

**MCD-PROFIBUS Gateway
for MCD3000 Series Soft Starter
and MCD Remote Operator**

P/N FS-1135

DANFOSS P/N 175G0092

User Manual

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REVISION NOTES

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TECHNICAL SUPPORT

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sales@fieldbus.com.au.

We will endeavour to reply immediately.

PREFACE

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CONTENTS

1	INTRODUCTION	7
1.1	IMPORTANT USER INFORMATION.....	7
1.2	GENERAL.....	7
2	INSTALING THE GATEWAY	9
2.1	GATEWAY CONNECTION DIAGRAM.....	9
2.2	FRONT PANEL	10
2.3	INSTALLATION SEQUENCE.....	12
2.4	POWER CONNECTION	12
2.5	PROFIBUS CONNECTION.....	13
2.5.1	Cabling	13
2.5.2	GATEWAY CONFIGURATION	14
2.6	MCD CONNECTION.....	15
2.6.1	Cabling	15
2.6.2	MCD device configuration.....	17
3	PROGRAMMING THE MASTER CONTROLLER	20
3.1	GSD FILE.....	20
3.2	DECLARING MODULES	20
3.3	SETTING PROFIBUS PARAMETERS	21
3.4	MASTER-SLAVE DATA EXCHANGE	23
3.6	DATA READ AREA	24
3.7	ISSUING COMMANDS	27
4	OPERATION OF THE GATEWAY	31
4.1	SCANNING SLAVES.....	31
4.2	SCANNING TIMES	31
4.3	OFFLINE SLAVES	33
5	SPECIFICATIONS	34
6	TROUBLESHOOTING	35

Table List

Table 1 – LED Indication	11
Table 2 – PROFIBUS socket pin assignment	13
Table 3 – RS-485 pin assignment	15
Table 4 – Soft starter Local/Remote modes	18
Table 5 – Soft starter RS-485 baud rate values	18
Table 6 – Soft starter address on RS-485 network	18
Table 7 – MCD Remote Operator RS-485 baud rate values	19
Table 8 – MCD Remote Operator address on RS-485 network	19
Table 9 – MCD Remote Operator network protocol	19
Table 10 – Gateway parameter, RS-485 link baud rate	21
Table 11 – Gateway parameter, gateway operation on communication loss	22
Table 12 – PROFIBUS Write / Out Memory	24
Table 13 – Command result codes	24
Table 14 – PROFIBUS Read / In memory	26
Table 15 – Valid commands	27
Table 16 – New Command / Command Acknowledge handshaking	29
Table 17 – Result Ready / Result Acknowledge handshaking	29
Table 18 – Scanning cycle length for different baud rates and the number of MCD devices present	32
Table 19 – Maximum time to detect return of an offline device	32
Table 20 – Gateway specifications	34
Table 21 – Troubleshooting guide	35

Figure List

Figure 1. Typical diagram of a PROFIBUS network, a gateway and an RS-485 sub-network.	9
Figure 2. Gateway front panel	10
Figure 3. Entering address via dip switches, an example	14
Figure 4. Recommended wiring diagram for one MCD device	16
Figure 5. Wiring diagram for a number of MCD devices connected to a single gateway	16

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1 INTRODUCTION

1.1 Important user information

This manual describes operation and programming of a PROFIBUS Gateway for MCD3000 Soft Starters and MCD Remote Operators, gateway firmware revision 3.0x. Throughout this manual the term “the gateway” refers to the MCD - Profibus Gateway, the term “soft starter” refers to an MCD3000 Soft Starter and the term “MCD device” refers to either a soft starter or an MCD Remote Operator that is directly connected to the gateway.

Gateways with firmware version 3.0x support MCD protocol as described in Danfoss manuals MG.15.Ax.02 and MG.17.Ex.02. It is compatible with:

- Soft starters with software version MCDI V6.1 or greater,
- MCD Remote Operator Batch #12 or greater.

Contact Fieldbus Specialists if you require a firmware version that supports earlier models.



Observe all the necessary safety precautions when controlling any MCD device over the serial communications link, including alerting personnel that the machinery may start without warning.

1.2 General

The gateway can be connected to a number of MCD devices over a single RS-485 cable using a proprietary protocol, specific to MCD devices. The gateway operates as a single PROFIBUS slave node. The PROFIBUS master can control all connected MCD devices – start, stop, reset trip conditions and read operational status, motor conditions or trip status.

The gateway is a certified PROFIBUS slave device. A number of gateways and other PROFIBUS slave devices can be connected to the same network, subject only to standard PROFIBUS limitations.

The gateway is a master on the RS-485 multi-drop MCD communications network. **Up to 23** MCD devices may be connected to a single Gateway. In this way up to 23 MCD devices will share one PROFIBUS address on the PROFIBUS communications network.

This manual describes how the gateway operates, how to connect MCD devices to the gateway and how to connect and operate the gateway on a PROFIBUS network.

When reading this manual, it may help to refer to the MCD Soft Starter instructions, Danfoss document no. MG.15.Ax.02 and MCD Remote Operator instructions, Danfoss document no. MG.17.Ex.02.

2 INSTALING THE GATEWAY

2.1 Gateway connection diagram

The diagram below shows how the gateway is connected to the PROFIBUS network and to the RS-485 sub-network.

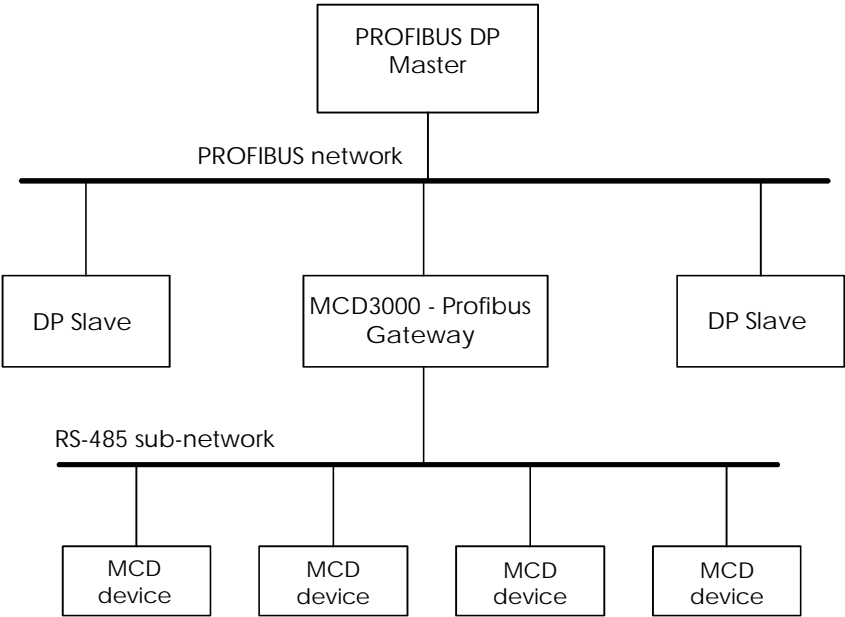


Figure 1. Typical diagram of a PROFIBUS network, a gateway and an RS-485 sub-network.

2.2 Front panel

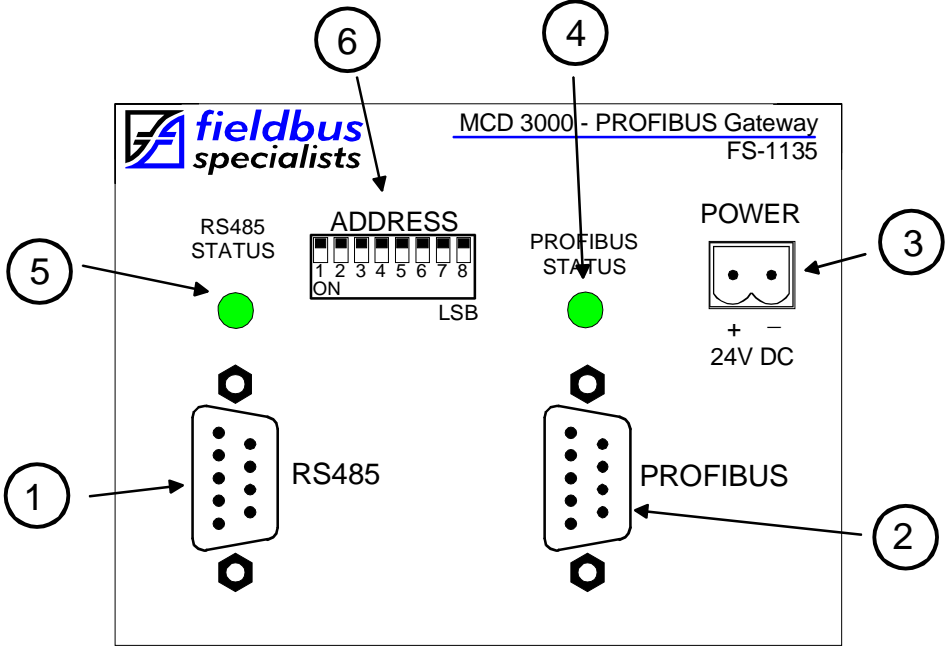


Figure 2. Gateway front panel

Fig. 2 shows the front panel of the gateway. Located on the front panel are:

- 1. RS-485 sub-network connector for connecting MCD devices, DB9, male,
- 2. PROFIBUS network connector, DB9, female,
- 3. Power connector, 2 pin removable terminal block,
- 4. Bi-colour PROFIBUS status LED,
- 5. Bi-colour RS-485 status LED,
- 6. Dip switches for PROFIBUS address selection.

The following table indicates the status of the PROFIBUS connection.

PROFIBUS LED	RS-485 LED	Gateway status
B	B	Gateway starting (max. 6 sec) or no power
R/B	ANY	Invalid PROFIBUS address
R/B	ANY	PROFIBUS link down – no PROFIBUS master, incorrect address or no connection,
G/R/B	ANY	PROFIBUS link error – wrong configuration or parameters in PROFIBUS master
G	ANY	PROFIBUS link up and problem-free
G	R/B	No communication on the RS-485 link
G	G/R	Occasional errors on the RS-485 link
G	G	Both PROFIBUS and RS-485 links operational and error-free

Legend:

B - LED off

G - LED steady green

R/B - LED flashing red/off

G/R - LED flashing green/red

G/R/B - LED flashing green/red/off

ANY – applies irrespective of LED status

Table 1 – LED Indication

These simple rules may be worth remembering:

- Flashing indicates errors on the relevant link,
- Flashing red means that the gateway attempts to communicate but fails every time,
- Flashing red/green means that the gateway can communicate, but errors occur.

2.3 Installation sequence

When installing the gateway, we recommend the following sequence:

- Connect power, see section 2.4 for details. If there are no indications of power, check voltage and polarity.
- Set the PROFIBUS address on dip switches, configure and activate PROFIBUS master, see section 2.5 for instructions. Configure the PROFIBUS master for one MCD device only. On success the PROFIBUS status LED will go green, on error it will blink red. If the LED stays red, check the cable, address on the gateway and address setting in the master. If the LED flashes green/red, verify the configuration of modules in the PROFIBUS master. **Do not proceed further unless the PROFIBUS LED is steady green.**
- Configure and connect the first MCD device, set it to address 1, see section 2.6 for details. On success, the RS-485 status LED should go green. We recommend initially to configure PROFIBUS master for only one MCD device connected to the gateway and to get this configuration working successfully. Later on you can increase the number of MCD devices. If the RS-485 status LED stays solid red, check the RS-485 cable, configuration of the MCD device, wiring and the value of the PROFIBUS parameter in the gateway configuration data in PROFIBUS master – RS-485 sub-network baud rate setting.
- Configure and connect the remaining MCD devices, make also the relevant changes to the configuration of PROFIBUS master. On success the RS-485 LED should go solid green. If it flashes green/red, one or more MCD devices do not communicate with the gateway.

2.4 Power connection

The gateway requires 24V DC power, approx. 130mA. The voltage can be unregulated – the gateway will operate correctly for power voltage in the range 12-32V. The current drawn changes with voltage – ~240mA for 12V and ~90mA for 32V. The power connector is a removable terminal block, 2 pin. The device is reverse polarity protected – in the case of reversed connection it will not get damaged but it will not operate either.

Presence of correct power can be verified by looking at the LEDs on the front panel – at least one LED should be illuminated at all times, whether green or red.

2.5 PROFIBUS connection

The PROFIBUS socket of the gateway must be connected to a PROFIBUS network in accordance with PROFIBUS Technical Guideline “Installation Guideline for PROFIBUS DP/FMS”, PROFIBUS International Order No. 2.112.

2.5.1 Cabling

The gateway PROFIBUS connection requires a PROFIBUS cable with DB9 male connector. Pin assignment in the PROFIBUS socket is as follows:

DB9 socket Pin	Purpose
1	Shield/functional ground
2	Not connected
3	RXD/TXD-P (Data Line)
4	Not connected
5	Data ground (reference potential for VP)
6	VP – supply voltage, +5V
7	Not connected
8	RXD/TXD-N (Data Line, Inverted)
9	Not connected

Table 2 – PROFIBUS socket pin assignment

Pins 3 (RXD/TXD-P) and 8 (RXD/TXD-N) must be connected. The other pins can be used, if needed.

The gateway does not provide termination on the PROFIBUS cable. If the gateway is located at either end of the cable, the termination resistors should be provided externally, usually in a PROFIBUS plug with the termination option. The gateway provides termination power on pins 5 and 6, in accordance with the PROFIBUS Specification.

The shield on the PROFIBUS socket is galvanically connected to the metal top lid on the enclosure. An earthing lug is provided for earthing the top lid. When the PROFIBUS cable plug is in the

socket, the shield on the PROFIBUS cable is connected with the socket shield, the top lid and the earthing lug.

2.5.2 Gateway configuration

The gateway automatically detects the baud rate for the PROFIBUS network. All standard baud rates are supported as per PROFIBUS Specification, up to 12 Mbits/s.

The PROFIBUS node address of the gateway is configured with an 8-way DIP switch that is located on the front panel of the gateway. The address must be set to a value that is not in use by any other device on the PROFIBUS network. Valid address range – 0 to 125.

The procedure for setting the node address of the gateway is as follows:

- Ensure that the device is not powered up by unplugging the power connector.
- Set the DIP switches to the desired value (see figure below).
- Reinsert the power connector

Fig. 2 shows the location of the DIP switches on the front panel.

These switches are used to enter the address, with the most significant bit on the left and the least significant bit on the right. The address is entered in binary, with the switch in up position for '0' and in the switch in the down position for '1'.

For example, to set the address "3", binary 0000 0011, the switches need to be positioned as follows.

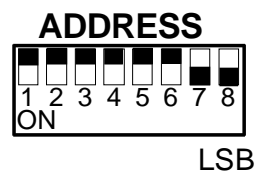


Figure 3. Entering address via dip switches, an example

In addition to setting the address, it is necessary to define the gateway's configuration in the PROFIBUS master. For detailed description of this important stage, refer to section 3.

2.6 MCD connection

2.6.1 Cabling

The MCD devices should be connected to the RS-485 serial sub-network as per the relevant Operating Instructions. The gateway is connected to the RS-485 sub-network using a 9 pin male DB connector, located to the left side of the enclosure. Pin assignment is as the following table indicates.



Pins not listed there are unused or reserved and **MUST NOT** be connected.

Pin Number	Purpose
1	+ Signal
5	Shield/Ground
9	- Signal

Table 3 – RS-485 pin assignment

We recommend using a shielded twisted pair cable. When the gateway is located away from the MCD device, the communications cable should be shielded and should not be run in the vicinity of high current power cabling. It is advisable to fit termination resistors at each end of the cable to match its characteristic impedance, typically in the range of 100-120 ohm.

The recommended connection diagrams are shown in fig. 4 and fig. 5 below. We recommend connecting cable shield on the gateway side only and we recommend that the connection point 61 or B7 on the MCD device be left unconnected.

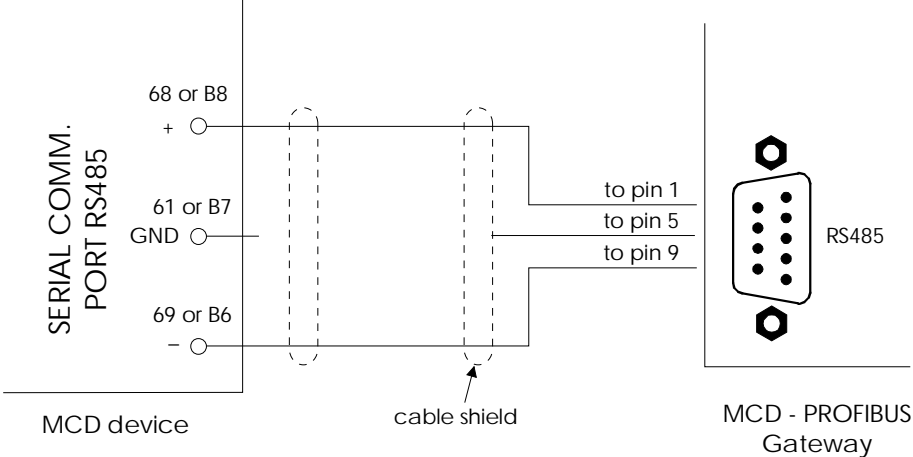


Figure 4. Recommended wiring diagram for one MCD device.

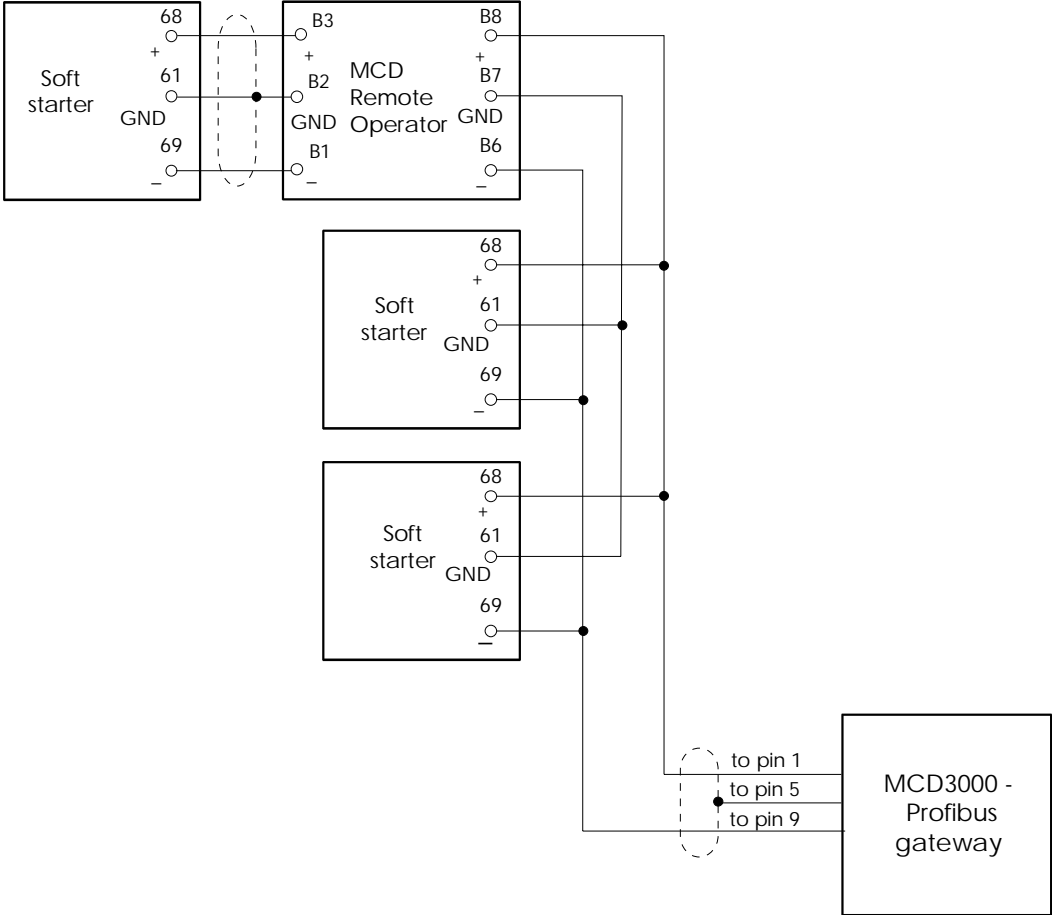


Figure 5. Wiring diagram for a number of MCD devices connected to a single gateway

If a number of MCD devices are connected to a single gateway, we recommend wiring them as in fig. 5. The cable should constitute a single line, without side branches.

Note that we recommend connecting GND points (61 or B7) on all MCD devices to guarantee that they share the same ground potential. If the devices are connected to the common ground in some other way (ex. via a metallic mounting), it may not be necessary to connect points 61 or B7.



RS-485 interface on MCD devices is not galvanically isolated. Failure to equalize ground potential on all MCD devices connected via RS-485 link may result in their damage.

2.6.2 MCD device configuration

The gateway can communicate at any of the baud rates that MCD devices can support. All MCD devices connected to the same sub-network must be configured for the same baud rate.

Each MCD device must be configured with a node address. Each must have a different address and each address must be in the range 1 to the number of MCD devices connected to the gateway, inclusive. Example: if four devices are connected to a gateway, they must have addresses 1, 2, 3 and 4.

For MCD Remote Operators connected to the gateway, the term “address” refers to the MCD Remote Operator address, Parameter 2, not the address of the soft starter connected to the MCD Remote Operator.

For soft starters connected directly to the gateway, Local/Remote Mode parameter (Parameter 20) must be set to 0, 1 or 2. Setting this parameter to 3 disables the RS-485 communications port. For more detailed explanation refer to the MCD3000 Soft Starter Operating Instructions.

Soft starter must be set for “Local” operation using the Local/Remote pushbutton on the front panel. When this is done, the LED labeled “REMOTE” on the front panel is off.



NOTE: When the soft starter is set for “Remote”, it does not execute commands received over the RS-485 link. However, it still acknowledges these commands. Consequently, the gateway and the PROFIBUS master cannot detect this condition. For working with a gateway, we recommend to set Local/Remote Mode parameter (Parameter 20) to 2 – “Local control only”. This will eliminate the possibility of the Soft Starter being accidentally set for “Remote”.

The MCD devices must be configured using the keypad/LCD display on their front panels. The method of setting parameters is described in details in the Operating Instructions.

The following tables show the relevant parameters for a soft starter connected directly to the gateway.

Parameter 20		Local/Remote Mode
Configuration Options		0-3
Acceptable settings		0-2
Recommended setting		2
Unacceptable setting		3

Table 4 – Soft starter Local/Remote modes

Parameter 22		Serial communication baud rate
Configuration Options		1 -5
Acceptable settings		1-5
Default Setting		4 – 9600 baud

Table 5 – Soft starter RS-485 baud rate values

Parameter 23		Address for RS-485 serial communications
Configuration Options		1 – 99
Required Setting		A number between 1 and the total number of MCD devices on the network

Table 6 – Soft starter address on RS-485 network

For soft starters connected to the gateway via a Remote Operator, refer to the Remote Operator instructions for soft starter configuration. The following tables show the relevant parameters for an MCD Remote Operator connected directly to a gateway.

Parameter 1		Serial communication baud rate
Configuration Options		1 -5
Acceptable settings		1-5
Default Setting		4 – 9600 baud

Table 7 – MCD Remote Operator RS-485 baud rate values

Parameter 2		Address for RS-485 serial communications
Configuration Options		1 – 99
Required Setting		A number between 1 and the total number of MCD devices on the network

Table 8 – MCD Remote Operator address on RS-485 network

Parameter 4		RS485 Network Protocol
Configuration Options		1,2
Required settings		1

Table 9 – MCD Remote Operator network protocol

3 PROGRAMMING THE MASTER CONTROLLER

3.1 GSD file

Information on the technical characteristics of the gateway is loaded into PROFIBUS master software by means of a GSD file. A floppy disk with the GSD file is supplied with the gateway. The GSD file name is "FS1135.GSD". Follow the instructions in the PROFIBUS configuration/management software manual for loading the GSD file and adding a new node to the network.

If you need a copy of the GSD file, please contact us at sales@fieldbus.com.au.

For the PROFIBUS master to communicate with the gateway, it must be provided with information about the way that the gateway works. You can do it by following these steps:

- load the GSD file, for details refer to the manual for master configuration software,
- declare the required modules within the gateway,
- if default parameters are not suitable, change these parameters.

3.2 Declaring modules

The gateway is a modular PROFIBUS slave, consisting of several modules as defined in the GSD file. The GSD file defines two types of modules – a Control Module and an MCD device module.

The Control Module has 10 bytes of input data and 3 bytes of output data, no consistency. It must be declared as the first module in the configuration.

If you cannot establish communication with PROFIBUS master, verify that the configuration of the gateway in the master. If the first module is not as above – 10 bytes IN and 3 bytes OUT, redefine the gateway configuration.

In addition to the Control Module, you must declare an MCD device module (5 Bytes In, module with data consistency) for each MCD device connected to the gateway. The gateway

assumes that the addresses of the MCD devices start at 1 and are consecutive, up to the number of expected devices.

The first MCD device module relates to the MCD device with address 1, the second one to 2 and so on. Address values are not related to physical positioning of MCD devices on the RS-485 sub-network.

NOTE for users of SIMATIC S7:

Slave modules are defined as so called “modules with data consistency”. This is necessary to guarantee accuracy of reading the current. The consequence of it in S7 is that module data cannot be read directly – direct reading always returns 0. Instead, you should use SFC14 to cyclically copy module data to PLC internal memory and then retrieve the required values. In case of problems consult an S7 expert re. the memory addresses to be used for slave modules and the correct way of retrieving module data.

3.3 Setting PROFIBUS parameters

The gateway requires three parameters, associated with the control module in the gateway configuration. The first parameter defines the desired baud rate on the RS-485 network. The gateway supports all the baud rates that the MCD devices support:

First Parameter Value	Baud Rate
1	1,200 bps
2	2,400 bps
3	4,800 bps
4	9,600 bps (Default)
5	19,200 bps

Table 10 – Gateway parameter, RS-485 link baud rate

The second parameter defines gateway operation if communication with the master stops:

Second parameter	Action on communication breakdown
1	Stop polling MCD devices
2	STOP command sent to all MCD devices
3	COAST TO STOP sent to all devices

Table 11 – Gateway parameter, gateway operation on communication loss

The selected action will be executed when the gateway had established initial communication with the master and subsequently this communication stops.

If the second parameter is set to 1, the gateway will stop polling MCD devices on communications breakdown. This may cause soft starters to trip, if they are so programmed (Parameter 24). For other values of the second parameter, the gateway will keep on polling and will prevent soft starters from tripping.

The third parameter defines the timeout, in seconds, for communication with the master.

If the gateway stays off-line on PROFIBUS for the time period as set in the third parameter, the gateway will take action as defined by the second parameter. Allowed range is 0 to 255. Default value is 5, setting the timeout at 5 sec. If the third parameter is set to 0, no timeout supervision will be carried out and once communication with master commences, the gateway will keep on polling MCD devices irrespective of the status of gateway-master link.

On receiving an invalid parameter value or invalid configuration data from the PROFIBUS master, the gateway goes offline and flashes the PROFIBUS status LED green, red and then turns it off. After a few seconds the PROFIBUS master will try again to set the gateway to ONLINE state and the cycle repeats until the error is corrected.

3.4 Master-slave data exchange

Data exchanged between PROFIBUS master and slaves are of two types – configuration data and process data.

Configuration data are transmitted once only when the master establishes communication with the slave. These data carry information about slave configuration – the modules declared there. Also included in the configuration data are parameters, sent from master to the slave. In case of the gateway, the configuration data instruct the gateway about the number of MCD devices to scan, about the baud rate on the RS-485 network and about required action if the gateway goes off-line on PROFIBUS.

Process data are the data transmitted cyclically between the master and slave. The PLC writes the data for the slave to the Write area and reads the data from the slave from the Read area. Locations of the Write and Read areas in the PLC memory are specific to each PLC. For details consult the PLC manual.

3.5 Data write area

The only write data (data transferred from PROFIBUS master to the gateway) are contained in the control module – 3 bytes of data. These three bytes are used to issue commands to MCD devices, as described later in this manual.

The first byte is the Master Handshake Register. Only the two least significant bits B0 and B1 are used, the other six bits are ignored by the gateway. Meaning of the value of bits B0 and B1 is explained later in this document.

The second byte is the Command Register. When PROFIBUS master controller issues a command to a MCD device, it writes the code of the command to the Command Register. Table 15 below shows all the valid values – command codes - that can be written to the Command Register and the commands associated with these values. The values in the table are shown in hexadecimal. These values have been chosen to resemble the original command codes as used by MCD devices. For example, the ASCII command code for Stop is "B12". The hexadecimal value selected for Stop is B2 (hex), 0xB2 in C language notation and 1011 0010 in binary.

The third byte – Address Register – contains the RS-485 sub-network address of the MCD device that the command is for.

Offset	Contents	Comments
0	Master Handshake Register	Bit B0: New Command Bit. Bit B1: Result Acknowledge Bit.
1	Command Register	see Table 15 below
2	Slave Address Register	Address of the slave that the command is for.

Table 12 – PROFIBUS Write / Out Memory

3.6 Data read area

Read data (data that the PROFIBUS master reads from the gateway) come from the control module – 10 bytes – and from each slave module defined for MCD devices – 5 bytes for each MCD device. Actual memory addresses depend on programming of the master controller, so in the following description we refer to offsets, where the very first byte in a module is assumed to have offset 0 and the subsequent bytes within the module follow.

The first byte in the control module – offset 0, Slave Handshake Register – operates in the way similar to the Master Handshake Register. Only the bits B0 and B1 are used. More detailed explanation can be found later in this document.

The second byte at offset 1 carries the code of the outcome of the command – 1 for success, error codes 2, 3 or 4 in case of failure, see the table below for details.

Result code	Description
1	Successful completion
2	The gateway rejected the command – invalid command code or data
3	No reply from the target or target rejecting the command
4	Invalid target address

Table 13 – Command result codes

The next four bytes (at offsets 2 to 5) carry information about network status of devices on the RS-485 sub-network. The first byte (at offset 2) relates to addresses 1-8, the second to 9-16, the third to 17-23 and the fourth is unused. Four bytes are always reserved, irrespective of the number of slaves present.

When bit B0 in byte at offset 2 is set, it indicates that the MCD device with address 1 is present and communicating. Similarly, bit B1 set indicates slave 2 present. A bit set to 0 means that

the corresponding slave is not present or not communicating. Bits related to slaves not declared on the network are always set to 0.

All data related to a slave (status data, trip codes, current and temperature) are valid only if the relevant network status bit is set.

The four bytes at offsets 6-9 are used for commands that return data, such as Request Status. The content of these bytes is the same as the content of the data part of a reply received from the MCD devices, refer to the relevant MCD device Operating Instructions for more details.

Slave modules have 5 read bytes each, one block for each MCD device. The structure of each 5-byte block is the same, see Table 14. This table assumes consecutive placement of modules in master's memory. If your master controller places modules differently, the offset values will be different.

The value in two-byte Current register is an unsigned 16-bit (two byte) integer in the range 0-9999, with the first byte being the least significant one and the second byte being the most significant.

The last byte – Temperature register - carries information about motor's temperature, given as percentage of the motor's thermal capacity, range 0 to 250%, encoded as an unsigned integer. If the MCD device reports motor temperature greater than 250%, the gateway will report 250%.

As a general rule, all unused bits or bytes are always set to 0.

Table 14 shows the structure of the Read area for a controller that allocates modules consecutively in memory. For other controllers, such as S7, the values of offset start from 0 for each module and placement of consecutive modules in PLC memory can be arbitrary.

	Offset	Contents	Comments
10-byte control block	0	Slave Handshake Register	Bit B0: Command Ackn. bit Bit B1: Result Ready bit
	1	Command Result Register	1: Success. 2: Invalid/rejected command. 3: No/rejected response from slave. 4: Invalid slave address
	2	Online Slaves Register 1	Bit B0: Slave 1 online. ... Bit B7: Slave 8 online.
	3	Online Slaves Register 2	Slave 9 online - Slave 16 online.
	4	Online Slaves Register 3	Slave 17 online - Slave 23 online.
	5	Online Slaves Register 4	unused
	6-9	Data Read Registers	Command Data Reply
5-byte block for address 1	10	Status for address 1	Status value for device at address 1
	11	Trip for address 1	Trip value for device at address 1
	12-13	Current for address 1	Motor Current, 0 – 9999 Amps.
	14	Temperature for addr. 1	Motor Thermal Capacity, 0 – 250%
5-byte block for address 2	15	Status for address 2	As above
	16	Trip for address 2	As above
	17-18	Current for address 2	As above
	19	Temperature for addr. 2	As above

5-byte block for address 23	120	Status for address 23	As above
	121	Trip for address 23	As above
	122-123	Current for address 23	As above
	124	Temperature for addr. 23	As above

Table 14 – PROFIBUS Read / In memory

3.7 Issuing Commands

PROFIBUS master can issue commands to each MCD device at any time. The following Table 15 lists the commands as well as the purpose of these commands. The commands are shown in hexadecimal notation.

Command	Action
0xB0	Start Motor
0xB2	Stop Motor
0xB4	Reset Trip State
0xB6	Coast To Stop
0xC2	Read Status
0xC6	Read RS-485 Protocol Version
0xC8	Read Trip Status
0xD0	Read motor Current
0xD2	Read Motor Temperature
0xFF	Read Gateway Firmware Revision

Table 15 – Valid commands

This is the procedure for issuing a command:

- Write the slave address into the Slave Address Register (Control module, Write data, byte at offset 2),
- Write the command into the Command Register (Control module, Write data, byte at offset 1),
- As the last step, toggle the Command Request Bit in the Master Handshake Register (Control module, Write data, byte at offset 0) - change the bit from 0 to 1 or from 1 to 0 - so that it is different from the Command Acknowledgment Bit in Slave Handshake Register.

Then the following happens:

- The gateway toggles the Command Acknowledge Bit in Slave Handshake Register (Control module, Read data, byte at offset 0) to make it the same as the Command Request Bit. This indicates an acknowledgement of the command (but not its completion).
- When the command processing has finished, whether successfully or not, the gateway places the results into the Command Result Register (Control module, Read data,

byte at offset 1).

- In the last step the gateway toggles the Result Ready Bit in Slave Handshake Register (Control module, Read data, byte at offset 0), indicating the completion of the command as well as the availability of the results.

This is how Master can read the outcome of the command:

- Upon detecting change of value of the Result Ready Bit, PROFIBUS master should read the Command Result Register (Control module, Read data, byte at offset 1).
- If the command was "Read Status" or "Read Trip Status", PROFIBUS master can also read the Data Read Registers. These are bytes at offsets 6 through to 9 in the Control module Read data. The content of these four bytes is the same as the four bytes that MCD device sends in reply to the equivalent command, refer to the MCD device Operating Instructions for details.
- If the command was "Read Gateway Firmware Revision", PROFIBUS master can retrieve the content of the Data Read Registers, bytes at offsets 6-9 in Control Module. The firmware revision is encoded as four ASCII characters. Example – for Rev. 3.01, the content of the four data bytes will be '0' (0x30), '3' (0x33), '0' (0x30) and '1' (0x31).
- As the last step, PROFIBUS master should toggle the Command Acknowledge Bit in the Master Handshake Register (Control module, Write data, byte at offset 0) to indicate to the gateway that the result/reply has been read.

PROFIBUS master must **NOT** issue a command until:

- the gateway has acknowledged the previous command – bits B0 in Master and Slave Handshake Registers are equal, whether 0 or 1,
- the reply to it has been acknowledged – bits B1 in Master and Slave Handshake Registers are equal, whether 0 or 1.



Status of the motor can be affected by a number of factors other than commands. Consequently, you must not assume that the motor is in any particular state even if a command has been accepted and returned Success in Command Result Register. To monitor status of the motor, the master controller should continuously monitor the Status register.

An attempt to issue a command before the gateway has acknowledged and responded to the previous one will be

ignored and may lead to an unpredictable behaviour of the gateway.

On startup, the PROFIBUS master should set the Master Handshake Register to 0. The gateway resets Slave Handshake Register to 0 while not on PROFIBUS network. This guarantees proper startup conditions for the handshaking mechanism. We recommend that PROFIBUS master program checks the correct startup conditions – bits B0 and B1 in both handshake registers being equal.

The tables below show possible combinations of handshaking bits and their meaning. Symbol X means either 0 or 1, /X means the opposite to X.

New Command Bit (B0)	Command Acknowledge Bit (B0)	Meaning
X	/X	Bits are different. PROFIBUS master has issued a command, but the gateway has not accepted it yet.
X	X	Bits are the same. No command or the gateway has accepted the command.

Table 16 – New Command / Command Acknowledge handshaking

Result Ready Bit (B1)	Result Acknowledge Bit (B1)	Meaning
X	/X	Bits are different. The gateway placed command results in PROFIBUS data and awaits the master’s confirmation.
X	X	Bits are the same. No results or the result has been read.

Table 17 – Result Ready / Result Acknowledge handshaking

It is the gateway’s responsibility to acknowledge the command bits via the ‘Command Acknowledge Bit’. It is the PROFIBUS master’s responsibility to acknowledge the result bits via the ‘Result Acknowledge Bit’. Failure to follow the handshaking procedure may lead to unpredictable behaviour of the gateway.

Commands take precedence over scanning of slaves and will be executed within 250 msec. If the PROFIBUS master detects undue delay in gateway acknowledging the command or

sending a response, it should restart the gateway by placing it in OFFLINE state and then returning it to ONLINE.

This is an example of the complete procedure for resetting trip state of an MCD device at address 3 using Reset Trip State command:

1. Check that the device is on-line, i.e. the network status bit is set – in this case check Read byte at offset 2, bit B2. If this bit is set to 1, you can proceed. If the bit equals 0, the device at address 3 is offline.
2. Check that previous commands have been completed – Master Handshake Register and Slave Handshake Register are equal.
3. Write command code 0xB4 (Reset Trip State) to Command Register - byte at offset 1 in Write area. Also write slave address 3 to Address Register – byte at offset 2 in Write area. The sequence in which these bytes are being written into is irrelevant.
4. Modify bit B0 in Master Handshake Register – change it from 0 to 1 or from 1 to 0, whichever is applicable, to indicate to the gateway that a command is pending. You may monitor that bit B0 in Slave Handshake Register changes to equal bit B0 in Master Handshake Register, indicating that the gateway device accepted the command. Be aware that this change does not have to be immediate.
5. Wait for bit B1 in Slave Handshake Register to change, indicating that a reply is waiting. This may take some time, needed for execution of the command.
6. Read Command Result Register. If it equals 1, the command has been successful. If Command Result Register equals 2, 3 or 4, the command failed. In either case, acknowledge the response by modifying bit B1 in Master Handshake Register to make it equal B1 in Slave Handshake Register.

For commands that do not return any data (such as Start or Stop), there is no need to read Data Read Registers at offsets 6 to 9.

4 OPERATION OF THE GATEWAY

4.1 Scanning slaves

The gateway starts scanning slaves only after the PROFIBUS master sends the configuration data and the gateway goes online on PROFIBUS.

The gateway periodically retrieves Status, Trip Code, Current and Temperature from each slave and updates the PROFIBUS process Read data in an autonomous fashion. Status and Trip Code are being read most frequently – in each scan cycle, Current is read once every third scan cycle and Temperature every tenth scan cycle.

On the first scan the Status, Trip Code, Current and Temperature are read from all declared devices. The device network status bits in the Read area, offset 2-4, are set for all slaves that reply, refer to Table 14.

If an MCD device fails to respond to a data request command, it is considered an “Offline Slave” and has its corresponding network status bit cleared. Also cleared are the process data bytes related to this device.

Note that Status, Trip code, Current and Temperature process data for each slave in PROFIBUS master memory are valid only if the relevant network status bit is set. If the network status bit is not set, then the process data associated with that particular slave are invalid.

4.2 Scanning times

The following Table 18 gives an indication of the time required to complete a polling cycle for a number of slaves present on a serial link over the supported baud rates. The times are in seconds. These figures indicate possible delay in detecting changes to Status and Trip code – data read in each scan cycle.

No. of Devices	1,200 bps	2,400 bps	4,800 bps	9,600 bps	19,200 bps
1	0.500	0.300	0.190	0.130	0.110
2	1.000	0.600	0.380	0.260	0.220
3	1.500	0.900	0.570	0.390	0.330
4	2.000	1.200	0.760	0.520	0.440
5	2.500	1.500	0.950	0.650	0.550
10	5.000	3.000	1.900	1.300	1.100
15	7.500	4.500	2.850	1.820	1.650
20	10.000	6.000	3.800	2.600	2.200

Table 18 – Scanning cycle length for different baud rates and the number of MCD devices present

The Current register is scanned once every three scan cycles. Consequently, the average time between two consecutive reads of the current register of the MCD devices is three times greater than the time as in the table above.

The Temperature register is scanned once every ten scan cycles. Consequently, the average time between two consecutive reads of the Temperature register of the MCD devices is ten times greater than the time as in the table above.

The gateway will automatically detect if a MCD device that was declared offline becomes available again. The Table 19 shows the worst case time for detecting such a device, assuming that only one device on the network is offline. The time is in seconds.

No. of Devices	1,200 bps	2,400 bps	4,800 bps	9,600 bps	19,200 bps
1	0.250*	0.250*	0.250*	0.250*	0.250*
2	5.000	3.000	1.900	1.300	1.100
3	7.500	4.500	2.850	1.950	1.650
4	10.000	6.000	3.800	2.600	2.200
5	12.500	7.500	4.750	3.250	2.750
10	25.000	15.000	9.500	6.500	5.500
15	37.500	22.500	14.250	9.750	8.250
20	50.000	30.000	19.000	13.000	11.000

* Only the offline device is on the network, so no other scanning takes place.

Table 19 – Maximum time to detect return of an offline device

4.3 Offline slaves

Since up to 23 slaves can share the same RS-485 serial link, it is critical that communication delays are kept to a minimum. Slaves that are slow to respond slow down the entire serial link. It is important that slaves that fail to respond do not hold up the gateway. The following scheme is used to handle offline slaves:

- If a slave fails to respond to a command, it is considered an offline slave and joins a list of offline slaves, internal to the gateway.
- In each polling cycle all online slaves are polled. After 5 polling cycles, a command is sent to one of the offline slaves.
- On a subsequent offline slave poll, the next slave on the list of offline slaves is polled.
- Once an offline slave responds to a command it is no longer considered an offline slave.

This mechanism helps keep network delays to a minimum while also being able to recover offline slaves when they come online.

The above mechanism allows connecting/disconnecting MCD devices while the network is working, with minimal impact on the rest of the network.

5 SPECIFICATIONS

Item	Value
Enclosure	
- Width	100 mm
- Height	75 mm
- Depth	110 mm
Mounting	DIN Rail or Screw Mounting
PROFIBUS Interface	
- Connector Type	9 Pin DB Female
- Galvanically Isolated	Yes (850V)
- Status Indicator (Type)	5mm Bi-Coloured LED
- Configured	Dip switches (Address)
MCD Subnetwork Interface	
- Connector Type	9 Pin DB Male
- Galvanically Isolated	Yes (1000V)
- Status Indicator (Type)	5mm Bi-Coloured LED
- Configured	Via PROFIBUS
Power	
- Voltage	24V
- Consumption	3.2 Watts
- Connector Type	Removable Screw Terminal
- Reverse Polarity Protection	Yes
- Surge / Short Protection	Fuse
Other Items	
- Field Programmable	Yes
- Weight	Approx. 350g
- Protection Class	IP 20

Table 20 – Gateway specifications

6 TROUBLESHOOTING

Indications	Problem	Possible cause (check in the order listed)
LEDs all off for extended period	No power	No power Incorrect polarity Gateway's fuse blown
Both LEDs flashing red	PROFIBUS address invalid	PROFIBUS address on DIP switches set outside the valid range 0-125
PROFIBUS Status LEDs flashing red,	No communication with PROFIBUS master	PROFIBUS master is disconnected or off PROFIBUS cable is cut/broken/not installed correctly PROFIBUS address set incorrectly High inducted noise on the cable
PROFIBUS Status LEDs flashing green/red/off	Gateway communicating with PROFIBUS master, but unable to establish data link	Incorrect gateway configuration information in PROFIBUS master, incorrect parameter value
RS-485 Status LED flashing red	No communication on RS-485 link	RS-485 cable fault (cut/broken/not installed correctly) No devices are configured correctly for operation over RS-485 No device addresses are set correctly
RS-485 Status LED flashes red/green	Errors on RS-485 link, but some communication still takes place	Some devices not present Some devices are not configured for remote operation over RS-485 Some device addresses are set incorrectly Incorrect gateway configuration information in PROFIBUS master PROFIBUS master issues invalid command/request

Table 21 – Troubleshooting guide