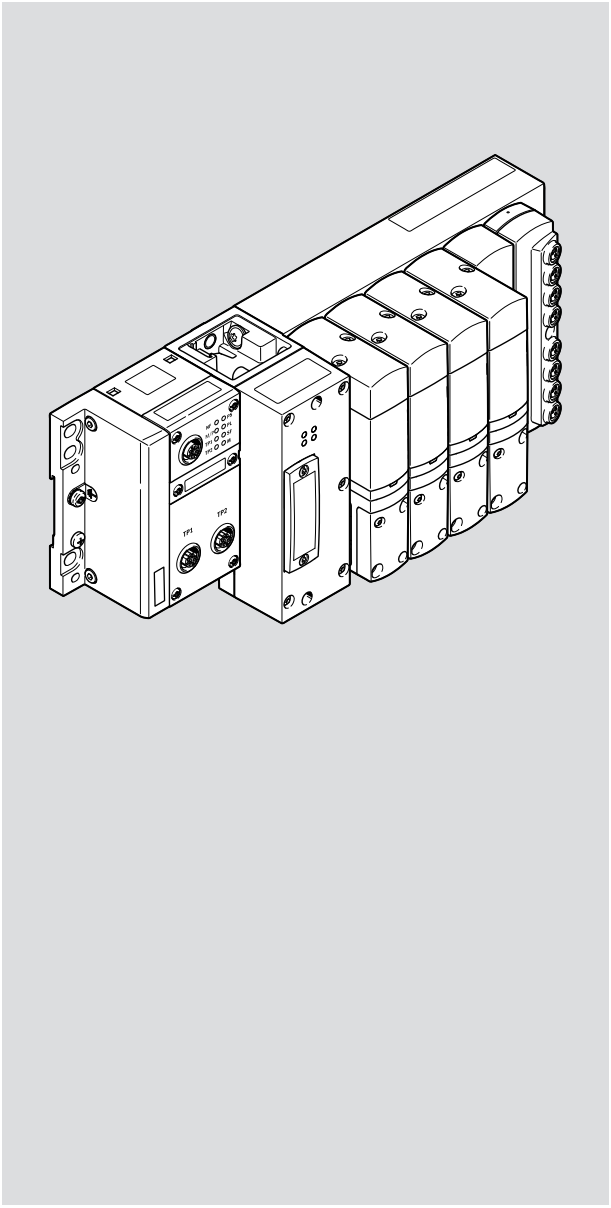
VTEM
Motion Terminal



FESTO

Manual

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Translation of the original instructions

Table of contents

1 About this document

1.1 Applicable documents

All available documents for the product ➔ www.festo.com/sp.

Document	Product	Contents
Assembly instructions	CPX, VTEM	–
Operating instructions	VTEM	System, function, parameterisation
Manual	GAMM-A...	Motion App
Manual	CPX terminal	System
Application note	VTEM	Various contents ➔ www.festo.com/sp ➔ VTEM ➔ Expert knowledge

Tab. 1: Applicable documents

1.2 Product version

This document refers to the following product versions:

Product	Version
VTEM-...	Motion Terminal VTEM from Revision 01
CTMM-S1-C	Controller of the Motion Terminal VTEM from Revision 01
Firmware	Firmware of the Controller CTMM from version 4.24.0
VEVM-S1-27-...	Valve for Motion Terminal VTEM from Revision 01
CTMM-S1-D-8E-M8-3	Digital input module for Motion Terminal VTEM from revision 02
CTMM-S1-A-8E-A-M8-4	Analogue input module for Motion Terminal VTEM from revision 02
Browser[1)]	– FIREFOX from version 38 (recommended) – Chrome from version 64 – INTERNET EXPLORER from version 11 – MICROSOFT EDGE from version 38

1) Use current version.

Tab. 2: Product version

The product version can be identified from the product labelling or with the help of appropriate Festo software.

Suitable software for determining the product version is available on the Festo website ➔ www.festo.com/sp.
Information on using the software can be found in the integrated Help function.

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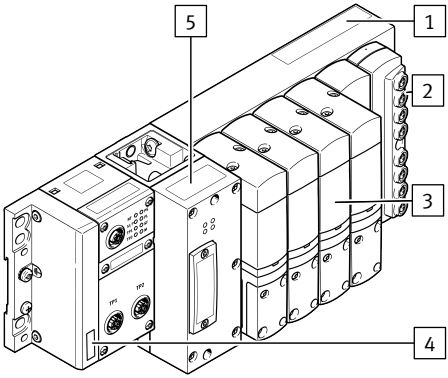
There may be an updated version of this document for this or later product versions
➔ www.festo.com/sp.

1.2.1 Product labelling

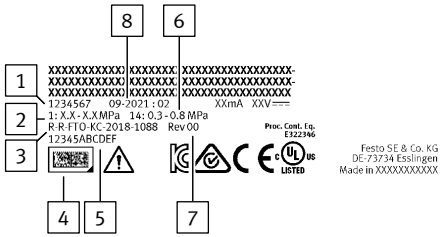
Product labelling is made up of various individual labels. They are shown below.
The Product Key for the Motion Terminal and the associated Data Matrix Code are shown on the labels on the Motion Terminal (➔ 1, 4). Scanning the Data Matrix Code with an appropriate device opens the Festo Support Portal with information appropriate for the product. Alternatively, the Product Key (11-digit alphanumeric code on the product labelling) can be entered in the search field of the Support Portal.



1 Motion Terminal label with Product Key (Motion Terminal)
2 Input module labelling
3 Valve labelling
4 Product Key (Motion Terminal)
5 Controller labelling

Fig. 1: Product labelling

Motion Terminal labelling



1 Part number
2 Operating pressure range (1)
3 Registration number for KC certification
4 Data Matrix Code
5 Product key
6 Pilot pressure range (14)
7 Revision
8 Serial number

Fig. 2: Motion Terminal labelling

Input module labelling

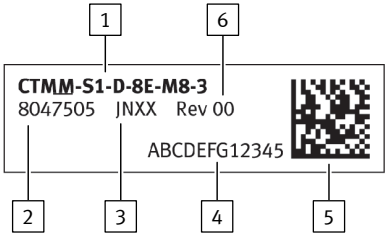


Fig. 3: Input module labelling

1 Order code
2 Part number
3 Serial number
4 Product key
5 Data Matrix Code
6 Revision

Valve labelling

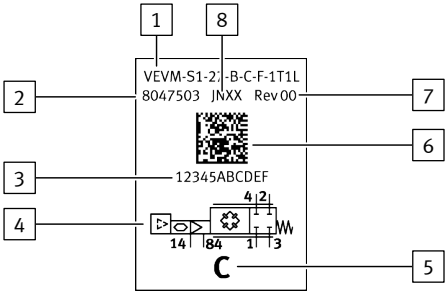


Fig. 4: Valve labelling

1 Order code
2 Part number
3 Product key
4 Circuit symbol
5 Information on initial position of the valve, C: normally closed
6 Data Matrix Code
7 Revision
8 Serial number

Controller labelling

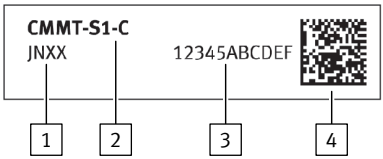


Fig. 5: Controller labelling

1 Serial number
2 Order code
3 Product key
4 Data Matrix Code

2 Safety

2.1 Safety instructions

- Observe identification on the product.
- Before working on the product, switch off the power supply and secure it against being switched on again.
- In the power-free status (normal position), compressed air may be trapped between the working air ports and connected drives. To avoid accidental movements of the connected drives due to leakage, carry out the following steps before switching off the supply voltage:
  - Bring the system into the exhausted state ➔ App control (app control): "Exhaust".
  - Disconnect the compressed air supply and, if applicable, the vacuum supply.
- During rapid movement of heavy masses, especially during braking, the pressure in the pneumatic system can increase and damage pneumatic components.
  - Set up the pneumatic installation with sufficient load reserve for the application.
- Store the product in a cool, dry environment protected from UV and corrosion. Keep storage times short.
- Comply with the handling specifications for electrostatically sensitive devices.
- Observe tightening torques. Unless otherwise specified, the tolerance is ± 20 %.

2.2 Intended use

The product is intended for controlling pneumatic drives and for implementing motion tasks (Motion Apps).

The product may only be used as follows:

- Use only in an industrial environment: outside industrial environments, e.g. in commercial areas and mixed commercial and residential areas, action to suppress interference may be required.
- Use exclusively in combination with modules and components that are certified for the specific product variant and have been tested and approved by Festo.
- Use in technically perfect original status without unauthorised modifications. Only the conversions or modifications described in this and the further applicable documents are permitted.

2.3 Training of qualified personnel

Work on the product may only be carried out by qualified personnel who can evaluate the work and detect dangers. The qualified personnel have skills and experience in dealing with electropneumatic (open-loop) control technology.

3 Function

3.1 General

The Motion Terminal VTEM provides a range of pneumatic open-loop and closed-loop control functions that are executed in the form of Motion apps (MA). Parameters and setpoint values for executing a Motion App can be specified. The Motion App converts these specifications into control commands at the corresponding valve.

3.1.1 Product design

The product can consist of the following modules, depending on the configuration ordered:

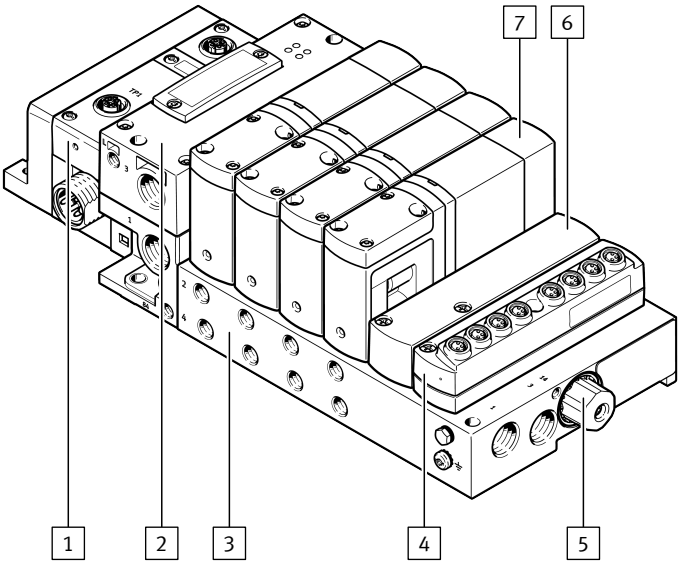


Fig. 6: Product design

1 CPX terminal electronics side

2 Controller Motion Terminal CTMM-S1-C

3 Manifold rail

4 Input module CTMM-S1-A/D-... (optional)

5 Pilot pressure regulator

6 Cover plate VABB-P11-27-T (optional)

7 Valve slice VEVM-S1-27-...

3.1.1.1 CPX terminal electronics side

The CPX terminal establishes the connection to a higher-order controller (➔ 6.1 Supported CPX bus nodes) by means of an internal controller (CPX-CEC-...-V3) or a bus node.

3.1.1.2 Controller Motion Terminal CTMM-S1-C

The Motion Terminal controller forms the interface between the CPX terminal and the components of the Motion Terminal.
The controller has an Ethernet interface for accessing the WebConfig user interface for the Motion Terminal. Compressed air (1) and common exhaust or vacuum (3), as well as pilot exhaust air (84) and pressure compensation (L) can be connected to the controller housing.
From the perspective of the CPX terminal, the Motion Terminal is a single component and is modelled with a defined amount of input and output data in the process data of the CPX terminal ➔ 3.5 Communication between PLC and Motion Terminal.
The terminal CPX and the CPX module CTMM-S1-C can be parameterised with the operator unit (CPX-MMI), the Festo Maintenance Tool (CPX-FMT) software or the higher-level system.

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Further information on the parameterisation of the CPX system and its modules can be found in the CPX terminal manual ➔ 1.1 Applicable documents.

The following tables give an overview and a description of the CPX module parameters included in the CTMM-S1-C.

Function number[1)]	Bit	Parameter	Default
4828 + m × 64 + 0	0	Monitoring short circuit/overload sensor supply (SCS)	active
	2	Monitoring undervoltage outputs/valves U_{OUT}/U_{VAL}	active
4828 + m × 64 + 6	0	Monitoring negative pressure	active

1) m = module number (counting from left to right, beginning with 0)

Tab. 3: Overview of the CPX module parameters

Description of the CPX module parameters		
Monitoring short circuit/overload, monitoring undervoltage U_{OUT}/U_{VAL}		
Function number	4828 + m × 64 + 0 m = module number (0 ... 47)	
Description	Monitoring the Motion Terminal for the following error: – Short circuit or overload in sensor supply – Undervoltage at the valves U_{VAL} The monitoring of the errors can be individually activated or deactivated. Active monitoring has the following effect: – Error message at the CPX field bus nodes – Malfunction message in the VTEM diagnostic memory Both types of monitoring can also be activated for the entire CPX terminal. For details, see the manual of the CPX terminal ➔ 1.1 Applicable documents.	
Allocation	Bit 0	Monitoring short-circuit or overload of the sensor supply
	Bit 1	reserved
	Bit 2	Undervoltage monitoring at the valves U_{VAL}
	Bit 3 ... 7	reserved
Values	Bit 0, 2	0 = inactive
		1 = active (default)
Monitoring negative pressure		
Function number	4828 + m × 64 + 6 m = module number (0 ... 47)	
Description	Monitoring the Motion Terminal for the following errors: – Supply pressure at port (1) too low (< 3 bar) The error monitoring can be activated or deactivated. Monitoring must be deactivated for a pressure at port (1) of less than 3 bar. Active monitoring has the following effect: – Error message at the CPX field bus nodes – Malfunction message in the VTEM diagnostic memory	
Allocation	Bit 0	Monitoring negative pressure
	Bit 1 ... 7	reserved
Values	Bit 0	0 = inactive
		1 = active (default)

Tab. 4: Description of the CPX module parameters

3.1.1.3 Manifold rail

The manifold rail provides the air ports (2) and (4) for each of the valves, as well as the ports for compressed air supply (1) and common exhaust (3). In addition, the manifold rail can be connected to an external pilot air supply (14). The changeover between internal and external pilot air is effected using a blanking plug or selector in the manifold rail (➔ 1.1 Applicable documents Instructions for use of the Motion Terminal VTEM).

3.1.1.4 Pilot pressure regulator

The pressure regulator ensures a constant pilot pressure for the valves.

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The pressure regulator is set and sealed at the factory. The setting must not be changed; doing so will invalidate the warranty.

3.1.1.5 Input module CTMM-S1-A/D-... (optional)

Individual Motion Apps include the evaluation of digital or analogue sensor signals. The sensors necessary for this are connected to the CTMM input modules. The assignment of the inputs to a valve and thus to a Motion App is done via the system parameters ➔ 3.4.3.1 System parameters.

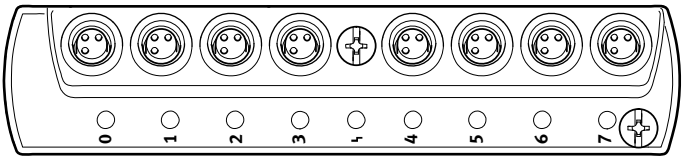

Fig. 7: Input module CTMM-S1-D

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The inputs are evaluated only by the controller of the Motion Terminal. The states of the inputs cannot be queried directly by the higher-order controller. However, various Motion Apps provide information about the states or values of the sensors.

The characteristics of the peripherals that are connected to the inputs of the input module must be made known to the system (input module configuration).
Required specifications ➔ 3.4.3.4 Sensor parameters:
- Sensor type
- Sensor orientation (for position sensors on the analogue input module CTMM-S1-A-...)

3.1.1.6 Cover plate VABB-P11-27-T

Vacant valve or module positions must be sealed with a cover plate.

3.1.1.7 Valves

The valves together with the controller form the central component of the Motion Terminal. A valve VEVM-S1- 27-... in each case contains 4x 2/2-way dynamic control valves with piezo pilot valves interconnected to form a full bridge. Each valve is additionally equipped with sensors so as to be able to detect the actual status of the valve and regulate it.

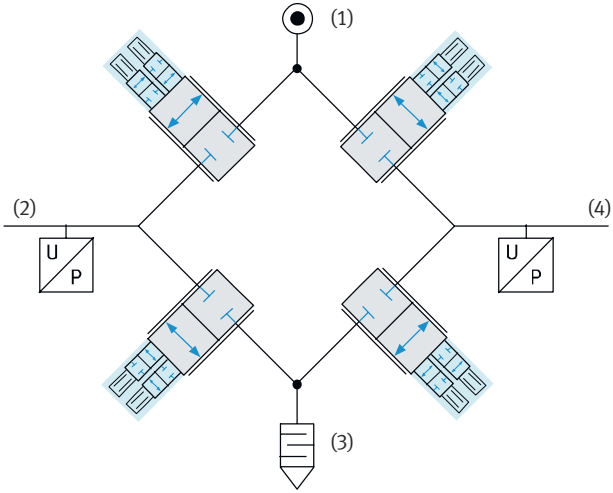


Fig. 8: Switching the full bridge of a valve slice

One of the licensed Motion Apps can be run on each valve, independently of the other valves.

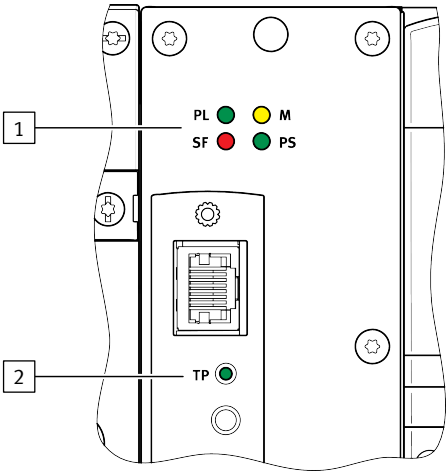
Numbering of the valves

The slots for the valves are numbered sequentially in ascending order from left to right, starting at the right of the controller with slot 0. The number (address) of a valve is given by the slot on which it is mounted.

3.1.2 Display components

For behaviour of display components and diagnostics options see ➔ 3.8.1 LED display components.

3.1.2.1 Controller



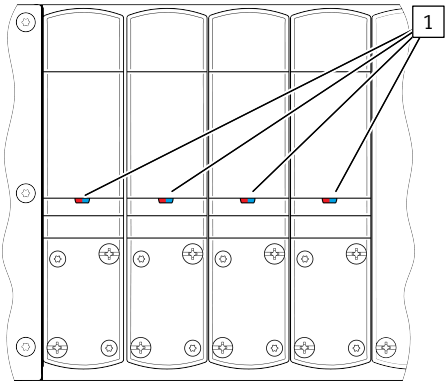
1 CPX-specific LEDs
2 Ethernet-specific LED

Fig. 9: LED displays on the controller

LED	Meaning	
CPX-specific LEDs		
PL (green)	Power Load	Monitor load voltage supply U_{VAL}
M (yellow)	Modify	Parameterisation mode (via CPX bus node or WebConfig interface)
SF (red)	System Failure	Communication errors
PS (green)	Power System	Monitor operating voltage supply $U_{EL/SEN}$
Ethernet-specific LED		
TP (green)	Ethernet Link/ Traffic	Ethernet connection/data traffic

Tab. 5: LED displays on the controller

3.1.2.2 Valve



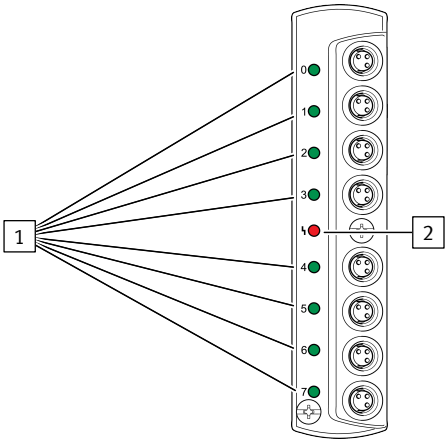
1 LED display on valve (red/blue)

Fig. 10: LED display on valve

LED	Meaning
(red)	Valve faults
(blue)	Operation/update

Tab. 6: LED display on valve

3.1.2.3 Input modules



1 LED display for input status (green, only digital input modules CTMM-S1-D-...)
2 LED display for module error (red)

Fig. 11: LED displays of input modules

LED	Meaning
(green)	Input status (digital input modules CTMM-S1-D-... only)
ϟ (red)	Short circuit/overload

Tab. 7: LED displays of input modules

3.1.3 Control elements

The product has no mechanical control elements. Parameters and setpoint values are only set using the WebConfig interface or the higher-order controller (PLC). The WebConfig interface can be opened with a web browser if there is an existing Ethernet connection to the controller of the Motion Terminal (➔ 3.3 WebConfig user interface).

3.1.4 Connecting elements

3.1.4.1 Electrical

Functional earth connection

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The right connection of the functional earth must be connected directly to the connection of the functional earth on the left end plate of the CPX terminal. The functional earth connection on the left-hand end plate of the CPX terminal must be connected to the earth potential with low impedance. Details on earthing are included in the manual of the CPX terminal ➔ 1.1 Applicable documents.

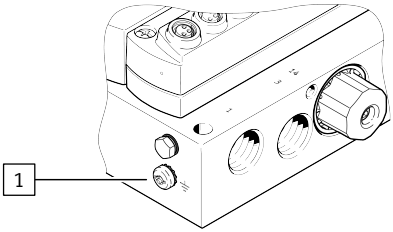


Fig. 12: Functional earth connection right

1 Functional earth connection

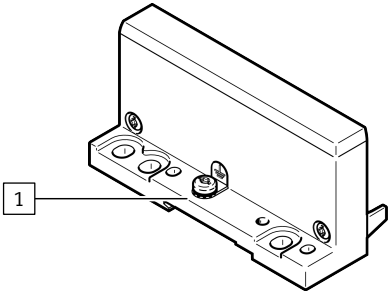
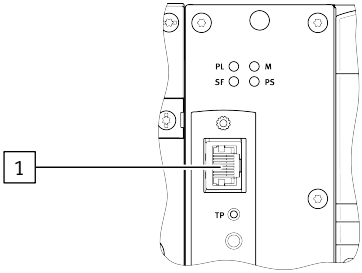


Fig. 13: Functional earth connection left

1 Functional earth connection (left-hand end plate CPX terminal)

Ethernet interface



1 Ethernet interface

Fig. 14: Ethernet interface

The Ethernet interface is located on the controller behind a transparent cover. The Ethernet interface is used exclusively for accessing the WebConfig interface for the controller.

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The Ethernet interface is only used for set-up and maintenance and may not be used during operation.

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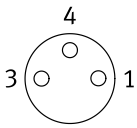
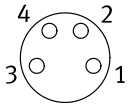
Unauthorised access to the device can cause damage or malfunctions.
When connecting the device to a network:
Protect the network against unauthorised access.
Measures to protect the network include:

- Firewall
- Intrusion Prevention System (IPS)
- Network segmentation
- Virtual LAN (VLAN)
- Virtual private Network (VPN)
- Security at physical access level (port security)

For additional information ➔ Guidelines and standards for security in information technology, e. g. IEC 62443, ISO/IEC 27001.

Input modules

CTMM-...-D-...			**CTMM-...-A-...**		
	1	+24 V U_{SEN}		1	+24 V U_{SEN}
	3	0 V U_{SEN}		2	Input
	4	Input		3	0 V U_{SEN}
				4	n. c.

Tab. 8: Input modules

3.1.4.2 Pneumatic

Ports for compressed air supply (1) and common exhaust (3) are available both on the controller and on the right-hand end of the manifold rail. The ports are internally connected in each case and can be used alternately or in parallel.
Ports (1) and (3) on the manifold rail should be selected for flow-intensive applications. For further improvement an independent, parallel circuitry for both the supply ports and exhaust ports should be selected. More information can be found in the expert knowledge ➔ www.festo.com/sp.
The product can be operated with internal or external pilot air.
– The pressure at port (1) must be > 3 bar for the internal pilot air supply.
– The pressure at port (14) must be > 3 bar for the external pilot air supply.
The pressure at port (1) is monitored by the device. If the pressure is less than 3 bar at port (1), an external pilot air supply of at least 3 bar is required; the negative pressure monitoring at (1) must be deactivated via the corresponding CPX module parameter ➔ Tab. 3 Overview of the CPX module parameters. The device does not monitor the pressure for port (14).
An external pilot air supply must be maintained for the entire duration of operation. After a pressure loss, a voltage reset is required before operation can be continued without error.

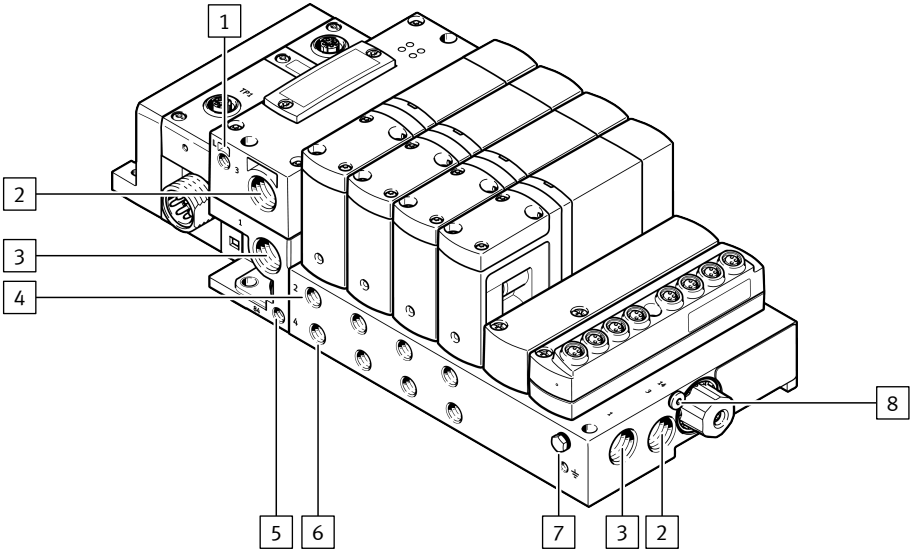


Fig. 15: Pneumatic ports

1 M7 port for pressure compensation (L)
2 G3/8 port for common exhaust/vacuum (3)
3 G3/8 port for compressed air supply (1)
4 Ports G1/8 for working air (2)
5 M7 port for pilot exhaust air (84)
6 Ports G1/8 for working air (4)
7 Selector for external pilot air or blanking plugs for internal pilot air M5
8 M5 port for external pilot air (14) or blanking plugs for internal pilot air

3.1.5 Definition of the direction of movement/position of the drive

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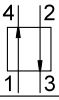
In this document and on the WebConfig interface, the direction of movement or the position of drives that are controlled by the Motion Terminal are generally described using the terms ‘advancing’ or ‘advanced’ and ‘retracting’ or ‘retracted’, respectively, which relate to piston rod cylinders with a piston rod at one end. Depending on the pneumatic function, the meaning of the terms can be used for other drives.

Term	Port (4)	Port (2)	Switching position of the valve	
Advancing/advanced	Pressurised	Exhausted	14	
Retracting/retracted	Exhausted	Pressurised	12	

Tab. 9: Definition of the direction of movement

3.2 Firmware versions

Changes from one firmware version to the next can be found in the corresponding release notes, which are provided with the firmware installation files in the Support Portal (➔ www.festo.com/sp). This version of the manual refers to the following firmware version: ➔ Tab. 2 Product version.
The device is updated to a new firmware version with the Festo Field Device Tool (FFT) (see Quick Guide for the Motion Terminal VTEM ➔ 1.1 Applicable documents). The device will subsequently function in accordance with the factory settings. If required, existing parameterisation data and settings can be exported to a configuration file before a firmware update and re-imported once the update has been completed (➔ 3.3.3 Export/import of parameterisation and settings).

3.3 WebConfig user interface

The Motion Terminal has a WebConfig interface for commissioning and functional testing.
It can be opened in a browser on a device connected to the Motion Terminal controller. The WebConfig interface for the controller cannot be opened via the Ethernet connection of a bus node in the CPX terminal.
The settings, configurations and actual values of the Motion Terminal can only be viewed; they cannot be changed without a password. The password must be entered via the menu bar of the WebConfig and can be changed after successful authentication. A forgotten password can only be reset by updating the firmware.

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Factory settings of the controller:
- IP address: 192.168.4.2,
- Subnet address: 255.255.0.0
- Password for activating edit mode: vtem

The password can be changed via the WebConfig interface.
Operation of the WebConfig interface is described in the “Motion Terminal VTEM, WebConfig interface” Quick Guide ➔ www.festo.com/sp.

3.3.1 Manual override

To enable testing of the functionality of a connected drive, the WebConfig interface has a "manual override" that makes it possible to use the basic logic function of the valves without using a Motion App.
The manual override is also used to test the tubing connection and direction of movement of the drive ➔ 3.1.5 Definition of the direction of movement/position of the drive.

3.3.2 Access control

Write access to a valve is possible at a certain time using either the WebConfig interface or the higher-order controller (PLC). As standard, the PLC has the write access rights, but they can be actively copied from the WebConfig interface.
Copying of the write access rights via the WebConfig interface is only possible if the valve is inactive (ValveMode = 61) ➔ Tab. 45 Status of the valve. This means that a running Motion App or transfer mode must be terminated before the WebConfig interface obtains write access to the valve.

3.3.3 Export/import of parameterisation and settings

Parameters and settings saved on the controller can be exported in the form of a single file from the device and then re-imported to the device. This includes the relevant data of all device components (controller, valves, input modules).
Possible applications:
- Exporting before a firmware update, then re-importing to be able to continue to use parameters and settings after the update ("Backup and Restore")
- Exporting the data from one device and importing to another device ("cloning" the terminal)

This file is exported and imported via the WebConfig interface, which can be found in the "Maintenance" tab. Exporting and importing are only possible if none of the valves are in operation at this time or data are currently being exchanged with the higher-order controller.
This means:
- The status of the valve (valve state) must not be Running for all valves (➔ 3.5.2.2 Structure of the input data (PDI)).
- Transfer mode cannot be active for any of the valves (➔ 3.5.4 Transfer mode).

No other actions are possible via the WebConfig interface while the configuration is being accessed by the export function (reading) or by the import function (writing). Control via the output data of the higher-order controller is also blocked until the access process has been completed.
An exported configuration file has the file name "VTEM_config_<Product Key>.csv". To aid orientation for the user, the name includes the Product Key of the controller from which the data was exported. The file can, however, be renamed without impacting usability for the import.

3.3.3.1 Behaviour during export

Behaviour during export:
- The parameters of all existing valve slots are exported, including those of the slots that do not have a valve inserted at this point.
- The parameters of all five parameter sets are exported (with system, application, tuning parameters and associated teach-in data) (➔ 3.4.3.9 Parameter sets).
- All sensor parameters (➔ 3.4.3.4 Sensor parameters) are exported as long as the corresponding input module is actually available.
- All parameters for the description of user-defined peripherals are exported, if available ➔ 3.4.3.5 Parameters for describing user-defined position sensors, ➔ 3.4.3.6 Parameters for describing user-defined flow sensors, ➔ 3.4.3.7 Parameters for the description of user-defined drives.

3.3.3.2 Behaviour during import

Behaviour during import:
- Parameters and settings for which no value was exported retain their previous value for the import.
- When the parameterisation data is read in, the values are checked for permissible value ranges. If the limits are violated, the parameter is set to the next critical limit.

When transferring a configuration file to a device with a different construction, the following must be observed:
- Parameterisation data for valves are assigned according to their slot.
  - When transferring from a longer device variant to a shorter one, the data of the "excess" valve slots are ignored.
  - When transferring from a shorter device variant to a longer one, data cannot be written for the additional valve slots (with a higher slot number).
- Parameterisation data for input modules are assigned according to their input module position (1 or 2).
  - As data for analogue and digital input modules are not compatible with one another, sensor parameters can only be imported if the type of the assembled input module corresponds with this position between the source and target device.
  - It is possible to transfer input module parameterisation data between device variants of different lengths (for example from 4 + 2 to 8 + 2, from 8 + 2 to 4 + 2, from 4 + 2 to 2 + 1, etc.).

Source device		**Target device**		**Sensor parameters are copied for the module**
Position 1	Position 2	Position 1	Position 2	
analogue	digital	analogue	digital	Position 1 and 2
analogue	digital	analogue	analogue	Position 1
analogue	digital	digital	digital	Position 2
analogue	digital	digital	analogue	–
digital	digital	–	digital	Position 2
–	analogue	analogue	analogue	Position 2

Tab. 10: Examples of devices that have two input module slots each

3.4 Motion Apps

The functions of the Motion Terminal are performed by what are known as Motion Apps. A Motion App generally executes a pneumatic task such as pressure regulation, flow control or the controlled acceleration and braking of a movement.
Motion App #01 “Directional control valve functions”, which is part of the basic equipment of the Motion Terminal, is described in this document: ➔ 3.6 Motion App #01: Directional control valve functions.

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Additional Motion apps are described in separate documentation ➔ www.festo.com/sp.

3.4.1 Motion App ID

Each Motion App has a unique ID. This ID is required both to select and to parameterise the Motion App. The respective ID is given in the Motion App documentation.

3.4.2 Licences

To be able to use a Motion App, a corresponding licence must be stored on the Motion Terminal controller. The number of licences required for every Motion App is based on the number of valves on which the Motion App should run simultaneously. Motion App #01 “Directional control valve functions” is licensed by default for all valves on the Motion Terminal. It is therefore possible to run a different directional control valve function on each of the maximum 8 valves of a Motion Terminal.
If, for example, Motion App #3 “Proportional pressure regulation" is to be run on 3 valves at the same, this Motion App requires 3 licences.

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The number of licences stored on the Motion Terminal and the number that are still free (not in use by an active Motion App) can be viewed on the WebConfig interface or read out via the information channel of the transfer mode ➔ Tab. 64 Licence information.

The licences are not assigned to a specific valve position. Every licensed Motion App can be run on any valve. The restrictions relating to the number of licences only apply when running a Motion App simultaneously on multiple valves.
When attempting to start a Motion App for which all licences on the device are already assigned to other valves, they are automatically withdrawn from all valves on which the corresponding Motion App is not actively used at this time (valve status "Configurable"), so that use is possible on the desired valve.

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Information on adding to your available licences can be found in the Festo catalogue
➔ www.festo.com/sp.

3.4.2.1 Demo licences

The demo period runs for the first 720 hours of operation of the Motion Terminal. During this period, non-permanently licensed Motion Apps can be temporarily activated.

The remaining duration of the demo period is displayed in the upper right corner of the WebConfig interface and can be read out via the information channel of the transfer mode ➔ Tab. 64 Licence information.
During the demo period, the "Use of demo licences" option can be activated and deactivated as often as desired. This is possible via the display in the upper right corner of the WebConfig interface or via the "Terminal settings" channel of the transfer mode ➔ Tab. 58 Meaning of the indices per addressed target and channel.
At the time of switching, a Motion App must not be operating on any of the valves (valve state ≠ "2" (running)). After activation of the “Use of demo licences” option, the number of available Motion App licences increases correspondingly and they can be assigned and used as usual.
After the expiration of the demo period, the "Use of demo licences" option may be automatically deactivated. If Motion Apps that are not regularly licensed are operated at this time, all Motion Apps are stopped. Ten hours before the end of the demo period, a corresponding warning is entered in the malfunction lists of all valve slots.
The yellow controller LED ➔ Tab. 103 LED display M (Modify) flashes so long as the option "Use of demo licences" is active.

3.4.3 Parameter

The basic conditions for operating a Motion App are set using system and app-specific parameters.
Four types of parameters are defined:
- System parameters describe the components that are connected to the Motion Terminal (tubing, drive, mounting position, etc.). System parameters apply to a valve position and thus to all Motion Apps running on this valve position.
- Application parameters describe the application of the Motion App (moving mass, travel time, minimum force, etc.). Application parameters can be stored separately on each valve for each Motion App.
- Tuning parameters enable the behaviour of a Motion App to be finely adjusted via the application parameters. The system behaviour can thus be optimised for special applications. Tuning parameters can be stored separately on each valve for each Motion App.
- Sensor parameters describe the sensors connected to the inputs of an input module. Sensor parameters can be read and written from every valve. They are not a component of the parameter sets (➔ 3.4.3.9 Parameter sets) and can be used equally from all valves.

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The following sections relate to transferring the parameters using the higher-order controller (PLC). Since communication only allows for integer values, the unit-based values are increased by a factor to return integer values.
Example:
A parameter can be defined in the range of 0 ... 100 mm in 0.01 mm steps. A value in the range 0 ... 10000 is transferred for this purpose. One increment (digit) therefore corresponds to 0.01 mm.

3.4.3.1 System parameters

System parameters describe the peripherals attached to a valve, using attributes such as tube length, cylinder type and mounting position. The system parameters of a parameter set apply jointly to all Motion Apps running on a valve, but the parameters are not used by all Motion apps.

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The parameters required to run a Motion App must be transferred before starting the Motion App.

Overview of system parameters

ID	System parameters
12	Tube length at (2)
13	Tube length at (4)
14	Tubing internal diameter at (2)
15	Tubing internal diameter at (4)
20	Drive type
21	Drive stroke
40	Volume of (2)
41	Volume of (4)
42	Operating medium
60	Mounting position of drive
61	Axis zero point offset
70	Sensor input for end position detection, retracted
71	Sensor input for end position detection, extended
75	Sensor input for partial stroke measurement, retracted
76	Sensor input for partial stroke measurement, extended
80	Sensor input for full stroke measurement
81	Sensor input for flow measurement at (2)
82	Sensor input for flow measurement at (4)

Tab. 11: Overview of system parameters

Tube length at (2)

ID	Value range	Digit value	Digit range
12	0 ... 20000 mm	1 mm	0 ... 20000 × 1 mm

Tab. 12: Tube length at (2)

Tube length at (4)

ID	Value range	Digit value	Digit range
13	0 ... 20000 mm	1 mm	0 ... 20000 × 1 mm

Tab. 13: Tube length at (4)

Tubing internal diameter at (2)

ID	Value range	Digit value	Digit range
14	2 ... 11 mm	1 mm	200 ... 1100 × 0.01 mm

Tab. 14: Tubing internal diameter at (2)

Tubing internal diameter at (4)

ID	Value range	Digit value	Digit range
15	2 ... 11 mm	1 mm	200 ... 1100 × 0.01 mm

Tab. 15: Tubing internal diameter at (4)

Internal diameter [mm] for Festo tubing				
Outside diameter [mm]	4	6	8	10
PUN	2.6	4.0	5.7	7.0
PUN-CM	2.5	4.0	5.5	7.0
PUN-H	2.6	4.0	5.7	7.0
PUN-V0	–	4.0	5.7	7.0
PUN-V0-C	2.0	2.0	4.0	6.0
PLN	2.9	4.0	5.9	7.0
PEN	2.7	4.0	5.7	7.0
PAN	2.9	4.0	5.9	7.0
PAN-MF	2.5	4.0	6.0	7.5
PAN-R	2.5	3.8	5.0	6.2
PFAN	2.9	4.0	5.9	7.0

Tab. 16: Internal diameter for Festo tubing

Drive type

The Festo drives supported by the Motion Terminal are shown in a list. The list contains a value for the “drive type” parameter for every drive. The default value must be replaced with the value of the connected drive type before using a corresponding Motion App.

ID	Value range
20	➔ 6.2 List of supported drives

Tab. 17: Drive type

The physical properties of one or more drives on the device can be stored to support special applications with drive combinations or drives that are not included in the list (➔ 4.4 Set parameters for the description of user-defined drives). They can then be selected for use via the "Drive type" system parameter.

Drive stroke

The drive stroke describes the maximum stroke of the drive without taking into account the mechanical stops within the total stroke.

ID	Value range	Digit value	Digit range
21[1)]	10 ... 5000 mm	1 mm	10 ... 5000 × 1 mm

1) The "drive stroke" parameter does not need to be defined when a semi-rotary drive is selected as the drive type. The value for the swivel angle is determined from the order code for the semi-rotary drive.

Tab. 18: Drive stroke

Volume of (2)

ID	Value range	Digit value	Digit range
40	0 ... 32 mm	0.001 l	0 ... 32000 × 0.001 l

Tab. 19: Volume of (2)

Volume of (4)

ID	Value range	Digit value	Digit range
41	0 ... 32 mm	0.001 l	0 ... 32000 × 0.001 l

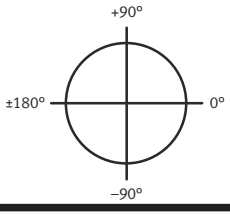
Tab. 20: Volume of (4)

Operating medium

ID	Value range	Digit value	Digit range
42	1 ... 32767	1	1 ... 32767 × 1

Tab. 21: Operating medium

Mounting position of drive

ID	Value range	Mounting position	Digit value	Digit range
60	–180° ... +180°		0.01°	–18000 ... 18000 × 0.01°

Tab. 22: Mounting position of drive

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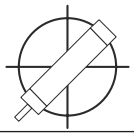
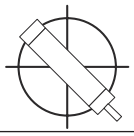
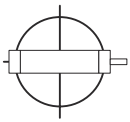
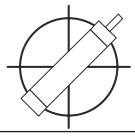
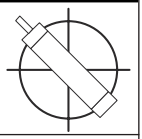
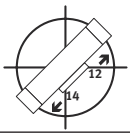
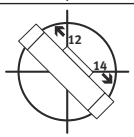
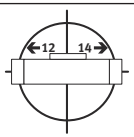
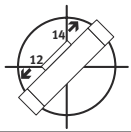
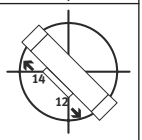
A positive value means that the mass is moved when extending upward (away from the ground) (port (4) pressurised, port (2) exhausted, switching position 14).

The specified value for the mounting position relates to the position of the plane on which the load is moved, and therefore differs depending on the selected drive ➔ Tab. 17 Drive type.

Drive type	–135°	–45°	0°	45°	135°
Cylinder with piston rod					
Linear drive (12 = "retracting") (14 = "extending")					
Semi-rotary drive	Semi-rotary drives may only be used in the following installation situations in which the gravitational force does not have any influence on the motion behaviour of the semi-rotary drive due to the mounting position. – Centre of gravity within the axis of rotation: any mounting position permitted. – Centre of gravity outside the axis of rotation (not recommended): Only vertical mounting position permitted, axis points vertically up or down. In these cases, the "Drive mounting position" parameter must not be parameterised. Any use outside the installation situations described above can result in unpredictable movements of the semi-rotary drive and is therefore not permissible.				

Tab. 23: Meaning of the mounting position with different drive types

Axis zero point offset

ID	Value range	Digit value	Digit range
61	0 ... 5000 mm	1 mm	0 ... 5000 × 1 mm

Tab. 24: Axis zero point offset

Sensor input for end position detection, retracted

ID	Digit value	Value range[1)]
70	1	[20 ... 27] or [40 ... 47] and [50 ... 57] or [80 ... 87] and [90 ... 97]

1) dependent on valve and linkage

Tab. 25: Sensor input for end position detection, retracted

Sensor input for end position detection, extended

ID	Digit value	Value range[1)]
71	1	[20 ... 27] or [40 ... 47] and [50 ... 57] or [80 ... 87] and [90 ... 97]

1) dependent on valve and linkage

Tab. 26: Sensor input for end position detection, extended

Sensor input for partial stroke measurement, retracted

ID	Digit value	Value range[1)2)]
75	1	[20 ... 27] or [40 ... 47] and [50 ... 57] or [80 ... 87] and [90 ... 97]

1) dependent on valve and linkage
2) Value = –1, if partial stroke measurement not used

Tab. 27: Sensor input for partial stroke measurement, retracted

Sensor input for partial stroke measurement, extended

ID	Digit value	Value range[1)2)]
76	1	[20 ... 27] or [40 ... 47] and [50 ... 57] or [80 ... 87] and [90 ... 97]

1) dependent on valve and linkage
2) Value = –1, if partial stroke measurement not used

Tab. 28: Sensor input for partial stroke measurement, extended

Sensor input for full stroke measurement

ID	Digit value	Value range[1)2)]
80	1	[20 ... 27] or [40 ... 47] and [50 ... 57] or [80 ... 87] and [90 ... 97]

1) dependent on valve and linkage
2) Value = –1, if full stroke measurement not used

Tab. 29: Sensor input for partial stroke measurement, full stroke measurement

Sensor input for flow measurement at (2)

ID	Digit value	Value range[1)2)]
81	1	[20 ... 27] or [40 ... 47] and [50 ... 57] or [80 ... 87] and [90 ... 97]

1) dependent on valve and linkage
2) Value = –1, if flow measurement is not used

Tab. 30: Sensor input for flow measurement at (2)

Sensor input for flow measurement at (4)

ID	Digit value	Value range[1)2)]
82	1	[20 ... 27] or [40 ... 47] and [50 ... 57] or [80 ... 87] and [90 ... 97]

1) dependent on valve and linkage
2) Value = –1, if flow measurement is not used

Tab. 31: Sensor input for flow measurement at (4)

3.4.3.2 Application parameters

Application parameters describe the basic conditions under which a Motion App is to be executed, using attributes such as mass during retracting and advancing, travel time, and acceleration. Here, the application parameters of a parameter set can be individually adapted for each Motion App (➔ 3.4.3.9 Parameter sets). This means that, for example, the “mass during retracting” can be defined differently for different Motion Apps on the same valve.
Not all Motion Apps use application parameters.

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The parameters required to run a Motion App must be transferred before starting the Motion App.

Overview of application parameters

ID	Application parameters
100	Retract load[1)]
101	Advance load[2)]
102	Mass moment of inertia, retracting[1)]
103	Mass moment of inertia, advancing[2)]
120	Travel time, retracting[1)]
121	Travel time, advancing[2)]
124	Cushioning time until "target position reached"
126	Duration of threshold exceeded for following error
141	Tolerance for "target position reached"
142	maximum velocity
144	maximum acceleration
146	maximum braking deceleration
148	maximum jerk
150	Offset of project zero point
151	Offset of software end position negative (retracted)[1)]
152	Offset of software end position positive (advanced)[2)]
153	Distance to target position with constant final speed in retracting direction [1)]
154	Distance to target position with constant final speed in advancing direction [2)]
155	Final speed in the case of contact in the retracting direction [1)]
156	Final speed in the extension direction in the case of contact [2)]
182	maximum pressure rise at (2)
183	maximum pressure rise at (4)
184	Medium pressure level
200	maximum leakage for "Good" status
201	maximum leakage for "Warning" status
202	maximum leakage for "Critical" status
204	Threshold value for position following error
205	Threshold value for velocity following error
220	Characteristic (2)
221	Characteristic (4)
222	Soft-start function
223	Mode of operation

ID	Application parameters
224	End-position monitoring
225	Possibility of pressure build-up at the mechanical end position
255	Motion App to be taught in

1) (2) pressurised, (4) exhausted; switching position 12
2) (4) pressurised, (2) exhausted; switching position 14

Tab. 32: Overview of application parameters

3.4.3.3 Tuning parameters

The quality reached in the system behaviour via the settings of the system and application parameters may not be sufficient with some applications. The tuning parameters offer the option of having a greater influence on the system behaviour in these cases with certain Motion Apps.

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The use of tuning parameters is optional. Usually, the Motion Apps can be used without setting the tuning parameters (with default value 0).

The IDs of the tuning parameters are in the range of 230 ... 249. The assignment of these IDs is specifically defined by the Motion Apps. This definition can be found in the manual of the applicable Motion App.

3.4.3.4 Sensor parameters

The properties of the sensors connected to the inputs of the input modules are defined using the following parameters. The sensor parameters are read and written over a dedicated channel in transfer mode and can be performed via the process data of any valve (➔ 4.3 Setting sensor parameters).
The ID of the parameters for the individual inputs is calculated from the number of the input (0 ... 7), multiplied by a factor of 30 and then added to the number of the parameter type.

ID	Parameter	Values	Meaning
Input no. × 30 + 1[1)]	Sensor type	1001	SMT-8M-A-PS-24V-...
		2001	SDAP-MHS-M50-...
		2002	SDAP-MHS-M100-...
		2003	SDAP-MHS-M160-...
		2901	user-defined position sensor 1
		2902	user-defined position sensor 2
		2903	user-defined position sensor 3
		3001	SFAB-50U-...-2SA-...
		3002	SFAB-200U-...-2SA-...
		3003	SFAB-600U-...-2SA-...
		3004	SFAB-1000U-...-2SA-...
		3101	SFAH-50U-...-PNVBA-...

ID	Parameter	Values	Meaning
Input no. × 30 + 1[1)]	Sensor type	3102	SFAH-100U-...-PNVBA-...
		3103	SFAH-200U-...-PNVBA-...
		3901	user-defined flow sensor 1
		3902	user-defined flow sensor 2
		3903	user-defined flow sensor 3
Input no. × 30 + 2[1)]	Sensor orientation with position sensors[2)]	0	Output signal rising in advancing direction
		1	Output signal falling in advancing direction
	Sensor orientation for flow sensors[2)]	0	positive flow rate values
		1	negative flow rate values

1) Examples: the sensor type for input 0 is addressed with ID 1 (0 × 30 + 1). The sensor orientation for input 4 is addressed with ID 122 (4 × 30 + 2).
2) For analogue sensors only, e.g. SDAP-...

Tab. 33: Sensor parameters

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The sensor parameters are not a component of parameter sets, because they are independent of the valves.
For user-defined sensors, the sensor signal is interpreted according to the configured properties ➔ 3.4.3.5 Parameters for describing user-defined position sensors, ➔ 3.4.3.6 Parameters for describing user-defined flow sensors.

3.4.3.5 Parameters for describing user-defined position sensors

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The storage of user-defined position sensors is optional. As a rule, sensors from the list of supported position sensors should be used. No further description of them is required by the user.

It is possible to store up to three user-defined position sensors on the device to support special applications with measuring systems and sensors that are not listed in the list of supported position sensors. They can then be selected for use on an analogue input module using the "sensor type" sensor parameter.
For the description of user-defined position sensors, the "Access to extended sensor list" option must be set in the settings for the Motion Terminal. The setting is made in the menu for the WebConfig interface or the transfer mode in channel 14 ➔ Tab. 58 Meaning of the indices per addressed target and channel.
The properties of a user-defined position sensor, which are required for the correct interpretation of its measurement signals, are defined using the following parameters. The parameters for description of user-defined position sensors are read and written via channel 17 (user-defined peripherals) of the transfer mode and can be performed via the process data of any valve ➔ 3.5.4 Transfer mode. A position sensor type defined in this way is available for all analogue input module ports on the Motion Terminal.

ID	Parameter	Value range	Digit value	Digit range
1	Detection range (maximum value)	0 ... 10000 mm	1 mm	0 ... 10000 × 1 mm
Interpretation of the measured signal:			4 mA ≙ 0 mm 20 mA ≙ maximum value sensing range	

Tab. 34: Parameters for describing user-defined position sensors

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The parameters for the description of user-defined position sensors are not included in the parameter sets because they are independent of the valves.

3.4.3.6 Parameters for describing user-defined flow sensors

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The storage of user-defined flow sensors is optional. As a rule, sensors from the list of supported flow sensors should be used. No further description of them is required by the user.

It is possible to store up to three user-defined flow sensors on the device to support special applications with measuring systems and sensors that are not listed in the list of supported flow sensors. They can then be selected for use on an analogue input module using the "sensor type" sensor parameter.
For the description of user-defined flow sensors, the "Access to extended sensor list" option must be set in the settings for the Motion Terminal. The setting is made in the menu for the WebConfig interface or the transfer mode in channel 14 ➔ Tab. 58 Meaning of the indices per addressed target and channel.
The properties of a user-defined flow sensor that are required for the correct interpretation of its measurement signals are defined using the following parameters. The parameters for the description of user-defined flow sensors are read and written via channel 17 (user-defined peripherals) of the transfer mode and can be performed via the process data of any valve ➔ 3.5.4 Transfer mode. A flow sensor type defined in this way is available for all analogue input module ports on the Motion Terminal.

ID	Parameter	Value range	Digit value	Digit range
1	Detection range (maximum value)[1)]	1 ... 3000 l/min	1 l/min	1 ... 3000 × 1 l/min
2	Lower limit of the measured values to be assumed as reliable[2)]	0.1 ... 10%	0.1%	1 ... 100 × 0.1%
Interpretation of the measured signal:			4 mA ≙ 0 l/min 20 mA ≙ maximum value sensing range	

1) Maximum value of the interpreted flow rate with reference to the operating medium to be used at 0 °C. With a different sensor reference standard, the maximum flow rate value specified in its datasheet must be converted accordingly.
2) relative to the maximum value of the sensing range

Tab. 35: Parameters for describing user-defined flow sensors

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The specified maximum value of the interpreted flow rate refers to the operating medium used at 0 °C. With a different sensor reference standard, the maximum flow rate value specified in its datasheet must be converted accordingly.
The parameters for the description of user-defined flow sensors are not included in the parameter sets because they are independent of the valves.

3.4.3.7 Parameters for the description of user-defined drives

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The storage of user-defined drives is optional. As a rule, drives from the list of supported drives can be used. No further description of them is required by the user. ➔ 6.2 List of supported drives

Up to eight user-defined drives can be stored on the device for support of special applications with drive combinations or drives that are not listed in the list of supported drives. They can then be selected for use on a valve using the "Drive type" system parameter.
The "Access to extended drive list" option must be set in the settings for the Motion Terminal for the description of user-defined drives. The setting is made in the menu for the WebConfig interface or the transfer mode in channel 14 ➔ Tab. 58 Meaning of the indices per addressed target and channel.
The physical properties of a user-defined drive are defined using the following parameters. The parameters for the description of user-defined drives are read and written via channel 17 (user-defined peripherals) of the transfer mode and can be performed via the process data of any valve ➔ 4.4 Set parameters for the description of user-defined drives. A drive defined in this way is available for all valves of the Motion Terminal.
Not all physical properties of a drive are known. Notes on which parameters for the description of a user-defined drive are particularly relevant for operation with a specific Motion App and specifications for any approximate specifications are included in the list of supported drives ➔ 6.2 List of supported drives.

ID	Parameter	Value range	Digit value	Digit range
1	Design	1 = single-acting piston rod cylinder		
		2 = double-acting piston rod cylinder		
		3 = rodless cylinder (linear drive)		
2	Piston diameter (internal cylinder diameter)	5 ... 3276.7 mm	0.1 mm	50 ... 32767 × 0.1 mm
3	Piston rod diameter[1)]	0 ... 3276.7 mm	0.1 mm	0 ... 32767 × 0.1 mm
4	Piston mass	0.01 ... 327.67 kg	0.01 kg	1 ... 32767 × 0.01 kg
5	Piston rod mass per linear metre[1)]	0 ... 327.67 kg/m	0.01 kg/m	0 ... 32767 × 0.01 kg/m
6	Dead volume at the retracted drive end	0 ... 3276.7 cm^3	0.1 cm^3	0 ... 32767 × 0.1 cm^3
7	Dead volume at the extended drive end	0 ... 3276.7 cm^3	0.1 cm^3	0 ... 32767 × 0.1 cm^3
8	Pneumatic master value of the connection to the chamber pressurised for extending	0 ... 327.67 l/(s*bar)	0.01 l/(s*bar)	0 ... 32767 × 0.01 l/(s*bar)
9	Pneumatic master value of the connection to the chamber pressurised for retracting	0 ... 327.67 l/(s*bar)	0.01 l/(s*bar)	0 ... 32767 × 0.01 l/(s*bar)
10	Coulomb friction force	0 ... 3276.7 N	0.1 N	0 ... 32767 × 0.1 N
11	Viscosity coefficient of friction	0.1 ... 3276.7N*s/m	0.1 N*s/m	1 ... 32767 × 0.1N*s/m
12	Maximum impact energy at the retracted drive end	0.01 ... 32.767 J	0.001 J	10 ... 32767 × 0.001 J
13	Maximum impact energy at the extended drive end	0.01 ... 32.767 J	0.001 J	10 ... 32767 × 0.001 J

ID	Parameter	Value range	Digit value	Digit range
14	Range of action of end-position cushioning at retracted drive end	0 ... 3276.7 mm	0.1 mm	0 ... 32767 × 0.1 mm
15	Scope of action of end-position cushioning at the extended drive end	0 ... 3276.7 mm	0.1 mm	0 ... 32767 × 0.1 mm

1) Only required for cylinder with piston rod

Tab. 36: Parameters for the description of user-defined drives

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The parameters for the description of user-defined drives are not included in the parameter sets because they are independent of the valves.

3.4.3.8 Teach-in data

Some Motion Apps require a teach-in process to set the characteristics of the connected peripherals and to achieve the desired behaviour during standard operation (➔ 3.7 Teach-in run). The data from this teach-in process are stored in the parameter set in a manner specific to the Motion App (➔ 3.4.3.9 Parameter sets). The data are continuously updated and saved to the Motion Terminal when the corresponding Motion App is in operation.

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The teach-in data are stored in the parameter set that is currently active and automatically saved as non-volatile data (➔ 3.7.5 Saving the teach-in data).

The teach-in data can be read out and overwritten if required. In this way, for example, a backup of the teach-in data can be generated or the teach-in data can be transferred to identically constructed systems. The teach-in data are read and written via channels 1 ... 5 in transfer mode (➔ 3.5.4.1 Structure of the process data in transfer mode). For addressing, the associated Motion App must be referenced (addressed target) and the ID of the teach-in datum (index) specified (➔ Tab. 57 Meaning of the addressed targets per channel). The teach-in data specific to the Motion App can be found in the manual of the applicable Motion App.
There is also an option for transferring teach-in data and the related parameters to another Motion Terminal by exporting the data to a configuration file (➔ 3.3.3 Export/import of parameterisation and settings).

3.4.3.9 Parameter sets

The Motion Terminal can manage 5 different parameter sets for each valve, each set comprising system parameters, application parameters, tuning parameters and teach-in data (➔ 3.7 Teach-in run). When changing the connected peripherals, it is easy to modify the parameterisation of the valve by activating a different parameter set.

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Parameter set 1 is automatically selected when the Motion Terminal is started. Changing the parameter set is described in section ➔ 4.6 Changing an active parameter set.

Structure of a parameter set

The following example is intended to illustrate the structure of a parameter set.

Valve at slot 1					
Parameter set 3	Motion App A	Motion App B	Motion App C	Motion App D	Motion App ...
System parameters	Sys. par. a				
	Sys. par. b				
	Sys. par. c				
	Sys. par. ...				
Application parameters	App. par. m	App. par. m	App. par. m	App. par. m	App. par. m
	App. par. n	App. par. n	App. par. n	App. par. n	App. par. n
	App. par. o	App. par. o	App. par. o	App. par. o	App. par. o
	App. par. ...	App. par. ...	App. par. ...	App. par. ...	App. par. ...
Tuning parameters	Tun. par. x	Tun. par. x	Tun. par. x	Tun. par. x	Tun. par. x
	Tun. par. y	Tun. par. y	Tun. par. y	Tun. par. y	Tun. par. y
	Tun. par. ...	Tun. par. ...	Tun. par. ...	Tun. par. ...	Tun. par. ...
Teach-in data	Data record 1	Data record 2	Data record 3	Data record 4	Data record 5

Tab. 37: Example of the structure of parameter set 3

3.4.4 Setpoint and actual values

Setpoint and actual values can be written and read cyclically by the process data.

Setpoint and actual values	
Writing setpoint values	Output data (PDO, Process Data Output)
Reading actual values	Input data (PDI, Process Data Input)

Tab. 38: Setpoint and actual values

The setpoint and actual values are specific to the individual Motion Apps. The structure of the process data is described in section (➔ 3.5 Communication between PLC and Motion Terminal).

3.4.5 Waiting time between Motion Apps

In the following cases, calibration of the associated valve takes place before the Motion App that has been started is executed:

- Following a restart of the Motion Terminal, a Motion App is started for the first time.
  Exception: Motion App #01 in operating mode "controlled"
- After execution of Motion App #01 in operating mode "controlled", Motion App #01 is started for the first time in the operating mode "regulated" or another Motion App is started.

This calibration can take up to 60 seconds and will be performed automatically prior to execution of the Motion App. The calibration can be viewed as a return value in the process data ➔ Tab. 50 Information on invalid output data.

3.5 Communication between PLC and Motion Terminal

The communication between the higher-order controller (PLC) and the Motion Terminal controller is based on input and output data of 8 × 6 bytes each from the CPX terminal. Each of the maximum 8 valves on a Motion Terminal is assigned 6 bytes of input data (PDI) and 6 bytes of output data (PDO), regardless of the actual number of valves.

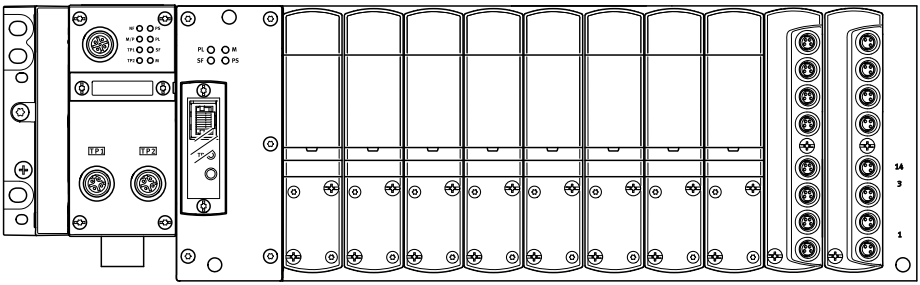

Fig. 16: Motion Terminal

Depending on the current operating mode of a valve, the following functions and content can be transferred using the process data:

- Start/run/exit a Motion App ➔ 3.5.3 Running a Motion App.
- Parameterisation of input modules using the PLC ➔ 4.3 Setting sensor parameters.
- Parameterisation of the Motion App using the PLC (parameter download) ➔ 4.1 Setting system, application and tuning parameters.
- Reading the configured Motion App (parameter upload) ➔ 4.2 Reading out system, application and tuning parameters.
- Reading system data and measurement values ➔ 3.5.4.2 Information on the status of the Motion Terminal (info channel).
- Reading diagnostic information and acknowledging errors ➔ 3.8.3 Diagnostics channel in transfer mode.

i

The current process data (PDO and PDI) of all slots are displayed in the "Monitoring" view of the WebConfig interface.
Not all tasks are possible via the process data range of non-existent or unused slots. Only tasks that are not valve-related can be executed, such as parameterisation of input modules, reading of system data and measured values as well as diagnostic information.

3.5.1 Numerical representation

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Setpoint values and actual values, as well as parameters, are represented within the process data as a two's complement value in the format “16 bit signed integer” (signed int16).

3.5.2 Structure of the process data when operating a Motion App

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Description of the process data when operating a Motion App (➔ 3.5.3 Running a Motion App).

3.5.2.1 Structure of the output data (PDO)

During operation of a Motion App, the 6 bytes of output data (PDO) per valve slot are divided into 3 sections:

- Command (➔ Tab. 40 Detailed view of the "Command" section of the output data (PDO))
- Setpoint value 1
- Setpoint value 2

Valve on one of the slots 0 ... 7					
Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte 0
Setpoint value 2		Setpoint value 1		Command	

Tab. 39: Structure of the output data (PDO) per valve

The following table is a detailed view of the "Command" section.

Detailed view of the Command section															
PDO byte 1								PDO byte 0							
Command															
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
app option								app control		valve mode					

Tab. 40: Detailed view of the "Command" section of the output data (PDO)

Operating mode of the valve (valve mode)

The operating mode of the valve (valve mode) is specified by bits 5 ... 0 in byte 0 (PDO).

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This section is allocated the same function in every operating mode and is of central importance for the control of the Motion Terminal. Allocation of the other sections depends on the current operating mode of the valve.

Value dec.	Operating mode of the valve	Description
0	reserved	Invalid value
1 ... 59	Running a Motion App (value corresponds to Motion App ID)	Selection of the Motion App to be run by its ID. The setpoint values required to run the Motion App are transferred using bytes 5 ... 2 (PDO).
60	Teach-in run	Teach-in of the relevant characteristics of the connected system for execution of particular Motion apps.
61	End Motion App	Ending the Motion App currently running on the valve.
62	Acknowledge error Clear malfunction list	Inactive errors must be acknowledged to change the status of the valve from "not ready" to "ready".
63	Transfer mode	Transfer of parameters, diagnostic information and settings for the valves (➔ 3.5.4 Transfer mode).

Tab. 41: Operating mode of the valve

Control of the Motion App (app control)
The information for controlling the Motion App is specified using bits 7 ... 6 in byte 0 (PDO).
The exact function is specific to the Motion App and can be found in the manual of the Motion App.

Setting the Motion App (app option)
The setting of a Motion App is specified using byte 1 (PDO).
The exact function is specific to the Motion App and can be found in the manual of the Motion App.

"Setpoint value 1" and "setpoint value 2" sections (setpoint1, setpoint2)
Setpoint values for executing a Motion App are specified using the bytes 5 ... 4 (PDO) (setpoint value 2) and 3 ... 2 (PDO) (setpoint value 1).
The exact function is specific to the Motion App and can be found in the manual of the Motion App.

3.5.2.2 Structure of the input data (PDI)

When a Motion app is running, the 6 bytes of input data (PDO) for each valve slot are divided into 3 sections:

- Status (➔ Tab. 43 Detailed view of the "Status" section of the input data (PDI))
- Actual value 1
- Actual value 2

Valve on one of the slots 0 ... 7					
Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte 0
Actual value 2		Actual value 1		Status	

Tab. 42: Structure of the input data (PDI) per valve

The following table is a detailed view of the "Status" section.

Detailed view of the "Status" section															
PDI byte 1								PDI byte 0							
Status															
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
app state								valve state		valve mode					

Tab. 43: Detailed view of the "Status" section of the input data (PDI)

Operating mode of the valve (valve mode)

The valve mode that is currently active is returned using bits 5 ... 0 in byte 0 (PDI).

Value dec.	**Operating mode of the valve**	**Description**
1 ... 59	Operating Motion App	Display of currently running Motion App using the ID.
60	Teach-in run	➔ 3.7 Teach-in run
61	Valve inactive (in initial position)	No Motion App is currently being executed, or the most recently executed Motion App has been stopped. If the valve is inactive due to an error in the output data, the cause is output in the section "app state" ➔ 3.5.3.5 Feedback in the case of invalid output data.
62	Valve inactive (in initial position)	Not used. Feedback for command "62" (acknowledge error) is "61" (valve inactive).
63	Transfer mode active	➔ 3.5.4 Transfer mode

Tab. 44: Operating mode of the valve

Example
To start Motion App #05, the value “5” is transferred in the PDO section "valve mode". The Motion App is only actually started when the value “5” is present in the PDI section "valve mode" (and “2” is present in the section "valve state").

Status of the valve (valve state)
The current status of the valve (valve state) is given by bits 7 ... 6 in byte 0 (PDI).

Status of the valve	Meaning	Bit 7	Bit 6	Dec.
Not ready (not ready)	Start process for Motion Terminal is not completed or an error that has been detected and eliminated is yet to be acknowledged.	0	0	0
Ready (configurable)	The valve is inactive. A Motion App can be run or it can be switched to transfer mode.	0	1	1
Running (running)	A Motion App is currently being executed.	1	0	2
Error (failure)	An error has been detected but not yet eliminated. The Motion App has been stopped.	1	1	3

Tab. 45: Status of the valve

Status of the Motion App (app state)
The current status of the Motion App (app state) is shown by a range of information using bits 7 ... 0 in byte 1 (PDI).

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The information described here is valid during operation of all Motion Apps. Additional information specific to the Motion App that is transferred in the Motion App (app state) is included in the manuals for the Motion Apps.

Indicating warnings
Bit 7 in byte 1 (PDI) will indicate if warnings are pending in the diagnostic memory of the Motion Terminal.

Value	Description
0	There are no warnings from the active Motion App.
1	The active Motion App is indicating a warning that is pending in the diagnostic memory of the Motion Terminal.

Tab. 46: Indicating warnings

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Working with warnings and errors (➔ 3.8 Diagnostics options).

3.5.3 Running a Motion App

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The system and application parameters must be defined depending on the Motion App before operation (➔ 3.4.3 Parameter). The Motion App uses the parameter values defined by the user and the teach-in data from the active parameter set if necessary (➔ 4.6 Changing an active parameter set). The system and/or application parameters used by a Motion App are documented in the manual for that Motion App.

3.5.3.1 Requirements

- The Motion Terminal boot procedure is completed.
- System and application parameters required by the Motion App have been transferred (➔ 4.1 Setting system, application and tuning parameters).
- If the Motion App should access sensor data, the sensor parameters required for all assigned sensor inputs have been transferred (➔ 4.3 Setting sensor parameters).
- If necessary, a teach-in run for the Motion App has been carried out (➔ 3.7 Teach-in run).
- The status of the valve on which the Motion App is to be run is “ready” ("configurable") (➔ 3.5.2.2 Structure of the input data (PDI)).
- There is no active or inactive error on the valve on which the Motion App is to be run (➔ 3.8.3.6 Readout of a malfunction list; ➔ 3.8.3.7 Acknowledging errors and clearing the malfunction list).

3.5.3.2 Starting a Motion App

To start a Motion App, setpoint values 1 and 2 and the command (comprising "valve mode", "app control" and "app option") must be transferred in the 6 byte PDO for the corresponding valve.

Example

Motion App #02 “Proportional directional control valve” (PDO byte 0, bits 5 ... 0 => 2_{10}) is to be started with the following specifications:

- Switching status of the air ports (app control):
  (2) active, (4) active (PDO byte 0, bit 7 => 1, PDO byte 0, bit 6 => 1)
- Valve type (app option): 2 x 3/3 (PDO byte 1 => 15_{10})
- Degree of opening (2) (setpoint value 1): +50% (PDO byte 2+3 =>5000_{10})
- Degree of opening (4) (setpoint value 2): +40% (PDO byte 4+5 =>4000_{10})

PDO byte	**5**	**4**	**3**	**2**	**1**								**0**							
Area	Setpoint value 2		Setpoint value 1		Command															
Bits	15 ... 0		15 ... 0		7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Function	setpoint value 2		setpoint value 1		app option								app control		valve mode					
Value	4000		5000		0	0	0	0	1	1	1	1	1	1	0	0	0	0	1	0

Tab. 47: Assignment of the output data (PDO) for sample operation of the Motion App #02

The input data are used to return the current status of the valve and of the Motion App:

- Operating mode of the valve (valve mode): Motion App #02 (PDI byte 0, bits 5 ... 0 => 000010_2)
- Status of the valve (valve state): running (running) (PDI byte 0, bits 7 ... 6 => 10_2)
- Status of the Motion App (app state):
  - End-position sensing:
    e.g. sensor for end position "advanced" returns "1" (PDI byte 1, bit 2 => 1)
    e.g. sensor for end position "retracted" returns "0" (PDI byte 1, bit 0 => 0)
  - Warning: no warning pending (PDI byte 1, bit 7 => 0)
- Actual value 1 (actual value 1): degree of opening: e.g. + 50.02% (PDI byte 3 ... 2 =>500210)
- Actual value 2 (actual value 2): degree of opening: e.g. +39.99% (PDI byte 5 ... 4 => 3999_{10})

PDI byte	**5**	**4**	**3**	**2**	**1**								**0**							
Area	Actual value 2		Actual value 1		Status															
Bits	15 ... 0		15 ... 0		7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Function	actual value 2		actual value 1		app state								valve state		valve mode					
Value	3999		5002		0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0

Tab. 48: Sample feedback to input data (PDI) for operation of Motion App #02

3.5.3.3 Controlling a Motion App

During operation, the behaviour of a Motion App can be controlled by adjusting the values for "app control", "app option", "setpoint value 1" and "setpoint value 2".

3.5.3.4 Ending a Motion App

To end a Motion App, the operating mode of the valve (valve mode) must be set to the value "61". The Motion App is then ended. The value in the section "valve state" of the input data (PDI) changes to "01_2" (configurable).
Another Motion App can now be started, or a switch to transfer mode can be made (➔ 3.5.4 Transfer mode).

3.5.3.5 Feedback in the case of invalid output data

If incorrect or – in the present status – invalid output data is transferred from the higher-order controller to the Motion Terminal controller during start-up of a Motion App, the Motion App is prevented from starting. If there is invalid output data during operation of a Motion App, this is stopped. In both cases, corresponding feedback is sent on the status of the Motion App (app state) to the input data:

- Operating mode of the valve (valve mode): 61 (Motion App stopped) (PDI byte 0, bits 5 ... 0 => 111101_2)
- Status of the valve (valve state): ready (configurable) (PDI byte 0, bits 7 ... 6 => 01_2)
- Status of the Motion App (app state): ➔ Tab. 50 Information on invalid output data
- Actual value 1 (actual value 1): (PDI byte 3 ... 2 => current pressure [mbar] at port (2))
- Actual value 2 (actual value 2): (PDI byte 5 ... 4 => current pressure [mbar] at port (4))

PDI byte	5	4	3	2	1								0							
Area	Actual value 2		Actual value 1		Status															
Bits	15 ... 0		15 ... 0		7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Function	actual value 2		actual value 1		app state								valve state		valve mode					
Value	Current pressure		Current pressure		➔ Tab. 50 Information on invalid output data								0	1	1	1	1	1	0	1

Tab. 49

Meaning of PDI byte 1

Value dec.	App state	Meaning
1	valve mode invalid	Invalid value in section "valve mode"
2	app control invalid	Invalid value in section "app control"
3	app option invalid	Invalid value in section "app option"
4	setpoint1 invalid	Invalid value in “setpoint value 1” section
5	setpoint2 invalid	Invalid value in “setpoint value 2” section
6	parameters invalid	Incorrect parameterisation (more precise information ➔ 3.8.3 Diagnostics channel in transfer mode)
10	Access denied (WebConfig access)	Access by PLC denied owing to active access by WebConfig interface.
11	blocked due to saving	Access blocked due to active save process.
12	no license for this app	No licence available for the requested Motion App.
13	all licences in use	No free licence available for the requested Motion App.
14	licence file invalid	Licence file is invalid.
15	no valve detected	No valve detected on the valve slot addressed.
16	valve self calibration running	Valve self-calibration process in operation.

Tab. 50: Information on invalid output data

3.5.3.6 Standby mode of a Motion App after an error has occurred

If an error occurs during execution of a Motion App, the status of the valve (valve state) changes to the value "3" (failure). The active operation of the running Motion App is stopped and the valve is switched to the safe state. As soon as the cause of the error has been remedied and the error is no

longer active, the valve automatically switches to status "0" (not ready). In the event of errors that were caused by the execution of the Motion App itself, the cause is already cleared by the implicit stop.
The Motion App remains in standby mode as long as the higher-order controller continues to transmit the ID of the previously running Motion App as the operating mode of the valve (valve mode). In this case, no further actuating signals are generated for the valve. The valve outputs remain closed. However, the actual values defined for this Motion App are still determined and output in the process data. The standby mode can be ended via the operating mode (valve mode) 61 ➔ 3.5.3.4 Ending a Motion App.
In the two statuses "3" (failure) and "0" (not ready), it is possible to switch to the transfer mode, for example to read out the malfunction list ➔ 3.5.4 Transfer mode. After exiting the transfer mode, no further execution of the Motion App in standby mode is possible.
The valve status "0" (not ready) can be acknowledged as usual by the operating mode (valve mode) 62 ➔ 3.8.3.7 Acknowledging errors and clearing the malfunction list. The valve returns to operating mode (valve mode) 61 with valve status "1" (configurable). The standby mode may then be terminated. The valve is ready for operation again for a Motion App.

3.5.4 Transfer mode

The transfer mode (valve mode (valve mode)= “63”) includes the option of exchanging information such as parameters (➔ 4 Parameterisation), status values or diagnostic information (➔ 3.8.3 Diagnostics channel in transfer mode) between the Motion Terminal and the higher-order controller using a range of channels. The transfer mode makes use of process data (6 bytes output data (PDO) and 6 bytes input data (PDI) for each valve).

3.5.4.1 Structure of the process data in transfer mode

Structure of the output data (PDO)

During operation of the transfer mode the 6 bytes of output data (PDO) per valve slot are divided into 3 sections:
- Command ➔ Tab. 40 Detailed view of the "Command" section of the output data (PDO)
- Parameter ➔ Tab. 56 Detailed view of the "Parameters" section of the output data (PDO)
- Value ➔ Tab. 58 Meaning of the indices per addressed target and channel

Valve on slots 0 ... 7					
Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte 0
Value		Parameter		Command	

Tab. 51: Structure of the output data (PDO) per valve

The following table is a detailed view of the "Command" section.

Detailed view of the "Command" section															
PDO byte 1								PDO byte 0							
Status															
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
transfer control			channel					–		valve mode = 63					

Tab. 52: Detailed view of the "Command" section of the output data (PDO)

Byte 0

The valve is set to transfer mode with the value "63" using the valve operating mode (valve mode, PDO byte 0, bits 5 ... 0).

Bits 7 ... 6 in byte 0 (PDO) are ignored in transfer mode.

Channel (channel)
The channel over which the information is to be transferred is selected with bits 4 ... 0 in byte 1 (PDO).
Values that are not listed are reserved and cannot be used.

Value dec.[1)]	Channel	Meaning	Access
1	parameter set 1	Parameterisation in parameter set 1	read/write
2	parameter set 2	Parameterisation in parameter set 2	read/write
3	parameter set 3	Parameterisation in parameter set 3	read/write
4	parameter set 4	Parameterisation in parameter set 4	read/write
5	parameter set 5	Parameterisation in parameter set 5	read/write
14	terminal settings	Settings of the entire Motion Terminal	read/write
15	valve settings	Valve settings	read/write
16	input module settings	Parameterisation of the input modules	read/write
17	user-defined peripherals	Parameterisation of user-defined peripherals	read/write
25	information	Information on the status of the terminal (➔ Tab. 58 Meaning of the indices per addressed target and channel)	read
31	malfunctions	Access to the diagnostic memory (➔ Tab. 58 Meaning of the indices per addressed target and channel)	read

1) Values that are not listed are reserved and cannot be used.

Tab. 53: Available channels

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More information on the parameter sets ➔ 3.4.3.9 Parameter sets.

Transfer control (transfer control)

The transfer of the transfer mode is controlled with bits 7 ... 5 in byte 1 (PDO).

Value dec.[1)]	Transfer	Meaning
1	download	Transfer from the PLC to the Motion Terminal
2	upload	Transfer from the Motion Terminal to the PLC
3	Exit transfer mode	Transfer mode is exited; the valve mode switches to 61 (valve in initial position), the valve status switches to the value 1 (configurable).
4	Save parameterisation as persistent data	The data for the valve currently being parameterised are permanently saved to the Motion Terminal.

1) Values that are not listed are reserved and cannot be used.

Tab. 54: Possible assignment of transfer control

Valve on slots 0 ... 7					
Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte 0
Value		Parameter		Command	

Tab. 55: Structure of the output data (PDO)

The following table is a detailed view of the "Parameters" section.

Detailed view of the Parameters section															
PDO byte 3								PDO byte 2							
Parameter															
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
index								addressed target							

Tab. 56: Detailed view of the "Parameters" section of the output data (PDO)

Addressing of data transfer (addressed target)
Channel-specific address of the target that will be written to or read from during the transfer.

Channel	addressed target	Meaning	Digit value
1 ... 5	1 ... 59	ID of the Motion App for which parameters are to be transferred. The purpose of the specification for system parameters is a validity check of the specified value, with this check being specific to the Motion App.	1
	60	Transfer parameters for the teach-in run	1
	101 ... 159	100 + ID of Motion App for which the teach-in data are to be transferred	1
14	0	Settings of the entire Motion Terminal	1
15	0	Valve settings	1
16	1	Transfer information for peripherals at the first input module from the left	1
	2	Transfer information for peripherals at the second input module from the left	1
17	1 ... 3	Number of the user-defined position sensor for which parameters are to be transferred	1
	11 ... 13	10 + number of the user-defined flow sensor for which parameters are to be transferred	1
	101 ... 108	100 + number of the user-defined drive for which parameters are to be transferred	1
25	1	Hardware information	1
	2	Software information	1
	3	Licence information	1
	11	Pressures	1
	12	Temperatures	1
	13	Booster strokes (degree of opening)	1
	14	Flow rates (volumetric flow rate)	1
	21	Proximity signals (via digital sensors on the input module)	1
	22	Positions (via analogue sensors on the input module)	1
	23	Flow rates (volumetric flow rate) (via analogue sensors on the input module)	1
31	–	addressed target is not used in this channel	–

Tab. 57: Meaning of the addressed targets per channel

Index (index)
Depending on the channel selected, the information to be transferred is more precisely identified by byte 3 (PDO).

Channel	adressed target	Index	Meaning	Digit value
1 ... 5	1 ... 60	0 ... 255	ID of the system, application or tuning parameters that are to be transferred ➔ 3.4.3 Parameter	1
	101 ... 159	0 ... 255	ID of the teach-in value that is to be transferred ➔ manual of the corresponding Motion App	1
14	0	51	Retention of existing teach-in data for parameter changes	1
		52	Access to extended sensor list	1
		53	Access to extended drive list	1
		54	Use of demo licences during the demo period	1
15	0	1	Number of the active parameter set	1
		2	ID of the assigned Motion App	1
16	1 ... 2	0 ... 255	Sensor parameter ID ➔ Tab. 33 Sensor parameters	1
17	1 ... 3	1	ID of the parameter for describing a user-defined position sensor ➔ Tab. 34 Parameters for describing user-defined position sensors	1
	11 ... 13	1 ... 2	ID of the parameter for describing a user-defined flow sensor ➔ Tab. 35 Parameters for describing user-defined flow sensors	1
	101 ... 108	1 ... 15	ID of the parameter for the description of a user-defined drive ➔ Tab. 36 Parameters for the description of user-defined drives	1
25	1	0 ... 255	ID of the hardware info ➔ Tab. 62 Hardware information	1
	2	0 ... 255	ID of the software info ➔ Tab. 63 Software information	1
	3	0 ... 255	ID of the licence info ➔ Tab. 64 Licence information	1
	11	0 ... 255	ID of the pressure value ➔ Tab. 66 Pressure values	1
	12	0 ... 255	ID of the temperature value ➔ Tab. 67 Temperatures	1
	13	0 ... 255	ID of the booster stroke value ➔ Tab. 68 Booster strokes	1
	14	0 ... 255	ID of the flow rate value at the valve ➔ Tab. 69 Flow rates at the valve	1
	21	0 ... 255	ID of the proximity signal value ➔ Tab. 70 Proximity signals	1
	22	0 ... 255	ID of the position value ➔ Tab. 71 Positions	1

Channel	adressed target	Index	Meaning	Digit value
25	23	0 … 255	ID of the flow rate value at the external sensor ➔ Tab. 72 Flow rates at the external sensor	1
31	–	1 … 40	Number of the position in the diagnostic memory with content to be read	1
		253	Position of most recent diagnostic message of the "error" type	1
		254	Position of earliest diagnostic message of the "error" type	1
		255	Number of diagnostic messages in the diagnostic memory	1

Tab. 58: Meaning of the indices per addressed target and channel

"Value" section (value)

This section is used to transfer numerical values. The significance and function of the numerical values are defined by the sections described above.

Structure of the input data (PDI)

In transfer mode, the purpose of the input data (PDI) is to confirm the transfer that has taken place or to output the requested value. To do this, the information that was transferred via "valve mode", "channel", "transfer control", "addressed target" and "index" to the output data is returned to the corresponding positions in the input data.

i

The "valve state" section shows the information described in section (➔ 3.5.2.2 Structure of the input data (PDI)).

Valve on slots 0 … 7					
Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte 0
Value		Parameter		Status	

Tab. 59: Structure of the input data (PDI)

The following table is a detailed view of the "Status" section.

Detailed view of the "Status" section															
PDI Byte 1								PDI Byte 0							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
transfer control			channel					valve state		valve mode = 63					

Tab. 60: Detailed view of the "Status" section of the input data (PDI)

The following table is a detailed view of the "Parameters" section.

Detailed view of the "Parameters" section															
PDI Byte 3								PDI Byte 2							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
index								addressed target							

Tab. 61: Detailed view of the "Parameters" section of the input data (PDI)

3.5.4.2 Information on the status of the Motion Terminal (info channel)

Channel 25 enables the read-out of various information that shows the status of the Motion Terminal.

Hardware information **Channel 25, addressed target 1**		
Index	Meaning	Digit value
1	Hardware ID of the controller CTMM-S1-C	1
2	Hardware ID of the interlinking board	1
21	Hardware revision valve 0	1
41	Hardware revision valve 1	1
61	Hardware revision valve 2	1
81	Hardware revision valve 3	1
101	Hardware revision valve 4	1
121	Hardware revision valve 5	1
141	Hardware revision valve 6	1
161	Hardware revision valve 7	1
181	Hardware revision input module 1	1
201	Hardware revision input module 2	1

Tab. 62: Hardware information

Software information **Channel 25, addressed target 2**		
Index	Meaning	Digit value
1	Controller firmware version, major number	1
2	Controller firmware version, minor number	1
3	Controller firmware version, patch number	1
5	Controller bootloader version, major number	1
6	Controller bootloader version, minor number	1
7	Controller bootloader version, patch number	1
21	Valve 0 firmware version, major number	1
22	Valve 0 firmware version, minor number	1
23	Valve 0 firmware version, patch number	1
25	Valve 0 bootloader version, major number	1
26	Valve 0 bootloader version, minor number	1
27	Valve 0 bootloader version, patch version	1
41	Valve 1 firmware version, major number	1
42	Valve 1 firmware version, minor number	1
43	Valve 1 firmware version, patch number	1
45	Valve 1 bootloader version, major number	1
46	Valve 1 bootloader version, minor number	1
47	Valve 1 bootloader version, patch number	1
61	Valve 2 firmware version, major number	1
62	Valve 2 firmware version, minor number	1
63	Valve 2 firmware version, patch number	1
65	Valve 2 bootloader version, major number	1
66	Valve 2 bootloader version, minor number	1
67	Valve 2 bootloader version, patch number	1
81	Valve 3 firmware version, major number	1
82	Valve 3 firmware version, minor number	1
83	Valve 3 firmware version, patch number	1
85	Valve 3 bootloader version, major number	1
86	Valve 3 bootloader version, minor number	1
87	Valve 3 bootloader version, patch number	1
101	Valve 4 firmware version, major number	1

Software information **Channel 25, addressed target 2**		
Index	Meaning	Digit value
102	Valve 4 firmware version, minor number	1
103	Valve 4 firmware version, patch number	1
105	Valve 4 bootloader version, major number	1
106	Valve 4 bootloader version, minor number	1
107	Valve 4 bootloader version, patch number	1
121	Valve 5 firmware version, major number	1
122	Valve 5 firmware version, minor number	1
123	Valve 5 firmware version, patch number	1
125	Valve 5 bootloader version, major number	1
126	Valve 5 bootloader version, minor number	1
127	Valve 5 bootloader version, patch number	1
141	Valve 6 firmware version, major number	1
142	Valve 6 firmware version, minor number	1
143	Valve 6 firmware version, patch number	1
145	Valve 6 bootloader version, major number	1
146	Valve 6 bootloader version, minor number	1
147	Valve 6 bootloader version, patch number	1
161	Valve 7 firmware version, major number	1
162	Valve 7 firmware version, minor number	1
163	Valve 7 firmware version, patch number	1
165	Valve 7 bootloader version, major number	1
166	Valve 7 bootloader version, minor number	1
167	Valve 7 bootloader version, patch number	1
181	Input module 1 firmware version, major number	1
182	Input module 1 firmware version, minor number	1
183	Input module 1 firmware version, patch number	1
185	Input module 1 bootloader version, major number	1
186	Input module 1 bootloader version, minor number	1
187	Input module 1 bootloader version, patch number	1
201	Input module 2 firmware version, major number	1
202	Input module 2 firmware version, minor number	1

Software information **Channel 25, addressed target 2**		
Index	Meaning	Digit value
203	Input module 2 firmware version, patch number	1
205	Input module 2 bootloader version, major number	1
206	Input module 2 bootloader version, minor number	1
207	Input module 2 bootloader version, patch number	1

Tab. 63: Software information

Licence information **Channel 25, addressed target 3**		
Index	Meaning	Digit value
1 ... 59	Number of licences for Motion App # 01 ... # 59 (according to downloaded licence file)	1
101 ... 159	Number of free licences for Motion App # 01... # 59 (depending on current use)	1
253	Remaining time demo period, number of hours hh (based on time format hh:mm)	1
254	Remaining time demo period, number of minutes mm (based on time format hh:mm)	1

Tab. 64: Licence information

Product Key **Channel 25, addressed target 4**			
Index	Meaning		Value
1	Product Key controller	1st character (high byte, unsigned)	ASCII characters
		2nd character (low byte, unsigned)	ASCII characters
2		3rd character (high byte, unsigned)	ASCII characters
		4th character (low byte, unsigned)	ASCII characters
3		5th character (high byte, unsigned)	ASCII characters
		6th character (low byte, unsigned)	ASCII characters
4		7th character (high byte, unsigned)	ASCII characters
		8th character (low byte, unsigned)	ASCII characters
5		9th character (high byte, unsigned)	ASCII characters
		10th character (low byte, unsigned)	ASCII characters
6		11th character (high byte, unsigned)	ASCII characters
		12th character (low byte, unsigned)	ASCII characters

Tab. 65: Product Key

Pressure values **Channel 25, adressed target 11**		
Index	Meaning	Digit value
1	Supply pressure at port (1) (absolute)	0.001 bar
2	Supply pressure at port (1) (relative)	0.001 bar
3	Exhaust air pressure at port (3) (absolute)	0.001 bar
4	Exhaust air pressure at port (3) (relative)	0.001 bar
5	Ambient pressure (absolute)	0.001 bar
21	Pressure at valve 0, working air port (2) (absolute)	0.001 bar
22	Pressure at valve 0, working air port (2) (relative)	0.001 bar
23	Pressure at valve 0, working air port (4) (absolute)	0.001 bar
24	Pressure at valve 0, working air port (4) (relative)	0.001 bar
41	Pressure at valve 1, working air port (2) (absolute)	0.001 bar
42	Pressure at valve 1, working air port (2) (relative)	0.001 bar
43	Pressure at valve 1, working air port (4) (absolute)	0.001 bar
44	Pressure at valve 1, working air port (4) (relative)	0.001 bar
61	Pressure at valve 2, working air port (2) (absolute)	0.001 bar
62	Pressure at valve 2, working air port (2) (relative)	0.001 bar
63	Pressure at valve 2, working air port (4) (absolute)	0.001 bar
64	Pressure at valve 2, working air port (4) (relative)	0.001 bar
81	Pressure at valve 3, working air port (2) (absolute)	0.001 bar
82	Pressure at valve 3, working air port (2) (relative)	0.001 bar
83	Pressure at valve 3, working air port (4) (absolute)	0.001 bar
84	Pressure at valve 3, working air port (4) (relative)	0.001 bar
101	Pressure at valve 4, working air port (2) (absolute)	0.001 bar
102	Pressure at valve 4, working air port (2) (relative)	0.001 bar
103	Pressure at valve 4, working air port (4) (absolute)	0.001 bar
104	Pressure at valve 4, working air port (4) (relative)	0.001 bar
121	Pressure at valve 5, working air port (2) (absolute)	0.001 bar
122	Pressure at valve 5, working air port (2) (relative)	0.001 bar
123	Pressure at valve 5, working air port (4) (absolute)	0.001 bar
124	Pressure at valve 5, working air port (4) (relative)	0.001 bar
141	Pressure at valve 6, working air port (2) (absolute)	0.001 bar
142	Pressure at valve 6, working air port (2) (relative)	0.001 bar

Pressure values **Channel 25, adressed target 11**		
Index	Meaning	Digit value
143	Pressure at valve 6, working air port (4) (absolute)	0.001 bar
144	Pressure at valve 6, working air port (4) (relative)	0.001 bar
161	Pressure at valve 7, working air port (2) (absolute)	0.001 bar
162	Pressure at valve 7, working air port (2) (relative)	0.001 bar
163	Pressure at valve 7, working air port (4) (absolute)	0.001 bar
164	Pressure at valve 7, working air port (4) (relative)	0.001 bar

Tab. 66: Pressure values

Temperatures **Channel 25, addressed target 12**		
Index	Meaning	Digit value
1	Temperature at supply pressure sensor at port (1)	0.1 °C
3	Temperature at exhaust pressure sensor at port (1)	0.1 °C
5	Temperature at atmospheric pressure sensor	0.1 °C
21	Temperature at valve 0, working air port (2)	0.1 °C
23	Temperature at valve 0, working air port (4)	0.1 °C
41	Temperature at valve 1, working air port (2)	0.1 °C
43	Temperature at valve 1, working air port (4)	0.1 °C
61	Temperature at valve 2, working air port (2)	0.1 °C
63	Temperature at valve 2, working air port (4)	0.1 °C
81	Temperature at valve 3, working air port (2)	0.1 °C
83	Temperature at valve 3, working air port (4)	0.1 °C
101	Temperature at valve 4, working air port (2)	0.1 °C
103	Temperature at valve 4, working air port (4)	0.1 °C
121	Temperature at valve 5, working air port (2)	0.1 °C
123	Temperature at valve 5, working air port (4)	0.1 °C
141	Temperature at valve 6, working air port (2)	0.1 °C
143	Temperature at valve 6, working air port (4)	0.1 °C
161	Temperature at valve 7, working air port (2)	0.1 °C
163	Temperature at valve 7, working air port (4)	0.1 °C

Tab. 67: Temperatures

Booster strokes (degree of opening)
Channel 25, addressed target 13

Index	Meaning			Digit value
	Valve	Working air port	Booster	
21	0	2	Pressurisation	0.01%
22			Exhaust port	0.01%
23		4	Pressurisation	0.01%
24			Exhaust port	0.01%
41	1	2	Pressurisation	0.01%
42			Exhaust port	0.01%
43		4	Pressurisation	0.01%
44			Exhaust port	0.01%
61	2	2	Pressurisation	0.01%
62			Exhaust port	0.01%
63		4	Pressurisation	0.01%
64			Exhaust port	0.01%
81	3	2	Pressurisation	0.01%
82			Exhaust port	0.01%
83		4	Pressurisation	0.01%
84			Exhaust port	0.01%
101	4	2	Pressurisation	0.01%
102			Exhaust port	0.01%
103		4	Pressurisation	0.01%
104			Exhaust port	0.01%
121	5	2	Pressurisation	0.01%
122			Exhaust port	0.01%
123		4	Pressurisation	0.01%
124			Exhaust port	0.01%
141	6	2	Pressurisation	0.01%
142			Exhaust port	0.01%
143		4	Pressurisation	0.01%
144			Exhaust port	0.01%
161	7	2	Pressurisation	0.01%
162			Exhaust port	0.01%

Booster strokes (degree of opening) **Channel 25, addressed target 13**				
Index	Meaning			Digit value
	Valve	Working air port	Booster	
163	7	4	Pressurisation	0.01%
164			Exhaust port	0.01%

Tab. 68: Booster strokes

Flow rates at valve (volumetric flow rate)[1)] **Channel 25, addressed target 14**			
Index	Meaning		Digit value
	Valve	Working air port	
22	0	2	0.1 l/min
24		4	0.1 l/min
26		2 (Low Byte, signed)	10 l/min
		4 (High Byte, signed)	10 l/min
42	1	2	0.1 l/min
44		4	0.1 l/min
46		2 (Low Byte, signed)	10 l/min
		4 (High Byte, signed)	10 l/min
62	2	2	0.1 l/min
64		4	0.1 l/min
66		2 (Low Byte, signed)	10 l/min
		4 (High Byte, signed)	10 l/min
82	3	2	0.1 l/min
84		4	0.1 l/min
86		2 (Low Byte, signed)	10 l/min
		4 (High Byte, signed)	10 l/min
102	4	2	0.1 l/min
104		4	0.1 l/min
106		2 (Low Byte, signed)	10 l/min
		4 (High Byte, signed)	10 l/min
122	5	2	0.1 l/min
124		4	0.1 l/min
126		2 (Low Byte, signed)	10 l/min

Flow rates at valve (volumetric flow rate)[1] **Channel 25, addressed target 14**			
Index	Meaning		Digit value
	Valve	Working air port	
126	5	4 (High Byte, signed)	10 l/min
142	6	2	0.1 l/min
144		4	0.1 l/min
146		2 (Low Byte, signed)	10 l/min
		4 (High Byte, signed)	10 l/min
162	7	2	0.1 l/min
164		4	0.1 l/min
166		2 (Low Byte, signed)	10 l/min
		4 (High Byte, signed)	10 l/min

1) Volumetric flow rate assuming a density of air in standard conditions in accordance with ISO 8778/DIN 1945-1 (density 1.1850 kg/m³ of dry air at 20 °C) as a function of the current valve strokes and pressures at (1), (2) or (4) and (3). The pressure signals are used unfiltered, so the return values will vary under the same conditions according to the noise of the pressure sensors.

Tab. 69: Flow rates at the valve

Proximity signals **Channel 25, addressed target 21**		
Index	Meaning	Digit value
181	Raw value from proximity switch at input module 1, port 0	1
182	Interpreted value from proximity switch at input module 1, port 0	1
183	Raw value from proximity switch at input module 1, port 1	1
184	Interpreted value from proximity switch at input module 1, port 1	1
185	Raw value from proximity switch at input module 1, port 2	1
186	Interpreted value from proximity switch at input module 1, port 2	1
187	Raw value from proximity switch at input module 1, port 3	1
188	Interpreted value from proximity switch at input module 1, port 3	1
189	Raw value from proximity switch at input module 1, port 4	1
190	Interpreted value from proximity switch at input module 1, port 4	1
191	Raw value from proximity switch at input module 1, port 5	1
192	Interpreted value from proximity switch at input module 1, port 5	1
193	Raw value from proximity switch at input module 1, port 6	1
194	Interpreted value from proximity switch at input module 1, port 6	1
195	Raw value from proximity switch at input module 1, port 7	1

Proximity signals **Channel 25, addressed target 21**		
Index	Meaning	Digit value
196	Interpreted value from proximity switch at input module 1, port 7	1
201	Raw value from proximity switch at input module 2, port 0	1
202	Interpreted value from proximity switch at input module 2, port 0	1
203	Raw value from proximity switch at input module 2, port 1	1
204	Interpreted value from proximity switch at input module 2, port 1	1
205	Raw value from proximity switch at input module 2, port 2	1
206	Interpreted value from proximity switch at input module 2, port 2	1
207	Raw value from proximity switch at input module 2, port 3	1
208	Interpreted value from proximity switch at input module 2, port 3	1
209	Raw value from proximity switch at input module 2, port 4	1
210	Interpreted value from proximity switch at input module 2, port 4	1
211	Raw value from proximity switch at input module 2, port 5	1
212	Interpreted value from proximity switch at input module 2, port 5	1
213	Raw value from proximity switch at input module 2, port 6	1
214	Interpreted value from proximity switch at input module 2, port 6	1
215	Raw value from proximity switch at input module 2, port 7	1
216	Interpreted value from proximity switch at input module 2, port 7	1

Tab. 70: Proximity signals

Positions **Channel 25, addressed target 22**		
Index	Meaning	Digit value
181	Raw value from position sensor at input module 1, port 0	0.001 mA
182	Interpreted value from position sensor at input module 1, port 0	0.1 mm
183	Raw value from position sensor at input module 1, port 1	0.001 mA
184	Interpreted value from position sensor at input module 1, port 0	0.1 mm
185	Raw value from position sensor at input module 1, port 2	0.001 mA
186	Interpreted value from position sensor at input module 1, port 2	0.1 mm
187	Raw value from position sensor at input module 1, port 3	0.001 mA
188	Interpreted value from position sensor at input module 1, port 3	0.1 mm
189	Raw value from position sensor at input module 1, port 4	0.001 mA
190	Interpreted value from position sensor at input module 1, port 4	0.1 mm

Positions **Channel 25, addressed target 22**		
Index	Meaning	Digit value
191	Raw value from position sensor at input module 1, port 5	0.001 mA
192	Interpreted value from position sensor at input module 1, port 5	0.1 mm
193	Raw value from position sensor at input module 1, port 6	0.001 mA
194	Interpreted value from position sensor at input module 1, port 6	0.1 mm
195	Raw value from position sensor at input module 1, port 7	0.001 mA
196	Interpreted value from position sensor at input module 1, port 7	0.1 mm
201	Raw value from position sensor at input module 2, port 0	0.001 mA
202	Interpreted value from position sensor at input module 2, port 0	0.1 mm
203	Raw value from position sensor at input module 2, port 1	0.001 mA
204	Interpreted value from position sensor at input module 2, port 1	0.1 mm
205	Raw value from position sensor at input module 2, port 2	0.001 mA
206	Interpreted value from position sensor at input module 2, port 2	0.1 mm
207	Raw value from position sensor at input module 2, port 3	0.001 mA
208	Interpreted value from position sensor at input module 2, port 3	0.1 mm
209	Raw value from position sensor at input module 2, port 4	0.001 mA
210	Interpreted value from position sensor at input module 2, port 4	0.1 mm
211	Raw value from position sensor at input module 2, port 5	0.001 mA
212	Interpreted value from position sensor at input module 2, port 5	0.1 mm
213	Raw value from position sensor at input module 2, port 6	0.001 mA
214	Interpreted value from position sensor at input module 2, port 6	0.1 mm
215	Raw value from position sensor at input module 2, port 7	0.001 mA
216	Interpreted value from position sensor at input module 2, port 7	0.1 mm

Tab. 71: Positions

Flow rates at the external sensor **Channel 25, addressed target 23**		
Index	Meaning	Digit value
181	Raw value from flow sensor at input module 1, port 0	0.001 mA
182	Interpreted value from flow sensor at input module 1, port 0	0.1 l/min
183	Raw value from flow sensor at input module 1, port 1	0.001 mA
184	Interpreted value from flow sensor at input module 1, port 1	0.1 l/min
185	Raw value from flow sensor at input module 1, port 2	0.001 mA

Flow rates at the external sensor Channel 25, addressed target 23		
Index	Meaning	Digit value
186	Interpreted value from flow sensor at input module 1, port 2	0.1 l/min
187	Raw value from flow sensor at input module 1, port 3	0.001 mA
188	Interpreted value from flow sensor at input module 1, port 3	0.1 l/min
189	Raw value from flow sensor at input module 1, port 4	0.001 mA
190	Interpreted value from flow sensor at input module 1, port 4	0.1 l/min
191	Raw value from flow sensor at input module 1, port 5	0.001 mA
192	Interpreted value from flow sensor at input module 1, port 5	0.1 l/min
193	Raw value from flow sensor at input module 1, port 6	0.001 mA
194	Interpreted value from flow sensor at input module 1, port 6	0.1 l/min
195	Raw value from flow sensor at input module 1, port 7	0.001 mA
196	Interpreted value from flow sensor at input module 1, port 7	0.1 l/min
201	Raw value from flow sensor at input module 2, port 0	0.001 mA
202	Interpreted value from flow sensor at input module 2, port 0	0.1 l/min
203	Raw value from flow sensor at input module 2, port 1	0.001 mA
204	Interpreted value from flow sensor at input module 2, port 1	0.1 l/min
205	Raw value from flow sensor at input module 2, port 2	0.001 mA
206	Interpreted value from flow sensor at input module 2, port 2	0.1 l/min
207	Raw value from flow sensor at input module 2, port 3	0.001 mA
208	Interpreted value from flow sensor at input module 2, port 3	0.1 l/min
209	Raw value from flow sensor at input module 2, port 4	0.001 mA
210	Interpreted value from flow sensor at input module 2, port 4	0.1 l/min
211	Raw value from flow sensor at input module 2, port 5	0.001 mA
212	Interpreted value from flow sensor at input module 2, port 5	0.1 l/min
213	Raw value from flow sensor at input module 2, port 6	0.001 mA
214	Interpreted value from flow sensor at input module 2, port 6	0.1 l/min
215	Raw value from flow sensor at input module 2, port 7	0.001 mA
216	Interpreted value from position sensor at input module 2, port 7	0.1 l/min

Tab. 72: Flow rates at the external sensor

3.5.4.3 Feedback in the case of invalid output data

If invalid information is transmitted as part of the output data, corresponding feedback is provided in the input data in transfer mode:

- Operating mode of the valve (valve mode): 63 (transfer mode active) (PDI byte 0, bits 5 ... 0 => 111111_2)
- Status of the valve: valve state ➔ 3.5.2.2 Structure of the input data (PDI).
- Channel (channel): not assigned (PDI byte 1, bits 4 ... 0 => 0)
- Transfer control (transfer control): not assigned (PDI byte 1, bits 7... 5 => 0)
- Addressing of data transfer (addressed target): not assigned (PDI byte 2 => 0)
- Index (index): not assigned (PDI byte 3 => 0)
- Value (value): (PDI byte 5 ... 4) ➔ Tab. 73 Allocation of invalid information

Allocation of invalid information

The “value” (value) section indicates which part of the output data contains invalid information.

Value	Invalid command	Meaning
1	invalid channel	Invalid value in section "channel"
2	invalid transfer control	Invalid value in section "transfer control"
3	invalid addressed target	Invalid value in section "addressed target"
4	invalid index	Invalid value in section "index"
5	invalid value	Invalid value in section "value"
6	invalid combination	Invalid combination of values in various sections
7	access denied, data in use	The addressed data is currently being used by another valve
8	no data, slot is empty	The addressed data are not available because a valve is not mounted on the slot via which process data is communicated.

Tab. 73: Allocation of invalid information

Example of input data with incorrect value in section "index"															
PDI byte 1								PDI byte 0							
Command															
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	0	0	0	0	...	...	1	1	1	1	1	1
transfer control = 0			channel = 0					valve state		valve mode = 63 (transfer mode)					
PDI byte 3								PDI byte 2							
Parameter															
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
index = 0								addressed target = 0							
PDI byte 5								PDI byte 4							
Value															
Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
value = 4															

Tab. 74: Example of input data with incorrect value in section "index"

3.5.4.4 Saving settings as persistent data

To save the current settings of a valve on the Motion Terminal as persistent data, the transfer control method "save persistent" (transfer control = 4) is used. No special channel is required for this; the value in the section "channel" is not evaluated.

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After performing a teach-in run, the "save persistent" function should be executed. The appropriate parameters for the data acquired in the teach-in run are thereby permanently saved on the controller for the Motion Terminal.
Otherwise, the teach-in run must be executed again after restarting the Motion Terminal (➔ 3.7.6 Validity of teach-in data based on parameter changes).

Status of save process

The status of the save process is shown in the "value" section (value) of the input data (PDI).

Value	saving progress	Significance/remedy
1	saving in progress	Save process active.
2	saving successful	Save process is completed.
3	saving not possible	Save process cannot be executed. – Repeat the process. – If the problem persists, contact Festo Support.
4	saving failed	Save process failed. – Repeat the process. – If the problem persists, contact Festo Support.

Tab. 75: Status of save process

Content of output data for saving as persistent data															
PDO byte 1								PDO byte 0							
Command															
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	0	0	...	...	...	...	...	...	...	1	1	1	1	1	1
transfer control = 4 (save persistent)			channel = ... (ignored)					–		valve mode = 63 (transfer mode)					
PDO byte 3								PDO byte 2							
Parameter															
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
index = ... (ignored)								addressed target ... (ignored)							
PDO byte 5								PDO byte 4							
Value															
Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
value ... (ignored)															

Tab. 76: Content of output data for saving as persistent data

Content of input data if save process is successful

PDI byte 1								PDI byte 0							
Command															
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	0	0	...	...	...	...	...	...	...	1	1	1	1	1	1
transfer control = 4 (save persistent)			channel = ...					valve state		valve mode = 63 (transfer mode)					

PDI byte 3								PDI byte 2							
Parameter															
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
index = 0								addressed target = 0							

PDI byte 5								PDI byte 4							
Value															
Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
value = 2 (saving successful)															

Tab. 77: Content of input data if save process is successful

3.6 Motion App #01: Directional control valve functions

ID of the Motion App	Name of the Motion App	Pictogram of the Motion app
01	Directional control valve functions	

Tab. 78: Motion App #01: Directional control valve functions

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The Motion App ID must be transferred using the "operating mode of the valve (valve mode)" section of the process data (bits 5 ... 0 in byte 0 (PDO)) to run the Motion App on a valve (➔ 3.5.3 Running a Motion App).

3.6.1 Function description

The Motion App makes 9 directional control valve functions available for execution by the corresponding valve. The directional control valve function makes it possible to assign the characteristics of a conventional switching valve to a valve on the Motion Terminal. The integrated sensors enable monitoring of the switching position and of the pressure at the air ports. If the pilot pressure or power supply are interrupted, the valve reverts to its mechanical initial position (all channels are blocked). The valve types listed can be allocated cyclically to the CPX terminal by means of the process data (➔ Tab. 83 Valve type). In addition, the switching status of the particular valve type can be specified cyclically using the process data of the CPX terminal.

3.6.2 Required sensors

The Motion App does not require any external sensors. The use of proximity sensors is optional. If these are to be used in the return values of the Motion App (➔ 3.6.6.1 Status of the Motion App (app state)), the assignment of sensor inputs to the Motion App (to the valve) must be carried out via the WebConfig interface or using the higher-order controller (➔ 3.6.3 System parameters used).

3.6.3 System parameters used

ID	System parameters	Value range
70	Sensor input for end position sensing, retracted[1)] (optional)	20 ... 27 or 40 ... 47 and 50 ... 57 or 80 ... 87 and 90 ... 97[2)]
71	Sensor input for end position sensing, advanced[3)] (optional)	20 ... 27 or 40 ... 47 and 50 ... 57 or 80 ... 87 and 90 ... 97[2)]

1) (2) pressurised, (4) exhausted
2) regardless of the device version (position of input modules)
3) (4) pressurised, (2) exhausted

Tab. 79: System parameters

3.6.3.1 Sensor input for end position sensing, retracted((2) pressurised, (4) exhausted)

This parameter must only be used if proximity sensors are used and should be evaluated in the return value (optional). The value for the parameter is calculated from the position of the input module (valve slot), multiplied by a factor of 10 and then added to the number of the input on this input module (0 ... 7).

ID	Value range	Composition of the value (calculation of digits)
70	20 ... 27 (valve terminal with 2 valve slots and a slot for input modules)	[slot input module] ×10 + [number sensor input] × 1
	40 ... 47 and 50 ... 57 (valve terminal with 4 valve slots and 2 slots for input modules)	
	80 ... 87 and 90 ... 97 (valve terminal with 8 valve slots and 2 slots for input modules)	

Tab. 80: Sensor input for end position sensing, retracted

3.6.3.2 Sensor input for end position sensing, advanced((4) pressurised, (2) exhausted)

This parameter must only be used if proximity sensors are used and should be evaluated in the return value (optional). The value for the parameter is calculated from the position of the input module (valve slot), multiplied by a factor of 10 and then added to the number of the input on this input module (0 ... 7).

ID	Value range	Composition of the value (calculation of digits)
71	20 ... 27 (valve terminal with 2 valve slots and a slot for input modules)	[slot input module] ×10 + [number sensor input] × 1
	40 ... 47 and 50 ... 57 (valve terminal with 4 valve slots and 2 slots for input modules)	
	80 ... 87 and 90 ... 97 (valve terminal with 8 valve slots and 2 slots for input modules)	

Tab. 81: Sensor input for end position sensing, advanced

3.6.4 Application parameters used

Operating mode

The parameter enables the definition of the valve behaviour in relation to internal air consumption and compatibility for a fast change between Motion Apps.

Possible operating modes:

– Controlled:
  Operation as a classic switching valve with low internal air consumption, short switching times, secure closing/opening. When changing to another Motion App or to Motion App #01 with operating mode "regulated", the valve must be re-calibrated (➔ 3.4.5 Waiting time between Motion Apps).
– Regulated:
  Operation in compatibility mode for a fast change between Motion Apps. Higher internal air consumption, but no waiting time when changing to other Motion Apps.

ID	Selected operating mode	Value of parameter
223	Controlled	0 (standard setting)
	Regulated	1

Tab. 82: Operating mode

3.6.5 Default values

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General description of the structure of the process data when running a Motion App: (➔ 3.5.2 Structure of the process data when operating a Motion App).

3.6.5.1 Setting of the Motion App (app option)

Valve type

The valve type is defined using byte 1 (PDO).

Valve type	Value dec.
4/3 G (normally closed)	1
4/3 B (normally open)	2
4/3 E (normally exhausted)	3
2 × 3/2 O (normally open)	4
2 × 3/2 G (normally closed)	5
3/2 O + 3/2 G	6
4/2 bistable	7
2 × 2/2 G (normally closed)	8
4/2 mono	9

Tab. 83: Valve type

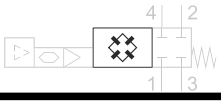
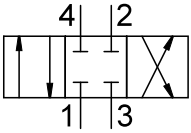
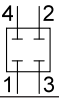
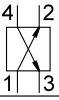
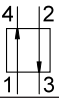
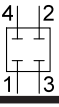
3.6.5.2 Control of the Motion App (app control)

Switching status of the valve

The switching status at the air ports (2) and (4) of the valve is controlled using bits 7 ... 6 in byte 0 (PDO) and is dependent on the valve type defined.

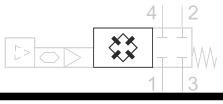
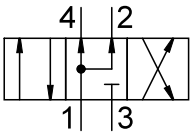
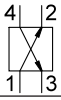
Possible switching statuses:

- Closed (G)
- Pressurised (B)
- Exhausted (E)

Conventional valve type	Switching status		Replacement symbol[1)]	Byte 0		Dec.
4/3 G	(4)	(2)		Bit 7	Bit 6	
Initial position: closed 	G	G		0	0	0
	E	B		0	1	1
	B	E		1	0	2
	G	G		1	1	3

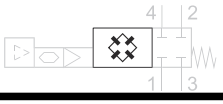
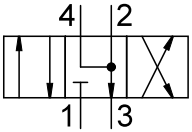
1) The symbol in this column replaces the full bridge in the circuit diagram for the valve VEVM and therefore represents the function in the switched status of the valve with corresponding setpoint value (right columns).

Tab. 84: Valve type 4/3 G

Conventional valve type	Switching status		Replacement symbol[1)]	Byte 0		Dec.
4/3 B	(4)	(2)		Bit 7	Bit 6	
Initial position: pressurised 	B	B		0	0	0
	E	B		0	1	1
	B	E		1	0	2
	B	B		1	1	3

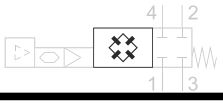
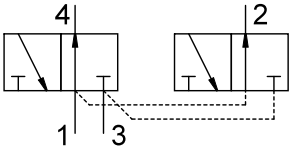
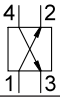
1) The symbol in this column replaces the full bridge in the circuit diagram for the valve VEVM and therefore represents the function in the switched status of the valve with corresponding setpoint value (right columns).

Tab. 85: Valve type 4/3 B

Conventional valve type	Switching status		Replacement symbol[1)]	Byte 0		Dec.
4/3 E	(4)	(2)		Bit 7	Bit 6	
Initial position: exhausted 	E	E		0	0	0
	E	B		0	1	1
	B	E		1	0	2
	E	E		1	1	3

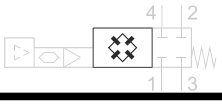
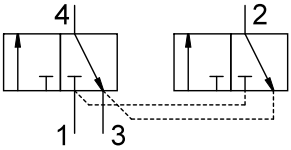
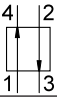
1) The symbol in this column replaces the full bridge in the circuit diagram for the valve VEVM and therefore represents the function in the switched status of the valve with corresponding setpoint value (right columns).

Tab. 86: Valve type 4/3 E

Conventional valve type	Switching status		Replacement symbol[1)]	Byte 0		Dec.
2 × 3/2 O	(4)	(2)		Bit 7	Bit 6	
Initial position: open 	B	B		0	0	0
	E	B		0	1	1
	B	E		1	0	2
	E	E		1	1	3

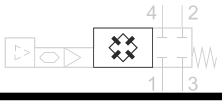
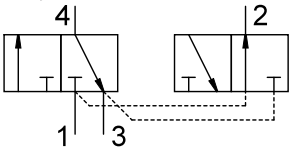
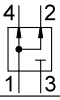
1) The symbol in this column replaces the full bridge in the circuit diagram for the valve VEVM and therefore represents the function in the switched status of the valve with corresponding setpoint value (right columns).

Tab. 87: Valve type 2 × 3/2 O

Conventional valve type	Switching status		Replacement symbol[1]	Byte 0		Dec.
2 × 3/2 G	(4)	(2)		Bit 7	Bit 6	
Initial position: closed 	E	E		0	0	0
	B	E		0	1	1
	E	B		1	0	2
	B	B		1	1	3

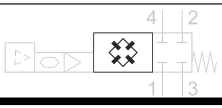
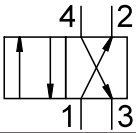
1) The symbol in this column replaces the full bridge in the circuit diagram for the valve VEVM and therefore represents the function in the switched status of the valve with corresponding setpoint value (right columns).

Tab. 88: Valve type 2 × 3/2 G

Conventional valve type	Switching status		Replacement symbol[1]	Byte 0		Dec.
3/2 O + 3/2 G	(4)	(2)		Bit 7	Bit 6	
Initial position: retracted ((2) pressurised, (4) exhausted) 	E	B		0	0	0
	B	B		0	1	1
	E	E		1	0	2
	B	E		1	1	3

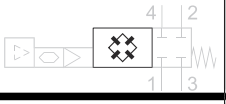
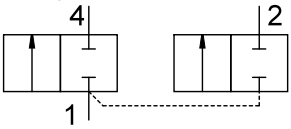
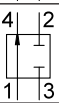
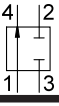
1) The symbol in this column replaces the full bridge in the circuit diagram for the valve VEVM and therefore represents the function in the switched status of the valve with corresponding setpoint value (right columns).

Tab. 89: Valve type 3/2 O + 3/2 G

Conventional valve type	Switching status		Replacement symbol[1]	Byte 0		Dec.
4/2 bistable	(4)	(2)		Bit 7	Bit 6	
Initial position: when the valve type is selected for the first time, (2) and (4) are blocked. If a switch is made from a different valve type to 4/2 bistable, the most recent switching position remains active. 	Hold status			0	0	0
	E	B		0	1	1
	B	E		1	0	2
	Hold status			1	1	3

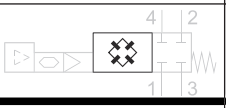
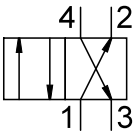
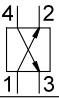
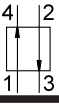
1) The symbol in this column replaces the full bridge in the circuit diagram for the valve VEVM and therefore represents the function in the switched status of the valve with corresponding setpoint value (right columns).

Tab. 90: Valve type 4/2 bistable

Conventional valve type	Switching status		Replacement symbol[1]	Byte 0		Dec.
2 × 2/2 G	(4)	(2)		Bit 7	Bit 6	
Initial position: closed 	G	G		0	0	0
	B	G		0	1	1
	G	B		1	0	2
	B	B		1	1	3

1) The symbol in this column replaces the full bridge in the circuit diagram for the valve VEVM and therefore represents the function in the switched status of the valve with corresponding setpoint value (right columns).

Tab. 91: Valve type 2 × 2/2 G

Conventional valve type	Switching status		Replacement symbol[1]	Byte 0		Dec.
4/2 mono	(4)	(2)		Bit 7[2]	Bit 6	
	E	B		–	0	0
	B	E		–	1	1

1) The symbol in this column replaces the full bridge in the circuit diagram for the valve VEVM and therefore represents the function in the switched status of the valve with corresponding setpoint value (right columns).

2) This bit is ignored

Tab. 92: Valve type 4/2 mono

3.6.5.3 Setpoint value 1 and 2 (setpoint value 1, setpoint value 2)

The Motion App does not use any setpoint value specifications.

3.6.6 Return values

3.6.6.1 Status of the Motion App (app state)

Status of the digital inputs (end position detection)

The status of the inputs of the digital input module CTMM-...-D-... that are assigned to the valve currently in use is shown using bits 2 and 0 in byte 1 (PDI).

The assignment of inputs is carried in the system parameters (➔ 3.6.3 System parameters used).

Position	Bit 2	Bit 1	Bit 0
End position advanced reached[1)]	0/1	–	–
End position retracted reached[2)]	–	–	0/1

1) (4) pressurised, (2) exhausted; switching position 14
2) (2) pressurised, (4) exhausted; switching position 12

Tab. 93: Status of the digital inputs

Switching position at the air ports (2) and (4)

The switching position at the air ports (2) and (4) of the valve is given by bits 6 ... 5 (4) and bits 4 ... 3 (2) in byte 1 (PDI).

Switching position		Bit 6	Bit 5	Bit 4	Bit 3
(4)	(2)				
Closed	–	0	0	–	–
Pressurised	–	0	1	–	–
Exhausted	–	1	0	–	–
Error[1)]	–	1	1	–	–
–	Closed	–	–	0	0
–	Pressurised	–	–	0	1
–	Exhausted	–	–	1	0
–	Error[1)]	–	–	1	1

1) If the problem persists, contact Festo Support.

Tab. 94: Switching position at the air ports

Warnings

Warnings in the diagnostic memory of the valve are shown via bit 7 in byte 1 (PDI).

Value	Description
0	There are no warnings from the active Motion App.
1	There is a warning in the diagnostic memory of the Motion Terminal.

Tab. 95: Warning

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For how to deal with warnings and errors: ➔ 3.8 Diagnostics options.

3.6.6.2 Actual value 1 and 2 (actual value 1, actual value 2)

Measured pressure at air ports (2) and (4)

The measured pressure at the air ports (2) and (4) of the valve is given as a signed integer value by bytes 5 ... 4 (PDI) (4) and 3 ... 2 (PDI) (2).

Connection	Value range	Digit value	Digit range	Data type	Byte (PDI)
(4)	–1000 ... +32767 mbar	1 mbar	–1000 ... +32767 × 1 mbar	signed int16	5 ... 4
(2)	–1000 ... +32767 mbar	1 mbar	–1000 ... +32767 × 1 mbar	signed int16	3 ... 2

Tab. 96: Measured pressure at air ports

3.7 Teach-in run

Various Motion Apps require information about the physical behaviour of the connected peripherals in order to run. This information is determined by the Motion Terminal during the process referred to as the "teach-in run". The information is saved as “teach-in data” within a parameter set on the Motion Terminal controller (➔ 3.4.3.8 Teach-in data).

A teach-in run can be executed in 2 different modes:

– Automatic
  An automatic program is executed which determines and saves the corresponding teach-in data. This mode is sufficient for most applications.
– Manual
  The valve is in teach-in mode. The movements of the drive are controlled manually (via the Web-Config interface or using the higher-order controller).
  This allows individual movements to be executed which can each then be analysed by the teach-in routine.

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The type of teach-in run that can be used depends on the Motion App for which the teach-in data are to be determined. Not all Motion Apps have the option of both types of teach-in run. Some Motion Apps can be completely operated without a teach-in run having been performed beforehand.
The steps performed automatically during a teach-in run are dependent on the Motion App to be taught in and, if applicable, documented in the description of the corresponding Motion App.

3.7.1 Prerequisites for starting the teach-in run

Before starting a teach-in run for a particular Motion App, the system and application parameters used by this Motion App must have been parameterised.
In addition, the application parameter “Motion App to be taught in” (255) must be parameterised to the ID of the Motion App for which the teach-in run is to be executed (➔ 3.4.3.2 Application parameters).

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Application parameters can be defined individually for each Motion App on a valve (➔ 3.4.3.2 Application parameters).
To carry out the teach-in run, the application parameter “Motion App to be taught in” (255) must be defined for the “teach-in run” mode (60). In this case, the teach-in run is treated like a Motion App. The ID of the Motion App for which a teach-in run is to be executed must be assigned as a value to the application parameter.

Example

A teach-in run for Motion App #07 “Presetting of travel time” is to be executed. To do this, the value “7” must be assigned to the application parameter “Motion App to be taught in” (255) for the “teach-in run” mode (60).

After defining the application parameter 255, you must exit transfer mode. The valve can now be switched to the “teach-in run” mode (60).

3.7.2 Default values

3.7.2.1 Selection of the teach-in run mode

The teach-in run mode (automatic/manual) is specified using bits 7 ... 6 in byte 0 (PDO).

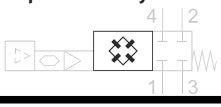
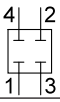
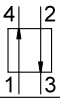
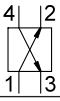
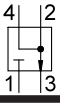
Teach-in run mode	Bit 7	Bit 6	Dec.
Stop teach-in run	0	0	0
Execute automatic teach-in run	0	1	1
Execute manual teach-in run[1)]	1	0	2
This mode is not assigned	1	1	3

1) This mode is not necessary for teaching-in most Motion Apps and is therefore not available.

Tab. 97: Teach-in run mode

3.7.2.2 Controlling the manual teach-in run

The movement of the drive for manual determination of the teach-in data is controlled using bytes 3 ... 2 (PDO).

Function	Switching status		Replacement symbol[1]	Value dec.
	(4)	(2)		
Blocked	G	G		0
Advancing	B	E		1
Retracting	E	B		2
Exhausting	E	E		3

1) The symbol in this column replaces the full bridge in the circuit diagram for the valve VEVM and therefore represents the function in the switched status of the valve with corresponding setpoint value (right columns).

Tab. 98: Controlling the manual teach-in run

3.7.3 Return values

3.7.3.1 End position sensing

If the Motion App to be taught in requires sensors, the information as to whether the end positions have been reached is provided by bits 2 and 0 in byte 1 (PDI).
The assignment of inputs corresponds to the specification via system parameters (➔ 3.4.3.1 System parameters).

Position	Bit 2	Bit 1	Bit 0
End position advanced reached[1]	0/1	–	–
End position retracted reached[2]	–	–	0/1

1) (4) pressurised, (2) exhausted; switching position 14
2) (2) pressurised, (4) exhausted; switching position 12

Tab. 99: End position sensing

3.7.3.2 Status of teach-in run

The current status of the teach-in run is given by bits 6 ... 3 in byte 1 (PDI).

Status	Bit 6	Bit 5	Bit 4	Bit 3	Dec.
not yet started (not started yet)	0	0	0	0	0
not taught-in (unlearned)	0	0	0	1	1
Check tubing and sensors (check tubes and sensors)	0	0	1	0	2
Selection of control strategy (choose control)	0	0	1	1	3
Adaptation of trajectory parameters (tune trajectory)	0	1	0	0	4
Determine reference value (determine reference value)	0	1	0	1	5
Identification (identification)	0	1	1	0	6
already operational, identification still in progress (already operable, further identification ongoing)	1	0	1	0	10
completed with restrictions (completed with limitations, reduced performance)	1	0	1	1	11
Partially completed ((2) valid) (partitially completed ((2) valid))	1	1	0	0	12
Partially completed ((4) valid) (partitially completed ((4) valid))	1	1	0	1	13
completed (completed)	1	1	1	0	14
cancelled with error (aborted with error)	1	1	1	1	15

Tab. 100: Status of teach-in run

3.7.4 Sequence of teach-in run

3.7.4.1 Automatic teach-in run

After the teach-in run mode (➔ 3.7.2.1 Selection of the teach-in run mode) has been set to “Execute automatic teach-in run”, the teach-in run starts. Depending on the Motion App for which the teach-in run is executed, the outputs (2) and (4) are pressurised. A connected drive will move during this step. The teach-in run status then changes to the value "14" (completed) (➔ 3.7.3.2 Status of teach-in run).

3.7.4.2 Manual teach-in run

The manual teach-in run is to be understood as an alternative to an automatic teach-in run ➔ 3.7.4.1 Automatic teach-in run. It is not available for every Motion App.
After the teach-in run mode (➔ 3.7.2.1 Selection of the teach-in run mode) has been set to “Execute manual teach-in run”, the drive can be moved between the end positions using the control for the manual teach-in run (➔ 3.7.2.2 Controlling the manual teach-in run).
The process can be observed using the “status of the teach-in run” (➔ 3.7.3.2 Status of teach-in run).
The teach-in run is completed when the “status of the teach-in run” changes to the value “14” (completed).

3.7.5 Saving the teach-in data

The teach-in data and reference values determined during the teach-in run are automatically saved in the active parameter set on the Motion Terminal controller as persistent data.

While the Motion App is running, the teach-in data are continuously reviewed and adjusted if appropriate. These adjustments are also saved directly as persistent data.

3.7.6 Validity of teach-in data based on parameter changes

In the event of a change to the system, application and/or tuning parameters, the teach-in data and reference values are discarded, as in this case it must be assumed that they no longer match the modified configuration.
Therefore, following the change to the system, application and/or tuning parameters in a parameter set, a new teach-in run must be executed for the Motion App affected by the changes.
The teach-in data are not automatically discarded for Motion Apps #12 "Leakage diagnostics" and #33 "Positioning".

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The teach-in data are also reset if the system, application and/or tuning parameters, which are always the same, are transferred from the higher-order controller at system start but have never been saved as persistent data on the Motion Terminal controller. In this case, the Motion Terminal starts with the default values for the parameters. As soon as they are overwritten by the higher-order controller, the change to the parameters causes the teach-in data to be discarded.
To prevent this behaviour, the system, application and/or tuning parameters must be saved once as persistent data on the Motion Terminal controller. This ensures that, when the higher-order controller transfers the parameters, which are always the same, no change can be detected between the saved and transferred values.

For special requirements, it may be the case that previously determined teach-in data need to be retained after the system, application and/or tuning parameters were changed. For this purpose, the option "Retention of existing teach-in data for parameter changes" can be set in the settings for the Motion Terminal.
The setting is made in the menu for the WebConfig interface or the transfer mode in channel 14 (➔ Tab. 58 Meaning of the indices per addressed target and channel). With a parameter change, the teach-in data are subsequently no longer reset automatically, but a message is entered once into the malfunction list. When this option is activated, it is crucial that the user ensures that the actuated parameter changes in combination with the existing teach-in data cannot lead to undesired behaviour of the drive.

3.8 Diagnostics options

Various options are available for diagnosing malfunctions.

Diagnostics option	Description	Detailed information
LED display components	The general system status of the Motion Terminal is indicated by the LED display elements on the controller, on the valves and on the input modules.	➔ 3.8.1 LED display components
CPX system diagnostics	The CPX system diagnostics provides information on the nature of malfunctions within the CPS terminal (including the Motion Terminal) by CPX error numbers.	➔ 3.8.2 Diagnostic interface ➔ CPX terminal manual
Diagnostics channel in transfer mode (Motion Terminal)	In addition to the information from the CPX diagnostics, the Motion Terminal provides information on errors and warnings. This information can be accessed via the transfer mode diagnostics channel.	➔ 3.8.3 Diagnostics channel in transfer mode

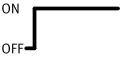
Tab. 101: Diagnostics options

3.8.1 LED display components

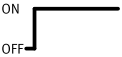
3.8.1.1 Controller

LED PL (green)		Meaning	Measure
lights	ON OFF	Voltage is present. No error.	–
off	ON OFF	No voltage present.	Check connection of the power supply.

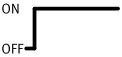
Tab. 102: LED display PL (Power Load)

LED M (yellow)		Meaning	Measure
 lights		Configuration active: the WebConfig interface has write access, or the PLC is executing write access on the parameterisation of the controller.	–
 flashes		Option for using demo licences active.	Note the time remaining for the demo period
 off		Configuration inactive: no access via the WebConfig interface.	–

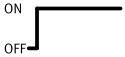
Tab. 103: LED display M (Modify)

LED PS (green)		Meaning	Measure
 lights		Voltage is present. No error.	–
 flashes		Voltage is present but outside the tolerance range.	Rectify short circuit/overload.
 off		No voltage present.	Check connection of the power supply.

Tab. 104: LED display PS (Power System)

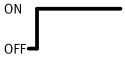
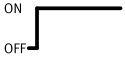
LED SF (red)		Meaning	Measure
 off		No error	–
 lights		Voltage of the load voltage supply U_{VAL} is outside the tolerance range.	Rectify short circuit/overload.
		Access to WebConfig interface is not possible or only conditionally.	Read and remedy error via PLC, CPX-FMT or FFT. Switch on operating supply voltage $U_{EL/SEN}$ off and back on.

Tab. 105: LED display SF (System Failure)

LED TP (green)		Meaning	Measure
 lights		Network connection is OK (link)	–
 flashes		Data traffic (Traffic) The flashing frequency depends on the traffic.	–
 off		No network connection / network cable is not connected.	If access to the WebConfig interface is required: Check network connection

Tab. 106: LED display TP (Ethernet Link/Traffic)

3.8.1.2 Valve

LED valve (blue/red)		Meaning	Measure
 red light		Valve faults	Check error log ➔ 3.8.3 Diagnostics channel in transfer mode.
		Load voltage supply U_{VAL} is not applied.	Check connection of the power supply U_{VAL}.
 blue light		Error-free operation	–
 blue flashing		Firmware update running	–
		Valve boots	–
		Valve being calibrated ➔ 3.4.5 Waiting time between Motion Apps.	–
 off		Valve has no power supply.	If the power supply of the terminal is switched on, switch off power supply and check valve to ensure it is seated properly.

Tab. 107: LED indicator valve status

3.8.1.3 Analogue input module

LED ϟ (red)		Meaning	Measure
off		No error	–
lights up		Short circuit/overload in sensor supply.	Rectify short circuit/overload.
		Module error	Switch on operating supply voltage U_{EL}/U_{SEN} off and back on.

Tab. 108: LED display module error, analogue

3.8.1.4 Digital input module

LED ϟ (red)		Meaning	Measure
off		No error	–
lights up		Short circuit/overload in sensor supply.	Rectify short circuit/overload.
		Module error	Switch on operating supply voltage U_{EL}/U_{SEN} off and back on.

Tab. 109: LED display module error, digital

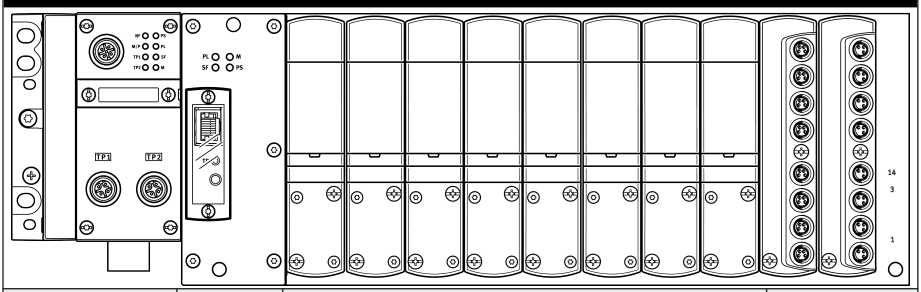
LED (green)		Meaning	Measure
lights up		Logic 1 (signal is present).	–
off		Logic 0 (signal not present).	–

Tab. 110: LED display input status, digital

3.8.2 Diagnostic interface

The diagnostic interface for the CPX terminal makes it possible to locate a malfunction to a specific component of the CPX terminal or of the Motion Terminal. For details, see the manual of the CPX terminal ➔ 1.1 Applicable documents.
The source of the malfunction within the Motion Terminal can be identified using the channel information.

Allocation of the channel numbers (without additional CPX modules)



	Controller	Valve slot								Input module	
		0	1	2	3	4	5	6	7	1	2
Input channel	E0	–	–	–	–	–	–	–	–	E1, E2 ... E9	E10, E11 ... E18
Output channel	A0	A1	A2	A3	A4	A5	A6	A7	A8	–	–

Tab. 111: Allocation of the channel numbers (without additional CPX modules)

Channels E2 ... E9 und E11 ... E18 correspond to the individual inputs (0 ... 7) of the applicable input module.

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Depending on the structure of the CPX terminal, the channel numbers shown above must be added to the number of the I/O channels that can be assigned to additional modules in the CPX terminal.

Example
If another digital input module with 8 input channels (0 ... 7) is installed between the bus node and the Motion Terminal controller, the Motion Terminal controller uses channels E8 und A0.

3.8.3 Diagnostics channel in transfer mode

The Motion Terminal uses the transfer mode to supply diagnostic information which, independently from the CPX error number, enables more precise analysis of the cause of the malfunction. Information on the time of the occurrence is also available.

3.8.3.1 Errors and warnings

The Motion Terminal distinguishes between 2 classes of malfunction:
- Error
- Warning

Error
A malfunction classified as an error is so serious that the Motion App currently running is automatically stopped or a Motion App is prevented from starting. After eliminating the cause of the error, the error must be acknowledged before it is possible to start a Motion App (➔ 3.8.3.7 Acknowledging errors and clearing the malfunction list).
Errors are logged in the diagnostic memory of the Motion Terminal.
The status of the valve (valve state) changes to a value of "3" (failure) (➔ 3.5.2.2 Structure of the input data (PDI)) when an error is present.
When the error has been eliminated, the value changes to "0" (not ready). Once the error has been acknowledged, the valve status changes back to a value of "1" (configurable).

Warning
A malfunction classified as a warning represents an undesirable state which, although it does not prevent the basic function of the Motion App that is running, may restrict the performance of the Motion App. Warnings are therefore displayed (section "app state", ➔ 3.5.2.1 Structure of the output data (PDO)) and logged in the diagnostic memory of the Motion Terminal. However, warnings do not have a direct impact on the operation of the Motion App.

3.8.3.2 Structure of the malfunction message

The information in the diagnostic memory of the Motion Terminal is made up of three parts:
- Malfunction code
- Malfunction subcode
- Classification of malfunction

The value transferred when the diagnostic memory is read is presented in bytes 5 ... 4 (PDI) in transfer mode and is made up of the following:

PDI byte 5								**PDI byte 4**							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Classification		Malfunction subcode						Malfunction code							

Tab. 112: Structure of the malfunction message

Malfunction code and subcode
The malfunction code is sufficient for the user to locate the cause of the malfunction. The malfunction subcode permits a detailed evaluation of the malfunction when required and should therefore always be specified when contacting Festo Support.

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A list of malfunction codes with a description of the possible cause and appropriate remedial measures can be found in the application note "Malfunction Code VTEM" (➔ 1.1 Applicable documents). Malfunction subcodes that can be used by the user to remedy errors are given here also.

Classification of malfunction

Malfunctions in the diagnostic memory of the Motion Terminal are assigned one of the following classifications. The classification of the malfunction is given by bits 7 ... 6 in byte 5 (PDI).

Classification	Meaning	Bit 7	Bit 6	Dec.
Reserved	–	0	0	0
Active error	The malfunction is classified as an error. The cause of the error is still present.	0	1	1
Inactive error	The malfunction is classified as an error. The cause of the error is no longer present, but the error has not been acknowledged (➔ 3.8.3.7 Acknowledging errors and clearing the malfunction list)	1	0	2
Warning	The malfunction is classified as a warning.	1	1	3

Tab. 113: Classification of malfunction

3.8.3.3 Structure of the time stamp

Every entry in the malfunction list has a time stamp, which documents the time at which it occurred. The reference variable for the time specifications is the operating time of the device since switch-on (Uptime). The time stamp is created in the format [hours]:[minutes]:[seconds]:[milliseconds]. The time stamp information that can be transferred when the diagnostic memory is read out is made up of three parts and is entered in bytes 5... 4 (PDI) of the transfer mode.

PDI byte 5								PDI byte 4							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Hours															

Tab. 114: Structure of the time stamp part 1: hours

PDI byte 5								PDI byte 4							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Minutes								Seconds							

Tab. 115: Structure of the time stamp part 2: minutes and seconds

PDI byte 5								PDI byte 4							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Milliseconds															

Tab. 116: Structure of the time stamp part 3: milliseconds

3.8.3.4 Structure of the VTEM diagnostic memory

The diagnostic memory of the Motion Terminal consists of a number of malfunction lists, each of which refers to one valve slot. Every list is displayed in the "Monitoring" view of the WebConfig interface and can be read out via the transfer mode ➔ 3.8.3.6 Readout of a malfunction list.
Malfunctions that only affect one of the valves are entered in the malfunction list of that valve; malfunctions of the controller or the input modules, on the other hand, affect all valves and are thus registered in the malfunction lists of all valve slots.
Every malfunction list can accommodate up to 40 malfunction messages and is populated chronologically. A new malfunction message always appears in position 1, and existing messages are moved "back" one position (previous position number 1).
The time stamp information of the existing malfunction messages can be read out via the positions 51 ... 190.
The reference time of positions 250 ... 252 refers to the copy of the malfunction list, which is created when channel 31 is called up in transfer mode and ensures consistent data over the period of several read operations in this channel. ➔ 3.8.3.6 Readout of a malfunction list
Information about the content of the malfunction list is available at positions 253 ... 255.

Position	Contents
1 ... 40	Malfunction messages (➔ 3.8.3.2 Structure of the malfunction message) in reverse order of their occurrence
51 ... 90	1st part of the time stamp of entry X + 50 Byte 5 ... 4: 16 bit unsigned = hours
101 ... 141	2nd part of the time stamp of entry X + 100 Byte 5: 8 bit unsigned = minutes Byte 4: 8 bit unsigned = seconds
151 ... 190	3rd part of the time stamp of entry X + 150 Byte 5 ... 4: 16 bit unsigned = milliseconds
250	1st part of the reference time of the snapshot of the malfunction list when channel 31 is called up Byte 5 ... 4: 16 bit unsigned = hours
251	2nd part of the reference time of the snapshot of the malfunction list when channel 31 is called up Byte 5: 8 bit unsigned = minutes Byte 4: 8 bit unsigned = seconds
252	3rd part of the reference time of the snapshot of the malfunction list when channel 31 is called up Byte 5 ... 4: 16 bit unsigned = milliseconds
253	Position of the most recent diagnostic message of the “error” type
254	Position of the earliest diagnostic message of the “error” type
255	Number of diagnostic messages in the malfunction list

Tab. 117: Structure of the malfunction lists

Overflow of a malfunction list
Each malfunction list has up to 40 entries. If there are more entries, there is a differentiation between the type of entry.
If the oldest entry is a warning, this entry is removed from the list.
However, if the oldest entry is an error, the list is frozen. If several errors or subsequent error occur one after another, this ensures that the first (and possibly the causal) error cannot be removed from the list.

Example of a malfunction list

The table below shows possible content of a malfunction list. This contains 3 malfunction messages. The most recent malfunction message at position 1 is classified as an error.

Position	Contents	Value dec.	Meaning
1	01l000000l00001010	1 l 0 l 10	Active error l malfunction subcode 0 l short circuit in one of the connected sensors on input module 1
2	11l000100l01001110	3 l 4 l 78	Warning l malfunction subcode 4 l PLC command invalid
3	11l000101l01001110	3 l 5 l 78	Warning l malfunction subcode 5 l PLC command invalid
...	00l000000l00000000	0 l 0 l 0	No malfunction message
40	00l000000l00000000	0 l 0 l 0	No malfunction message
51	00000000 00111100	60	Time stamp of the malfunction at position 1: 60 h, 24 min, 7 s and 52 ms
101	00011000l00000111	24 l 7	
151	00000000 00110100	52	
52	00000000 00101010	42	Time stamp of the malfunction at position 2: 42 h, 47 min, 11 s and 112 ms
102	00101111l00001011	47 l 11	
152	00000000 01110000	112	
53	00000000 00000000	0	Time stamp of the malfunction at position 3: 0 h, 8 min, 15 s and 753 ms
103	00001000 00001111	8 l 15	
153	00000010 11110001	753	
250	00000000 00111100	60	Information read out corresponds to the status of the time: 60 h, 24 min, 7 s and 365 ms
251	00011000l00000111	24 l 7	
252	00000001 01101101	365	
253	00 000000 00000001	1	The most recent error message is at position 1[1)]
254	00 000000 00000001	1	The earliest error message is at position 1[1)]
255	00 000000 00000011	3	There are 3 malfunction messages in the malfunction list

1) The latest and oldest error messages are identical in this example. there is only 1 error message in the malfunction list.

Tab. 118: Example of a malfunction list

3.8.3.5 What happens when an error occurs

When an error occurs, the valve is brought to a stop (status of the valve (valve state) = 3 (failure)).

If the cause of the error is no longer present, the valve status changes to "not ready" (valve state = 0 (not ready)).
After acknowledging the error, the valve status changes to "configurable" (valve state = 1 (configurable)) (➔ 3.8.3.7 Acknowledging errors and clearing the malfunction list).

3.8.3.6 Readout of a malfunction list

A malfunction list is read out using the transfer mode (valve mode = 63). The sections of the process data are used as follows:
- Operating mode of the valve (valve mode): 63 (transfer mode active) (PDO byte 0, bits 5 ... 0 => 111111_2)
- Channel (channel): 31 (malfunctions) (PDO byte 1, bits 4 ... 0 => 11111_2)
- Transfer control (transfer control): 2 (upload) (PDO byte 1, bits 7 ... 5 => 010_2)
- Addressing of data transfer (addressed target): valve slot for which the malfunction list is to be read out ➔ Tab. 119 Selection of the malfunction list (PDO byte 2 => 0, 100 ... 107).
- Index (index): position of the malfunction list with the value that is to be read out ➔ Example of a malfunction list (PDO byte 3 => 1 ... 40, 253 ... 255).

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A copy of the actual malfunction list is created at the moment in which channel 31 is called. As long as channel 31 is not exited, this copy will not change. This prevents the content changing between the individual queries (number of entries, upload of individual entries) and the received values from becoming inconsistent.
If inactive errors are acknowledged via the WebConfig interface, while the transfer mode channel 31 is active on the PLC side the display on the WebConfig interface will differ from the data received from the PLC.

addressed target	Meaning
0	Malfunction list of the valve slot via which the process data area is communicated
100	Malfunction list of valve slot 0
101	Malfunction list of valve slot 1
102	Malfunction list of valve slot 2
103	Malfunction list of valve slot 3
104	Malfunction list of valve slot 4
105	Malfunction list of valve slot 5
106	Malfunction list of valve slot 6
107	Malfunction list of valve slot 7

Tab. 119: Selection of the malfunction list

Example of output data for reading out the most recent entry in a malfunction list

Starting point for the sample content of a malfunction list ➔ Tab. 118 Example of a malfunction list.

Example of output data for reading out the most recent entry in a malfunction list															
PDO byte 1								PDO byte 0							
Command															
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	1	0	1	1	1	1	1	…	…	1	1	1	1	1	1
transfer control = 2			channel = 31					–		valve mode = 63 (transfer mode)					
PDO byte 3								PDO byte 2							
Parameter															
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
index = 1								addressed target = 0 (malfunction list of the valve slot via which the process data area is communicated)							
PDO byte 5								PDO byte 4							
Value															
Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
value = … (ignored)															

Tab. 120: Example of output data for reading out the most recent entry in a malfunction list

Example of input data with the content of the most recent entry in a malfunction list
Starting point for the sample content of a malfunction list ➔ Tab. 118 Example of a malfunction list.

Example of input data with the content of the most recent entry in a malfunction list															
PDI byte 1								PDI byte 0							
Command															
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
transfer control = 2			channel = 31					valve state = 3 (failure)		valve mode = 63 (transfer mode)					
PDI byte 3								PDI byte 2							
Parameter															
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
index = 1								addressed target = 0							
PDO byte 5								PDO byte 4							
Value															
Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0
1 (active error)		0 (no malfunction subcode)						10 (short circuit in one of the connected sensors at input module 2)							

Tab. 121: Example of input data with the content of the most recent entry in a malfunction list

3.8.3.7 Acknowledging errors and clearing the malfunction list

To change the valve status (valve state) from "0 (not ready) to"1" (configurable), the error must be acknowledged once the cause has been remedied.

1. End transfer mode by setting the transfer control (PDO byte 1, bits 7 ... 5) to a value of "3". The valve switches to mode (valve mode) 61, valve status (valve state) is "error" (value 3).
2. Remedy cause of error. Status of the valve changes to “not ready” (value 0).
3. Set operating mode of valve (valve mode, PDO byte 0, bits 5 ... 0) to the value "62" ("acknowledge error"). Status of the valve changes to "ready" (value 1).

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Acknowledgment deletes all entries in the malfunction list for this valve slot.
If the malfunction list of a valve slot contains accumulated entries of the "Warning" type but no active or inactive errors, the malfunction list can also be in the status (valve state) "1" (configurable) by reset of the operating mode to "62".

Acknowledgement of errors without previous read-out of malfunction list
If the error can be cleared without a read-out of the malfunction list (and hence without using transfer mode), the following simplified procedure results:
1. An error is present: PDI byte 0, bit 7 = 1 and bit 6 = 1.
   ↳ valve state = failure
2. The cause of the error has been remedied: PDI byte 0, bit 7 = 0 and bit 6 = 0.
   ↳ valve state = not ready
3. The error is acknowledged: set PDO byte 0, bit 5 ... 0 "valve mode" to the value $111110_2 = 62_{10}$.
4. The valve is once more ready: PDI byte 0, bit 7 = 0 and bit 6 = 1
   ↳ valve state = configurable
5. After acknowledging the error, a Motion App or transfer mode can be started.

4 Parameterisation

In this chapter, parameterisation refers to the transfer of system, application and tuning parameters from the higher-order controller (PLC) to the Motion Terminal VTEM.
The transfer mode of the Motion Terminal is used to transfer the parameter values (➔ 3.5.4 Transfer mode).

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In addition to the approach described here, it is also possible to set up the parameters of the Motion Terminal using the WebConfig user interface or to import them from a previously exported configuration file (➔ 3.3.3 Export/import of parameterisation and settings).
Parameterisation that has been created using the WebConfig interface and saved on the Motion Terminal controller can be transferred to the higher-order controller via a read-out in transfer mode.

4.1 Setting system, application and tuning parameters

System, application and tuning parameters are set using the transfer mode (➔ 3.5.4 Transfer mode).

4.1.1 Requirements

– The Motion Terminal boot procedure is completed.
– There are no Motion Apps currently running on the valve in question (valve state ≠ "2" (running)).

4.1.2 Sequence

To transfer system, application and tuning parameters, the following settings must be selected in the transfer mode:

- Operating mode of the valve (valve mode): 63 (transfer mode active) (PDO byte 0, bits 5 ... 0 => 111111_2)
- Channel (channel): 1 ... 5 (ID of the parameter set for which the parameters are to be defined) (PDO byte 1, bits 4 ... 0 => 00001_2 ... 00101_2)
- Transfer control (transfer control): 1 (download) (PDO byte 1, bits 7 ... 5 => 001_2)
- Addressing of data transfer (addressed target): 0 ... 60 (PDO byte 2 => 0_{10} ... 60_{10})
  - 0 for setting system parameters that are independent of the Motion App. In this case, compliance with value ranges that are specific to the Motion App is not checked.
  - 1 ... 59 for setting system, application or tuning parameters for the corresponding Motion App
  - 60 for setting parameters for the teach-in run ➔ 3.7.1 Prerequisites for starting the teach-in run
- Index (index): ID of the parameter to be set (PDO byte 3 => 12_{10} ... 255_{10})
- Value (value): value to be written to the parameter (PDO bytes 5 ... 4) ➔ 3.4.3 Parameter.

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Compared to the representation in section (➔ 3.4.3 Parameter), the value ranges for the parameters may be restricted by the specific Motion App. The specific value ranges for the Motion Apps are described in the manuals for the various Motion Apps.
If a system parameter is outside the valid value range for a Motion App to be started because it was set for another Motion App or with addressed target = 0, an error is returned if an attempt is made to start the Motion App.

Example

The system parameter "Tubing internal diameter at (2)" (ID 14) should be parameterised in parameter set 2 in order for a tubing internal diameter of 5.7 mm to be used from Motion App #04.

Example of setting the system parameter "Tubing internal diameter to (2)"															
PDO byte 1								PDO byte 0							
Command															
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	1	0	0	0	1	0	...	...	1	1	1	1	1	1
transfer control = 1 (download)			channel = 2 (parameter set 2)					–		valve mode = 63 (transfer mode)					
PDO byte 3								PDO byte 2							
Parameter															
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0
index = 14 (parameter ID 14)								adressed target = 4 (system parameter in compliance with value range for Motion App #04)							
PDO byte 5								PDO byte 4							
Value															
Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	0	0	1	0	0	0	1	1	1	0	1	0
value = 570 (570 × 0.01 mm = 5.7 mm)															

Tab. 122: Example of setting the system parameter "Tubing internal diameter to (2)"

The values are displayed in the corresponding sections of the input data (PDI) for confirmation (➔ Tab. 59 Structure of the input data (PDI)).

4.2 Reading out system, application and tuning parameters

The values of system, application and tuning parameters are read out using the transfer mode (➔ 3.5.4 Transfer mode).

4.2.1 Requirements

- The Motion Terminal boot procedure is completed.
- There are no Motion Apps currently running on the valve in question (valve state ≠ "2" (running)).

4.2.2 Sequence

To read out values for system, application and tuning parameters, the following settings must be selected in the transfer mode:

- Operating mode of the valve (valve mode): 63 (transfer mode active) (PDO byte 0, bits 5 ... 0 => 111111_2)
- Channel (channel): 1 ... 5 (ID of the parameter set from which a parameter value is to be read out) (PDO byte 1, bits 4 ... 0 => 00001_2 ... 00101_2)
- Transfer control (transfer control): 2 (upload) (PDO byte 1, bits 7 ... 5 => 010_2)
- Addressing of data transfer (addressed target): 0 ... 60 (PDO byte 2 => 0_{10} ... 60_{10})
  - 0 for reading out system parameters (independent of Motion App)
  - 1 ... 59 for reading system, application or tuning parameters for the corresponding Motion App
  - 60 for reading out parameters for the teach-in run (➔ 3.7.1 Prerequisites for starting the teach-in run)
- Index (index): ID of the parameter with the value that is to be read out (PDO byte 3 => 12_{10} ... 255_{10})

The "Value" section is ignored.

Example

The value of the application parameter "Travel time, advancing" (ID 121) for Motion App #07 in the parameter set 4 is to be read out.

Example of reading out the application parameter "Travel time, advancing"															
PDO byte 1								PDO byte 0							
Command															
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	1	0	0	0	1	0	0	...	...	1	1	1	1	1	1
transfer control = 2 (upload)			channel = 4 (parameter set 4)					–		valve mode = 63 (transfer mode)					
PDO byte 3								PDO byte 2							
Parameter															
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	1	1	1	1	0	0	1	0	0	0	0	0	1	1	1
index = 121 (parameter ID 121)								adressed target = 7 (Motion App #07)							
PDO byte 5								PDO byte 4							
Value															
Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
value = ... (ignored)															

Tab. 123: Example of reading out the application parameter "Travel time, advancing"

The value of the application parameter is given by the input data in byte 5 ... 4 (PDI).

Displaying the read out application parameter via the input data															
PDI byte 1								PDI byte 0							
Command															
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	1	0	0	0	1	0	0	...	...	1	1	1	1	1	1
transfer control = 2 (upload)			channel = 4 (parameter set 4)					valve state		valve mode = 63 (transfer mode)					
PDI byte 3								PDI byte 2							
Parameter															
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	1	1	1	1	0	0	1	0	0	0	0	0	1	1	1
index = 121 (parameter ID 121)								adressed target = 7 (Motion App #07)							
PDI byte 5								PDI byte 4							
Value															
Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0
value = 100 (100× 0.01 s = 1 s)															

Tab. 124: Displaying the read out application parameter via the input data

4.3 Setting sensor parameters

Sensor parameters are set using the transfer mode (➔ 3.5.4 Transfer mode).

4.3.1 Requirements

- The Motion Terminal boot procedure is completed.
- There are no Motion Apps running on any of the valves (valve state ≠ "2" (running)).
- There is no simultaneous access to the sensor parameters of the same input module via the transfer mode of another valve or via the WebConfig interface.

4.3.2 Sequence

To transfer the sensor parameters, the following settings must be selected in the transfer mode:
- Operating mode of the valve (valve mode): 63 (transfer mode active) (PDO byte 0, bits 5 ... 0 => 111111_2)
- Channel (channel): 16 (parameterisation of the input modules) (PDO byte 1, bits 4 ... 0 => 10000_2)
- Transfer control (transfer control): 1 (download) (PDO byte 1, bits 7 ... 5 => 001_2)
- Addressing of data transfer (addressed target): 1 ... 2 (number of input module) (PDO byte 2 => 1_{10} ... 2_{10})
- Index (index): ID of the sensor parameter to be set (PDO byte 3 => 1_{10} ... 212_{10})
- Value (value): value to be written to the parameter (PDO bytes 5 ... 4) (➔ Tab. 33 Sensor parameters).

Example

On an analogue input module mounted on the second slot provided for input modules, a sensor of type SDAP-MHS-M160 is connected on the last of the eight inputs. The sensor parameter "sensor type" should now be parameterised so that the measured analogue values are interpreted accordingly and can be used by Motion Apps.

Example of setting the sensor parameter "sensor type"

PDO byte 1								PDO byte 0							
Command															
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	1	1	0	0	0	0	...	...	1	1	1	1	1	1
transfer control = 1 (download)			channel = 16 (input module settings)					–		valve mode = 63 (transfer mode)					
PDO byte 3								PDO byte 2							
Parameter															
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	1	0	1	0	0	1	1	0	0	0	0	0	0	1	0
index = 211 (7 x 30 + 1)								adressed target = 2 (input module on the second slot provided for this)							
PDO byte 5								PDO byte 4							
Value															
Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	0	1	1	1	1	1	0	1	0	0	1	1
value = 2003 (SDAP-MHS-M160-...)															

Tab. 125: Example of setting the sensor parameter "sensor type"

The values are displayed in the corresponding sections of the input data (PDI) for confirmation (➔ Tab. 59 Structure of the input data (PDI)).

4.4 Set parameters for the description of user-defined drives

4.4.1 Requirements

- The Motion Terminal boot procedure is completed.
- A Motion App is not currently running on any valve (valve state ≠ "2" (running)).
- The option "Access to extended drive list" is set in the settings for the Motion Terminal. The setting is made in the menu for the WebConfig interface or the transfer mode in channel 14 (➔ Tab. 58 Meaning of the indices per addressed target and channel)
- There is no simultaneous access to the parameters of the same user-defined drive via the transfer mode of another valve or via the WebConfig interface.

i

After activation of the "Access to extended drive list" option, all Motion Apps can be selected and used for drives that have not been tested or approved by Festo for the Motion Terminal or a specific Motion App. The operation of Motion Apps using this option is therefore expressly outside the specification.

4.4.2 Sequence

The following settings must be selected in transfer mode to transfer the parameters for the description of user-defined drives:

- Operating mode of the valve (valve mode): 63 (transfer mode active) (PDO byte 0, bits 5 ... 0 => 111111_2)
- Channel (channel): 17 (parameterisation of user-defined peripherals) (PDO byte 1, bits 4 ... 0 => 10001_2)
- Transfer control (transfer control): 1 (download) (PDO byte 1, bits 7 ... 5 => 001_2)
- Addressing of data transfer (addressed target): 101 ... 108 (100 + number of the user-defined drive) (PDO byte 2 => 101_{10} ... 108_{10})
- Index (index): ID of the parameter for the description of user-defined drives that are to be set (PDO byte 3 => 1_{10} ... 13_{10})
- Value (value): value that is to be written to the parameter (PDO bytes 5 ... 4) (➔ Tab. 36 Parameters for the description of user-defined drives)

Example

A piston diameter of 25 mm should be stored for the first of eight possible user-defined drives.

Example of setting the parameter for the description of user-defined "piston diameter" drives															
PDO byte 1								PDO byte 0							
Command															
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	1	1	0	0	0	1	...	...	1	1	1	1	1	1
transfer control = 1 (download)			channel = 17 (user-defined peripherals)					–		valve mode = 63 (transfer mode)					
PDO byte 3								PDO byte 2							
Parameter															
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	0	0	1	0	0	1	1	0	0	1	0	1
index = 2 (piston diameter)								adressed target = 101 (user-defined drive 1)							
PDO byte 5								PDO byte 4							
Value															
Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	0	0	0	0	1	1	1	1	1	0	1	0
value = 250 (250 × 0.1 mm = 25 mm)															

Tab. 126: Example of setting the parameter for the description of user-defined "piston diameter" drives

The values are displayed in the corresponding sections of the input data (PDI) for confirmation (➔ Tab. 59 Structure of the input data (PDI)).

i

With the description and use of a user-defined drive the user must always ensure that the set parameters are complete and correctly describe the actual drive.

4.5 Save parameterisation as persistent data

i

Saving parameterisation on the Motion Terminal controller as persistent data is described in section: (➔ 3.5.4.4 Saving settings as persistent data).

i

Even in the case where the parameterisation is transferred to the Motion Terminal controller by the higher-order controller at every system start, this parameterisation should additionally be saved once, as persistent data, on the Motion Terminal controller. Otherwise, the teach-in data recorded during a teach-in run for a Motion App may be lost (➔ 3.7.6 Validity of teach-in data based on parameter changes).

4.6 Changing an active parameter set

Changing the active parameter set is controlled using the channel "valve settings" (channel = 15) (➔ 3.5.4.1 Structure of the process data in transfer mode). The “Value” section contains the number of the parameter set to be activated.

4.6.1 Requirements

- The Motion Terminal boot procedure is completed.
- There are no Motion Apps currently running on the valve in question (valve state ≠ "2" (running)).

4.6.2 Sequence

To set the active parameter set, the following settings must be selected in the transfer mode:

- Operating mode of the valve (valve mode): 63 (transfer mode active) (PDO byte 0, bits 5 ... 0 => 111111_2)
- Channel (channel): 15 (valve settings) (PDO byte 1, bits 4 ... 0 => 01111_2)
- Transfer control (transfer control): 1 (download) (PDO byte 1, bits 7 ... 5 => 001_2)
- Addressing of data transfer (addressed target): 0 (PDO byte 2 => 0)
- Index (index): 1 (PDO byte 3 => 1) -
- Value (value): number of the parameter set that should be actively switched (PDO bytes 5 ... 4)

4.6.3 Example

Parameter set 4 is to be selected as the active parameter set.

Example of output data for changing the active parameter set

PDO byte 1								PDO byte 0							
Command															
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	1	0	1	1	1	1	...	...	1	1	1	1	1	1
transfer control = 1 (download)			channel = 15 (valve settings)					–		valve mode = 63 (transfer mode)					
PDO byte 3								PDO byte 2							
Parameter															
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
index = 1 (active parameter set)								adressed target = 0							
PDO byte 5								PDO byte 4							
Value															
Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
value = 4															

Tab. 127: Example of output data for changing the active parameter set

Transfer is confirmed in the input data.

Example of input data with selected parameter set															
PDI byte 1								PDI byte 0							
Command															
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	1	0	1	1	1	1	...	...	1	1	1	1	1	1
transfer control = 1 (download)			channel = 15 (valve settings)					valve state		valve mode = 63 (transfer mode)					
PDI byte 3								PDI byte 2							
Parameter															
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
index = 1 (active parameter set)								adressed target = 0							
PDI byte 5								PDI byte 4							
Value															
Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
value = 4															

Tab. 128: Example of input data with selected parameter set

Once the active parameter set has been changed, its parameterisation and teach-in data will be provided for the operation of every Motion App subsequently started.

5 Technical appendix

5.1 Technical data

5.1.1 General

Characteristic valve values		
Switching time on	[ms]	8.5
Switching time off	[ms]	8.5
C value	[l/s*bar]	2
Standard nominal flow rate Pressurisation	[l/min]	450 at 0.6 MPa against 0.5 MPa (6 bar against 5 bar)
Standard nominal flow rate Exhaust port	[l/min]	480 at 0.6 MPa against 0.5 MPa (6 bar against 5 bar)
Direction of flow		Not reversible

Tab. 129: Characteristic valve values

Pressure and medium parameters			
Operating medium, control medium		Compressed air in accordance with ISO 8573-1:2010 [7:4:4]	
		Inert gases	
Information on operating medium, control medium		Lubricated operation not possible	
Vacuum operation		Only at the exhaust ports (3)	
Valve terminal total leakage	[l/h]	15 plus leakage of valve slots	
Leakage per valve slot	[l/h]	3 (with valve)	
		1 (with blind plate)	
		[bar]	[MPa]
Nominal operating pressure/nominal pilot pressure		6	0.6
Operating pressure, pilot pressure with internal pilot air via port (1)		3 ... 8	0.3 ... 0.8
Operating pressure, pilot pressure with external pilot air via port (14)		0 ... 8	0 ... 0.8

Tab. 130: Pressure and medium parameters

Permitted temperature ranges		
Storage	[°C]	–20 ... +40
Environment	[°C]	5 ... 50
Medium	[°C]	5 ... 50

Tab. 131: Temperature ranges

Environmental conditions		
Degree of protection		IP65[1)]
Relative humidity	[%]	0 ... 90
Vibration and shock resistance		➔ Assembly instructions CPX-VTEM

1) Fully assembled and unused connections sealed. IP65 degree of protection is not ensured when using the Ethernet port.

Tab. 132: Environmental conditions

Note on materials	
PWIS	Contains paint-wetting impairment substances[1)]

1) PWIS = paint-wetting impairment substances

Tab. 133: Note on materials

Port patterns	
Working air ports (2) and (4)	G 1/8
Pilot air (14)	M5
Valve ports (1) and (3)	G 3/8
Pilot exhaust air (84)	M7
Pressure compensation (L)	M7

Tab. 134: Port patterns

5.1.2 Power supply

Power supply			
Operating voltage (via CPX terminal)			
Voltage range	[V DC]	18 ... 30	
Nominal voltage	[V DC]	24	
Electrical isolation $U_{EL/SEN}$ and U_{VAL}		Yes, with separate supply at the CPX terminal	
Intrinsic current consumption VTEM at 24 V DC typ.			
		via $U_{EL/SEN}$	via U_{VAL}
Controller + linkage	[mA]	115	85
Per valve	[mA]	37	24
Analogue input module (plus intrinsic consumption of the sensors)	[mA]	12	0
Digital input module (plus intrinsic consumption of the sensors)	[mA]	12	0
Functional earth (FE)			
Via functional earth connection of the CPX terminal and functional earth connection at the VTEM terminal strip			

Tab. 135: Power supply

5.1.3 Approvals

Approvals	
CE marking in accordance with EU EMC Directive [1)]	See declaration of conformity ➔ www.festo.com/sp

1) The device is intended for industrial use. Measures for interference suppression may be required in residential areas.

Tab. 136: Approvals

5.1.4 Input modules

General		
Maximum length of the connected cables	[m]	30
Electrical protection		Internal electronic fuse per module
Galvanic isolation between the inputs		None

Tab. 137: General

Digital input module CTMM-...-D-...		
Interface		M8, 3-pin
Behaviour		Voltage input 24 V DC
Input characteristic		In accordance with IEC 61131-2, type 3
Switching logic		PNP, NO (normally open)
Switching level		
Signal 0	[V DC]	≤ 5
Signal 1	[V DC]	≥ 11

Tab. 138: Digital input module

Analogue input module CTMM-...-A-...	
Interface	M8, 4-pin
Behaviour	Current input 4 ... 20 mA
Compatible sensors	SDAP-MHS-M...-1L-A-E-0.3-M8

Tab. 139: Analogue input module

6 Supported peripherals

6.1 Supported CPX bus nodes

The CPX terminal can establish the connection to a higher-order controller via one of the following bus nodes:

Type code	Identifier	Protocol
CPX-FB11	Bus node	DEVICENET
CPX-FB13	Bus node	PROFIBUS
CPX-FB14	Bus node	CANopen
CPX-FB23-24	Bus node	CC-LINK
CPX-FB33	Bus node	PROFINET
CPX-FB36	Bus node	EtherNet/IP, Modbus TCP
CPX-FB37	Bus node	EtherCAT
CPX-FB38	Bus node	EtherCAT
CPX-FB39	Bus node	SERCOS
CPX-FB40	Bus node	ETHERNET POWERLINK[1)]
CPX-FB45	Bus node	PROFINET
T32	CoDeSys embedded controller	RS232 (S1)
T33	CoDeSys embedded controller	CANopen
T34	CoDeSys embedded controller	SoftMotion

1) No component available, individual configuration via CPX-FMT.

Tab. 140: Supported CPX bus nodes

6.2 List of supported drives

i

➔ www.festo.com/sp ➔ VTEM ➔ Expert knowledge

This list contains all Festo drives approved for the Motion Terminal and the corresponding value that must be entered in the “drive type” system parameter (ID 20) in order to be able to operate the respective drive with a Motion App.

7 Licences

This product uses open-source software. The following table lists the corresponding software packages as well as the licences that govern the software.

Software package	Licence	Version	Terms of the licence
Unity	MIT	–	➔ https://opensource.org/licenses/MIT
bbenv	GPL	2.0	➔ https://www.gnu.org/licenses/gpl-2.0
bootgen	Xilinx	–	–
bootloader	GPL	2.0+	https://www.gnu.org/licenses
busybox	GPL	2.0	https://www.gnu.org/licenses/gpl-2.0
e2fsprogs	GPL	2.0	https://www.gnu.org/licenses/gpl-2.0
gcovr	BSD	3	https://opensource.org/licenses/BSD-3-Clause
haserl	GPL	2.0	https://www.gnu.org/licenses/gpl-2.0
libb64	Public Domain Certification	–	–
libev	BSD	2	https://opensource.org/licenses/BSD-2-Clause
libiniparser	MIT	–	https://opensource.org/licenses/MIT
libnl	LGPL	2.1	https://www.gnu.org/licenses/lgpl-2.1
libtool	BSD	3	https://opensource.org/licenses/BSD-3-Clause
linux	GPL	2.0	https://www.gnu.org/licenses/gpl-2.0
lua	MIT	–	https://opensource.org/licenses/MIT
luafilesystem	MIT	–	https://opensource.org/licenses/MIT
lzo	GPL	2.0	https://www.gnu.org/licenses/gpl-2.0
mkimage	GPL	2.0+	https://www.gnu.org/licenses
mtdutils	GPL	2.0	https://www.gnu.org/licenses/gpl-2.0
sysroot	LGPL	2.1	https://www.gnu.org/licenses/lgpl-2.1
zlib	Zlib	–	https://zlib.net/zlib_license.html

Tab. 141: Licences

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