</tr>
</tbody>
</table>

Tab. 1/6: Setting of station numbers 32-63: position of the DIL switch elements
1.3 Connecting to the fieldbus

1.3.1 Fieldbus cable

Note
Faulty installations or high transmission rates may cause data transmission errors as a result of signal reflections and attenuations. Transmission errors can be caused by:
- Missing or incorrect terminating resistor.
- Incorrect screened connection.
- Branch lines of excess length.
- Transmission over long distances.
- Inappropriate cables.
Observe the cable specifications. Refer to the manual for your control system for information on the type of cable to be used.

Use a twisted, screened 5-wire cable as fieldbus line. The bus interface is supplied with power via the fieldbus line.

Pre-assembled bus cables are available from several manufacturers. Make sure the cables and plugs are suitable for the ambient conditions (e.g. cleaning agents used) and comply with the required IP protection class.

Note
If the valve terminal is mounted into a moving part of a machine, the fieldbus cable on the moving part must be provided with strain relief. Please observe also the relevant regulations in EN 60204 part 1.
1. Installation

1.3.2 Fieldbus baud rate and fieldbus length

The maximum permitted fieldbus length depends on the baud rate used. Tab. 1/7 shows the reference values.

<table>
<thead>
<tr>
<th>Baud rate</th>
<th>Maximum main bus length</th>
<th>Branch line length</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Maximum Cumulative</td>
</tr>
<tr>
<td>125 kBaud</td>
<td>500 m</td>
<td>6 m 156 m</td>
</tr>
<tr>
<td>250 kBaud</td>
<td>250 m</td>
<td>78 m</td>
</tr>
<tr>
<td>500 kBaud</td>
<td>100 m</td>
<td>39 m</td>
</tr>
</tbody>
</table>

Tab. 1/7: Maximum fieldbus and branch line lengths depending on the baud rate (as per ODVA specification V 2.0)

The maximum permitted length of a branch line depends on the total length of the branch lines and on the baud rate.

Details can be found in the manuals for your control system or scanner.

**Note**
- Refer to the manuals for your control system or bus interface in order to ascertain which T-adapter and maximum branch line length are permitted for your controller.
- Also take into account the sum of the branch line lengths when calculating the maximum permitted length of the fieldbus cable.

Information on setting the baud rate can be found in section 1.2.2.
1. Installation

1.3.3 Power supply for the DeviceNet

Avoid long distances between the power supply and the CDVI-DN.

**Caution**
- Make sure the polarity is correct when you connect the fieldbus interface and the power supply for the bus interface/internal logics.
- Connect the screen (pin 1).

**Note**
Bus stations have different tolerances in respect of the power supply, depending on the manufacturer. Observe this when planning the bus length and placing the power supply unit.

The following tolerance of the DeviceNet bus interface supply (pin 2) applies to the CDVI:

\[
V_{\text{max}} = 30 \text{ V} \\
V_{\text{min}} = 11 \text{ V}
\]

Recommendation:
Place the power supply unit approximately at the centre of the bus.
1.3.4 Pin allocation of the DeviceNet

**Note**
Make sure you check the pin allocation of your scanner with the relevant documentation.

The bus connection is established at “Bus in”. Use a 5-pin M12 socket from Festo for this purpose (type: FBSD-GD-9-5POL).

The fieldbus is continued at “Bus out”. Use a plug of type FBS-M12-5GS-PG9 for this purpose.

For the position of these connections, see also Fig. 1/1.

The following table shows the connection between the wire colour, signal and pin allocation:

<table>
<thead>
<tr>
<th>Wire colour</th>
<th>Signal</th>
<th>PIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blank</td>
<td>Screen</td>
<td>Pin 1</td>
</tr>
<tr>
<td>Red</td>
<td>24 V DC bus</td>
<td>Pin 2</td>
</tr>
<tr>
<td>Black</td>
<td>0 V bus</td>
<td>Pin 3</td>
</tr>
<tr>
<td>White</td>
<td>CAN_H</td>
<td>Pin 4</td>
</tr>
<tr>
<td>Blue</td>
<td>CAN_L</td>
<td>Pin 5</td>
</tr>
</tbody>
</table>

*) typical for DeviceNet cables

Tab. 1/8: Pin allocation of the DeviceNet
1. Installation

1.3.5 Connection example

1 Micro Style connections
2 Fieldbus
3 Power supply
4 Screen
5 Branch line
6 T-adapter

Fig. 1/5: Connection example
1. Installation

1.3.6 Bus terminal with terminating resistors

**Note**
Fit a bus terminal to both ends of a bus segment. This also applies if the bus interface is at the beginning of the bus cable.

If the CDVI valve terminal is at the end of the fieldbus system, a bus terminal is required there.

If you use a T-adapter, we recommend installing the terminating resistor at the free output of the T-adapter.

**Recommendation:**
Mount a terminating resistor (120 Ω, 0.25 W) between the connections for CAN_H (pin 4) and CAN_L (pin 5) for the bus terminal.
## 1.4 Power supply

### 1.4.1 Calculation of the current consumption

- Calculate the current consumption before selecting the power supply units, cables and fuses:

<table>
<thead>
<tr>
<th>Current consumption</th>
<th>Sums</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electronics and sensors (pin 1)</strong></td>
<td></td>
</tr>
<tr>
<td>CDVI-DN</td>
<td>100 mA</td>
</tr>
<tr>
<td>In the CP extension:</td>
<td></td>
</tr>
<tr>
<td>Valve terminal(^1) or CP output module(^1)</td>
<td>mA</td>
</tr>
<tr>
<td>CP input module(^1)</td>
<td>mA</td>
</tr>
<tr>
<td>Sensors(^1) on the CP input module</td>
<td>mA</td>
</tr>
<tr>
<td>Sum of pin 1</td>
<td>mA</td>
</tr>
</tbody>
</table>

\(^1\) Refer to the technical data for the relevant product.

<table>
<thead>
<tr>
<th>Valves and outputs (pin 2)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CDVI-DN: all solenoid coils energised simultaneously(^2) (^3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>120 mA</td>
</tr>
<tr>
<td>In the CP extension:</td>
<td></td>
</tr>
<tr>
<td>all solenoid coils energised simultaneously(^2) (^3)</td>
<td>mA</td>
</tr>
<tr>
<td>All digital outputs(^1) (^4)</td>
<td>mA</td>
</tr>
<tr>
<td>Sum of pin 2</td>
<td>mA</td>
</tr>
</tbody>
</table>

**Total** = mA

\(^2\) The valves have one or two solenoid coils depending on the valve type.

\(^3\) When switching on, with LEDs.

\(^4\) If not with their own load voltage supply.

Tab. 1/9: Current consumption calculation
1.4.2 Selecting the cables

- Calculate the required cable cross section and the maximum permitted line length.
- Avoid long distances between the power supply unit and the valve terminal. Long cables reduce the voltage supplied by the power supply unit.

Make sure the cables and sockets meet the ambient conditions (e.g. cleaning agents used) and fulfil the requirements of IP protection class.

1.4.3 Selecting the power supply unit

**Warning**
- Use only PELV circuits as per IEC/DIN EN 60204-1 for the electric power supply (protective extra-low voltage, PELV). Also observe the general requirements for PELV circuits laid down in IEC/DIN EN 60204-1.
- Use only power sources that guarantee reliable electrical isolation of the operating voltage as per IEC/DIN EN 60204-1.

Protection against electric shock (protection against direct and indirect contact) is guaranteed in accordance with IEC/DIN EN 60204-1 by using PELV circuits (electrical equipment of machines, general requirements).

Recommendation:
- Use controlled power supply units.
- Before selecting the power supply units, calculate the total current requirement in accordance with section 1.4.1.
1.4.4 Connecting the power supply of the valve terminal

Use only a 5-pin M12 socket (A-coded; see Appendix: Accessories) for the power supply of the manifold block and connect it only to the power supply (see also Fig. 1/1).

**Note**

All power supply connections are protected against reverse polarity, or the 0 V load voltage of the valves at the manifold blocks and expansion blocks with electric power supply are additionally protected with a fuse.

Pin allocation of the power supply connection

![Diagram of pin allocation]

1. 24 V DC operating voltage for the electronics (and input modules on CP string)
2. 24 V DC load voltage for valves (and outputs)
3. 0 V electronics (and output modules on CP string)
4. 0 V load voltage for valves (and outputs)
5. Earth terminal

**Fig. 1/6:** Pin allocation of the power supply connection on the manifold block
1. N.C.
2. 24 V DC load voltage for valves
3. 0 V load voltage for valves
4. Earth terminal

Fig. 1/7: Pin allocation of the power supply connection on the expansion block

Note
In the event of an extension of the CDVI-DN with a CP valve terminal of the first generation (without auxiliary power supply):

- Place a bridge between pins 3 and 4.

However, there will no longer be any galvanic isolation between the electronic voltage and the load voltage (valves).
1. Installation

Mounting the connector socket

Preparing

Once you have selected appropriate cables, connect them as follows (Fig. 1/8):

1. To open the plug, loosen the central knurled nut.
2. Open the strain relief on the rear part of the housing. Then pass the cable through.
3. Remove 5 mm of insulation from the end of the conductors and fit wire end sleeves on the stranded wires.
4. Connect the ends of the conductors.
5. Replace the connector part on the housing of the plug. Pull back the cable until there are no loops inside the housing.
6. Tighten the strain relief.
1. Installation

**Warning**
If the valve terminal is supplied with load voltage via an output of a “safety I/O module”, switch-on test pulses of the “safety I/O module” may cause unexpected reactions of the valve terminal.
- Make sure any switch-on test pulses are reliably suppressed or switched off.

Observe the following for the connection of the 24 V load voltage (pin 2):
- Observe the tolerance (21.6 V ... 26.4 V DC).
  Check the 24 V load voltage of the valves while the system is in operation.

**Caution**
Excessive voltages or short circuits can cause functional damage on the CP..-SC-DN, whereby actuators can no longer be controlled.
- Protect the load voltage of the solenoid coils with external fuses.

To ascertain the amperage of the fuses, first calculate the maximum current consumption in accordance with section 1.4.1.
Note
Check your EMERGENCY STOP concept to ascertain which measures are necessary for your machine/system in order to switch the system into a safe state in the event of EMERGENCY STOP:

- Switching off the load voltage for the valves and output modules in the secondary circuit of the power supply unit
- Switching off the compressed air supply for the valve terminal

Due to energy stored in the input circuitry of valve terminals, there may be a delayed reaction of the valves after switching off the load voltage.

Take this into consideration, for example as follows:
- By using an input signal in the controller to check whether the load voltage has been switched off.
- By blocking the control signal for the valves by locking the output signal with the “Load voltage” input signal.

Potential equalisation

Earth the CDVI valve terminal:

- At the power supply connection (pin 5).
- And on the housing (with cable lug on a spacer bolt on conductive surface).

Note
- By means of low-impedance connections, make sure the housing of the valve terminal and the earth terminal at pin 5 have the same potential and that there are no compensating currents.

In this way, you will avoid interference from electromagnetic sources.
1. Installation

Connection without galvanic isolation:

1. Connection for power supply
2. Potential equalisation
3. Earth terminal at pin 5
4. Load voltage which can be switched off separately and external fuses
5. Protective earth (PE)

Fig. 1/9: Connection example for power supply with one PELV power supply unit
1. Installation

Connection with galvanic isolation of operating and load voltage:

![Connection diagram]

1. Power supply unit for load voltage (valves and outputs)
2. Isolation monitoring device
3. Power supply unit for operating voltage (electronics and sensors)

Fig. 1/10: Connection example for power supply with two PELV power supply units

**Note**

Galvanic isolation will no longer be possible if you loop the voltage through to further I/O modules without galvanic isolation.
1.5 Extending the CDVI

1.5.1 Inserting expansion blocks

A Manifold block
B Single or double expansion blocks

The manifold block of the CDVI can be extended with:

- Single expansion blocks
- Double expansion blocks

with or without auxiliary power supply as dual or mono expansion block. A combination of dual and mono expansion blocks is allowed (until the address limit is reached).

Only valves which are to the right of the expansion block with auxiliary power supply are supplied by it with electric power. Up to nine power zones can be implemented by using extension modules with electric power.

The following combinations are possible at the most:

- Manifold block with 4 valve positions + 4 dual expansion blocks
- Manifold block with 8 valve positions + 4 dual expansion blocks
- Manifold block with 4 valve positions + 8 mono expansion blocks
- Manifold block with 8 valve positions + 8 mono expansion blocks
Advanced diagnostics (supplied load voltage) are only possible with new manifold blocks or new expansion blocks with additional electric power supply. These new blocks are distinguished by the 16-pole electrical connection (old = 12-pole) and the designation printed on the PCB. Advanced diagnostics are not possible if old blocks are combined with new ones.

1.5.2 CP extension connection

You can connect further CP modules to the VDVI-DN via the CP extension connection.

![CP extension connection](image)

Fig. 1/11: CP extension connection

**Note**

Modules which you connect to the CP extension connection are recognized only if the DIL switches are set correctly.

Information on setting the DIL switches can be found in section 1.2.2.

You can connect the following CP modules to the CP extension connection:

- CP input module with 8 or 16 inputs, either with M12 plugs (sockets assigned twice) or M8 plugs (sockets assigned once)
- CP input module (IP 20) with 16 inputs
1. Installation

- CP output module with 8 outputs. Power supply of the electronics via the CP extension connection. Load voltage: separately via an M18 plug.

- CP output module with 4 outputs. Power supply of the electronics and load via the CP string.

- CPV valve terminals with widths of 10, 14 and 18 mm. Available with 4, 6 or 8 valve sub-bases.

- CPV valve terminals with widths of 10 and 14 mm. Available with max. 8 valve sub-bases (each with 2 coils) or with max. 16 valve sub-bases (each with 1 coil).

**Note**
The CDVI-DN can be extended by no more than:
- One CP input module and
- One CP valve terminal or one CP output module.

**Caution**
Data transmission faults if the maximum permitted signal line length is exceeded
The total signal line length between the CDVI-DN and the last CP module must not exceed 10 m.
The CP connecting cables must have special electrical properties. Therefore make sure you use Festo CP connecting cables.

Pre-assembled CP connecting cables are available from Festo. They are available in various lengths and designs. An overview can be found in Appendix A.

**Note**
Use blanking plugs to seal unused connections (important for protection class IP).

Possible extensions are illustrated in the following diagram:
## Extension with CP modules

<table>
<thead>
<tr>
<th>CDVI-DN</th>
<th>O module or valve terminal (DIL2)</th>
<th>I module (DIL1)</th>
<th>Position of the DIL switches</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>DIL1: I module</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>DIL2: O module or valve terminal</td>
</tr>
</tbody>
</table>

![Diagram of extension options of the CDVI-DN]

- **Total line length of the CP system:** maximum 10 m
- **1** CDVI-DN
- **2** CP connecting cable 0.5 m, 2 m, 5 m, 8 m
- **3** CP input module with 16 inputs (8 x M12, 16 x M8 plug)
- **4** CP output module with 8 outputs (8 x M12 plug)
- **5** CPV or CPA valve terminal

Fig. 1/12: Extension options of the CDVI-DN
Startup

Chapter 2
2. Startup

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2. Startup

2.1 Preparing the CDVI valve terminal for startup

2.1.1 Switching on the operating voltages

Note
Please observe the switch-on instructions in the manual for your PLC.

- Before switching it on, make sure the details regarding the fieldbus configuration are complete and correct.

Observe the following points before switching on the power supply:

Common supply
Set up the common power supply of the control system and all fieldbus stations via a central power supply unit or a central switch.

Separate supply
If the control system and the fieldbus stations have separate power supplies, they should be switched on in the following sequence:

1. Switch on the operating voltage supply for all fieldbus stations.
2. Switch on the operating voltage supply for the controller.
2. Startup

2.1.2 Address assignment of the CDVI-DN

The CDVI-DN occupies 8, 16 or 24 addresses, irrespective of the number of solenoid coils equipped on it.

**Note**
You can prevent address shifts by extending the valve terminal between the last valve position and the right end plate.

**Caution**
The addresses may be shifted by replacing an expansion block with an expansion block of a different type. For example, the address assignment of the valve positions is shifted two addresses to the right by removing a double dual expansion block and replacing it with a double mono expansion block.

The following diagrams show the addressing sequence, depending on the base block:

![Diagram](image_url)

Fig. 2/1: Addressing of manifold block with 4 valve positions
2. Startup

Fig. 2/2: Addressing of manifold block with 8 valve positions

- A valve position on the CDVI valve terminal always occupies two addresses on the manifold block even if it is only equipped with a blanking plate.

- The extensions occupy a maximum of eight addresses (regardless of which expansion blocks are used). No more than eight mono expansion blocks or four dual expansion blocks can be mounted on a manifold block. Mixed components are allowed.

A Manifold block: 8 or 16 addresses
B Expansion blocks: maximum 8 addresses
If a valve position is equipped with a valve which has two pilot solenoids, the following assignment applies:

- Pilot solenoid 14 occupies the less significant address.
- Pilot solenoid 12 occupies the higher-value address.

In the event of valves with only one pilot solenoid, the higher-value address remains unused.

Addresses are therefore assigned on the CDVI valve terminal from left to right, however from right (14) to left (12) on the individual valve terminals.
2.2 Startup on the DeviceNet

Note
– The Festo valve terminal of type CDVI-DN can be used at all DeviceNet masters.
– This chapter describes the configuration and startup by the example of Allen-Bradley controllers.

2.2.1 General remarks

The following special features should be observed when using the CDVI valve terminal on the DeviceNet:

– The I/O addresses of all identified DeviceNet stations can be assigned freely as M-file addresses or as discrete I/Os in the scan list.

– The address assignment of a network station is usually made in ascending sequence.

– The input and output addresses can be assigned independently of each other.

Note
Assign the I/O addresses of the network stations so that sufficient reserve is available for subsequent extensions.

The following sections contain general instructions for the configuration of a valve terminal on the DeviceNet.

Detailed information can be found in the documentation or help function of your configuration program.
2.2.2 Configuring DeviceNet station properties (EDS)

When starting up a new DeviceNet station for the first time, you must inform your configuration program about certain properties of the station. The properties of the various stations are managed by the configuration program usually in a list or library, e. g. “EDS library” (EDS for electronic data sheets).

Installing an EDS file

Current EDS files and picture files (icons) can be found in the Internet under the following address:

– www.festo.com/fieldbus/
  File name: festo_dn.exe

You will require the following files for the CDVI-DN:

<table>
<thead>
<tr>
<th>File type</th>
<th>File name</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDS files</td>
<td>CDVI-DN.EDS</td>
</tr>
<tr>
<td>ICO file (icon)</td>
<td>CDVI-DN.ICO</td>
</tr>
<tr>
<td>BMP file (bitmap)</td>
<td>CDVI-DN.BMP</td>
</tr>
</tbody>
</table>

EDS file

The EDS files contain all the necessary information about the valve terminal of type CDVI-DN. You can install this file with your configuration program.

ICO/BMP file

You can assign the bitmap file or icon file to the valve terminal, depending on the configuration program used. The valve terminal is then displayed accordingly in the configuration program.

Notes on how to install an EDS file and an ICO or BMP file can be found in the manual or in the help function for your configuration program.


2.2.3 Supplementary notes: Modular EDS

Modular EDS provides a virtual slot system ("rack") in which the components of the CP system sit in virtual "slots" and can be configured individually. As a result, there are no gaps in the I/O mapping - only I/Os which actually exist are taken into account.

The components of a CP system always have this sequence within the rack:

1. CDVI-DN manifold block
2. CDVI-DN expansion blocks
3. CP output module or valve terminal
4. CP input module

Example of a rack:

<table>
<thead>
<tr>
<th>Slot</th>
<th>Icon</th>
<th>Assignment</th>
<th>Addresses</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>DeviceNet adapter</td>
<td>8I</td>
</tr>
<tr>
<td>I</td>
<td></td>
<td>CDVI-DN manifold block with 4 / 8 valve positions</td>
<td>8 / 16</td>
</tr>
<tr>
<td>II</td>
<td></td>
<td>CDVI-DN expansion blocks</td>
<td>8</td>
</tr>
<tr>
<td>III</td>
<td></td>
<td>Valve terminal (or CP output module)</td>
<td>16</td>
</tr>
<tr>
<td>IV</td>
<td></td>
<td>CP input module</td>
<td>16</td>
</tr>
</tbody>
</table>

Fig. 2/3: Example of a rack in modular EDS
2. Startup

2.2.4 General instructions for parametrisation at the DeviceNet

The following steps are required for parameterisation, depending on the configuration program, after the station properties have been configured (e.g. by installing the EDS file).

1. Insert the station in the project/network (online or offline). If the station is inserted offline, for example, it is selected from the station list and added to the network.

2. Assign the station to a scanner. A network may contain several scanners. The station must be assigned to a scanner.

3. Define the I/O parameters of the station. The following details are required here:
   - Number of I/O bytes to be transferred. For the CDVI-DN, the number depends on the connected extensions (see section 1.5):
     - 1...3 input bytes occupied
     - 1...5 output bytes occupied
   Tab. 2/1 shows the assignment.
   - Specification of the communication type. The following applies to the CDVI-DN:
     - “Polled communication” or “Change of state / cyclic”
   - Assign the I/O addresses of the station to the PLC operands.
   - Assign the status byte to the PLC operands.

4. Load the configuration into the scanner.
2. Startup

<table>
<thead>
<tr>
<th>Extension of the valve terminal</th>
<th>Number of input/output addresses</th>
<th>Number of I/O bytes (IB / OB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDVI-DN without CP extension</td>
<td>8/16/24 0 8 I</td>
<td>1/2/3 OB 1 IB</td>
</tr>
<tr>
<td>CDVI-DN with:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– CP input module</td>
<td>8/16/24 0 8 I + 16 I</td>
<td>1/2/3 OB 1 IB + 2 IB</td>
</tr>
<tr>
<td>CDVI-DN with:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– CP. valve terminal or</td>
<td>8/16/24 0 8 I + 16 O</td>
<td>1/2/3 OB 2 OB 1 IB</td>
</tr>
<tr>
<td>– CP output module</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CDVI-DN with:</td>
<td>8/16/24 0 8 I + 16 O</td>
<td>1/2/3 OB 2 OB 1 IB</td>
</tr>
<tr>
<td>– CP valve terminal / CP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– CP output module</td>
<td></td>
<td></td>
</tr>
<tr>
<td>and – CP input module</td>
<td>8/16/24 0 8 I + 16 I</td>
<td>1/2/3 OB 2 IB</td>
</tr>
</tbody>
</table>

Tab. 2/1: Number of assigned I/O bytes depending on the extension of the CDVI-DN
2. Startup

2.2.5 Parametrisation with RSNetWorx: EDS

This section gives instructions for parametrisation with RSNetWorx for DeviceNet version 4.01.00 from Rockwell. All steps specified refer to the example of the Allen-Bradley scanner 1756-SDN. They apply accordingly to other masters.

a) Inserting a station in the project/network

RSNetWorx for DeviceNet contains an EDS assistant which will help you install the EDS file(s). You can find the CDVI in the “Hardware” list after installing the EDS file(s). You can insert stations in the network on the right-hand side by pulling them with the mouse or by clicking the “Bus scan” button.

Fig. 2/4: Hardware list and network in RSNetWorx
b) Only with modular EDS: checking the configuration

Double-click on the CDVI-DN icon in the network (Fig. 2/4). A dialogue window appears with the name of the valve terminal in the heading.

Click on “Module Configuration”.

![Module Configuration Dialogue Window](image)

Fig. 2/5: RSNetWorx: Module Configuration

You can see possible hardware modules of your CDVI-DN system in the “Hardware” field.

Identified modules and their slot are listed on the right.
Double-click on the name of a module to the right of “Slot.” A dialogue window appears with the heading “Slot '..' - CDVI...”:

Fig. 2/6: RSNetWorx: Advanced Parameters

You can make various settings under “Advanced Parameters”, which are described in the following sections.
2. Startup

Click on “I/O Summary”.

Fig. 2/7: RSNetWorx: I/O Summary

You are provided here with an overview of the configuration of the input and output addresses of your CP system.
c) Assigning the station to a scanner

1. Double-click on the desired scanner in the network. A dialogue window appears.

2. Select the “Scanlist” tab and assign the available stations to the scanner:

![Diagram of Scanlist tab](image)

Fig. 2/8: “Scanlist” tab (example)
d) Parametrising stations

1. Double-click on a station in the “Scanlist” (Fig. 2/8). A dialogue window appears.

2. Only with conventional EDS: define the I/O parameters of the station. Confirm with OK.

![Fig. 2/9: Mask for defining the I/O parameters of the station](image)

**Hinweis**
Fieldbus communication is interrupted through a strobed connection.
- Make sure that the communication type "strobed" is **not** selected in the mask above.

Configuration example:
- Communication type: “Polled”
- 1 input byte for diagnostics (diagnostic byte)
- 5 output bytes for the CDVI-DN and an output module in the extension

Observe the overview in Tab. 2/1.
e) Assigning I/O addresses of the station

You can use the “Output” and “Input” tabs to assign the I/O addresses of the node to the PLC operands:

Fig. 2/10: Address assignment of the input of the 1-byte diagnostic information (“Polled”)

The CDVI-DN uses a “polled” connection to transmit the diagnostic information and the physical input data.
The physical output data are transmitted via the “polled” or “change of state” communication connection. In this example “polled”:

![Address assignment of the output (example)](image)

**Loading the configuration into the scanner.**

Finally, load the configuration data into the scanner. Further information can be found in the documentation for your scanner.
2.2.6 Device-specific parametrisation

The CDVI-DN supports various device parameters which you can use to set the reaction of the valve control and several status messages. The parameters are set by selecting “Device Parameters” in the network configurator.

The table in Tab. 2/4 shows an example of how to address the solenoid coils.

Program-controlled access to the PLC is made by “explicit message” programming. The addresses of the DeviceNet objects required for this purpose can be found in Appendix B.

Reaction of the outputs in fault mode

The bus stations assume fault mode if there is a fault in the communication via DeviceNet. These faults may be caused by:

– Physical interruption of the network.
– Interference to data telegrams.

In fault mode, the outputs for valve control and for the output modules can assume one of the following states:

– Reset output
– Set output
– Freeze current status of output

The status to be assumed can be determined separately for each output. The default setting is “Reset output”.

The valves of the CDVI-DN and the outputs of the modules in the CP extension are set with separate parameters:

**“Fault Action, Main Unit” parameter**

You can use this parameter to define for each output whether it is to freeze the current status in fault mode or assume a certain output status (0/1).

<table>
<thead>
<tr>
<th>Parameter value</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>The output is set to a certain output status (0 or 1). The output status is defined with the parameter “Fault Value, Main Unit”.</td>
</tr>
<tr>
<td>1</td>
<td>The status of the output is frozen.</td>
</tr>
</tbody>
</table>

Tab. 2/2:

**“Fault Value, Main Unit” parameter**

You can use this parameter to define the output status (0 or 1) which each output is to assume in fault mode.

<table>
<thead>
<tr>
<th>Parameter value</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Output is reset</td>
</tr>
<tr>
<td>1</td>
<td>Output is set</td>
</tr>
</tbody>
</table>

Tab. 2/3:

The set parameter value is only taken into account if the relevant output is set to 0 in the Fault Action parameter.
2. Startup

“Fault Action, Main Unit Extension” parameter
The same function as above with “Main Unit,” but for the output module in the extension.

“Fault Value, Main Unit Extension” parameter
The same function as above with “Main Unit,” but for the output module in the extension.

Reaction of the outputs in idle mode
Idle mode is assumed by the stations when this is requested by the master or scanner. In this status, the following applies:

– Inputs are transmitted.
– Outputs of the stations are no longer updated.

In idle mode, the outputs for valve control and for the output module can assume one of the following statuses:

– Reset output
– Set output
– Freeze current status of output

The status to be assumed can be determined separately for each output. The default setting is “Reset output”.

The valves of the CDVI-DN and the outputs of the modules in the CP extension are set with separate parameters:
“Idle Action, Main Unit” parameter
You can use this parameter to define for each output whether it is to freeze the current status in idle mode or whether it is to assume a certain output status (0/1).

<table>
<thead>
<tr>
<th>Parameter value</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>The output is set to a certain output status (0 or 1). The output status is defined with the “Idle Value, Main Unit” parameter.</td>
</tr>
<tr>
<td>1</td>
<td>The status of the output is frozen.</td>
</tr>
</tbody>
</table>

“Idle Action, Main Unit” parameter
You can use this parameter to define which output value (0 or 1) each output is to assume in idle mode.

<table>
<thead>
<tr>
<th>Parameter value</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Output is reset</td>
</tr>
<tr>
<td>1</td>
<td>Output is set</td>
</tr>
</tbody>
</table>

The set parameter value is only taken into account if the relevant output is set to 0 in the Fault Action parameter.

“Idle Action, Main Unit Extension” parameter
The same function as above with “Main Unit,” but for the output module in the CP extension.

“Idle Value, Main Unit Extension” parameter
The same function as above with “Main Unit,” but for the output module in the CP extension.
The following table shows an example of with which bit you can address the valve coils:

<table>
<thead>
<tr>
<th>Address</th>
<th>Unit</th>
<th>Bit</th>
<th>Assigned valve</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1st valve/coil 14</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1st valve/coil 12</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2nd valve/coil 14</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>3</td>
<td>2nd valve/coil 12</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>4</td>
<td>3rd valve/coil 14</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>5</td>
<td>3rd valve/coil 12</td>
</tr>
<tr>
<td>6</td>
<td>3</td>
<td>6</td>
<td>4th valve/coil 14</td>
</tr>
<tr>
<td>7</td>
<td>3</td>
<td>7</td>
<td>4th valve/coil 12</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>8</td>
<td>5th valve/coil 14</td>
</tr>
<tr>
<td>9</td>
<td>4</td>
<td>9</td>
<td>5th valve/coil 12</td>
</tr>
<tr>
<td>10</td>
<td>5</td>
<td>10</td>
<td>6th valve/coil 14</td>
</tr>
<tr>
<td>11</td>
<td>5</td>
<td>11</td>
<td>6th valve/coil 12</td>
</tr>
<tr>
<td>12</td>
<td>6</td>
<td>12</td>
<td>7th valve/coil 14</td>
</tr>
<tr>
<td>13</td>
<td>6</td>
<td>13</td>
<td>7th valve/coil 12</td>
</tr>
<tr>
<td>14</td>
<td>7</td>
<td>14</td>
<td>8th valve/coil 14</td>
</tr>
<tr>
<td>15</td>
<td>7</td>
<td>15</td>
<td>8th valve/coil 12</td>
</tr>
<tr>
<td>16</td>
<td>0</td>
<td>0</td>
<td>9th valve/coil 14</td>
</tr>
<tr>
<td>17</td>
<td>0</td>
<td>1</td>
<td>9th valve/coil 12</td>
</tr>
<tr>
<td>18</td>
<td>1</td>
<td>2</td>
<td>10th valve/coil 14</td>
</tr>
<tr>
<td>19</td>
<td>1</td>
<td>3</td>
<td>10th valve/coil 12</td>
</tr>
<tr>
<td>20</td>
<td>2</td>
<td>4</td>
<td>11th valve/coil 14</td>
</tr>
<tr>
<td>21</td>
<td>2</td>
<td>5</td>
<td>11th valve/coil 12</td>
</tr>
<tr>
<td>22</td>
<td>3</td>
<td>6</td>
<td>12th valve/coil 14</td>
</tr>
<tr>
<td>23</td>
<td>3</td>
<td>7</td>
<td>12th valve/coil 12</td>
</tr>
</tbody>
</table>

Tab. 2/4: Assignment of the bits to the solenoid coils
2. Startup

“Idle Action Main Unit” parametrisation example

Fig. 2/12: Parametrisation example with RSNetWorx
Condition counter for the valve function

The switching cycle counter is used for the preventive maintenance of wearing parts, necessary adjustments depending on movements etc.

One counter is available for each solenoid coil. The values are provided in 32-bit format. You can have the actual value compared automatically with a specified nominal value.

The following table shows the elements of the condition counter:

<table>
<thead>
<tr>
<th>Name</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Condition counter value”*)</td>
<td>Unsigned double integer</td>
</tr>
<tr>
<td>“Condition counter preselection”*)</td>
<td>Unsigned double integer</td>
</tr>
<tr>
<td>“Reset condition counter”</td>
<td>Unsigned short integer</td>
</tr>
<tr>
<td>“Condition counter status”</td>
<td>Unsigned short integer</td>
</tr>
</tbody>
</table>

*) saved remanently in the CDVI-DN

You can set and read out these parameters via the device parameters of your network configuration software.

Fig. 2/13: Mode of operation of the condition counter

The switching cycle counters automatically count the number of times the valves are actuated. You can use the “Reset Condition Counter” parameter to reset the counter value (“condition counter value”) at any time. The reset parameter
is positive edge orientated, only the transition from value “0” to value “1” resets the “condition counter value.”

You can use the “Condition Counter Preselection” parameter to define a limit value for each counter. The “Condition Counter Status” parameter is set if this limit value is exceeded. In addition to the individual “condition counter status,” all comparison results are summarised in the “Status Condition Counter” parameter.

The compare function is deactivated by the value “0” in “Condition Counter Preselection” (default setting).

Example

Fig. 2/14: Example of the parametrisation of the “condition counter” with RSNetWorx
2. Startup

2.2.7 Explicit message

The parameters specified in chapter 2.2.6 can also be read and written by the PLC. To do so, communicate via “Explicit Message.” Refer to the manual for your controller for information on programming this data transmission.

The following object descriptions are required to address the CDVI-DN:

<table>
<thead>
<tr>
<th>Object class</th>
<th>Attribute</th>
<th>Object name</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>8_d</td>
<td>3_d</td>
<td>Discrete Input Point Object</td>
<td>Boolean</td>
</tr>
<tr>
<td>9_d</td>
<td>3_d</td>
<td>Discrete Output Point Object</td>
<td>Boolean</td>
</tr>
<tr>
<td>100_d</td>
<td>3...8</td>
<td>Festo Discrete Output Object</td>
<td>UINT</td>
</tr>
<tr>
<td>101_d</td>
<td>3</td>
<td>Festo Discrete Input Object</td>
<td>UINT</td>
</tr>
<tr>
<td>102_d</td>
<td>1...6</td>
<td>Festo Diagnostics Object</td>
<td>(Various)</td>
</tr>
</tbody>
</table>

Detailed object descriptions can be found in Appendix B.
Diagnostics

Chapter 3
3. Diagnostics

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  3.1.3 LEDs as status indicators of the solenoid coils ....... 3-8
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  3.4.1 CP output module .................................... 3-13
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3.1 Diagnostics by means of LEDs

1. **PS** "Power system"
   - PS operating voltage electronics
2. **PL** “Power load”
   - PL valve load voltage
3. **MNS** “Module / network status”
4. **CP** “Compact performance”
   - CP extension modules
5. Status display of the solenoid coils

Fig. 3/1: LEDs of the CDVI-DN
3. Diagnostics

3.1.1 Standard operating status

In the standard operating status the LEDs are lit up in green. (lit up; flashing; off)

<table>
<thead>
<tr>
<th>LED</th>
<th>Colour</th>
<th>Operating status</th>
<th>Error handling</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS</td>
<td>Green</td>
<td>Lit up Power supply for electronics OK</td>
<td>None</td>
</tr>
<tr>
<td>PL</td>
<td>Green</td>
<td>Lit up Power supply for valves and CP outputs OK</td>
<td>None</td>
</tr>
<tr>
<td>MNS</td>
<td>Green</td>
<td>Lit up CDVI-DN is assigned to a master.</td>
<td>None</td>
</tr>
<tr>
<td>CP</td>
<td>Green</td>
<td>Lit up CP extension OK (if it exists)</td>
<td>None</td>
</tr>
<tr>
<td>CP</td>
<td>Off</td>
<td>Without CP extension</td>
<td>None</td>
</tr>
</tbody>
</table>

Tab. 3/1: LEDs in standard operating status
3. Diagnostics

3.1.2 Indication of errors by the LEDs

**Error diagnosis with the PS and PL LEDs**

The PS (power system) and PL (power load) LEDs indicate faults to the power supply.

<table>
<thead>
<tr>
<th>LED</th>
<th>Colour</th>
<th>Operating status</th>
<th>Error handling</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS</td>
<td>Off</td>
<td>Operating voltage for electronics not applied</td>
<td>• Check power supply of electronics (pin 1).</td>
</tr>
<tr>
<td>PS</td>
<td>Green, flashing</td>
<td>Operating voltage for electronics &lt; 20.4 V</td>
<td>• Check power supply of electronics (pin 1). Switch power off and on again.</td>
</tr>
<tr>
<td>PL</td>
<td>Off</td>
<td>Load voltage (for valves and CP outputs) not applied</td>
<td>• Check power supply for valves (pin 2).</td>
</tr>
<tr>
<td>PL</td>
<td>Green, flashing</td>
<td>Load voltage (for valves and CP outputs) &lt; 21.6 V</td>
<td></td>
</tr>
</tbody>
</table>

1) The green PL-LED on the manifold block flashes (common error message, load undervoltage/voltage failure) in the event of undervoltage or a voltage failure at the expansion block. These diagnostics options are possible only with new basic blocks and new expansion blocks with additional power supply with advanced functions.

Tab. 3/2: Error diagnosis with PS and PL LEDs
### Error diagnosis with the MNS LED (DeviceNet)

<table>
<thead>
<tr>
<th>LED</th>
<th>Colour</th>
<th>Operating status</th>
<th>Error handling</th>
</tr>
</thead>
<tbody>
<tr>
<td>MNS</td>
<td>Off</td>
<td>– Operating voltage for electronics not applied</td>
<td>• Check operating voltage supply (pin 1).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Dup_MAC_ID-Test(^{\ast}) has not yet been concluded</td>
<td>• Wait for end of test.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>If the LED remains off:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Station number possibly assigned twice; correct station numbers.</td>
</tr>
<tr>
<td></td>
<td>Green,</td>
<td>– CDVI-DN is not assigned to any master.</td>
<td>• Check configuration.</td>
</tr>
<tr>
<td>MNS</td>
<td>Flashing</td>
<td>– Dup_MAC_ID-Test has been concluded, but CDVI-DN has no connection to the fieldbus.</td>
<td>• Master is possibly not in RUN mode; check master status.</td>
</tr>
<tr>
<td></td>
<td>Red,</td>
<td>– Connection time-out or Malfunction of the master</td>
<td>• Find out and eliminate cause of time-out.</td>
</tr>
<tr>
<td>MNS</td>
<td>Flashing</td>
<td></td>
<td>• Check master status.</td>
</tr>
<tr>
<td></td>
<td>Red</td>
<td>– Communication fault</td>
<td>• Check the baud rate setting and the connection to the network.</td>
</tr>
<tr>
<td></td>
<td>Lit up</td>
<td>– Hardware fault which cannot be rectified</td>
<td>• Replace CDVI-DN; servicing required.</td>
</tr>
<tr>
<td></td>
<td>Red-green</td>
<td>– Specific communication fault</td>
<td>• Check fieldbus.</td>
</tr>
<tr>
<td></td>
<td>Flashing</td>
<td></td>
<td>• Check master status.</td>
</tr>
</tbody>
</table>

\(^{\ast}\) Test algorithm which ensures that no station numbers on the network are assigned twice. The test is usually carried out automatically when the network connection is set up.

Tab. 3/3: Fault diagnosis with MNS LED
Fault diagnosis with the CP LED

A deviation of the actual CP extension of your CDVI-DN from the CP extension set on the DIL switch can cause problems when starting the system. Refer here to section 1.2.2.

The following table shows the reaction.

<table>
<thead>
<tr>
<th>Extension of the CDVI-DN (examples)</th>
<th>Deviation</th>
<th>Reaction</th>
</tr>
</thead>
</table>
| ![Image](image1)                    | Extension **greater** than the DIL switch setting | – System starts.  
  – LED CP lights up in red.  
  Superfluous, non-configured module is ignored. |
| ![Image](image2)                    | Extension **smaller** than the DIL switch setting | – System starts.  
  – LED CP lights up in red.  
  The missing module is identified automatically if it is added later on. |

Tab. 3/4: Reaction in the event of a deviation between the CP extension and the DIL switch setting

**Note**
- Make a new nominal-actual comparison in the event of any deviations.
3. Diagnostics

3.1.3 LEDs as status indicators of the solenoid coils

There is a yellow LED for each solenoid coil (see Fig. 3/1). This LED indicates the switching status of the solenoid coil.

<table>
<thead>
<tr>
<th>LED</th>
<th>Colour</th>
<th>Solenoid coil</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Off</td>
<td>– Normal position</td>
<td>Signal not applied (logical “0”)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Switching position</td>
<td>Signal applied (logical “1”) but:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>– Load voltage of valves lies below the permitted tolerance range ((&lt; 21.6 \text{ V DC}))</td>
</tr>
<tr>
<td></td>
<td>Yellow</td>
<td>– Switching position</td>
<td>Signal applied (logical “1”)</td>
</tr>
<tr>
<td></td>
<td>Lit up</td>
<td>– Normal position</td>
<td>Signal applied (logical “1”) but:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>– Compressed air supply not OK or</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>– Pilot exhaust blocked or</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>– Servicing required</td>
</tr>
</tbody>
</table>

Tab. 3/5: LEDs for status indication of the solenoid coils
3.2 Reaction to malfunctions in the control system

The reaction of the outputs to control or communication malfunctions can be set by means of the parameters

- “Fault Value” and “Fault Action”
- “Idle Value” and “Idle Action”

The default setting is “Reset output”.

Further information on parametrisation can be found in section 2.2.6.

Note
Please observe the following if the outputs are reset in the event of a PLC stop or field bus interruption or malfunction:
- Monostable valves move to normal position.
- Bistable valves remain in the current position.
- Mid-position valves move to the mid position (depending on the valve type: pressurized, exhausted or blocked).
3. Diagnostics

3.3 Diagnostics at the DeviceNet

The following bus diagnostics are available:

- Diagnostics with the DeviceNet scanner
- Diagnostics with the software Configurator
  (e.g. RSNetWorx, see section 3.3.1)

3.3.1 Diagnostics with the software configurator

1. Make sure the node is online at the DeviceNet.
2. Double click on the icon of the valve terminal in the software configurator (e.g. RSNetWorx).
3. Click on the “Configuration Settings” tab.
4. Double click on the “Status Byte” parameter line. Detailed information are shown (see Fig. 3/2).
3. Diagnostics

Fig. 3/2: Display of detailed information on diagnostics
The following table shows the structure of the diagnostic information (status byte / diagnostic byte):

<table>
<thead>
<tr>
<th>Bit</th>
<th>Applies to</th>
<th>Comment in the EDS file</th>
<th>Explanation</th>
</tr>
</thead>
</table>
| 0   | CP extension:  
- CP. valve terminal  
- CP output module | CP valve / output module missing | CP connection interrupted |
| 1   | CP input module in the extension | CP input module missing | CP connection interrupted |
| 2   | CP output module in the extension | Electrical overload at CP output module | Short circuit or overload at output module (see section 3.4.1) |
| 3   | CP output module in the extension | No power supply at CP output module | Load voltage failure at output module |
| 4   | CP input module in the extension | No or overloaded sensor power supply | Failure of operating voltage at input module or sensors, short circuit/overload in sensor supply (see section 3.4.2) |
| 5   | CP. valve terminal | Power supply at CP valve terminal below 20.4 V | Valve power supply < 20.4 V |
| 6   | CDVI manifold block  
- CDVI extension block | Condition counter reached preselection | At least one valve counter has exceeded the limit value. |
| 7   | CDVI manifold block | Valve power supply at main unit below 21.6 V | Valve power supply < 21.6 V |

Tab. 3/6: Explanation of the diagnostic information (status byte)

Additional information can be found in Appendix B.1.8.
3.4 Short circuit/overload

Detailed information on CP input and output modules can be found in the “CP Modules Electronics” manual.

3.4.1 CP output module

If there is a short circuit or overload:
- All digital outputs of a CP output module are switched off.
- The green LED “Diag” on the output module flashes quickly.
- Bit 2 (short circuit/overload) in the device status byte is set to logical “1”.

Note
The outputs cannot be used again until the short circuit or overload has been eliminated and the error deleted.

Deleting an error
You can delete the error by resetting all outputs. The following alternatives are available for this purpose:

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Set all outputs of the output module to logical “0” (RESET)</td>
<td>– Manually or automatically in the program</td>
</tr>
<tr>
<td>or • Briefly interrupt the CP connection at the CP output module</td>
<td>– Outputs on the output module are reset automatically.</td>
</tr>
<tr>
<td>or • Briefly interrupt the operating voltage of the CP system.</td>
<td>– All outputs on the CP system are reset automatically.</td>
</tr>
</tbody>
</table>
The outputs can be reused afterwards. The outputs are switched off again if the short circuit/overload still prevails.

3.4.2 Sensor supply at an input module

If there is a short circuit, overload or voltage fault in the sensor supply:

- The sensor supply for all inputs of the module is switched off.
- If the green LED “Diag” on the input module is flashing quickly,
- the error bit $V_{sen}$ (bit 4 in the DeviceNet status byte) is set to logical “1.”

**Note**
The inputs cannot be used again until the short circuit or overload has been eliminated and the error deleted.

Deleting the error/short circuit/overload

You can delete the error in one of the following ways:

- Briefly interrupt the CP connection at the CP input module
  or
- Briefly interrupt the operating voltage of the CP system on the CDVI-DN.

The inputs can then be queried again. The error is indicated again if the short circuit/overload still exists.

With module CP-E16-M8-Z:
The short circuit/overload is automatically reset and the voltage switched on again.
Technical data and accessories

Appendix A
A. Technical data and accessories

Contents

A. Technical data and accessories ........................................... A-1
A.1 Technical data .......................................................... A-3
A.2 Accessories ............................................................. A-5
### A.1 Technical data

#### General information

<table>
<thead>
<tr>
<th>Temperature range:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>– Operation</td>
<td>-5°C ... +50°C</td>
</tr>
<tr>
<td>– Storage/transport</td>
<td>-20°C ... +40°C</td>
</tr>
</tbody>
</table>

| Relative air humidity | 95 %, non condensing |

| Recommended shelf life | Max. 18 months |

<table>
<thead>
<tr>
<th>Protection class</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>– IP66 and IP67 (EN 60529)</td>
<td></td>
</tr>
<tr>
<td>– Type 4 as per NEMA250</td>
<td></td>
</tr>
<tr>
<td>(hosedown test, test no. 5.7)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Protection against electric shock</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(protection against direct and indirect contact)</td>
<td></td>
</tr>
<tr>
<td>as per EN 60204-1/IEC 204</td>
<td></td>
</tr>
<tr>
<td>By means of PELV power supply unit</td>
<td></td>
</tr>
<tr>
<td>(protected extra low voltage)</td>
<td></td>
</tr>
</tbody>
</table>

| Valves | See description of pneumatics type P.BE-CDVI-... |

#### Operating voltage of electronics

<table>
<thead>
<tr>
<th>Pin 1 of power supply connection</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>– Nominal value</td>
<td>24 V DC (protected against incorrect polarity, internally fused, automatic restart, galvanically isolated from the power supply of the valves, provided PIN3 and PIN4 are not bridged, see page 1-21)</td>
</tr>
<tr>
<td>– Tolerance</td>
<td>20.4 ... 26.4 V (-15% / +10%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Current consumption</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>– Nominal value</td>
<td>Max. 100 mA + current consumption of sensors (and modules; see section 1.4.1)</td>
</tr>
</tbody>
</table>

| Residual ripple | 4 Vpp (within tolerance) |
### Load voltage of solenoid valves

<table>
<thead>
<tr>
<th>Pin 2 power supply connection for manifold block and expansion block with auxiliary power supply</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nominal value</strong></td>
<td>24 V DC (protected against incorrect polarity, internally fused, automatic restart, galvanically isolated from the power supply of the valves, provided PIN3 and PIN4 are not bridged, see page 1-21)</td>
</tr>
<tr>
<td><strong>Tolerance</strong></td>
<td>21.6 ... 26.4 V (+/- 10%)</td>
</tr>
</tbody>
</table>

| Current consumption | Sum of all switched-on solenoid valves (CDVI + CP extension); see section 1.4.1 and the relevant pneumatics manuals |

| Minimum power supply requirement | 0.4 V/ms voltage increase time until the high current phase is reached |

| Residual ripple | 4 Vpp (within tolerance) |

### Operating voltage of DeviceNet bus interface

<table>
<thead>
<tr>
<th>Micro Style connection: pin 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nominal value</strong></td>
<td>24 V DC (protected against incorrect polarity, external fuse required)</td>
</tr>
<tr>
<td><strong>Tolerance</strong></td>
<td>11 ... 30 V</td>
</tr>
</tbody>
</table>

| Galvanic isolation | Bus interface opto-decoupled |

### Electromagnetic compatibility

|  |
|---|---|
| **Interference emission** | See declaration of conformity (www.festo.com) |
| **Interference immunity** | See declaration of conformity (www.festo.com) |

---

Technical data for the pneumatics can be found in the “Pneumatics manual, P.BE-CDVI...”
A.2 Accessories

→ www.festo.com/catalogue

Note
When using plugs or cables from other manufacturers, make sure the properties of the plugs and cables meet the requirements of your application (in particular IP protection class, resistance to cleaning agents, clean design requirements).
A. Technical data and accessories
DeviceNet objects

Appendix B
B. DeviceNet objects

B.1 DeviceNet objects

This chapter describes the representation of the CDVI-DN within the DeviceNet Object model. Some information is in English in order for the original terms of the DeviceNet specification to be used unambiguously.

B.1.1 DeviceNet object model

Fig. B/1: The DeviceNet object model
B. DeviceNet objects

B.1.2 Overview

Basic data:

<table>
<thead>
<tr>
<th>Information</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vendor name</td>
<td>Festo Corporation</td>
</tr>
<tr>
<td>Device type</td>
<td>12D (0_{CH})</td>
</tr>
<tr>
<td>Product code</td>
<td>5141D 1415H</td>
</tr>
<tr>
<td>Major revision /</td>
<td>2</td>
</tr>
<tr>
<td>minor revision</td>
<td>1</td>
</tr>
<tr>
<td>Input size / output</td>
<td>Depending on the string</td>
</tr>
<tr>
<td>size / output size</td>
<td>extension set with DIL</td>
</tr>
<tr>
<td>Product name</td>
<td>CDVI-DN</td>
</tr>
</tbody>
</table>

DeviceNet object classes

The following DeviceNet object classes are supported:

<table>
<thead>
<tr>
<th>Object class</th>
<th>Attributes</th>
<th>Name</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>8_d</td>
<td>3_d</td>
<td>Discrete Input Point Object</td>
<td>BOOL</td>
</tr>
<tr>
<td>9_d</td>
<td>3_d</td>
<td>Discrete Output Point Object</td>
<td>BOOL</td>
</tr>
<tr>
<td>100_d</td>
<td>1...5</td>
<td>Festo Output Word Object</td>
<td>UINT</td>
</tr>
<tr>
<td>101_d</td>
<td>1</td>
<td>Festo Input Word Object</td>
<td>UINT</td>
</tr>
<tr>
<td>102_d</td>
<td>1...6</td>
<td>Festo Diagnostic Object</td>
<td>(Various)</td>
</tr>
</tbody>
</table>
B. DeviceNet objects

B.1.3 Discrete Input Point Object: class code 8d

<table>
<thead>
<tr>
<th>Attribute ID</th>
<th>Access</th>
<th>Name</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Get</td>
<td>Value</td>
<td>BOOL</td>
<td>Input value of the input (0/1)</td>
</tr>
</tbody>
</table>

B.1.4 Discrete Output Point Object: class code 9d

<table>
<thead>
<tr>
<th>Attribute ID</th>
<th>Access</th>
<th>Name</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Get/Set</td>
<td>Value</td>
<td>BOOL</td>
<td>Output value of the output (0/1)</td>
</tr>
</tbody>
</table>

B. DeviceNet objects

B.1.5 Festo Discrete Output Object: class code 100d

Each instance has 16 bits.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Access</th>
<th>Name</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Get/Set</td>
<td>Output value</td>
<td>INT</td>
<td>Value of the output (0/1)</td>
</tr>
<tr>
<td>5</td>
<td>Get/Set</td>
<td>Fault Action</td>
<td>INT</td>
<td>Parameter value: 0 = the status of the output is defined by the &quot;Fault Value&quot; (0/1) 1 = the status of the output is frozen</td>
</tr>
<tr>
<td>6</td>
<td>Get/Set</td>
<td>Fault Value</td>
<td>INT</td>
<td>Defines the status of the output in fault mode if Fault Action is set to 0.</td>
</tr>
<tr>
<td>7</td>
<td>Get/Set</td>
<td>Idle Action</td>
<td>INT</td>
<td>Parameter value: 0 = the status of the output is defined by the &quot;Idle Value&quot; (0/1) 1 = the status of the output is frozen</td>
</tr>
<tr>
<td>8</td>
<td>Get/Set</td>
<td>Idle Value</td>
<td>INT</td>
<td>Defines the status of the output in idle mode, if Idle Action is set to 0.</td>
</tr>
</tbody>
</table>

B.1.6 Festo Discrete Input Object: class code 101d

Instance 1: for a CP input module

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Access</th>
<th>Name</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Get</td>
<td>Input value</td>
<td>INT</td>
<td>Input value of the input module (0/1)</td>
</tr>
</tbody>
</table>
B. DeviceNet objects

B.1.7 Festo Diagnostics Object: class code 102d

Instance 1 ... 32

An instance is assigned to each solenoid coil of the manifold block:

- Least significant solenoid coil: instance 1
- Most significant solenoid coil: instance 24

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Access</th>
<th>Name</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Get</td>
<td>Condition Counter Value</td>
<td>UDINT</td>
<td>Counter value of the condition counter</td>
</tr>
<tr>
<td>2</td>
<td>Get/Set</td>
<td>Condition Counter Preselection</td>
<td>UDINT</td>
<td>Limit value of the condition counter</td>
</tr>
<tr>
<td>5</td>
<td>Get/Set</td>
<td>Reset Condition Counter</td>
<td>USINT</td>
<td>Resets the condition counter: sets the value to “1”. The value is set to “0” again after the reset.</td>
</tr>
<tr>
<td>6</td>
<td>Get</td>
<td>Condition Counter Status</td>
<td>USINT</td>
<td>Becomes “1” when the limit value of the condition counter is reached</td>
</tr>
</tbody>
</table>

Instance 33 ... 48

An instance is assigned to each output in the CP extension:

- Least significant solenoid coil: instance 33
- Most significant solenoid coil: instance 48

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Access</th>
<th>Name</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Get</td>
<td>Condition Counter Value</td>
<td>UDINT</td>
<td>Counter value of the condition counter</td>
</tr>
</tbody>
</table>
## B. DeviceNet objects

### instance 49

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Access</th>
<th>Name</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Get</td>
<td>Status/Compare Bit</td>
<td>UDINT</td>
<td>Status/Compare bits of all counters of the CDVI-DN. Least significant bit corresponds to counter 1, most significant bit corresponds to counter 24.</td>
</tr>
<tr>
<td>2</td>
<td>Get</td>
<td>Diagnostic Byte</td>
<td>BYTE</td>
<td>Diagnostic status</td>
</tr>
</tbody>
</table>
## B. DeviceNet objects

### B.1.8 Structure of the status byte (diagnostic bytes)

The status byte provides information about the identifiable errors of the CDVI-DN and the modules in the CP extension.

<table>
<thead>
<tr>
<th>Module</th>
<th>Bit 7 $V_{\text{load}}$</th>
<th>Bit 6 CM</th>
<th>Bit 5 $V_{\text{tot}}$</th>
<th>Bit 4 $V_{\text{sen}}$</th>
<th>Bit 3 $V_{\text{off}}$</th>
<th>Bit 2 SC/O</th>
<th>Bit 1 I mod.</th>
<th>Bit 0 O mod.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDVI-DN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valve terminal on CP string</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CP input module</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CP output module</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- O module: CP connection interrupted at output module
- I module: CP connection interrupted at input module
- SC/O: Short circuit/overload at output module (see section 3.4.1)
- $V_{\text{off}}$: load voltage failure at output module
- $V_{\text{sen}}$: failure of operating voltage at input module or sensors, short circuit/overload in sensor supply (see section 3.4.2)
- $V_{\text{tot}}$: load voltage in expansion block $< 21.6$ V
- CM: condition monitoring. At least one valve counter has exceeded the limit value.
- $V_{\text{load}}$: Load voltage in manifold block $< 21.6$ V

Further information can be found in section 3.3.
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