REMIO

Communications interface

TPO version:
Time proportioning output

Modbus®

Profibus-DP

DeviceNet™

User Manual

REMIO

Communicating interface for the TE range of power units

TPO Version: Time Proportioning Output

Communications protocols
Modbus®
Profibus-DP
DeviceNet™

User Manual

Part No. HA 175874 ENG Issue 2.0 Printed in France 01/2000

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RELEVANT EUROPEAN DIRECTIVES

SAFETY

REMIO products are not affected by the European Low Voltage Directive of 73/23/EEC of 19/2/73 (amended by the Directive 93/68/EEC of 22/7/93).

ELECTROMAGNETIC COMPATIBILITY (EMC)

(For industrial environments only, must not be used in domestic environments)

Eurotherm certifies that REMIO products, installed and used in compliance with this User Manual, meet the following EMC test standards and enable the system which incorporates them to comply with the EMC Directive, as far as the REMIO products are concerned.

EMC test standards

Immunity	Generic standard	EN50082-2
	Test standards	EN 61000-4-2, EN 61000-4-4, EN 61000-4-3 EN 61000-4-6, ENV 50204
Emission	Generic standard	EN 50081-2
	Radiated	EN 55011 Class A

EMC Guide

In order to help you reduce the effects of electromagnetic interference depending on the product installation, Eurotherm can supply you with the 'Electromagnetic Compatibility' Installation Guide (part no. HA 025464 ENG).
This guide lists the rules generally applicable for EMC.

VALIDATION BY INDEPENDENT BODY

Eurotherm has validated the compliance of REMIO products with EMC test standards through product design and laboratory testing.

Personnel

The installation, configuration, commissioning and maintenance of the REMIO interface must only be carried out by personnel qualified and trained to work with low voltage electrical equipment in an industrial environment.

Independent alarm

Given the safety regulations concerning personnel and property, and the value of the equipment controlled by REMIO and the power units, we recommend the use of independent safety devices (alarms), which should be tested regularly.

Eurotherm can supply various types of alarm device for this purpose.

Further information

For any further information, or if in doubt, please contact Eurotherm Controls where qualified staff are available to advise or assist you with the commissioning of your installation.

Chapter 1

IDENTIFYING THE REMIO INTERFACE

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Chapter 1 IDENTIFYING THE INTERFACE

GENERAL INTRODUCTION

The REMIO communications interface is designed to control several power units from the TE range via the digital communications bus.

This User Manual describes the use of the TPO version of REMIO interfaces, with three communications protocols:

Modbus®, Profibus-DP, DeviceNet™

The REMIO/TPO interface receives setpoints via the communications bus and transmits them to the power units which it controls, in the form of a modulated logic output signal.

REMIO is a modular product, comprising:

- a Base Module and
- two Optional Modules (Expansion Modules).

The Base Module provides communications bus and power supply connections and the necessary configurations.

In the TPO version, each module (the Base Module as well as the Expansion Modules) comprises 16 outputs, designed to transmit the setpoints received by the communications bus to the power units in the form of a logic output signal with dual-mode time proportioning (TPO).

The maximum output count for the REMIO is 48.

REMIO TPO modules allow the use of two power unit firing modes, depending on the power supply used:

- Fast cycling with a 24Vdc power supply
- Advanced Single-cycle with a 24Vac supply.

The LEDs on the REMIO front panel show the state of the communications bus and of the module power supply.

REMIO is mounted on a symmetrical DIN rail.

Detailed operation of the communications bus is described in the following manuals:

- REMIO/Modbus® Communications Manual (part no. HA 175814 FRA)
- REMIO/Profibus-DP Communications Manual (part no. HA 176078 FRA)
- REMIO/DeviceNet™ Communications Manual (part no. HA 176272 FRA)

Operation of the power units controlled is described in the User Manuals:

- TE10S/ (part no. HA174780 ENG)
- TE10S/PLF (part no. HA174784 ENG)
- TE200S (part no. HA175921 ENG)
- TE300 (part no. HA175437 ENG)

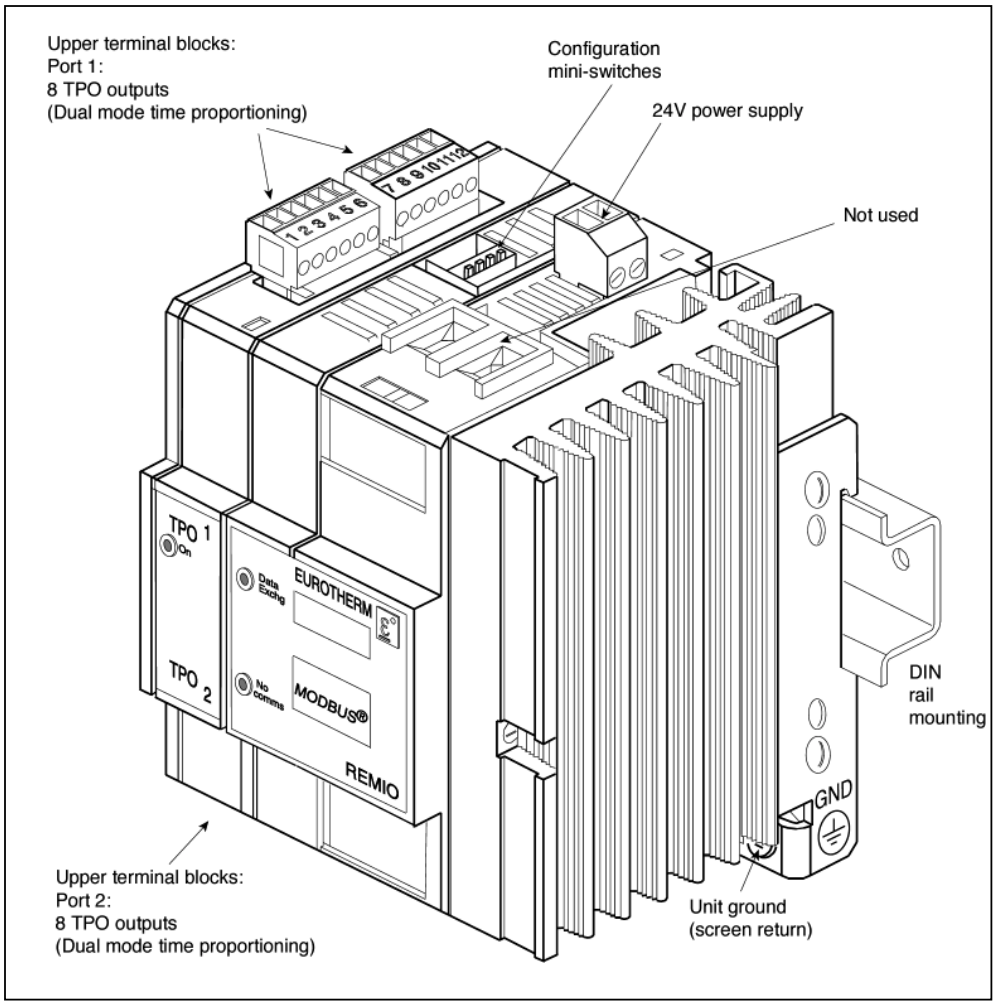

Figure 1-1 Overview of REMIO/TPO Base Module (Modbus® protocol)

FRONT PANEL OF UNIT

The following diagrams show:

- the front panels of the REMIO/TPO unit in various physical configurations
  - without optional modules: Base Module version
  - with optional modules (maximum configuration)
- the front panel labels which correspond to each protocol.

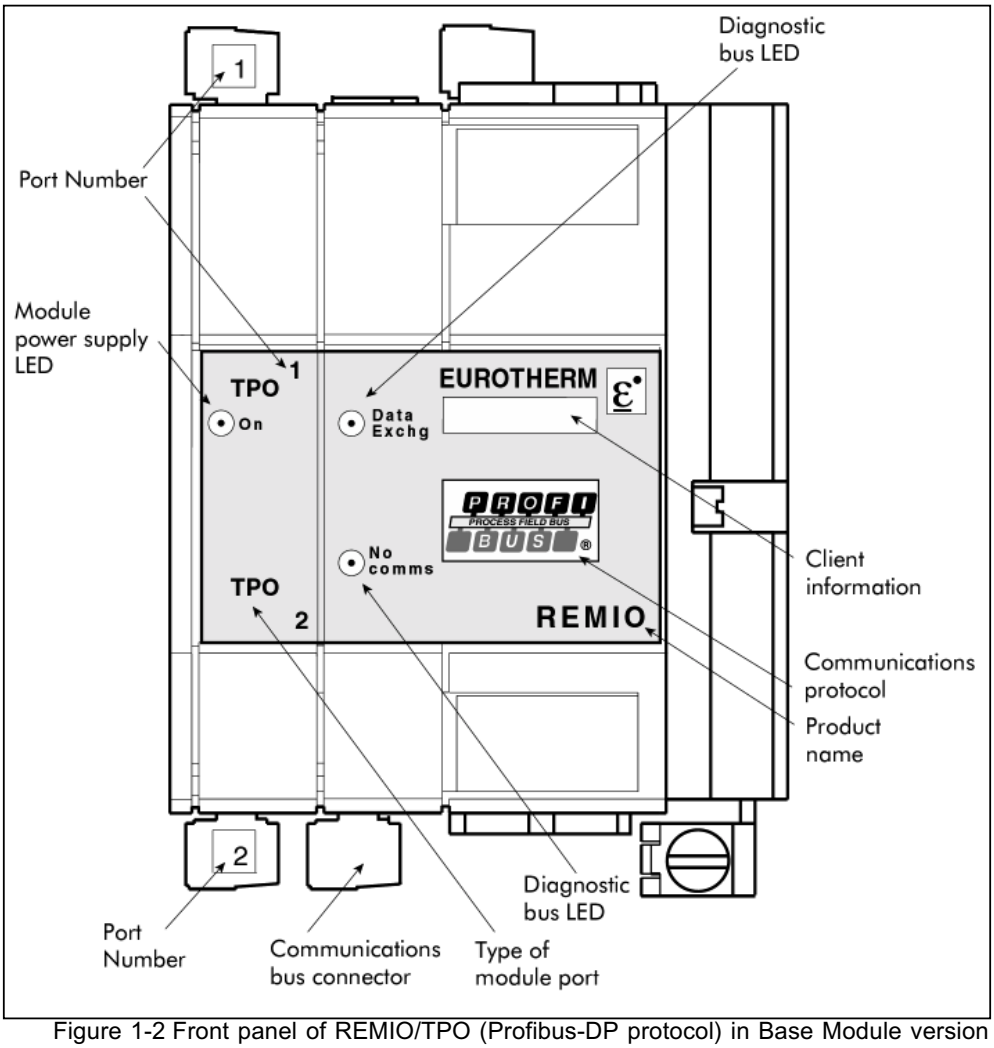

Figure 1-2 Front panel of REMIO/TPO (Profibus-DP protocol) in Base Module version

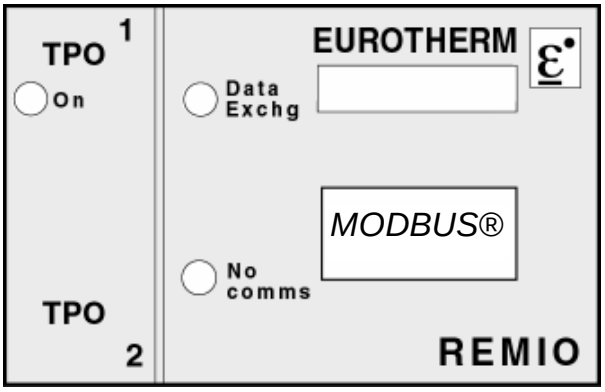

Figure 1-3A REMIO/TPO Base Module label in Modbus® protocol

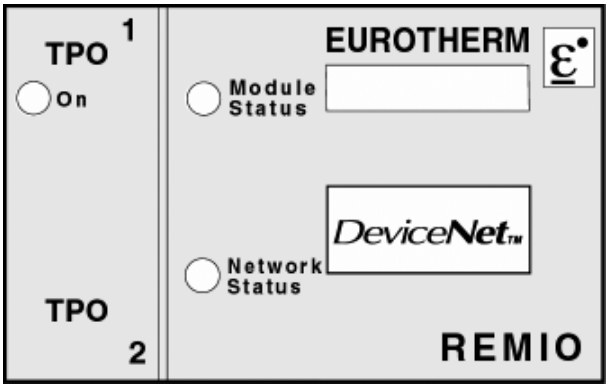

Figure 1-3B REMIO/TPO Base Module label in DeviceNet™ protocol

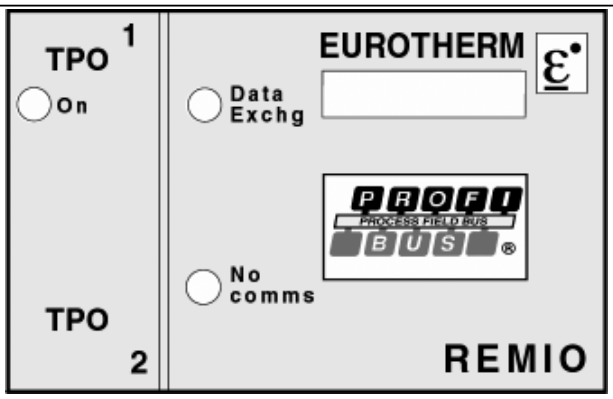

Figure 1-3C REMIO/TPO Base Module label in Profibus-DP protocol

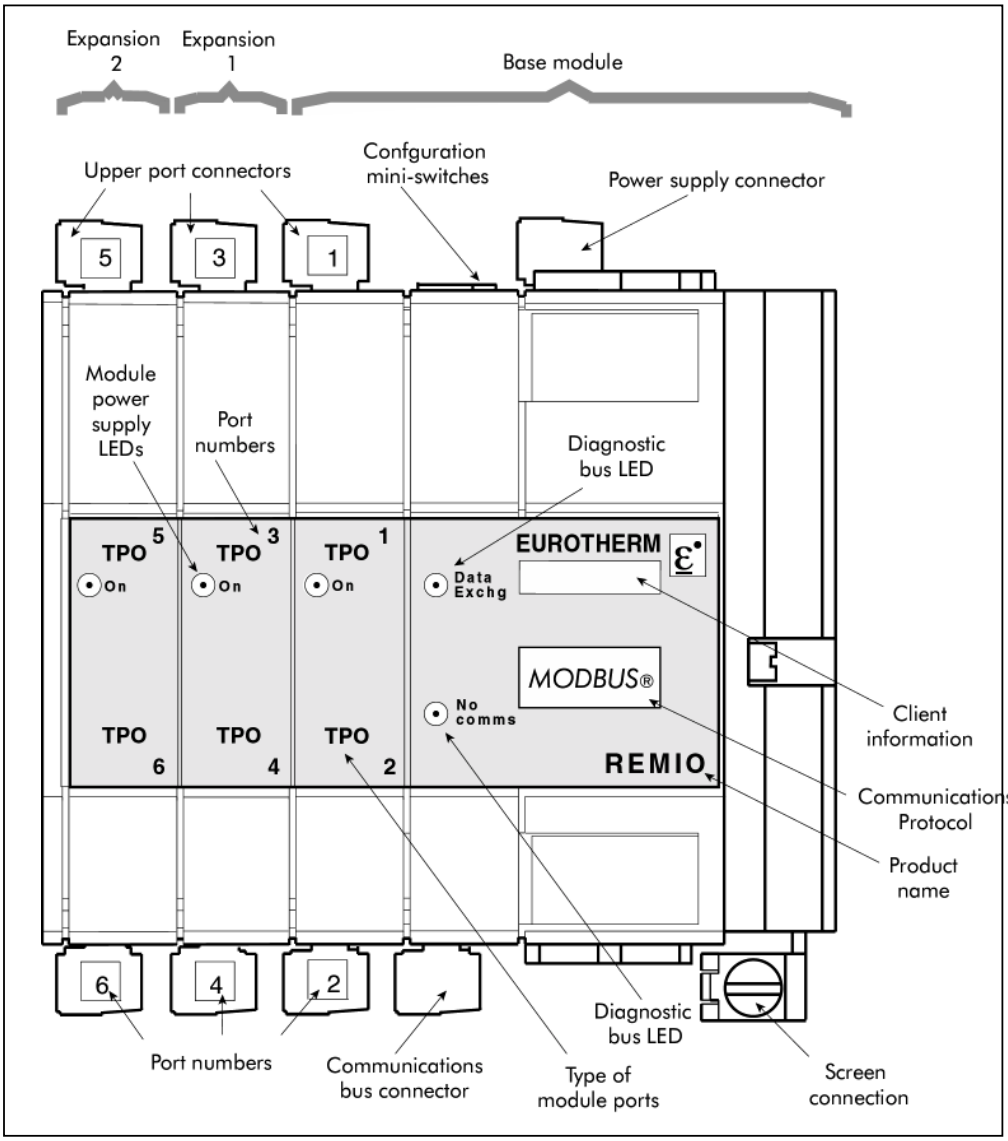

Figure 1-4 Front panel of REMIO/TPO (Modbus® protocol) in maximum configuration (48 outputs)

TECHNICAL SPECIFICATION

The REMIO communications interface is designed to drive various thyristor power units controlling resistive industrial loads and short-wave infrared elements.

Hardware configuration

Base Module	2 ports each with 8 outputs providing dual-mode time proportioning logic output signals (TPO). • Configuration mini-switches • Power supply connector • Communications bus connector
Expansions 1 or 2	2 ports each with 8 outputs providing dual-mode time proportioning logic output signals (TPO).

Port specification

TPO outputs	Voltage 20V, modulated Time proportioning from 0 to 100% Maximum current limited to 6.5mA Possible to connect two solid state relay (SSR) inputs from the TE range in series on each TPO output
Common excitation potential	For all TPO outputs a common +20Vdc supply is available on each port
Resolution	8 bits (0.4%)
Connectors	Plug-in, M3 screws

Communications

Communications protocol	Modbus or Profibus-DP or DeviceNet™ (specify when ordering)	
Bus	2-wire	Standard RS485 (Modbus® or Profibus-DP)
		or CAN Bus (DeviceNet™)
Transmission rate	Modbus	9.6k or 19.2kbaud (configurable)
	Profibus-DP	auto Baud rate detection up to 1.5Mbaud
	DeviceNet™	125k, 250k or 500kbaud (configurable)

Diagnostics

Communications	State of communications bus State of TPO outputs
LED indication	State of communications bus Module power supply

Power supply

Voltage	24Vdc non-polarised (-15%, +25%) or 24Vac (-15%, +10%)
Consumption	Depends on number of outputs used (20VA max)

Thyristor firing

General	All base module and optional module outputs are modulated in the same way: Burst-firing or Intelligent Single-cycle
Selection	By type of supply voltage
Firing modes	DC supply voltage (24Vdc): Burst-firing Number of firing or non-firing cycles at 50% setpoint: 8 cycles AC supply voltage (24Vac): Intelligent Single-cycle Firing or non-firing by a complete number of half-cycles DC component absent
Switching	Firing starts and ends at zero voltage

Environment

Operating temperature	0°C to +45°C at 2000m max. altitude
Storage temperature	-10°C to +70°C
Power supply circuit protection	External 2A fuse
External wiring	To be carried out in accordance with Standard IEC 364
Operating atmosphere	Non-explosive, non-corrosive & non-conductive
Humidity	RH: 5% to 95%, non-condensing and non-streaming
Pollution	Pollution degree 2 permissible, defined by IEC 664

Physical dimensions

Dimensions (mm)	Height: 115 (122: including connectors) Depth: 92.5 Width: Base module = 87.5 One Optional Module = 17.5 Maximum configuration = 122.5
Mass (kg)	0.9 (maximum configuration)

Warning!

EUROTHERM has made every effort to ensure that the specification given in this manual is as accurate and up to the minute as possible. However, in order to maintain our 'leading edge', it may be necessary to make certain changes or omissions to our specification.

We cannot be held responsible for any damage to persons or property or for any financial loss or costs arising from this.

PRODUCT CODE

REMIO / Base Module / Exp.1 / Exp.2 / Protocol / Transmission rate / Manual // 00

Base Module	Code
16 dual-mode* time-proportioned outputs	TP

Expansion Module 1	Code
Expansion 1 provides (16 dual-mode* time-proportioned outputs)	TP
Without Expansion 1	-

Expansion Module 2	Code
Expansion 2 provides (16 dual-mode* time-proportioned outputs)	TP
Without Expansion 1 or 2	-

Communications protocol	Code
Modbus®	MOP
Profibus-DP	PFP
DeviceNet™	DNP

Transmission rate		Code
Modbus® :	9.6kbaud	96
	19.2kbaud	192
Profibus-DP :	(auto Baud rate detection)	AUTO
DeviceNet™ :	125kbaud	125
	250kbaud	250
	500kbaud	500

Manual language	Code
French	FRA
English	ENG

*) The firing mode of TPO module outputs is determined by the power supply type:
24Vac = Advanced Single-cycle; 24Vdc = Fast Cycling

EXAMPLE OF PRODUCT CODE

Example 1

Number of TE10S solid state relays (SSRs) controlled by REMIO : 15
(15 < 16 = without Expansion Modules)

Communications used	:	Modbus® at 9.6kbaud
Firing mode	:	Advanced Single-cycle
User Manual	:	English

Code: **REMIO / TP / - / - / MOP / 96 / ENG // 00**
Power supply : 24Vac

Example 2

Number of TE10S solid state relays controlled by REMIO : 40
(2 x 16 = 32 < 40 < 3 x 16 = 48 ⇒ 2 Expansion Modules)

Communications used	:	Profibus-DP
Firing mode	:	Fast Cycling
User Manual	:	French

Code: **REMIO / TP / TP / TP / PFP / AUTO / FRA // 00**
Power supply : 24Vdc

IDENTIFICATION LABEL

An identification label gives all the necessary information on REMIO characteristics, as shipped from the factory. The identification label is located on the left side of the unit.

Figure 1-5 Example of REMIO identification label (corresponds to coding example No. 1)

Warning!

Following any re-configuration on the part of the user, there is no guarantee that the unit will correspond to the label information.

Chapter 2

WIRING

Contents Page

Chapter 2 WIRING

INSTALLATION - SAFETY

Danger!

REMIO units must be installed by qualified personnel trained to work with low voltage electrical equipment in an industrial environment.

Units must be installed in fan-cooled electrical cabinets, to ensure that condensation and pollution are excluded.
The cabinet must be closed and bonded to the protective earth in accordance with Standards NFC 15-100, IEC 364 or current national Standards.
It is recommended that a fan-failure detection device or a thermal safety cut-out should be fitted in the cabinet.

Warning!

REMIO units are designed to be DIN-rail mounted, with the heatsink positioned vertically, with no obstructions above or below which could inhibit or impede airflow.
Leave a minimum gap of 2cm between two units placed side by side.

The temperature of the heatsink may reach 85°C. Avoid all contact, even occasional, with the heatsink when the unit is operational.
The heatsink remains hot for around 15 minutes after the unit has been switched off.

WIRING – SAFETY

Danger!

REMIO wiring must be carried out by trained personnel who are qualified to work in a low voltage industrial environment.
It is the user's responsibility to wire and protect the installation in accordance with current professional Standards.

Before any connection or disconnection, ensure that the power supply cables are isolated from voltage sources.

Warning!

The REMIO earthing screw, labelled: 
must be connected to the reference ground plane of the electrical cabinet.

To ensure correct grounding of the REMIO unit, in accordance with the European Directive 'Electromagnetic Compatibility' make sure that the ground link of the unit is properly bonded to the reference ground plane (panel or bulkhead).

Failing this, it is necessary to add a ground connection at most 10cms long between the earth connection and the reference ground plane.

TERMINAL BLOCK LABELLING

The REMIO communications interface comprises the following terminal blocks:

- control terminal blocks (2 terminal blocks of 6 terminals for each port)
- power supply terminal block
- communications bus terminal block.

The connectors are plug-in.

The terminals on the control and communications bus terminal blocks accept conductors up to a maximum of $1.5mm^2$.

The terminals on the power supply terminal block accept conductors up to a maximum of $2.5mm^2$.

Control

Control terminal block

Each control port consists of two terminal blocks (two plug-in connectors).

Each 6-terminal control terminal block (see Figures 2-1 to 2-4) comprises 4 TPO outputs and 2 'common +20Vdc' terminals (terminal numbers 1, 6 or 7, 12).

Module type	Port numbers	Terminal numbers	TPO output numbers
Base module	1 1 2 2	2 to 5 8 to 11 2 to 5 8 to 11	1 to 4 5 to 8 9 to 12 13 to 16
1st Optional module	3 3 4 4	2 to 5 8 to 11 2 to 5 8 to 11	17 to 20 21 to 24 25 to 28 29 to 32
2nd Optional module	5 5 6 6	2 to 5 8 to 11 2 to 5 8 to 11	33 to 36 37 to 40 41 to 44 45 to 48
All types	1 to 6	1, 6, 7 & 12	User voltage +20Vdc

Table 2-1 Terminal function of control terminal blocks

Reminder : the maximum current of a TPO output is 6.5mA

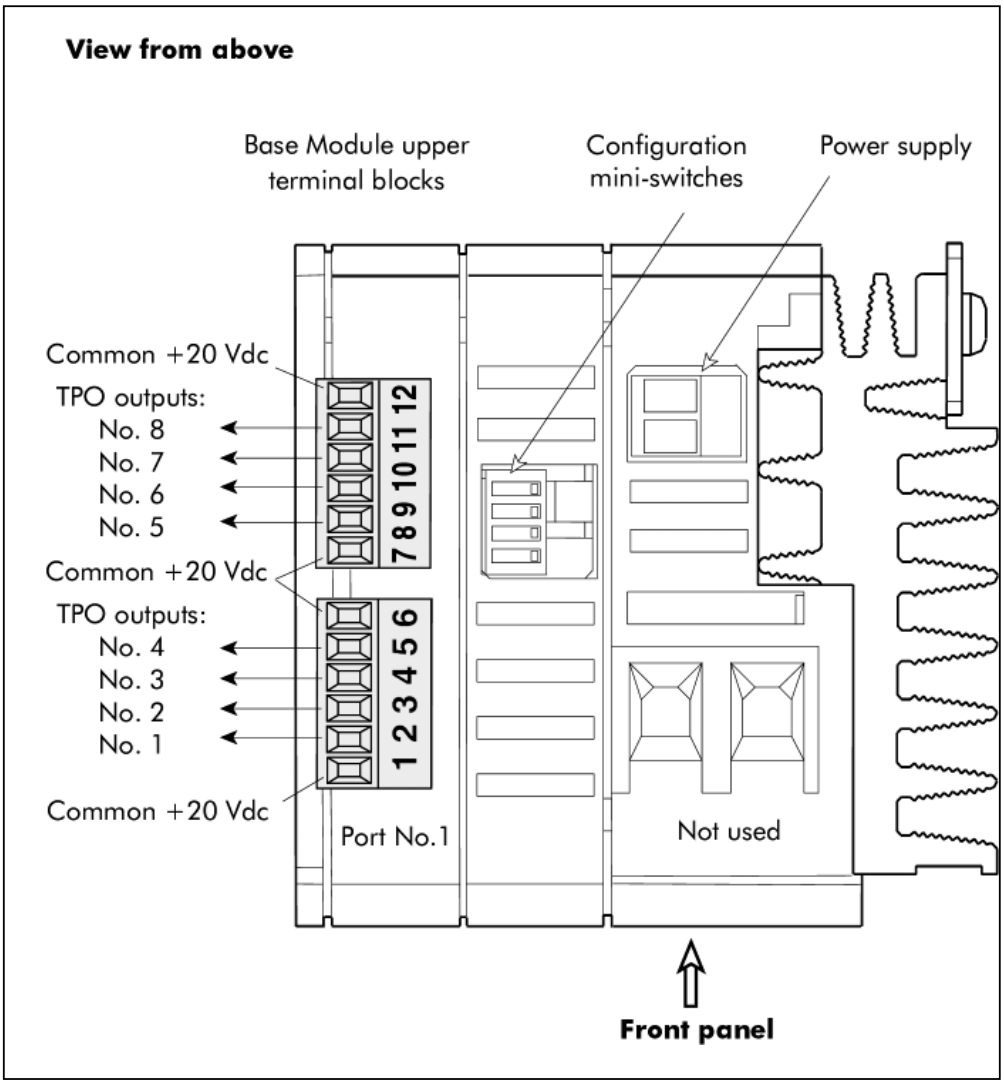

Figure 2-1 Labelling on Base Module control terminals (upper terminal blocks)

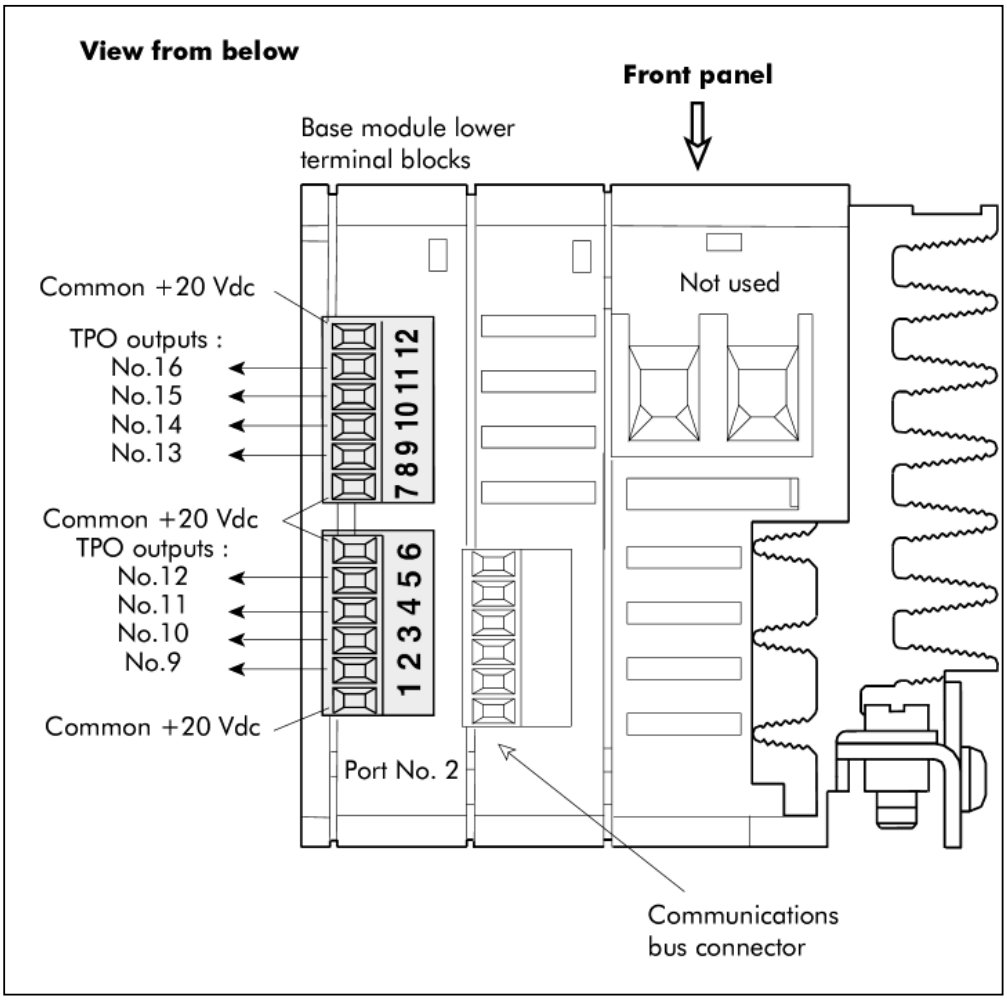

Figure 2-2 Labelling on Base Module control terminals (lower terminal blocks)

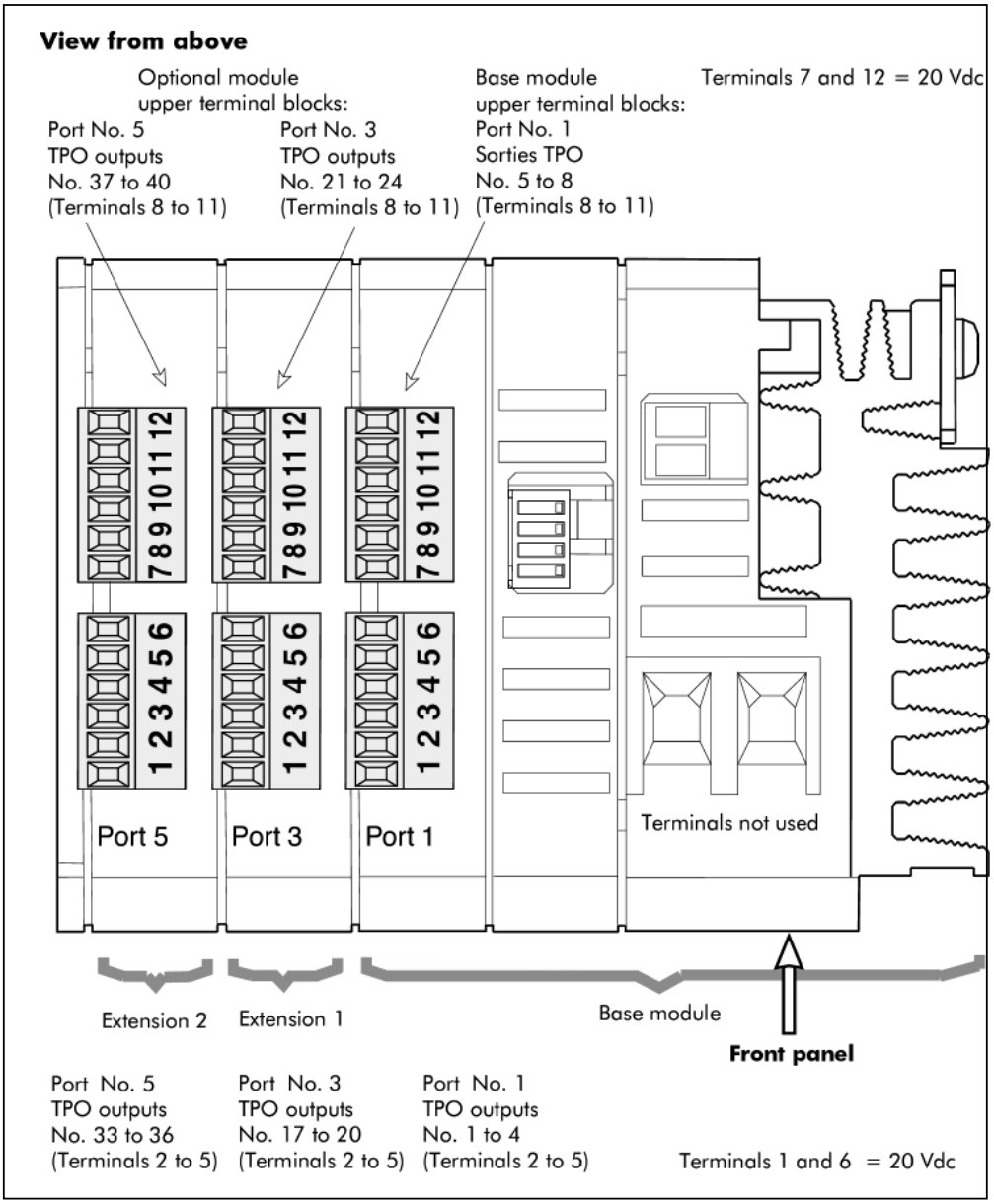

Figure 2-3 Labelling on control terminals (2 Expansion Modules, upper terminal blocks)

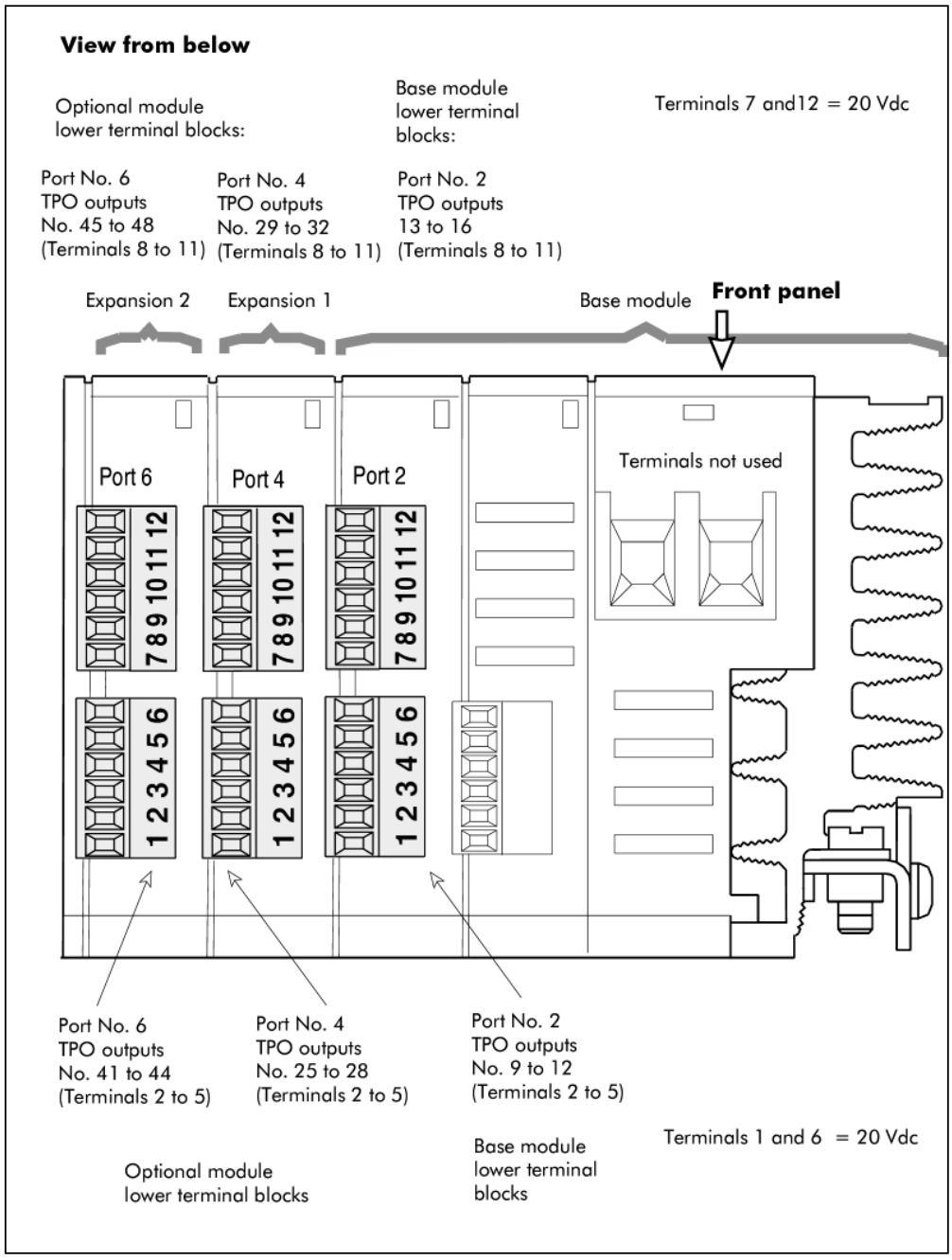

Figure 2-4 Labelling on control terminals (2 Expansion Modules, lower terminal blocks)

Control wiring

REMIO TPO outputs must be connected to DC inputs (DC current) on thyristor power units.

The following diagram shows an example of control wiring for two power units:
two Eurotherm TE10S solid state relays (SSRs).

Power cabling is not shown in this diagram (for wiring of power unit supply and load cables, see the appropriate User Manuals).

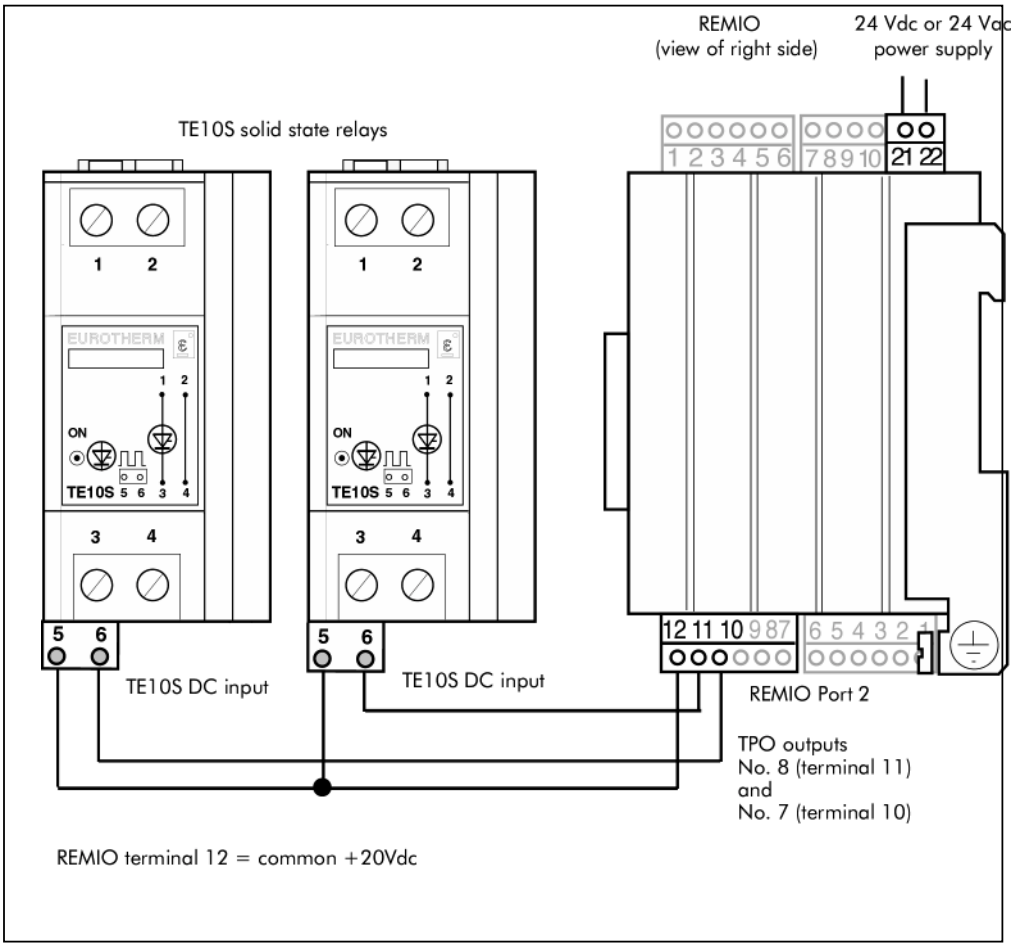

Figure 2-5 Example of control wiring for TE10S power units (REMIO port 2 outputs 7 & 8)

Power supply

The power supply terminal block (terminals 21 & 22) is located on top of the unit.
The connector is of the plug-in type.

The voltage is: 24Vdc non-polarised (-15%, +25%) or
24Vac (-15%, +10%).

Reminder : The type of power supply defines operation in Fast cycling (24Vdc) or in Advanced Single-cycle (24Vac).

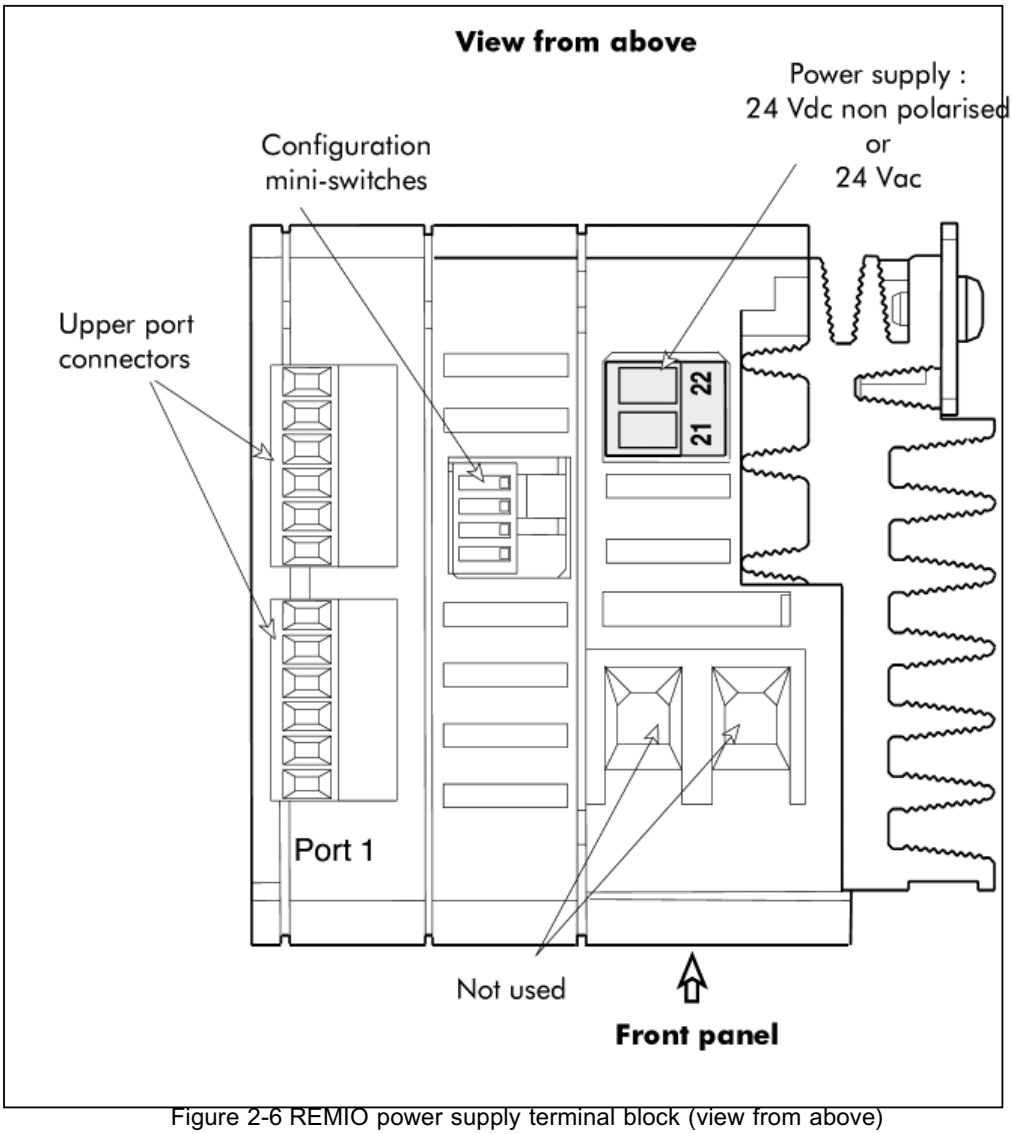

Figure 2-6 REMIO power supply terminal block (view from above)

Warning!

A 2Amp fuse must be provided for power supply protection

Communications bus

Communications bus terminal block

The communications bus terminal block is located underneath the unit.
This terminal block has:

- 6 terminals, numbered 61 to 66 for Modbus® and Profibus-DP protocols
- 5 terminals, numbered 1 to 5 for DeviceNet™ protocol

Terminal Number	Terminal labelling, depending on protocol		
	Modbus®		Profibus-DP
61	Rx-/Tx-	(B)	B
62	Rx+/Tx+	(A)	A
63	Not used	(0V)	0V
64	Rx+/Tx+	(A)	A
65	Rx-/Tx-	(B)	B
66	Not used	Not connected	+5V

Table 2-2 Labelling on communications bus terminals in Modbus® and Profibus-DP protocols

Important!

- In Profibus-DP protocol, by convention the potential of the A terminals is greater than that of the B terminals when the RS485 line is in an active state
- In Modbus® and Profibus-DP protocols:
  terminals 61 & 65 are internally interconnected;
  terminals 62 & 64 are internally interconnected

Terminal Number	Terminal labelling, depending on DeviceNet™ protocol	
1	V- (not connected)	(B)
2	CAN_L	(A)
3	Drain (not connected)	(0V)
4	CAN_H	(A)
5	V+ (not connected)	(B)

Table 2-3 Labelling on communications bus terminals in DeviceNet™ protocol

Communications bus wiring

In order to guarantee operational reliability of the digital communications link (without data corruption due to noise or line reflection) connections should be made using screened, twisted pairs.

The screen should be connected to the ground at both ends in accordance with the wiring diagrams (see Figures 2-8 & 2-9).

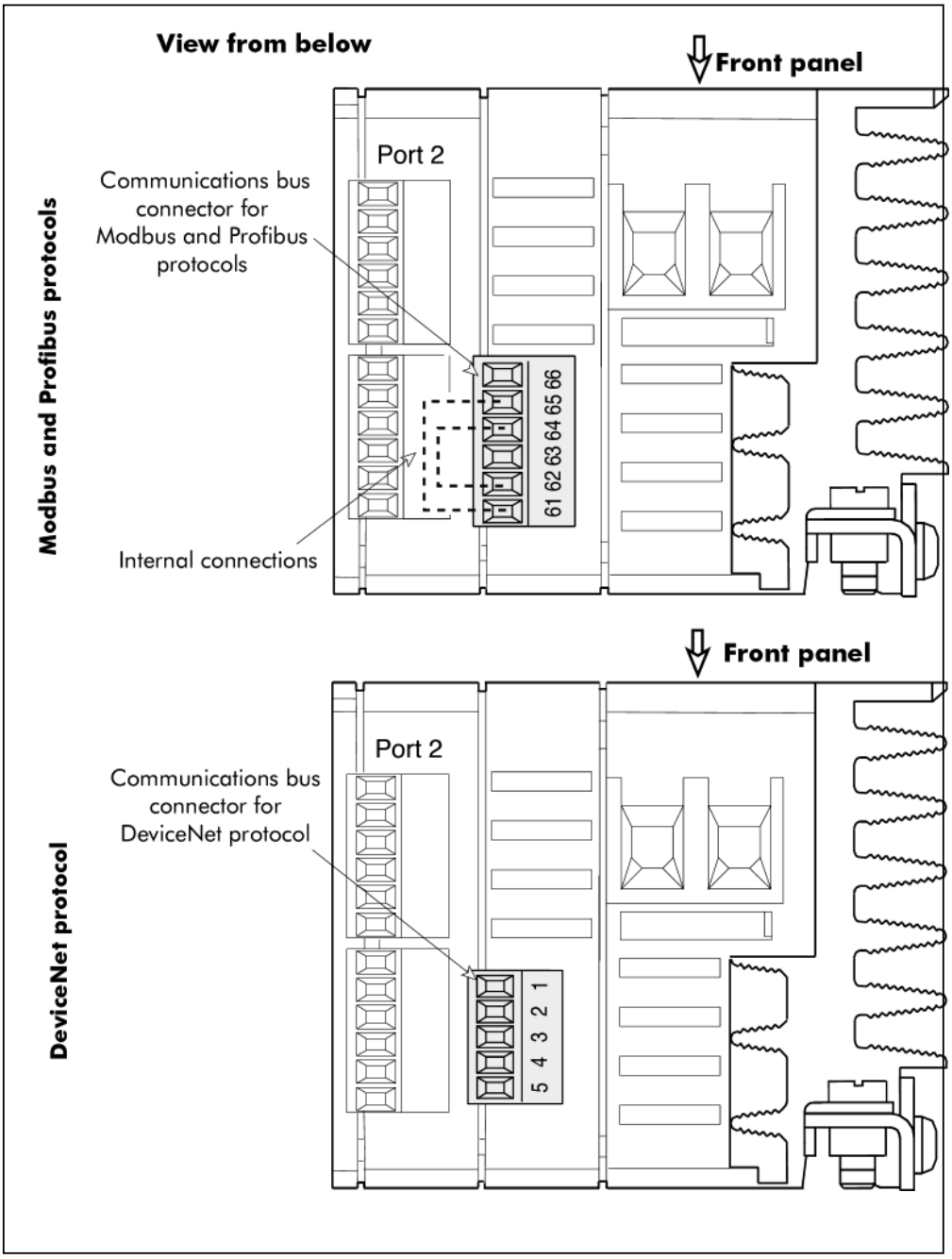

Figure 2-7 Communications bus terminal block for various protocols

SCREENING EXAMPLE

Control and communications bus cable screens should be connected to ground at both ends, in the shortest possible way.
A screen grounding screw is provided for this purpose on the REMIO.

Important!

The ground return screw of the unit should be connected to the ground plane via the shortest possible link.

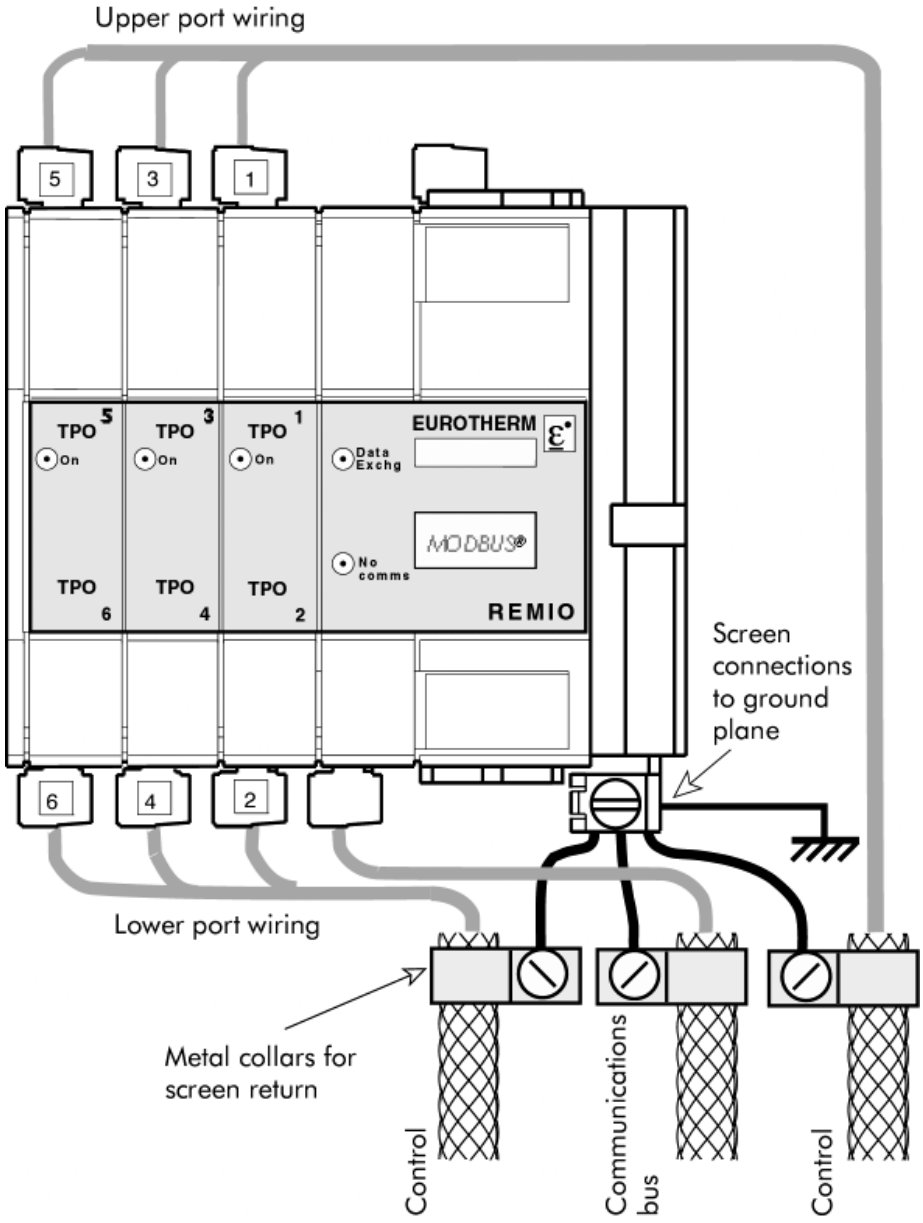

Figure 2-8 Screen grounding example for control and communications conductors

WIRING EXAMPLE OF REMIO / TE ASSEMBLY

Wiring of the REMIO interface and power unit assembly comprises:

- REMIO ground wiring, labelled with the symbol 
- power supply wiring
- communications bus connection
- power unit control wiring.

In order to guarantee correct EMC performance of the power units controlled by the REMIO, REMIO outputs and the power unit inputs should be wired using screened cables.

Control and communications bus cable screens must be connected to the REMIO ground as shown in Figure 2-8.

Figure 2-9 gives a wiring example for an assembly of REMIO and TE range power units.

TE unit power wiring is not shown in Figure 2-9.
For power wiring, see the User Manuals for the TE range.

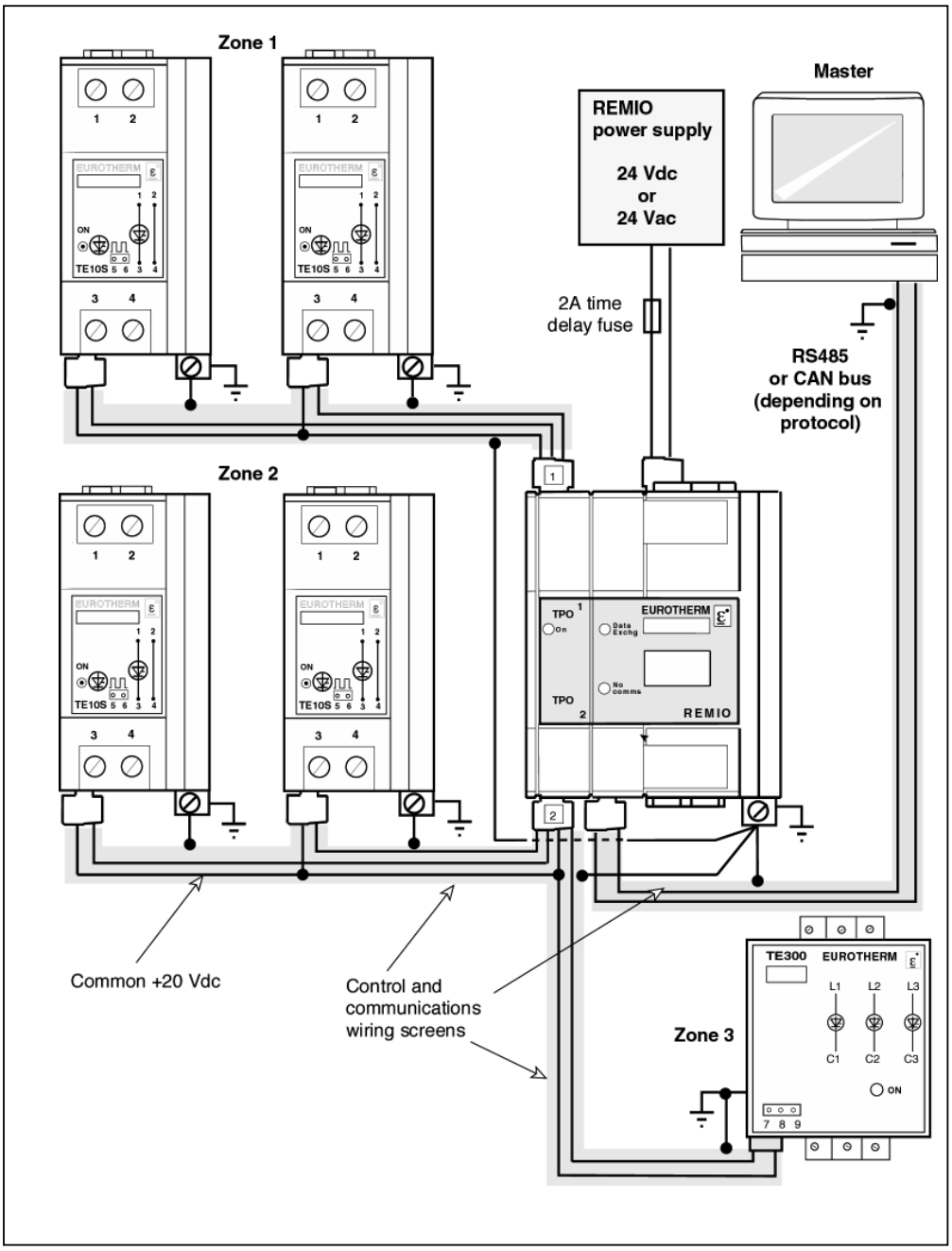

Figure 2-9 Wiring example of power unit assembly from the TE range (divided into three zones), controlled by the REMIO / TPO Base Module.
Note : TE300 operation is in Logic Mode only

Chapter 3

DIGITAL COMMUNICATIONS

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Chapter 3 DIGITAL COMMUNICATIONS

GENERAL INTRODUCTION

REMIO interfaces are fitted with digital communications as standard.
This performs four main functions:

- configuring the communications protocol parameters
- configuring the REMIO interface address on the bus
- controlling the state of the REMIO interface
- monitoring all the operating parameters.

This digital link is available for the following data transfer physical layer standards:

- RS485 for Profibus-DP or Modbus® communications protocols
- CAN for DeviceNet™ protocol.

The communications bus is electrically isolated from any other inputs or outputs.

The choice of protocol is made when ordering the unit and cannot be re-configured by the user.

Message transfer is of the ‘Master/Slave’ type.
The REMIO interface always operates in ‘Slave’ mode, with the monitoring system or supervisor as ‘Master’.

Any exchange includes a request from the 'Master' and a response from the 'Slave'.

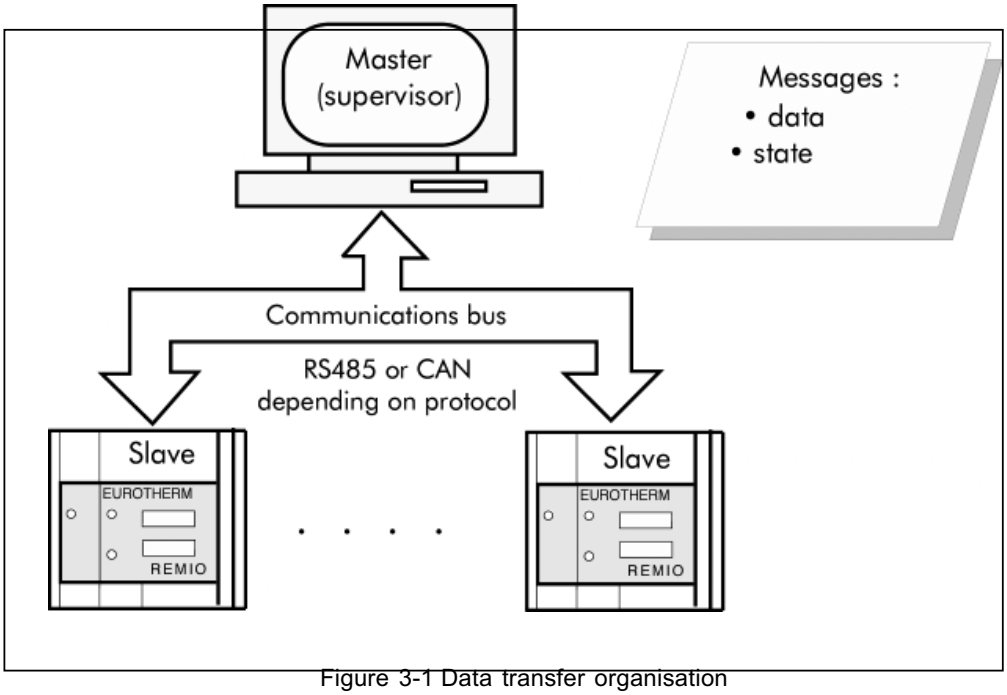

Figure 3-1 Data transfer organisation

MODBUS® PROTOCOL

Modbus® protocol is a binary type serial communications protocol (or RTU).

Important : A detailed description of how Modbus® protocol operates is given in the manual 'REMIO: Modbus® Communications Manual', part no. HA 175814 ENG

The transmission frame is in binary characters.

Character format: 1 start-bit – 8 data bits – 1 stop bit
There is no parity bit

Transmission rates 9.6 or 19.2 kbaud, depending on the mini-switch configuration provided

Modbus® protocol controls the request and response cycle between the Master and the Slaves. Each exchange comprises two messages, except in broadcast mode when the response is not transmitted.

The frame structure is identical for the request and the response:

- Slave address (1 byte) : specifies the Slave concerned on the communications bus
- function code (1 byte) : indicates the operation to be carried out
- data (n bytes) : group of parameters necessary for the function
- CRC -16 error check (2 bytes) : cyclic redundancy check

The error response frame structure comprises:

- Slave address (1 byte)
- function code +128 (1byte)
- error code (1 byte)
- CRC – 16 error check (2 bytes) : cyclic redundancy check.

Error codes

Error code (in decimal)	Error type
1	Function forbidden
2	Data address prohibited
3	Data value outside limits
4	Peripheral failure
5	ACK (positive acknowledging signal)
6	Not used (reserved)
7	NACK (negative acknowledging signal)
8	Write operation not possible
9	No data request
10	Too many data requests

Table 3-1 Meaning of Modbus® error codes

Addressing

To communicate with REMIO, Modbus® protocol uses:

- the REMIO interface device address (address on the bus used)
- the TPO output addresses of each port.

Important!

As shipped from the factory, the REMIO default device address is configured to 32 (decimal).

This address may be re-configured by the user via the digital link

In normal operation, addresses 1 to 247 may be used for the device address.

Important!

Make sure that there is only one unit at each device address.

The REMIO address is located at internal address 100, in the internal parameter list.

The values of the TPO output parameters are from 0 to 255 (00_{HEX} to FF_{HEX}), which constrains the data value at each of these addresses to one byte (8 bits).

The addresses are accessible in read and write. The contents of all TPO output addresses can be modified by broadcast, except the REMIO device address.

The 'TPO output' parameters are located from address 11 to 58 in the parameter list.

Parameter TPO outputs				Internal address (decimal)
Module	**Port**	**Output No.**	**Terminal No.**	
Base Module	Port 1	1 to 4 5 to 8	2 to 5 8 to 11	from 11 to 14 from 15 to 18
	Port 2	9 to 12 13 to 16	2 to 5 8 to 11	from 19 to 22 from 23 to 26
1st Optional Module	Port 3	17 to 20 21 to 24	2 to 5 8 to 11	from 27 to 30 from 31 to 34
	Port 4	25 to 28 29 to 32	2 to 5 8 to 11	from 35 to 38 from 39 to 42
2nd Optional Module	Port 5	33 to 36 37 to 40	2 to 5 8 to 11	from 43 to 46 from 47 to 50
	Port 6	41 to 44 45 to 48	2 to 5 8 to 11	from 51 to 54 from 55 to 58

Table 3-2 'TPO output' parameter addresses in Modbus® protocol

PROFIBUS-DP PROTOCOL

Specifications for Profibus-DP

Process **F**ield Bus **D**ecentralised **P**eriphery

communications protocol are defined in Standards:

EN 50170 / DIN 19245 / Part 3.

Important!

A detailed description of Profibus-DP operation is given in the manual 'REMIO: Profibus-DP Communications Manual, part no. HA 176078 FRA

The transmission frame is in binary characters, with even parity.

Character format : 1 start-bit – 8 data bits – 1 parity bit – 1 stop bit

Transmission rate

The following transmission rates are available:

9.6 kbaud
19.2 kbaud
93.75 kbaud
187.5 kbaud
500 kbaud
1500 kbaud

with auto Baud rate detection of rate used.

Addressing

The device address (address of the REMIO on the bus used) is set by configuration using the Profibus-DP function Set_Slave_Address via the link Master, provided that the REMIO is in the parameterisation wait phase (WPRM).

Important!

As shipped from the factory, the REMIO default device address is configured as 32 (decimal).
This address may be reconfigured by the user via the digital link.

In normal operation, the following addresses can be used: from 4 to 125

Important!

Make sure that there is only one unit assigned to each device address.

Addresses 0 to 3 are generally reserved for the Master.
Address 126 is not accepted by REMIO.
Address 127 is reserved for broadcast to comply with the Profibus Standard.

The TPO output parameter values are from 0 to 255 (00_{HEX} to FF_{HEX}) which constrains the data value at each of these addresses to one byte (8 bits), with a 0.4% resolution.

The TPO output parameters are accessible at the following addresses:

Parameter	TPO outputs			Address
Module	**Port**	**Output No.**	**Terminal No.**	**(decimal)**
Base Module	Port 1	1 to 4 5 to 8	2 to 5 8 to 11	from 6 to 9 from 10 to 13
	Port 2	9 to 12 13 to 16	2 to 5 8 to 11	from 14 to 17 from 18 to 21
1st Optional Module	Port 3	17 to 20 21 to 24	2 to 5 8 to 11	from 22 to 25 from 26 to 29
	Port 4	25 to 28 29 to 32	2 to 5 8 to 11	from 30 to 33 from 34 to 37
2nd Optional Module	Port 5	33 to 36 37 to 40	2 to 5 8 to 11	from 38 to 41 from 42 to 45
	Port 6	41 to 44 45 to 48	2 to 5 8 to 11	from 46 to 49 from 50 to 53

Table 3-3 'TPO output' parameter decimal addresses in Profibus-DP protocol

State diagram

The state diagram illustrating data transfer via the Read/Write process comprises four states (see Figure 3-2):

- powering up
- waiting for parameterisation
- waiting for configuration
- transfer of parameter data.

Powering up

After each power-up, the unit enters a two sequence wait phase:

- Parameterisation then
- Configuration.

Parameterisation

This is the wait phase for the parameterisation message (WPRM).
In this phase, reading the configuration (Get_Cfg) is allowed.
A diagnostic request (Slave_Diag) is permitted.

The Parameterisation frame (Set_Prm) contains the following data:

- Parameterisation of the system (PNO identification, acceptance of synchronisation modes, 'Watchdog' time…)
- Parameterisation of the data (the parameters designated by the Master to be accessible in cyclic read).

In addition, as described in the paragraph 'Addressing', in the WPRM phase one may change the REMIO interface address via the Set_Slave_Address function.

Any other type of message will be rejected during the Parameterisation wait phase.

Important!

REMIO parameterisation is fixed and unique for all units

Configuration

This is the wait phase for the configuration message (WCFG).
The configuration message specifies the structure of the Input and Output Buffer.
Both Parameterisation (Set_Prm) and the diagnostic request (Slave_Diag) are allowed.

Any other type of message will be rejected during the configuration wait phase.
In any particular installation, the REMIO interface can only receive a change in configuration (Check_Cfg) from the Master which has set the parameters.

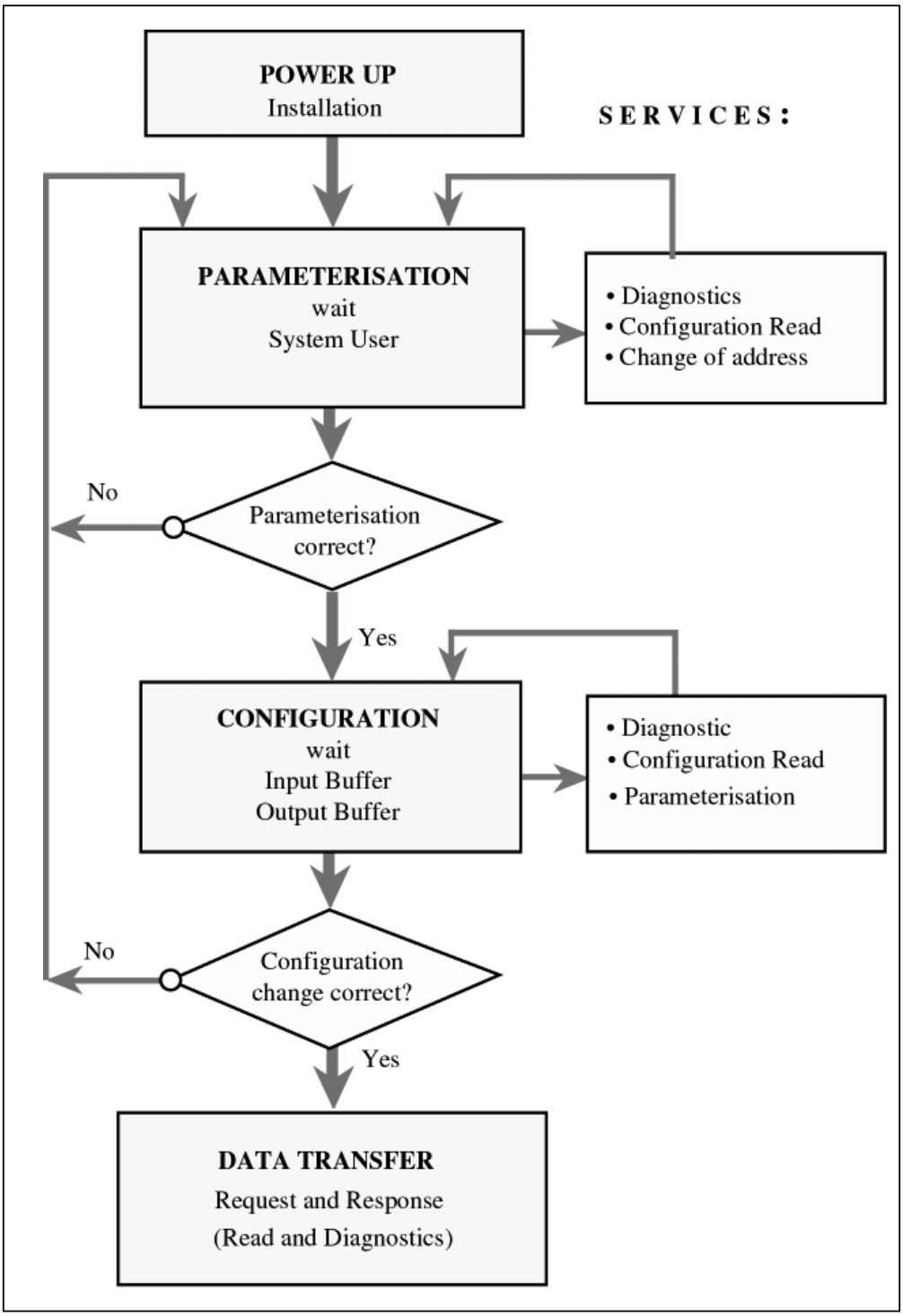

Figure 3-2 State diagram of Read/Write process in Profibus-DP protocol.

Data transfer

If Parameterisation and Configuration have been accepted, the data transfer phase (DXCHG) is reached and the REMIO interface is ready to transfer data to the Master which has configured and parameterised it.

Functions which are permitted during the DXCHG phase are as follows:

- Diagnostic (Slave_Diag)
- Parameterisation and Configuration:
    - Configuration read (Get_Cfg)
    - Configuration check (Check_Cfg)
    - Parameterisation (Set_Prm)
- Process data transfer:
    - Request and Response (Data_Exchange)
    - Multiple data read (Read_Input)
    - Re-read of outputs (Read_Output)
- Control of transmission modes (Global_Control).

DEVICENET™ PROTOCOL

DeviceNet™ protocol is a serial communications protocol designed for communications between simple industrial devices and their monitoring or control units.

Important!

A detailed description of DeviceNet™ protocol operation is given in the Manual 'REMIO: DeviceNet™ Communications Manual', part no. HA 176272 FRA.

All REMIO operating and communications variables are considered as
'DeviceNet™ Objects'.

The REMIO interface is in the set of components called
'Group 2 Only Pre-defined Master/Slave Devices'
according to the DeviceNet™ 2.0 specification.

All the DeviceNet™ Objects and their attributes are accessible by the
'Explicit Messaging Connection'
according to the rules set by the Specification.

REMIO TPO outputs appear in the form of Objects called
'REMIO Variables'

A global transfer of REMIO TPO variables is possible via the
'Poll I/O Connection'
(Fragmentation supported).

Transmission rates

In DeviceNet™ protocol, the transmission rate is configurable via the mini-switches (see Chapter 4, Configuration):

125 kbaud
250 kbaud
500 kbaud.

Error codes

As soon as the Slave detects an error in the Master's request, an error code is used in the response frame.

The code for 'General Error Service' is 14_{HEX}

Error codes (in HEX)	Error type
2	Resource unavailable
8	Service not supported
9	Invalid attribute value (data value outside definition)
0B	Already in requested mode (state)
0C	Object state conflict
0E	Attribute not modifiable
0F	Privilege violation (access refused)
10	Device state conflict
11	(Reply) data too large
13	Insufficient data
14	Attribute not supported (not authorised)
15	Too much data
16	Object does not exist
18	No stored attribute data
19	Storage failure
1F	Vendor specific error
20	Invalid parameter

Table 3-4 Meaning of DeviceNet™ error codes

Addressing

The 'MAC ID' device address (REMIO address on the bus used) is set at configuration time via the communications bus using the 'Explicit Messaging Connection' of the ' Object Device_Net™'.

Important!

As shipped from the factory, the REMIO default device address is configured as 32 (decimal).
This address may be reconfigured by the user via the digital link.

In normal operation, device addresses from 0 to 63 may be used.

Important!

Make sure that there is only one unit assigned to each device address.

The 'REMIO Variables' corresponding to the TPO outputs on the REMIO interface are members of the set 'DeviceNet™ USINT', able to be manipulated by DeviceNet™ protocol access services 'GET_Attribute_Single' & 'SET_Attribute_Single'.

REMIO Variables		TPO outputs		Identifier (decimal)
Module	**Port**	**Output No.**	**Terminal No.**	
Base Module	Port 1	1 to 4 5 to 8	2 to 5 8 to 11	from 7 to 10 from 11 to 14
	Port 2	9 to 12 13 to 16	2 to 5 8 to 11	from 15 to 18 from 19 to 22
1st Optional Module	Port 3	17 to 20 21 to 24	2 to 5 8 to 11	from 23 to 26 from 27 to 30
	Port 4	25 to 28 29 to 32	2 to 5 8 to 11	from 31 to 34 from 35 to 38
2nd Optional Module	Port 5	33 to 36 37 to 40	2 to 5 8 to 11	from 39 to 42 from 43 to 46
	Port 6	41 to 44 45 to 48	2 to 5 8 to 11	from 47 to 50 from 51 to 54

Table 3-5 Identification of 'TPO output REMIO variables' in DeviceNet™ protocol

Permissible values for 'TPO output REMIO variables' range from:
0 to 255 (decimal) & 00_{HEX} to FF_{HEX}
which constrains the data value at each of these addresses to one byte (8 bits).

State diagram for operation

The REMIO interface state diagram comprises four states (see Figure 3-3):

- powering up
- auto test
- waiting for configuration (if necessary)
- data transfer of REMIO DeviceNet™ variables.

Powering up

After each power-up, the unit enters an Initialisation phase.

Auto test

After initialisation, if all the internal resources and the stored configuration are valid, the REMIO interface enters a state which allows communications to take place.

If this is not the case, the REMIO interface can adopt:

- a state of waiting for configuration (if necessary) or
- operation shut down in the case of a non-recoverable error.

Configuration

The configuration necessary for operation of the DeviceNet™ REMIO interface is described in the manual 'REMIO: DeviceNet™ Communications Manual', part no. HA176272 FRA.

Operation

This is the normal state of the REMIO interface, in which it is ready to transfer data to the link Master.

Operation shut down

In the event of a non-recoverable fault, the REMIO interface changes to a non-active state, from which only the sequence of:

- switching off, then
- switching on

can reset the state, once the fault has been rectified.

Examples of non-recoverable faults:

- the unit configured to an address already assigned to another unit on the same bus
- internal operating problem.

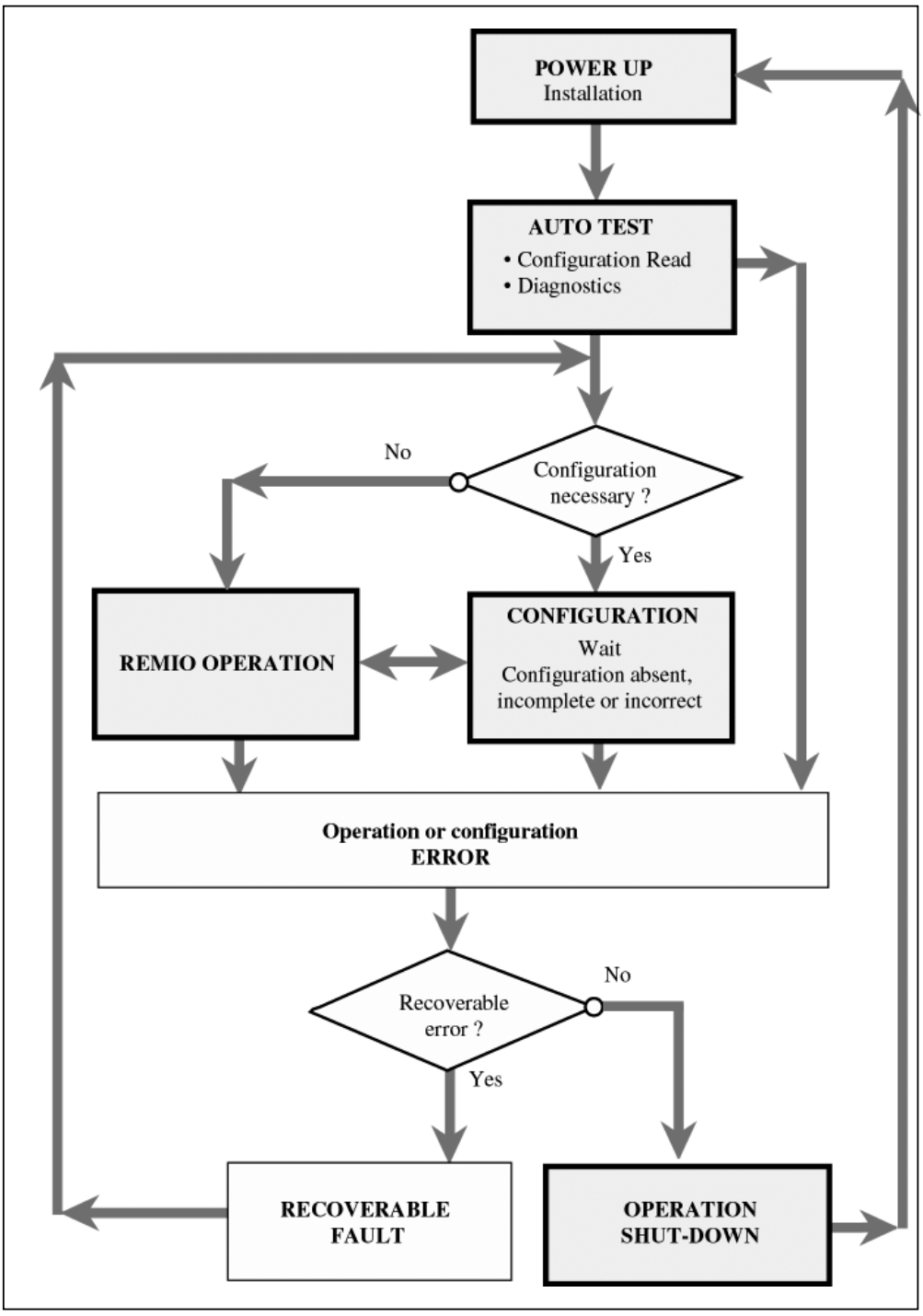

Figure 3-3 Operating state diagram for REMIO in DeviceNet™ protocol

Chapter 4

CONFIGURATION

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Chapter 4 CONFIGURATION

GENERAL INTRODUCTION

The REMIO interface is configured using the SW1 mini-switches located on the top of the unit.

Viewed from above, the ON position is shown to the left of the switches
(front panel of product facing you).

The SW1 mini-switches determine the transmission rate and the communications bus termination resistors.

Mini-switch	Function according to protocol		
	Modbus®	**Profibus-DP**	**DeviceNet™**
SW1.1	Port configuration as outputs*	Port configuration as outputs*	Port configuration as outputs*
SW1.2	Transmission rate	Not used	Transmission rate
SW1.3	Bus termination	Bus termination	Transmission rate
SW1.4	Bus polarisation	Bus polarisation	Bus termination

Table 4-1 Function of configuration mini-switches

*) As shipped from the factory, the position of SW1.1 is ON

Important!

In the REMIO TPO version,
the position of SW1.1 must always be ON.

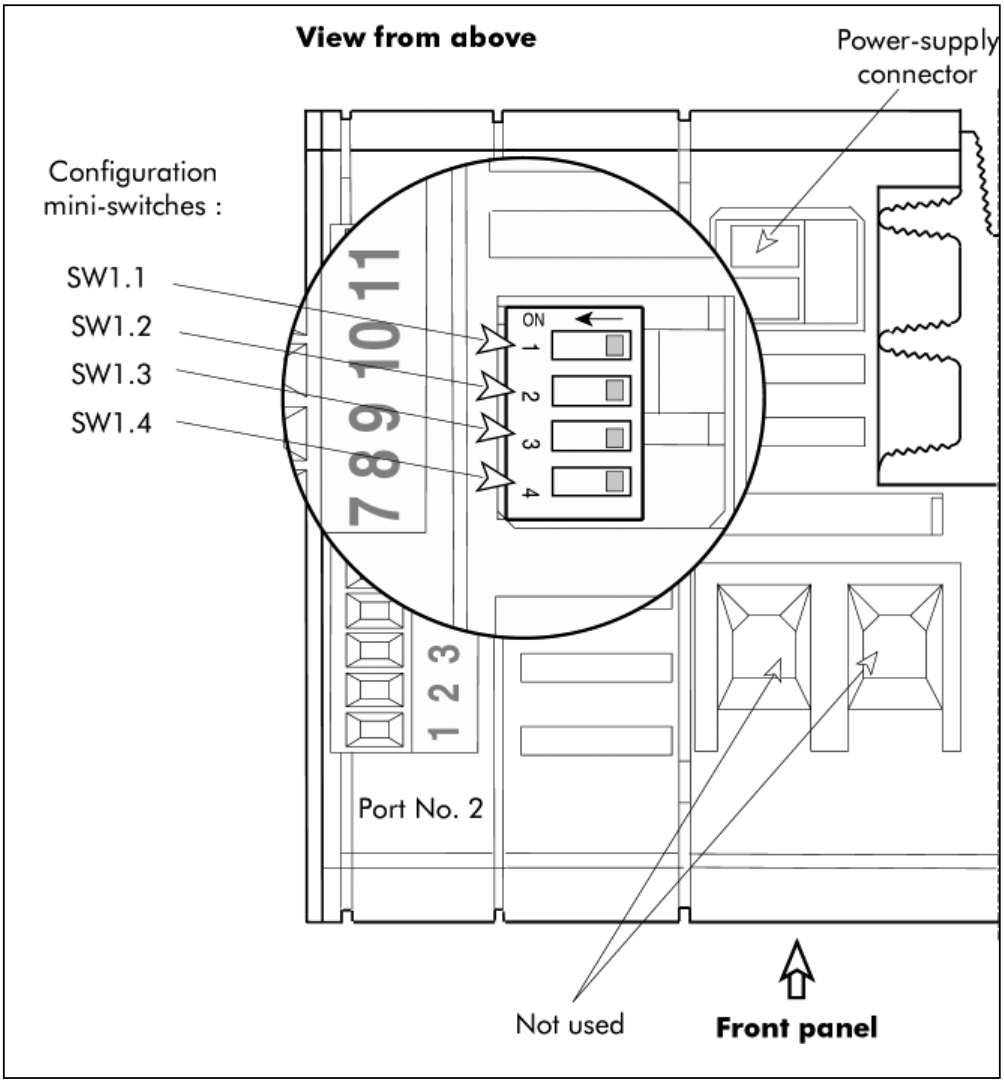

Figure 4-1 Layout of configuration mini-switches

SW1 mini-switch positions:

ON = the mini-switch is to the left (direction of arrow)
OFF = the mini-switch is to the right
(view from above, front panel towards you)

TRANSMISSION RATE

The transmission rate is configured by:

- the SW1.2 mini-switch for Modbus® protocol
- the SW1.2 & SW1.3 mini-switches for DeviceNet™ protocol.

In Profibus-DP protocol, the transmission rate is defined by the link Master;
REMIO baud rate setting is automatic and does not require any configuration to the bus.

Protocol	Transmission rate (kbaud)	Mini-switch position	
		SW1.2	SW1.3
Modbus®	9.6	OFF	Used for bus termination configuration
	19.2	ON	
DeviceNet™	125	OFF	OFF
	250	ON	OFF
	500	OFF	ON
Profibus-DP	up to 1500	Not used: auto selection	Used for bus termination configuration

Table 4-2 Transmission rate configuration

TERMINATION RESISTORS

Modbus® & Profibus-DP protocols

The communications bus must be fitted with termination resistors at each end:

- a line impedance matching resistor
- two RS485 bus polarisation resistors.

Mini-switches SW1.3 & SW1.4, located on the top of the REMIO interface, allow internal resistors to be connected at the end of the communications bus.

Important!

Only the last unit on the communications bus should be fitted with impedance matching resistors.
If the last unit on the bus is the REMIO, its mini-switches SW1.3 & SW1.4 should be in the ON position.

For all other REMIO units on the same communications bus, mini-switches SW1.3 & SW1.4 should be in the OFF position. The positions of SW1.3 & SW1.4 should always match.

As shipped from the factory, mini-switches SW1.3 & SW1.4 are OFF.

The matching resistor value depends on the characteristic impedance of the line (120Ω to 220Ω). The REMIO matching resistor is 220Ω.
The polarisation resistors are 390Ω connected to both power rails.

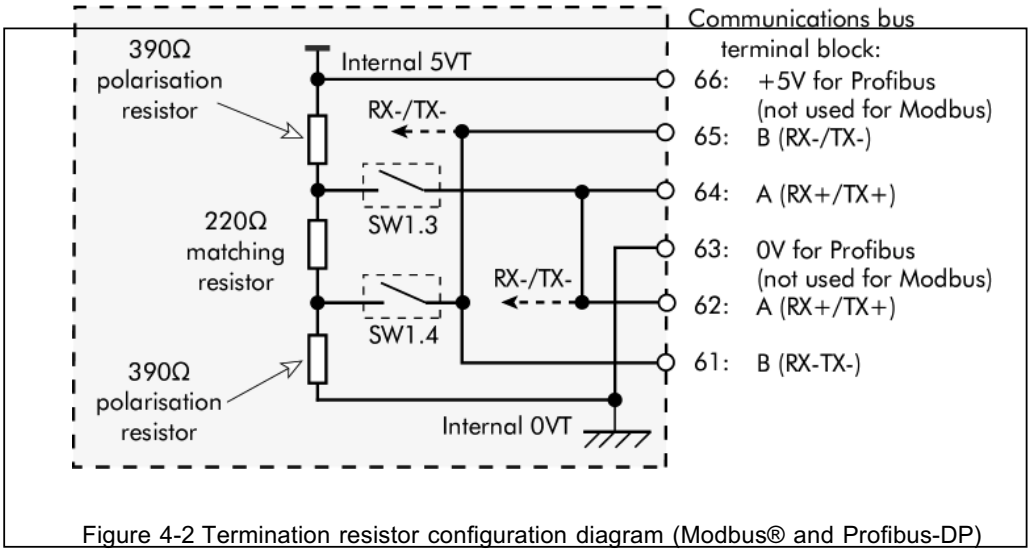

Figure 4-2 Termination resistor configuration diagram (Modbus® and Profibus-DP)

DeviceNet™ protocol

The communications bus must be fitted with a line impedance matching resistor at each end.

The CAN bus used in DeviceNet™ protocol does not require polarisation resistors, because bus operation is defined by impedance.

Mini-switch SW1.4, located on the top of the unit, allows an internal resistor to be connected at the end of the communications bus.

Important!

Only the last unit on the communications bus should be fitted with an impedance matching resistor.
If the last unit on the bus is the REMIO, mini-switch SW1.4 should be in the ON position.

For all other REMIO units on the same communications bus, the SW1.4 mini-switches should be in the OFF position.

As shipped from the factory, mini-switch SW1.4 is OFF.

The matching resistor value depends on the characteristic impedance of the CAN bus.
The REMIO matching resistor is 120Ω in DeviceNet™ protocol.

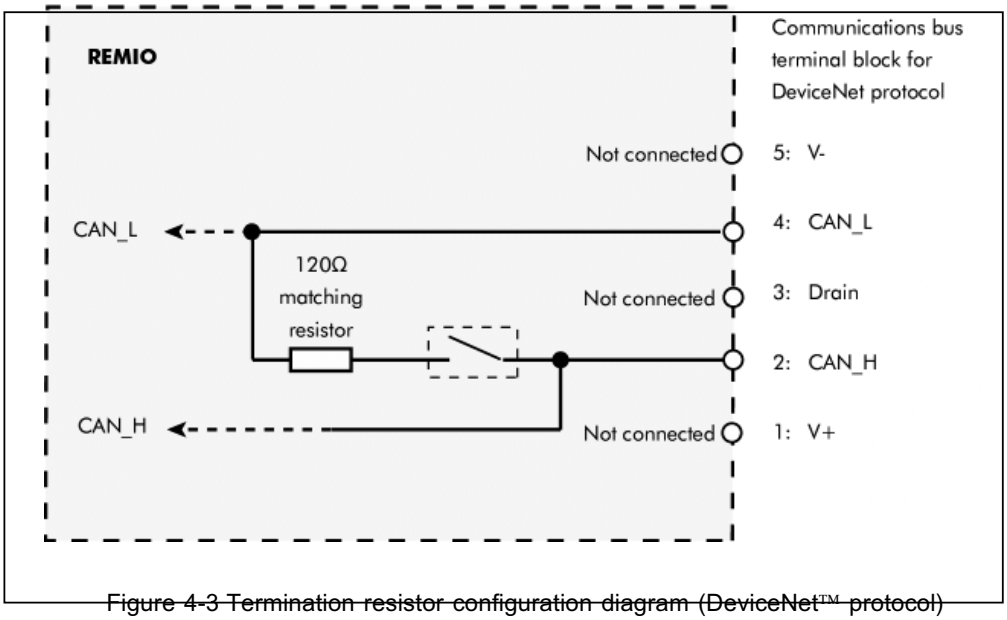

Figure 4-3 Termination resistor configuration diagram (DeviceNet™ protocol)

Chapter 5

OPERATION

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Chapter 5 OPERATION

THYRISTOR FIRING MODES

General introduction

The TPO version of the REMIO communications interface has two thyristor firing modes for the power units controlled (SSRs) :

- Fast cycling
- Advanced Single-cycle

The firing mode is selected by means of the REMIO power supply feed.

A DC voltage supply (24Vdc -15%, +25%) sets thyristor firing in '8-cycle' Fast cycling mode (see next page)

An AC voltage supply (24Vac -15%, +10%) sets thyristor firing in Advanced Single-cycle mode (see page 5-5).

'FAST CYCLING' MODE

Fast cycling mode is a duty cycle mode which consists of supplying a series of complete mains voltage cycles to the load.

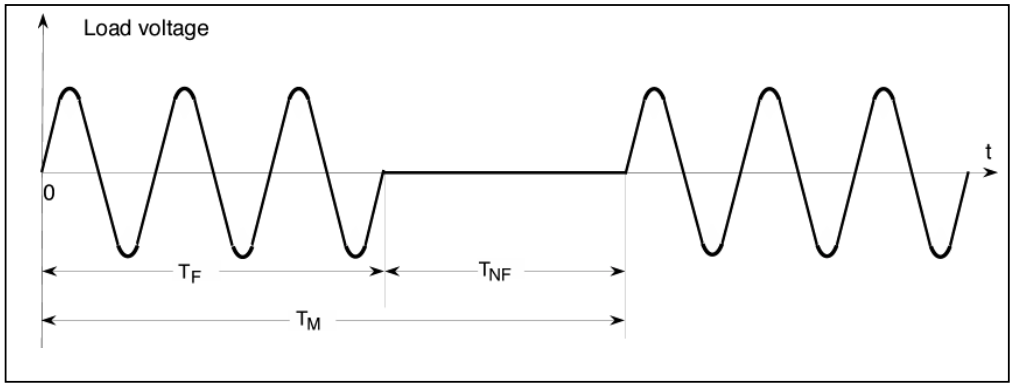

Figure 5-1 'Fast cycling' mode
(T_F - firing time; T_{NF} - non-firing time; T_M - modulation time)

Thyristor firing and non-firing are synchronised with the mains and, for a resistive load, are performed at zero voltage.

This type of firing eliminates steep rates of voltage applied to the load, minimises interference to the mains supply and, above all, avoids generating radio frequency interference (RFI).

In 'Fast cycling' mode, the power delivered to the load depends on the firing time T_F and the non-firing time T_{NF}.

The load power is proportional to the firing rate (τ) which is defined by the ratio of the firing time T_F to the modulation time $T_M = T_F + T_{NF}$

The firing rate (or duty cycle) is expressed by the following ratio:

$$\tau = \frac{T_F}{T_F + T_{NF}} = \frac{T_F}{T_M}$$

The power delivered to the load can be expressed by:

$$P = \tau \, . \, P_{MAX}$$

Where P_{MAX} represents the load power for full thyristor firing.

The modulation time in ‘Fast cycling’ mode is variable according to the power setpoint.

- At 50% of maximum setpoint (τ = 50%), modulation time comprises:
  - 8 firing cycles
  - 8 non-firing cycles.

- For a zone less than 50% of maximum setpoint (τ < 50%):
  - firing time remains constant at 8 mains cycles
  - non-firing time increases and, as a consequence,
  - modulation time increases also.

- For a zone greater than 50% of maximum setpoint (τ > 50%):
  - non-firing time remains constant at 8 mains cycles
  - firing time increases and, as a consequence,
  - modulation time increases also.

As a result of this type of modulation, REMIO offers precision control which adapts to each setpoint zone.

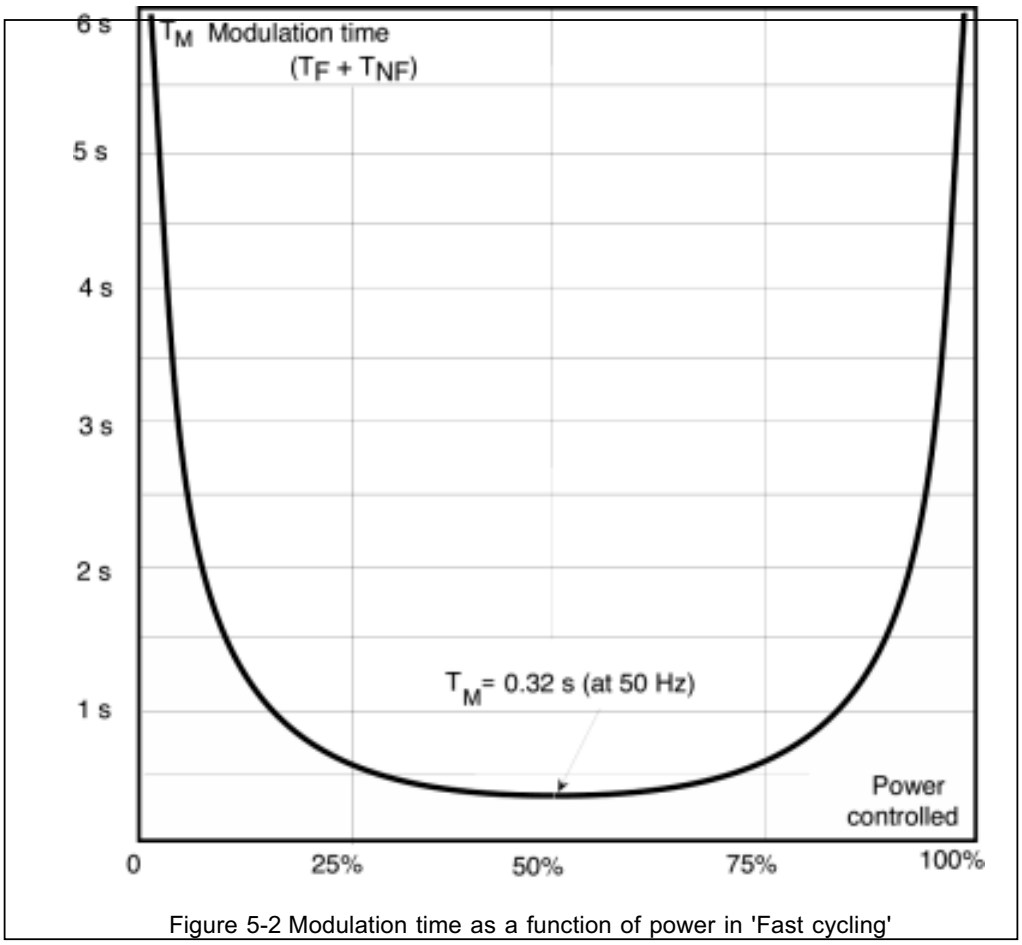

Figure 5-2 Modulation time as a function of power in 'Fast cycling'

'ADVANCED SINGLE-CYCLE' MODE

The Fast cycling mode with a single firing or non-firing cycle is called ‘Single-cycle’ (or ‘Standard Single-cycle’).

In 'Standard Single-cycle', the unit of thyristor firing or non-firing is one mains cycle.

In order to minimise power fluctuations during modulation time, the ‘Advanced Single-cycle’ thyristor firing mode uses half-cycle units for firing or non-firing.

- For τ = 50%, firing and non-firing times each correspond to one mains cycle (see Figure 5-3).
- For setpoints less than or greater than 50%, firing and non-firing times are calculated to within one half-cycle.

This firing mode considerably reduces modulation time compared to the firing mode by complete cycles.
Control performance is enhanced and fluctuations in the controlled power are reduced as a consequence of more rapid modulation.

'Advanced Single-cycle' firing mode reduces flickering in short-wave infrared elements and thus minimises resulting visual nuisance.

To avoid the DC component, the control system adjusts the number of positive and negative half-cycles.

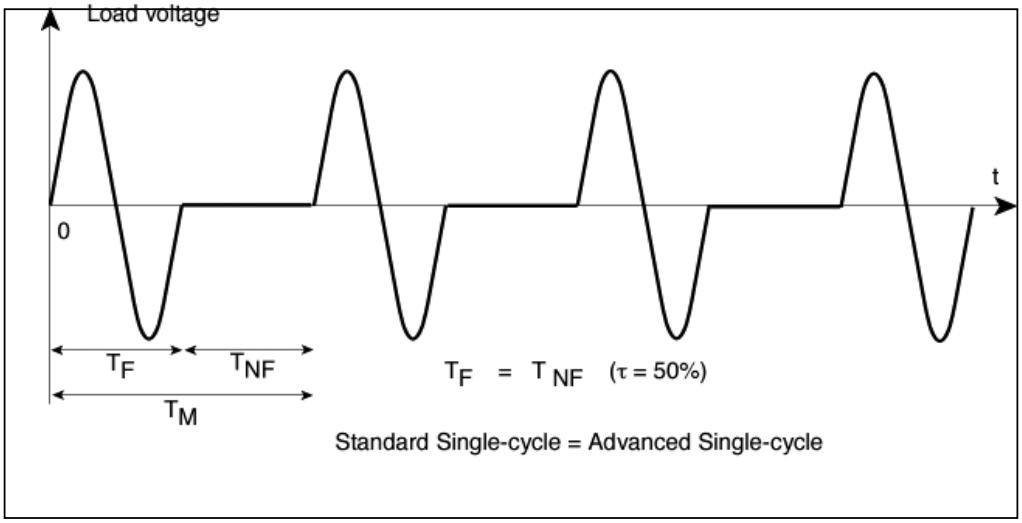

Figure 5-3 'Single-cycle' and 'Advanced Single-cycle' firing modes with τ = 50% ($T_F = T_{NF}$)

Figure 5-4 shows a firing example with a 33% firing rate in 'Standard Single-cycle' and 'Advanced Single-cycle' modes.

As for any firing zone less than 50% of the maximum setpoint (τ < 50%):

- for 'Standard Single-cycle', firing time is fixed at one mains cycle
- for 'Advanced Single-cycle', firing time is fixed at one mains half-cycle.

Setpoint changes cause variation in firing time. This has the effect of varying the modulation period.

As the figure below illustrates, 'Advanced Single-cycle' firing mode considerably reduces modulation time compared to firing by complete cycles. Control performance is enhanced as a result of more rapid modulation.

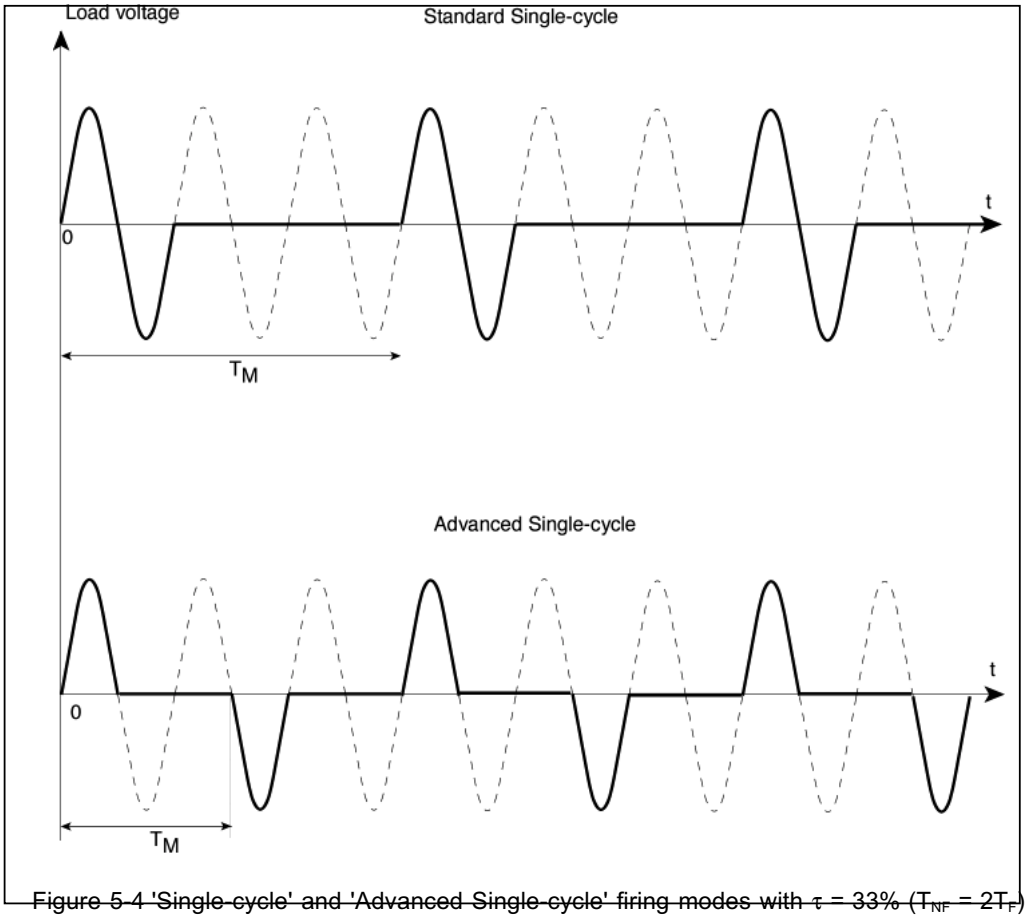

Figure 5-4 'Single-cycle' and 'Advanced Single-cycle' firing modes with τ = 33% (T_{NF} = 2T_F)

Figure 5-5 shows a firing example with a 66% firing rate in 'Standard Single-cycle' and 'Advanced Single-cycle' modes.

As for any firing zone greater than 50% of the maximum setpoint (τ > 50%):

- for 'Standard Single-cycle', non-firing time is fixed at one mains cycle
- for 'Advanced Single-cycle', non-firing time is fixed at one mains half-cycle.

Setpoint changes cause variation in firing time. This has the effect of varying the modulation period, as mains half-cycles are the unit of firing or non-firing in 'Advanced Single-cycle' mode.

As the figure below illustrates, 'Advanced Single-cycle' mode considerably reduces modulation time compared to firing by complete cycles. Control performance is enhanced as a result of more rapid modulation.

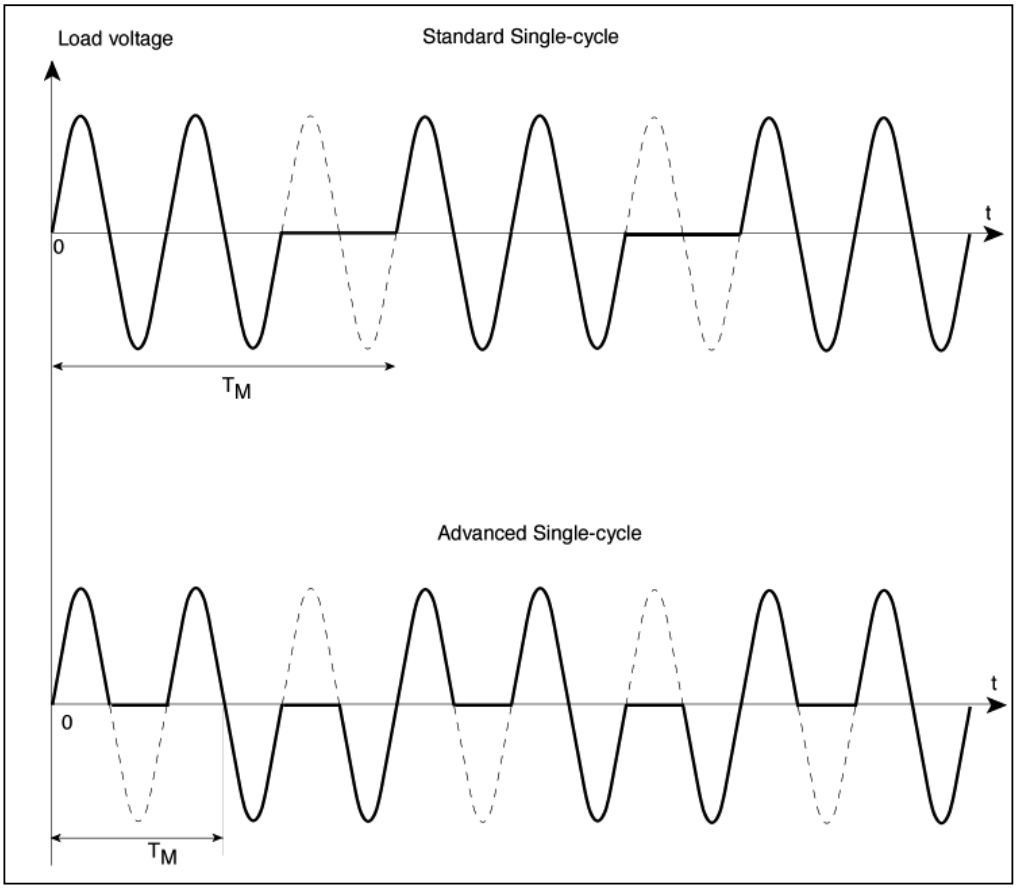

Figure 5-5 'Single-cycle' and 'Advanced Single-cycle' firing modes with τ = 66% ($T_F = 2T_{NF}$)

LED OPERATION

The REMIO has diagnostic LEDs on the front panel.

The Base Module comprises:

- two LEDs indicating the communications state and
- one LED indicating whether the power supply is present.

The green 'ON' power supply LED on each module is lit if this module (base module as well as the optional module) is supplied with power.

The green 'ON' LED is not lit if the module power supply is cut.

Modbus® and Profibus-DP protocols

Two LEDs are used to diagnose the state of the communications bus:

- the green LED labelled Data Exchg and
- the red LED labelled No comms.

Front panel LED labelling and colour		**Diagnostics**
Data Exchg (Green)	**No comms (Red)**	
On	Off	Normal data transfer The communications bus is active and duration of the parameter 'Time_out' has not elapsed since the last communications frame.
Off	On	Communications disrupted Bus inactive or duration of the parameter 'Time_out' has elapsed.
Off	Off	No power supply The REMIO is not communicating

Table 5-1 Diagnostics in Modbus® and Profibus-DP protocols by REMIO front panel LEDs

DeviceNet™ protocol

Two bi-coloured LEDs are used to diagnose the state of the REMIO and the communications bus:

- the green/red LED labelled Network Status (communications bus diagnostics)
- the green/red LED labelled Module Status (REMIO diagnostics).

The LEDs operate independently of one another.

LED operation	**LED labelling and function**	
	'Module Status' REMIO diagnostics	**'Network Status' Comms bus diagnostics**
OFF	REMIO not supplied	REMIO not supplied
Green - Red - Green	Start up auto test	Start up auto test
Flashing green	REMIO in wait mode: configuration absent, incomplete or incorrect	Communications OK, REMIO not assigned to a Master
Green on	REMIO operational	Communications OK, REMIO assigned to a Master
Flashing green / red	-	Transmission rate not authorised
Flashing red	Auto recoverable fault	Time Out elapsed
Red on	REMIO out of service	Communications problem

Table 5-2 Diagnostics in DeviceNet™ protocol by 'Module Status' and 'Network Status' LEDs