

**PROFIBUS Gateway
for MCD 3000 Series Soft Starters**

P/N FS-1135

User Manual

Ver. 1.9

10 October 2003

© Copyright 2002 Fieldbus Specialists

REVISION NOTES

Index	Date	Chapter	Author	Rev.	Revision note
1	04-Feb-2002	All	AMcN	1.0	Created
2	11-Feb-2002	All	AJ	1.1	Various corrections
3	10-Mar-2002	All	AJ	1.2	Extended indications for invalid PROFIBUS address
4	14-Mar-2002	2.6.2, 7	AJ	1.3	Local/Remote setting recommendations, corrections to Specifications
5	4-April-2002	2.6.1	AKJ	1.4	Wiring diagrams added, mapping of read memory corrected
6	5-MAY-2002	All	AmcN, AJ	1.5	Unified format, added functions to handle comm. breakdown
7	25-OCT-2002		AJ	1.6	Added comments related to Siemens S7 PLC
8	1-OCT-2003		JP	1.7	Added comments re. firmware version 2.02 and code compliance with Danfoss manual AMB00000 Rev. G
9	9-OCT-2003		JP/AJ	1.8	Modified to reflect compliance with AMB00000 Rev. G
10	10-OCT-2003		JP	1.9	Note re.byte sequencing in 2.10

TECHNICAL SUPPORT

In case of any questions or problems, please contact Fieldbus Specialists on

sales@fieldbus.com.au.

We will endeavour to reply immediately.

PREFACE

The data and illustrations in this manual are not binding. Fieldbus Specialists reserve the right to modify our products in line with our policy of continuous product development. The information in this manual is subject to change without notice and should not be considered as a commitment by Fieldbus Specialists.

Fieldbus Specialists assume no responsibility for any errors that may appear in this document.



Although this product has been developed with great care and extensively tested, Fieldbus Specialists cannot guarantee the suitability of this product for any purpose. Warranty claims shall be limited to the right to require rectification of faults. Liability for any damages, which may have arisen from the use of this product or its documentation, shall be limited to cases of intent.

CONTENTS

1	INTRODUCTION	6
1.1	IMPORTANT USER INFORMATION.....	6
1.2	GENERAL.....	6
2	INSTALING THE GATEWAY	8
2.1	GATEWAY CONNECTION DIAGRAM.....	8
2.2	FRONT PANEL	9
2.3	INSTALLATION SEQUENCE.....	11
2.4	POWER CONNECTION	11
2.5	PROFIBUS CONNECTION.....	12
2.5.1	Cabling	12
2.5.2	GATEWAY CONFIGURATION	13
2.6	MCD3000 CONNECTION.....	14
2.6.1	Cabling	14
2.6.2	MCD3000 configuration	16
3	PROGRAMMING THE MASTER CONTROLLER	18
3.1	GSD FILE.....	18
3.2	DECLARING MODULES	18
3.3	SETTING PROFIBUS PARAMETERS.....	19
3.4	MASTER-SLAVE DATA EXCHANGE	21
3.5	DATA WRITE AREA.....	21
3.6	DATA READ AREA	22
3.7	ISSUING COMMANDS	24
4	OPERATION OF THE GATEWAY	29
4.1	SCANNING SLAVES.....	29
4.2	SCANNING TIMES	29
4.3	OFFLINE SLAVES	31
5	SPECIFICATIONS	32
6	TROUBLESHOOTING	33

Table List

Table 1 – LED Indication	10
Table 2 – PROFIBUS socket pin assignment	12
Table 3 – RS-485 pin assignment	14
Table 4 – MCD 3000 Local/Remote modes	17
Table 5 – MCD 3000, RS-485 baud rate values.....	17
Table 6 – MCD 3000 node address on RS-485 network.....	17
Table 7 – Gateway parameter, RS-485 link baud rate	19
Table 8 – Gateway parameter, gateway operation on communication loss	20
Table 9 – PROFIBUS Write / Out Memory in control module.....	22
Table 10 – Command result codes	22
Table 11 – PROFIBUS Read / In memory.....	24
Table 12 – Valid commands.....	25
Table 13 – New Command / Command Acknowledge handshaking	27
Table 14 – Result Ready / Result Acknowledge handshaking	27
Table 15 – Scanning cycle length for different baud rates and the number of MCD 3000 devices present.....	30
Table 16 – Maximum time to detect return of an offline device	30
Table 17 – Gateway specifications.....	32
Table 18 – Troubleshooting guide.....	33

Figure List

Figure 1. Typical diagram of a PROFIBUS network, a gateway and an RS-485 sub-network.	8
Figure 2. Gateway front panel	9
Figure 3. Entering address via dip switches, an example	13
Figure 4. Recommended wiring diagram for one MCD3000 device.....	15
Figure 5. Wiring diagram for a number of MCD3000 devices connected to a single gateway.....	15

1 INTRODUCTION

1.1 Important user information

This manual describes operation and programming of a PROFIBUS gateway for MCD3000 series soft starters, gateway firmware revision 2.11.

Gateway with firmware version 2.11 complies with MCD3000 protocol as described in Danfoss manual AMB00000 Rev. G and is likely to be incompatible with earlier versions of the soft starter. Remote programming of parameters is not supported at the moment. Contact Fieldbus Specialists if you require a firmware version that supports earlier models.



Observe all the necessary safety precautions when controlling any MCD 3000 series device over the serial communications link, including alerting personnel that the machinery may start without warning.

1.2 General

The MCD 3000 series of solid state soft starters incorporate a serial communications facility that allows for the remote control and interrogation of the MCD 3000 from an intelligent host (master) via a multi-drop RS-485 communications network using a proprietary protocol, specific to MCD 3000 devices.

The RS-485 link may be used to interface a MCD 3000 device to a PROFIBUS network using the PROFIBUS to MCD 3000 gateway. The PROFIBUS Master can then control any connected MCD 3000 device – start it, stop, reset trip conditions and read operational status, motor conditions or trip status.

The PROFIBUS to MCD 3000 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 3000 communications network. **Up to 30** MCD 3000 devices may be connected to a single Gateway. In this way up to 30 MCD 3000 devices will share one PROFIBUS address on the PROFIBUS communications network.

This manual describes how the PROFIBUS to MCD 3000 gateway operates, how to connect MCD 3000 series soft starters 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 3000 Operating Instructions, Danfoss document no. AMB00000.

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.

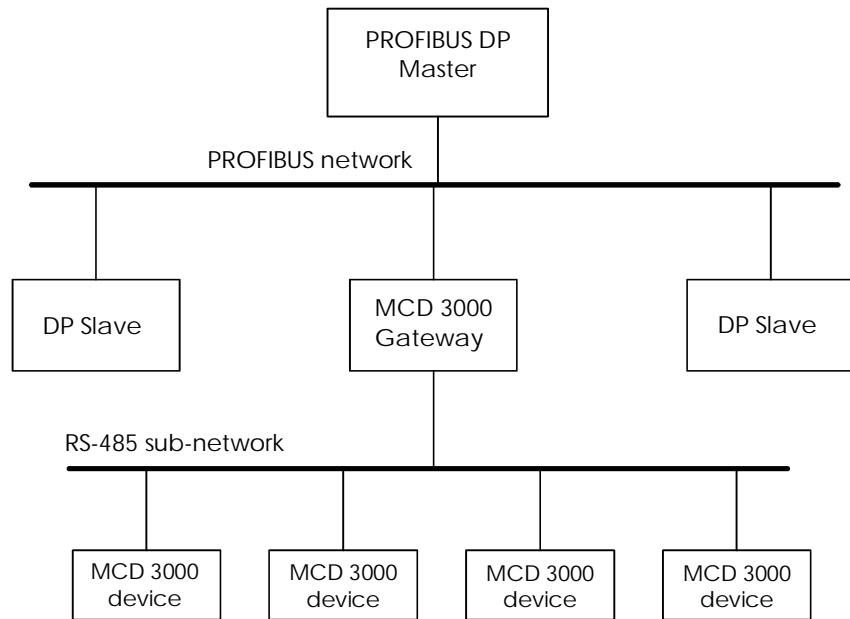


Figure 1. Typical diagram of a PROFIBUS network, a gateway and an RS-485 sub-network.

A gateway can coexist with a number of other PROFIBUS nodes, including other gateways. Each gateway constitutes a single PROFIBUS node, even if it connects to a number of MCD 3000 devices.

2.2 Front panel

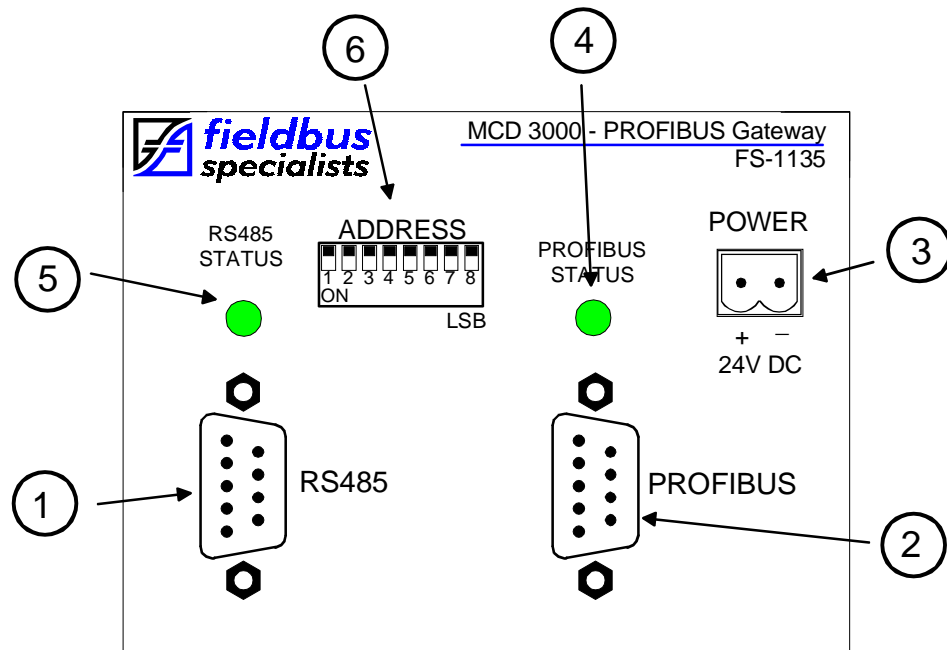


Figure 2. Gateway front panel

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

1. RS-485 sub-network connector for connecting up to 30 MCD 3000 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 parameter in Master
G	ANY	PROFIBUS link up and problem-free
ANY	R/B	No communication on the RS-485 link
ANY	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 until you get the PROFIBUS LED steady green.**
- Configure and connect the first MCD 3000 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 MCDs. If the RS-485 status LED stays solid red, check the RS-485 cable, the MCD 3000 device configuration (set to Local), wiring to MCD 3000 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 3000 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 3000 does 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 – it is ~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 PROFIBUS to MCD 3000 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 PROFIBUS to MCD 3000 Gateway 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.

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 PROFIBUS to MCD 3000 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. 1 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.

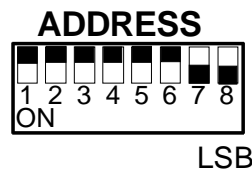


Figure 3. Entering address via dip switches, an example

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 MCD3000 connection

2.6.1 Cabling

The MCD 3000 devices should be connected to the RS-485 serial sub-network as per the MCD 3000 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 soft starter, 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 diagram is shown in fig. 4 below. We recommend connecting cable shield on the gateway side only and we recommend that the connection point 61 on the MCD3000 device be left unconnected.

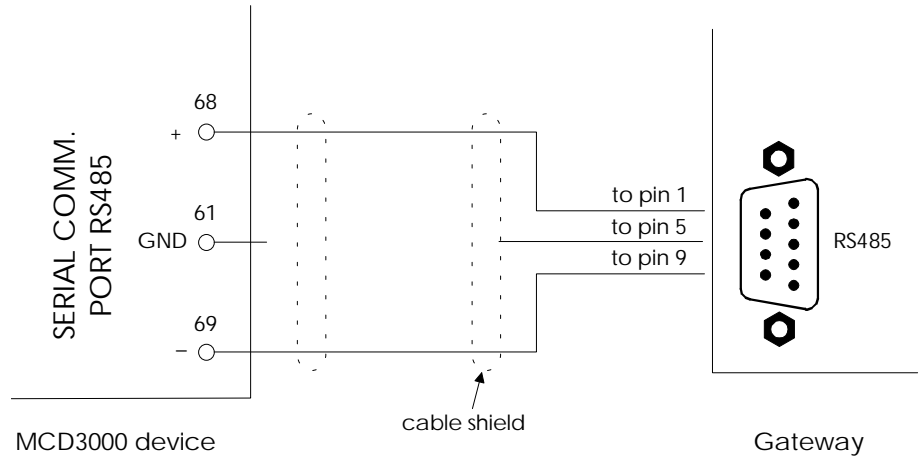


Figure 4. Recommended wiring diagram for one MCD3000 device.

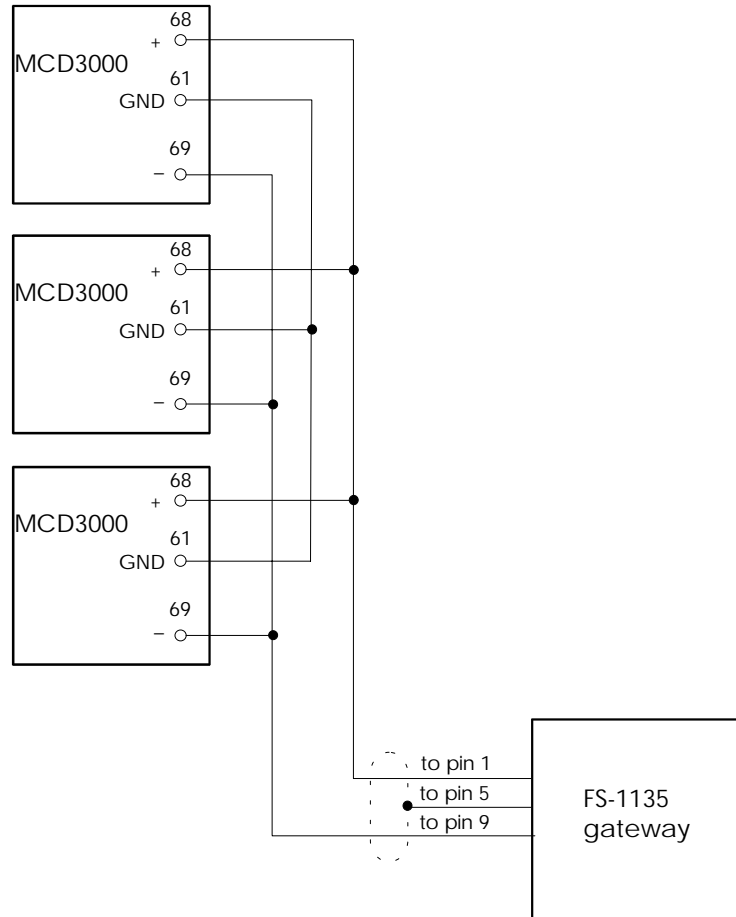


Figure 5. Wiring diagram for a number of MCD3000 devices connected to a single gateway

If a number of MCD3000 devices are connected to a single gateway, we recommend wiring them in series, see fig. 5. The cable should constitute a single line, without side branches.

Note that we recommend connecting GND points (61) on all MCD 3000 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.



RS-485 interface on MCD3000 is not galvanically isolated. Failure to equalize ground potential on MCD 3000 devices connected via RS-485 link may result in their damage.

2.6.2 MCD3000 configuration

The gateway can communicate at any of the baud rates that MCD 3000 devices can support. All MCD 3000 devices connected to the same sub-network must be configured for the same baud rate.

Each MCD 3000 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 3000 devices connected to the gateway, inclusive. Example: if four devices are connected to a gateway, they must have addresses 1, 2, 3 and 4.

Each MCD 3000 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 MCD 3000 Operating Instructions.

MCD 3000 devices 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 MCD3000 device 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 MCD3000 device being set for "Remote" accidentally or by mistake.

The MCD 3000 devices must be configured using the keypad/LCD display on its front panel. The method of setting

parameters is described in details in the MCD 3000 Series Soft Starter Operating Instructions.

The following tables show the required configuration for the MCD 3000 soft starter parameters relevant to the operation of the gateway.

Parameter 20		Local/Remote Mode
Configuration Options	0	Local/Remote enabled
	1	Local/Remote enabled only when motor stopped
	2	Local control only
	3	Remote control only
Default Setting	0	Local/Remote enabled

Table 4 – MCD 3000 Local/Remote modes

Parameter 22		Serial communication baud rate
Configuration Options	1	1200 baud
	2	2400 baud
	3	4800 baud
	4	9600 baud
	5	19200 baud
Default Setting	4	9600 baud

Table 5 – MCD 3000, RS-485 baud rate values

Parameter 23		MCD 3000 address for RS-485 serial communications
Configuration Options	1 – 99	
Required Setting	A number between 1 and the total number of MCD 3000 devices on the network	

Table 6 – MCD 3000 node address on RS-485 network

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 the new slave, the gateway, 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,
- set PROFIBUS parameters of the gateway.

3.2 Declaring modules

The gateway is a modular PROFIBUS slave, consisting of several modules as defined in the GSD file. The gateway must be configured with the control module declared first, and then with one slave module declared for each soft starter connected to it.

The control module has 10 bytes of input data and 3 bytes of output data, no consistency. This module is declared in the GSD file with the "Preset" keyword and many configuration applications will automatically declare it as required and in the correct position – as the first module in the configuration. Check that the software you are using supports the "Preset" keyword and if not, declare this module manually as the first one in the configuration data of the gateway.

In addition to the control module, you must declare a slave module (5 Bytes In, module consistency) for each MCD 3000 device connected to the gateway. The gateway assumes

that the addresses of the MCD 3000 devices start at 1 and are consecutive, up to the number of expected devices.

The first motor starter module relates to the MCD 3000 with address 1, the second one to 2 and so on. Address values are not related to physical positioning of MCD 3000 devices on the RS-485 sub-network.

NOTE for users of SIMATIC S7:

Motor starter modules are defined as so called “modules with data consistency”. This is necessary to guarantee accuracy of current reading. 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 motor starter 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 3000 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 7 – 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 MCD3000 devices
2	STOP command sent to all MCD3000 devices
3	COAST TO STOP sent to all devices

Table 8 – 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 MCD3000 devices on communications breakdown. This may cause MCD3000 devices to trip, if they are so programmed (Parameter 24). For other values of this parameter, the gateway will keep on polling and will prevent MCD3000 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 MCD3000 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 slave 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 MCD3000 gateway, the configuration data instruct the gateway about the number of MCD 3000 devices to scan, about the baud rate on the RS-485 network and about required action if the gateway goes off-line on PROFIBUS. Master controller generates the configuration data autonomously and the PLC has no control over their transmission or content.

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 MCD3000 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 MCD3000 device, it writes the code of the command to the Command Register. Table 9 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 MCD3000 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 12 below
2	Slave Address Register	Address of the slave that the command is for.

Table 9 – PROFIBUS Write / Out Memory in control module

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 3000 devices – 4 bytes for each MCD 3000. 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 10 – 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 17-24 and the fourth to 25-30. 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 MCD3000 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 MCD3000 devices, refer to the MCD 3000 Series Soft Starter Operating Instructions for more details.

Slave modules have 5 read bytes each, one block for each MCD3000 device. The structure of each 5-byte block is the same, see Table 11. 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 Status_1 register is read from the MCD3000 device and then inverted, to yield positive logic – 1 meaning YES/TRUE and 0 meaning NO/FALSE.

The value in Trip register is as described in the starter manual.

The value in two-byte Current register is an unsigned 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 MCD3000 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 11 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
0	Slave Handshake Register	Bit Bit B0: Command Ackn. Bit 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 24 online.
5	Online Slaves Register 4	Slave 25 online - Slave 30 online.
6-9	Data Read Registers	Command Data Reply
10	Status for address 1	Status_1 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 address 1	Motor Thermal Capacity, 0 – 250%
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 address 2	As above
...
...
155	Status for address 30	As above
156	Trip for address 30	As above
157-158	*Current for address 30	As above
159	Temperature for address 30	As above

Table 11 – PROFIBUS Read / In memory

3.7 Issuing Commands

PROFIBUS master can issue commands to each MCD 3000 at any time. The following Table 12 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
0xC0	Read Status
0xC2	Read Status_1
0xC6	Read RS-485 Protocol Version
0xC8	Read Trip Status
0xD0	Read Current
0xD2	Read Temperature
0xFF	Read Gateway Firmware Revision

Table 12 – 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”, “Read Status_1” or “Read Trip Status”, PROFIBUS master should 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 3000 device sends in reply to the equivalent command, refer to the MCD 3000 device Operating Instructions for details.
- If the command was “Read Gateway Firmware Revision”, PROFIBUS Master should 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. 2.02, the content of the four data bytes will be ‘0’ (0x30), ‘2’ (0x32), ‘1’ (0x31) and ‘0’ (0x30).
- 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 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 13 – 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 14 – 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 reading status data of an MCD3000 device at address 3 using Read Status 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 0xC0 (Request Status) 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, retrieve the requested device status from Data Read Registers at offsets 6 to 9. If Command Result Register equals 2, 3 or 4, process the error. 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_1, Trip Code, Current and Temperature from each slave and updates the PROFIBUS process Read data in an autonomous fashion. Status_1 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_1, Trip Code, Current and Temperature are read from all declared devices. The device network status bits in the Read area, offset 2-5, are set for all slaves that reply, refer to Table 11.

The addressing scheme for the MCD 3000 Soft Starters assumes that the node addresses of all the MCD 3000 devices are in the range from 1 up to the number of devices preset in the configuration. Devices with higher addresses are not scanned.

If a slave 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 slave.

Note that Status_1, 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 16 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_1 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
25	12.500	7.500	4.750	3.120	2.750
30	15.000	9.000	5.700	3.900	3.300

Table 15 – Scanning cycle length for different baud rates and the number of MCD 3000 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 3000 devices is three times greater than the time as in the table above.

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
25	62.500	37.500	23.750	16.250	13.750
30	75.000	45.000	28.500	19.500	16.500

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

Table 16 – Maximum time to detect return of an offline device

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 3000 devices is ten times greater than the time as in the table above.

The gateway will automatically detect if a MCD 3000 device that was declared offline becomes available again. The Table 16 above 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.

4.3 Offline slaves

Since up to 30 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 to connect/disconnect MCD 3000 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)
MCD3000 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 17 – 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 18 – Troubleshooting guide