Eurotherm Monitoring and Acquisition unit

EMA

RMS current and voltage measurement with digital communications

User manual

EMA USER MANUAL

CONTENTS

Page

For a detailed description of the digital communications used by EMA units, (Profibus DP and Modbus® protocols), see the manual

'EMA Digital Communication' ref.: HA 176197 ENG - issue 2.0

CE

APPLICABLE EUROPEAN DIRECTIVES

CE marking and safety

EMA products installed and used in compliance with this user manual meet the essential requirements of the European Low Voltage Directive 73/23 EEC dated 19 February 1973 (modified by Directive 93/68 EEC dated 22 July 1993).

ELECTROMAGNETIC COMP ATIBILITY (EMC)

Electromagnetic compatibility is defined for **industrial environments** only, not for domestic environments.

EMA products installed and used in compliance with this user manual are certified compliant with the following EMC test standards. A system incorporating these products may be certified compliant with the EMC Directive as far as EMA products are concerned.

Test standards

Test		EMC test standard
Immunity	Generic standard	EN50082-2
	Electrostatic discharge	EN 61000-4-2 (06/1995)
	Fast transients	EN 61000-4-4 (01/1995)
	Electromagnetic fields	EN 61000-4-3 and ENV 50204
	Radio frequencies in common mode	EN 61000-4-6
Emission	Generic standard	EN 50081-2
	Radiated and conducted	EN 55011 Class A (1991)

Declaration of conformity

Availability

A declaration of CE conformity is available on request.

Validation by competent body

Eurotherm Automation has validated the compliance of EMA products with the European Low Voltage Directive and EMC test standards through product design and laboratory testing.

The tests performed on EMA products are listed in a Technical Construction File validated by the LCIE (Laboratoire Central des Industries Électriques), a recognised competent body.

EMC guide

In order to help you reduce the effects of electromagnetic interference associated with the installation of the product, Eurotherm Automation can supply you with an ‘Electromagnetic Compatibility’guide (Ref. HA 025464).

This guide lists best practices generally applied for EMC.

PRECAUTIONS

Important precautions and specific information are indicated in the manual by two symbols:

This symbol means that failure to take note of the information may have serious consequences for the safety of personnel and may even lead to electrocution.

Danger!

This symbol means that failure to take note of the information may have serious consequences for the facility or may lead to incorrect operation.

Caution!

These symbols attract the reader's attention to specific points. However the whole of the manual remains applicable.

Personnel

The unit must only be installed, configured, commissioned and maintained by qualified staff authorised to work on low voltage electrical industrial facilities.

Independent alarm

It is the user's responsibility to fit an independent safety mechanism which must be inspected regularly. This is highly recommended given the value of the equipment controlled by the monitoring unit. These alarms must be inspected regularly.
Eurotherm can supply appropriate devices.

Further information

For any further information or if in doubt please contact your local Eurotherm office where qualified staff are available to advise you or assist with commissioning your facility.

Chapter 1

IDENTIFICATION OF THE MONITORING UNIT

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GENERAL PRESENTATION

The **EMA** monitoring and acquisition unit is designed to **measure rms** currents and voltages such as those found on loads controlled by thyristor units with the following firing modes:

- firing angle variation ('**Phase angle**' mode, see specifications for details)
- supply voltage modulation ('**Burst firing**' mode)
- supply voltage modulation with a single firing period and one or a half cycle of non-firing ('**Single-cycle**' and **'Advanced single-cycle**' modes).

The measurements are available:

- on the unit's front panel **display**,
- **remotely**, via the digital communication bus.

Depending on the model, a maximum of **5 voltage measurements** and **5 current measurements** are possible.

The following features are located on the front panel:

- a two-line by 16 character LCD display,
- a female DB9 connector for configuration by PC, using the RS232 standard,
- diagnostic LEDs indicating communication operation,
- a button for scrolling through the display measurements (measurements, alarms, identification).

The display enables the user to read the measurements and quickly diagnose the state of the unit.

A space is provided to enable the user to affix an identification tag.

The following features are located on the rear panel:

- plug-in connectors for measurement signals, power supply and digital communications.
- mini-switches for configuring bus termination resistors.

The EMA unit measures to an accuracy of ±(**0.5%** of the measurement **±0.1%** of full scale):

- rms currents in the range **0.01 A** to **1.1 A or 0.05 A** to **5.5 A**,
- rms voltages from **5 V** to **550 V**.

For values exceeding **110%** of the full scale, the measurement will necessarily be **false** as the unit clips the signal and displays the maximum value of the measurement range.

For each channel, alarms are signalled on the display and via the digital communication if the upper or lower thresholds are exceeded.

If the EMA unit is to be reconfigured by the customer, **configuration software** is required. This software, supplied as **standard** on $3^1/_2$" disks, operates on a **PC** running Windows 95, 98 or NT.

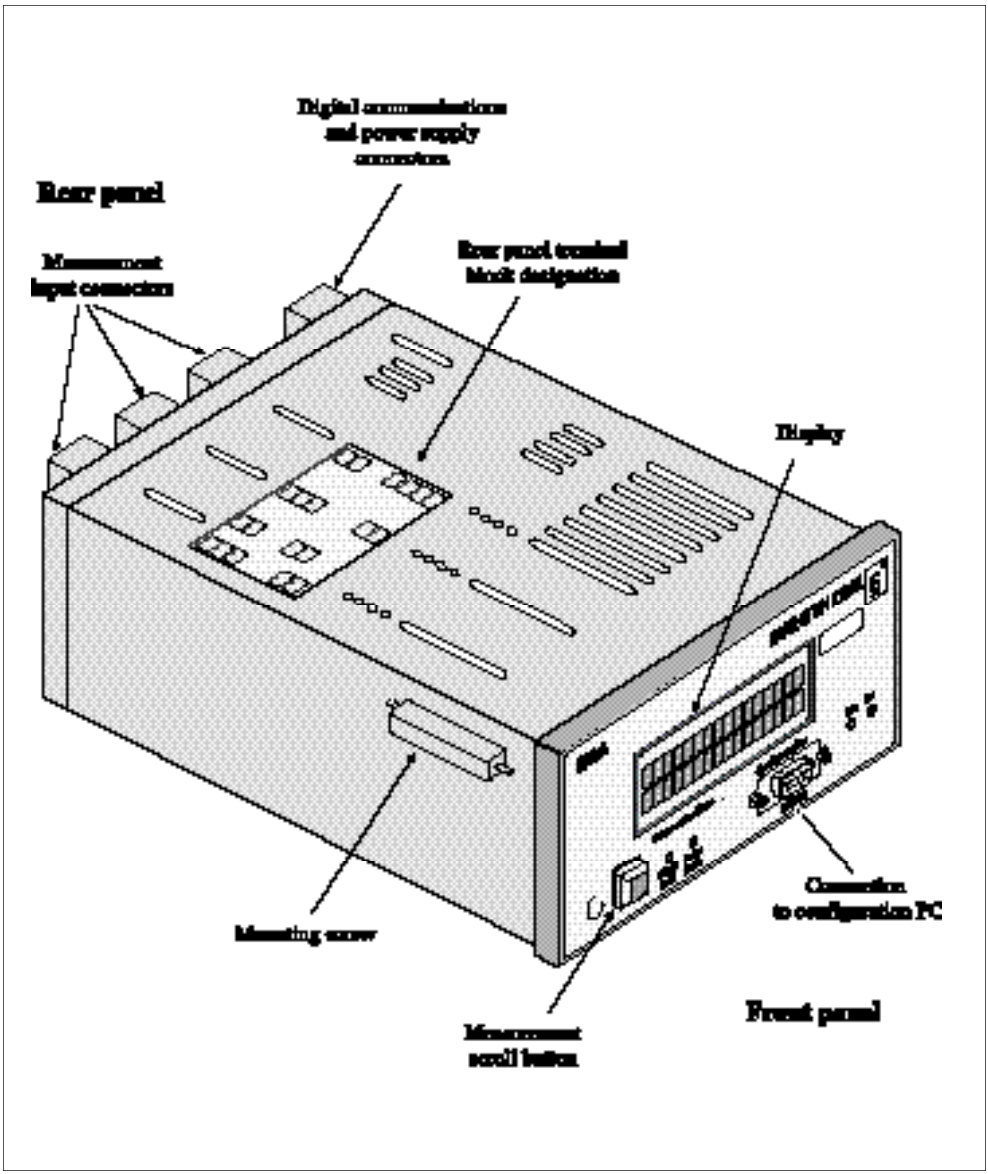

Figure 1-1 Overview of EMA monitoring unit

SPECIFICATIONS

Inputs

RMS current	1 A rating: 0.01 to 1.1 A 5 A rating: 0.05 to 5.5 A
Max. instantaneous peak current	1 A rating: ±1.6 A 5 A rating: ±8.0 A
RMS voltage	5 V to 550 V with peak voltage range ±800 V
Number of measurement channels	Up to 10 measurements Modularity by pairs of voltage/current measurements: 5 current and 5 voltage measurement channels

Measurements

Current	Display scale configurable from 1 A to 20,000 A (direct reading with external current transformer).
Voltage	Autoranging
Intrinsic precision	In burst firing, advanced single-cycle or phase angle modes with a thyristor firing angle ≥ 25°: ± (0.5% of measurement ± 0.1% of full scale) the voltage scales are: 35 V (V < 35 V) or 500 V (V ≥ 35 V); the current scales for the 1 A input are: 0.07 A (I < 0.07 A) or 1A (I ≥ 0.07 A), the current scales for the 5 A input are: 0.95 A (I < 0.95 A) or 5 A (I ≥ 0.95 A). If current or voltage transformers are used, the precision of the transformer must be taken into account to obtain the overall measurement precision.
Frequency of signals measured	47 Hz to 63Hz
Integration time (filtering)	Configurable from 1 s to 1300 s.

Power supply

Mains supply	115 Vac or 230 Vac (depending on product code) Frequency: 47 Hz ≤ f ≤ 63 Hz (same frequency as measurements)
Consumption	18 VA
Protection	0.5 A internal fuse and varistor.

Local display

Monitoring unit	Unit identification (name, destination, bus address)
Measurement channel	Identification (by scrolling, for each channel) of: • variable name (8 characters) • value measured and measurement unit (4 significant digits) • digital link state • alarms if the lower or upper thresholds are exceeded.

Digital communication

Protocol	Profibus-DP and Modbus®
Transmission speed	9.6, 19.2, 93.75, 187.5, 500 or 1500 kbaud for Profibus (automatic baud rate detection) 9.6 or 19.2 kbaud for Modbus
Bus	RS485 two-wire isolated serial link
Diagnostics	• LCD front panel display • LEDs for digital communication state • LEDs for transmission state (transmit and receive) • Diagnostic field in frames (Profibus).

Alarms

Type	Measured value outside upper or lower thresholds.
Configuration	Current: from 0 to the maximum of the adjusted scale (1 to 20,000A). Voltage: from 0 to 550 V.

Configuration

Mode	Without interrupting communications with the link master.
Configuration software	For PC (Windows 95/98 or NT), shipped as standard on 3½" disks. Multilingual program: English, French, German, Spanish, Italian. Female DB9 configuration connector on front panel.
Parameters configured	Identification of unit and bus address. For each channel: - identification and description - scale for current inputs (1 to 20,000 A) - voltage scaling factor (±25%) - integration time - alarm high and low thresholds

Isolation

Measurement channels	Between measurement channels and low level channels and circuits: Double isolation up to 500 Vac Between current measurement channels on a single connector Single isolation up to 500 Vac
Conformity	Complies with the requirements of the European Low Voltage Directive and standards EN 50178 and IEC 664-1. Over-voltage category III.

Environment

Operating temperature	0°C to 45°C at a maximum altitude of 2000 m.
Storage temperature	-10°C to 70°C.
Operating atmosphere	Non-explosive, non-corrosive and non-conductive. Pollution degree 2.
Humidity	RH: from 5% to 95% non-condensing and non-streaming.
Protection	IP20 in accordance with IEC 529. IP65 for front panel (option).
External wiring	Must comply with IEC 364

Physical details

Overall dimensions	Height: 72 mm; Width: 156 mm; Depth: 227 mm
Weight	1.5 kg.

Important!

For loads with a high starting current (large variations in resistance depending on temperature, e.g. **Molybdenum**, **Molybdenum disilicide**, **Tungsten** or motors), check that the peak current measured **does not exceed** the maximum peak value specified.

Warning!

EUROTHERMhas taken particular care to ensure that these specifications are correct. However, in order to maintain our 'leading edge' we continually strive to improve our products, which may lead to modifications or omissions in the specifications. We shall not be held responsible for any damage, injury, losses or expenses incurred as a result of such modifications.

ORDERING CODE

Supply	Communication	Transmission	Number of	Current input	Manual
EMA / voltage /	protocol /	rate	/ I-V channels /	rating	/ language / Option / **00**

1. Supply voltage	Code
115 volts	**115V**
230 volts	**230V**

4. Number of current / voltage channels	Code
2 current measurement channels and 2 voltage measurement channels	**2I2V**
4 current measurement channels and 4 voltage measurement channels	**4I4V**
5 current measurement channels and 5 voltage measurement channels	**5I5V**

2.Communication protocol	Code
Profibus-DP	**PFP**
Modbus®	**MOP**

5. Current input rating	Code
1 amp	**1A**
5 amps	**5A**

3. Transmission rate	Code
Modbus® protocol	
Read only at 9.6 kbaud	**R96**
Read only at 19.2 kbaud	**R192**
Profibus protocol	
Read only up to 1.5 Mbaud	**RAUT**

6. Manual language	Code
French	**FRA**
English	**ENG**

7. Option	Code
IP65 protective cover for front panel	**IP65**

Ordering code example

Installation:

EMA monitoring unit with configuration software

Supply voltage	230 V
Communication protocol	Profibus-DP
Number of measurement channels	10 (5 voltage and 5 current)
Current input rating	1 A
Manual shipped	English
Protection	IP65 front panel protection

Ordering code:

EMA / 230V / PFP / RAUT / 5I5V / 1A / ENG / IP65 / / 00

Chapter 2

INSTALLATION

Contents Page

SAFETY DURING INSTALLATION

Mounting

Danger!

The EMA monitoring unit must be installed in a fan-cooled cabinet, to ensure that condensation and pollution are excluded. The cabinet must be closed and connected to the protective earth according to IEC 364 or applicable national standards.

The units are designed for use at an ambient temperature of 45°C or less. For installations in a fan-cooled cabinet we recommend fitting a fan failure detection device or a thermal safety cut-out.

Units must be mounted with no obstructions above or below which could reduce or hamper cooling. If several units are fitted in the same cabinet, arrange them such that hot air from one unit is not drawn into the unit above.

Caution!

Overheating may lead to incorrect operation. This may in turn cause damage to the components.

Wiring

Danger!

Wiring must be performed by qualified staff authorised to work on low voltage industrial electrical facilities.

Before connecting or disconnecting the unit check that power and control cables and leads are isolated from voltage sources.

The protective earth must be connected before any other connections are made and should be the last cable to be disconnected.

It is the user's responsibility to wire and protect the facility according to best practice and applicable standards.
A suitable device, ensuring that the unit can be electrically separated from the supply, must be installed upline to enable work to be performed safely.

Commissioning

Danger

The EMA's internal circuitry includes components at dangerous voltages when the unit is connected to the power supply and to measurement points.
Users must not access internal components.

Important!

Eurotherm Automation shall not be held responsible for any damage or injury, losses or expenses incurred due to inappropriate use of the product or failure to comply with the instructions in this manual.

Users are therefore responsible for checking, before commissioning, that all the EMA unit's rated values correspond to the conditions of use and the facility.

DIMENSIONS

Overall dimensions of the EMA unit (mm): **227** × **156** × **72**

Front panel (mm): **72** × **144**

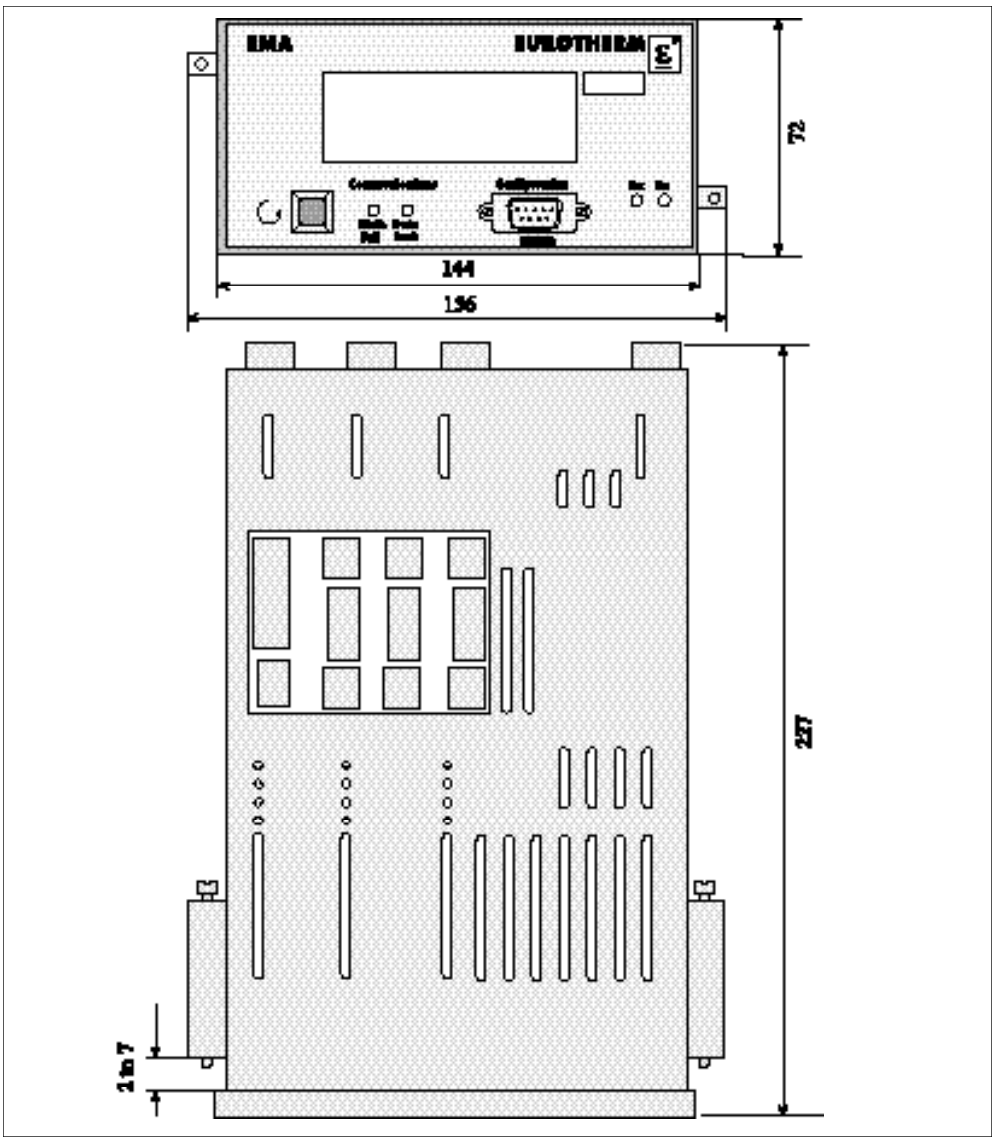

Figure 2-1 Dimensions (mm)

MOUNTING

EMA monitoring units are designed to be mounted on a vertical support (panel).
Maximum panel thickness: 7 mm, minimim thickness: 2 mm.

Leave a gap of at least 5 cm between two units placed side by side.

Before mounting, prepare the panel **cut-out** with dimensions as shown.
Panel cut-out for mounting (mm): **138 (+1; -0)** × **68 (+0.7; -0).**

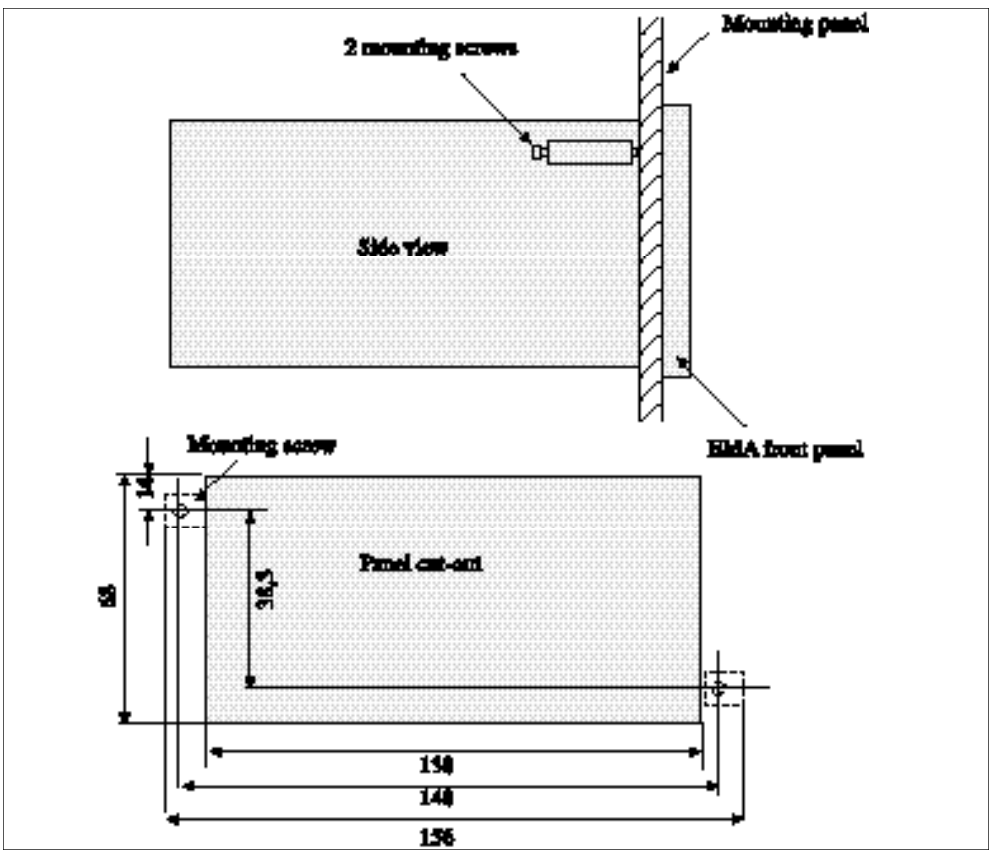

Figure 2-2 Mounting

The EMA unit is fixed into panel with **two screws** (supplied with the unit). The screws are tightened onto the rear of the mounting panel (see figure 2-2).

Maximum tightening torque: 1.5 N.m.

FRONT PANEL

The following features are located on the front panel:

- a two-line by 16 character LCD display
- a DB9 female connector (RS232 standard) for configuration using a PC
- a push button for scrolling through the measurements (display pages)
- diagnostic LEDs indicating the state of digital communications
- diagnostic LEDs indicating transmission and reception of digital signals

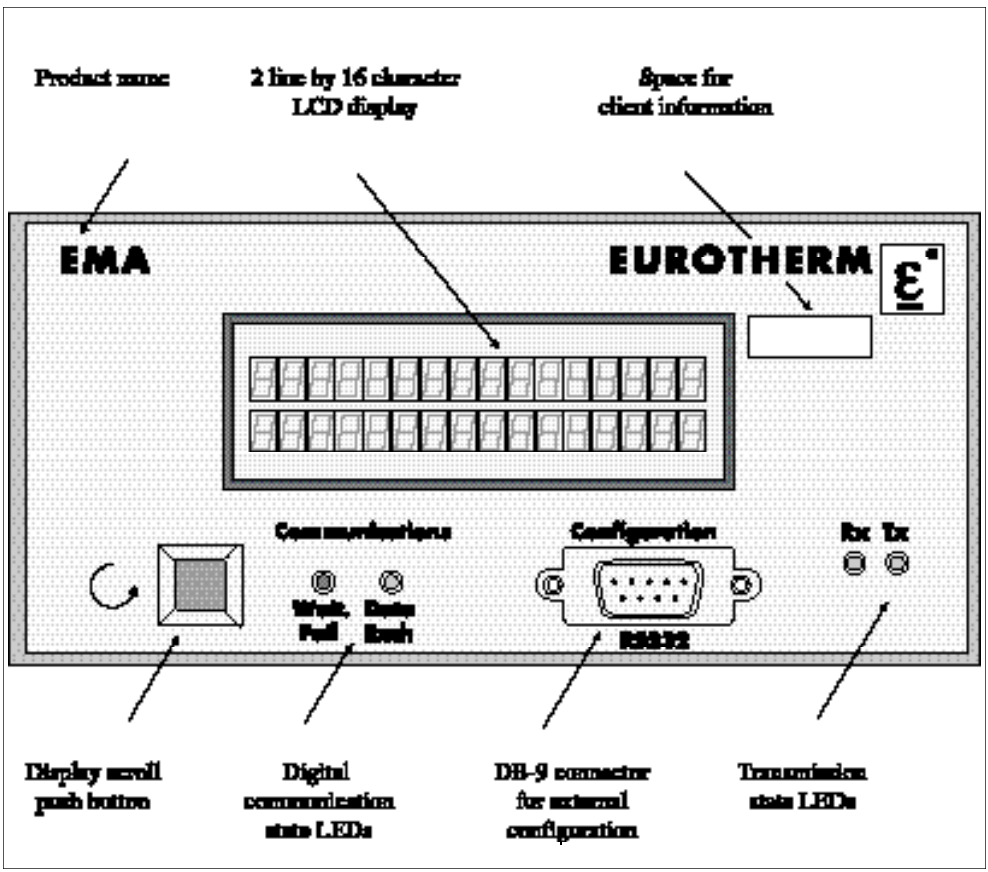

Figure 2-3 Front panel

REAR PANEL

The following plug-in terminal blocks are located on the rear panel:

- power supply and protective earth
- measurement inputs
- digital communications

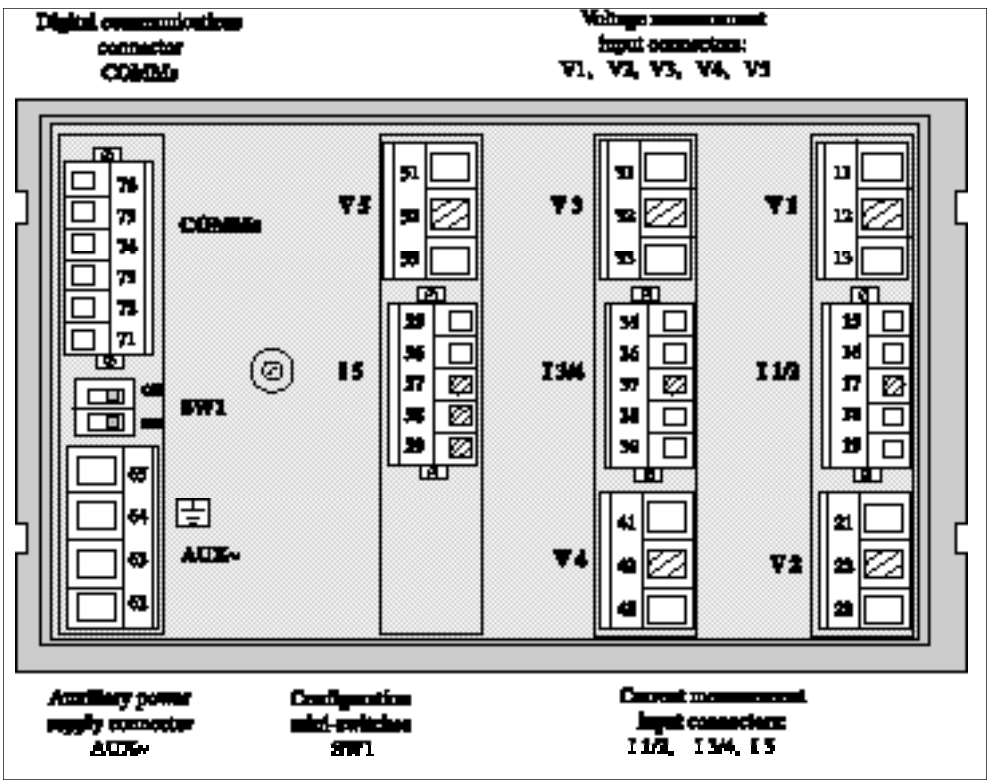

Figure 2-4 EMA rear panel

A description of the terminals is given on the following pages together with the wiring for:

- protective earth
- auxiliary power supply
- current and voltage measurements
- digital communication

WIRING

The monitoring unit is wired on the rear panel terminal blocks (except for the configuration socket).

Important!

Plug-in terminal blocks are used; there is no need to open the unit.

Connectors for wiring the power supply, measurement inputs and digital communication are supplied with the unit.

The connector terminals are numbered as shown on the label on the top of the EMA unit (see figure 1-1).

Plug-in terminal block	Terminal capacity (mm^2)	Tightening torque (N.m)	Stripping length (mm)
Power supply Voltage inputs	2.5	0.7	6 to 7
Current inputs Digital communication	1.5	0.5	6 to 7

Table 2-1 Wiring details

Caution!

- The cross-section of the wiring conductors must meet the IEC 943 standard.
- The voltage drop in the current input leads must be low enough to match the precision class for the external current transformer.

Auxiliary supply terminal block

The EMA protective earth and power supply are connected to the **AUX~** terminal block.

Terminal block name	Terminal number	Terminal labelling	Function
AUX~	62	L	Connection to mains supply phase
	63	N	Connection to main supply neutral
	64	PE	Protective earth
	65	PE	Ground return for digital communication cable shield connection

Table 2-2 Auxiliary supply terminals

Protective earth connection

The **protective earth** is connected to terminal **64 (PE)** as shown on figure 2-5.

The protective earth terminal is labelled with the following symbol:

Danger!

The protective earth cable should be connected before any other connections are made during wiring and should be the last cable to be disconnected.

The internal connection between terminals **64** and **65** ensures that the protective earth (or ground) is returned by terminal **65 (PE)**.

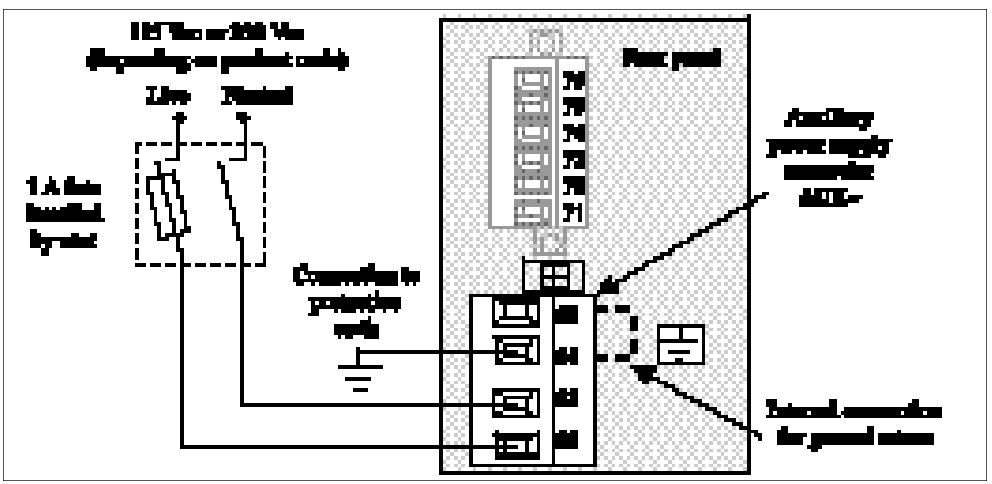

Figure 2-5 Protective earth and auxiliary supply wiring

Power supply wiring

The unit's power supply should be connected to the **AUX~** terminal block as shown on figure 2-5.

The supply is factory-set to **115 Vac** or **230 Vac** depending on the ordering code

Caution!

A **1 A** fuse should be installed by the user to protect the power supply.

Measurement input terminal blocks

The measurement channels are independent and isolated.

The **voltage** (current) measurement inputs are indicated by **V (I)** and two digits: **Vxx (Ixx)**.
The **first** digit indicates the measurement **channel number**.
The **second** digit indicates the **terminal number** (1 or 2).

e.g. V31 and V32 correspond to terminals 1 and 2 of the third voltage measurement channel.
I21 and I22 correspond to terminals 1 and 2 of the second current measurement channel.

Function	Channel number	Terminal block labelling	Terminal number	Terminal labelling
Voltage measurement	1	V 1	11	V 11
			12	Not used
			13	V 12
	2	V 2	21	V 21
			22	Not used
			23	V 22
	3	V 3	31	V 31
			32	Not used
			33	V 32
	4	V 4	41	V 41
			42	Not used
			43	V 42
	5	V 5	51	V 51
			52	Not used
			53	V 52
Current measurement	1	I 1/2	15	I 11
			16	I 12
			17	Not used
	2		18	I 21
			19	I 22
	3	I 3/4	35	I 31
			36	I 32
	4		37	Not used
			38	I 41
			39	I 42
	5	I 5	55	I 51
			56	I 52
			57	Not used
			58	Not used
			59	Not used

Table 2-3 Description of measurement terminals

Measurement wiring

Current measurements (direct or via an external current transformer) should be connected to inputs I 11 and I 12 through to I 51 and I 52 (see table on previous page).

Important! Eurotherm Automation can supply external current transformers from 10 A / 1 A to 500A / 1 A. Contact your local Eurotherm office for details.

Voltage measurements should be connected on inputs V 11 and V12 through to V 51 and V 52.

Caution!

- External fuses are designed to protect the voltage measurement wiring and should be installed as close as possible to the measurement points.

The diagram below shows an example of

- current measurement using an external current transformer
- direct voltage measurement

in a resistive load controlled by a power thyristor unit (e.g. TE10P).

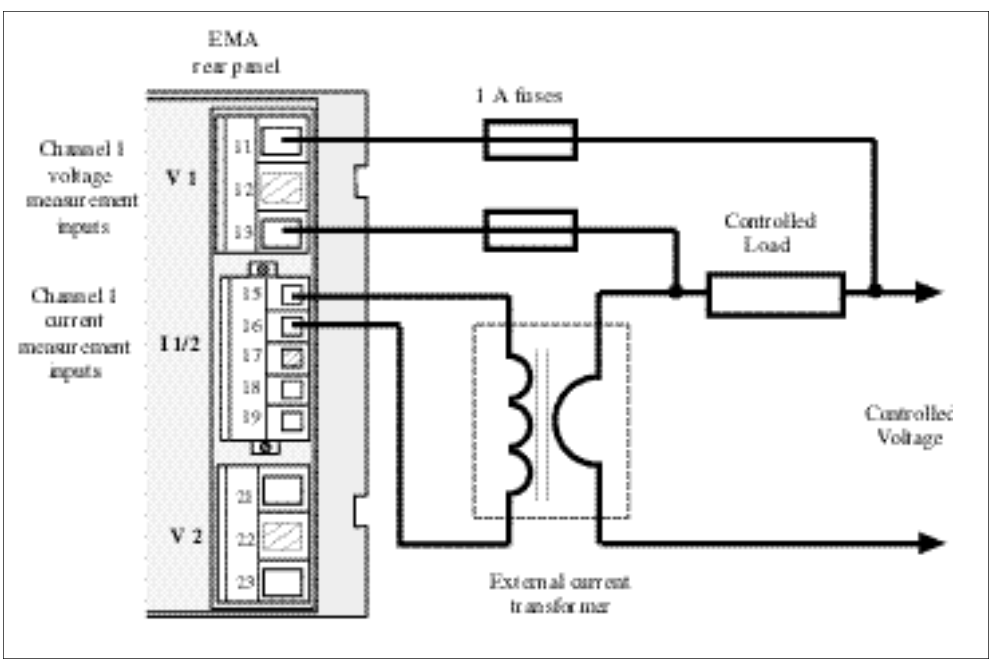

Figure 2-6 Example showing wiring of voltage and current inputs for a resistive load controlled by a thyristor unit.

Digital communication wiring

Communication bus wiring and shield grounding

Caution!

The digital communications bus should be connected with **shielded twisted pairs**. The communication bus **shield** should be **grounded at both ends** to ensure maximum immunity to electromagnetic interference.

To simplify grounding of the communications cable shield, a **metal ferrule** may be used, connected to the protective earth by a return wire (see figure 2-8).

To wire the communication bus and ground the shield, proceed as follows:

- **Strip** the shielded cable as shown on figure 2-7.
  The wires must be long enough to enable them to be connected to the communications terminal block.
- **Insert** the cable into the ferrule so that the shield is in contact with the metal ferrule (see figure 2-8).
- **Crimp** the ferrule to the ground return terminal, terminal **65 (PE)** (see figure 2-8).

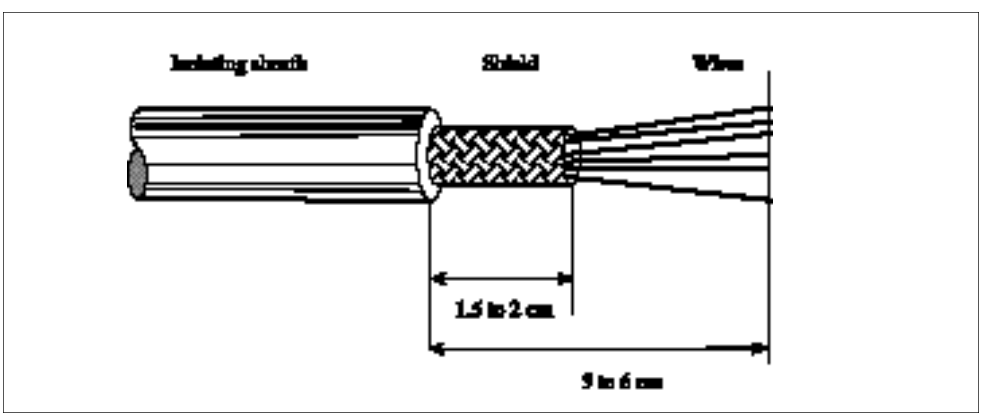

Figure 2-7 Bus cable stripping for shield grounding

The maximum length of the transmission line is **1.2 km** for speeds ≤ **93.75 kbaud**.

Digital communications wiring

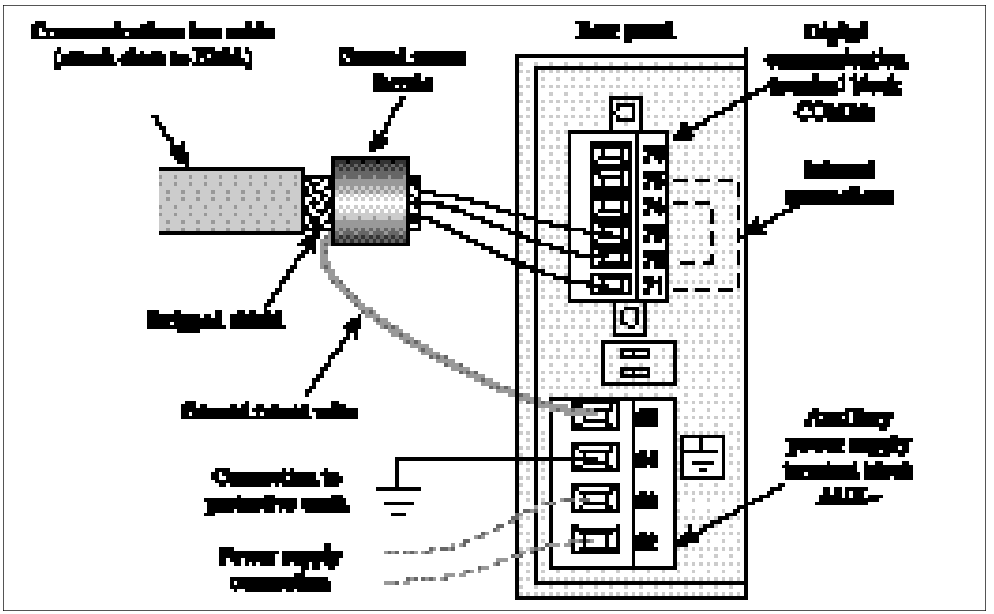

Figure 2-8 Communications bus wiring and ground shielding

Digital communications terminal block

The digital communications terminals are isolated from the other signals.

Communications terminal block terminals			Labelling for:	
Number	**Labelling**	**Function**	**Profibus**	**Modbus (active state)**
71	**B**	Signal receive and transmit	B	RX- / Tx-
72	**A**		A	Rx+ / Tx+
73	**GND**	0 V for digital signals	0V	Not used
74	**A**	Signal receive and transmit	A	Rx+ / Tx+
75	**B**		B	RX- / Tx-
76	**5VP**	+5 V for digital signals	5VP	Not used

Table 2-4 Function of terminals on digital communications terminal block

Important!

- By convention, the potential of terminals **A** is **greater than** the potential of terminals **B** when the RS485 line is **active**.
- Terminals **71** and **75** are **connected together** inside the unit.
  Terminals **72** and **74** are **connected together** inside the unit.

Communications bus wiring

The digital communication bus uses **two active wires** (RS485).
The **0 V** (GND) connection is optional.

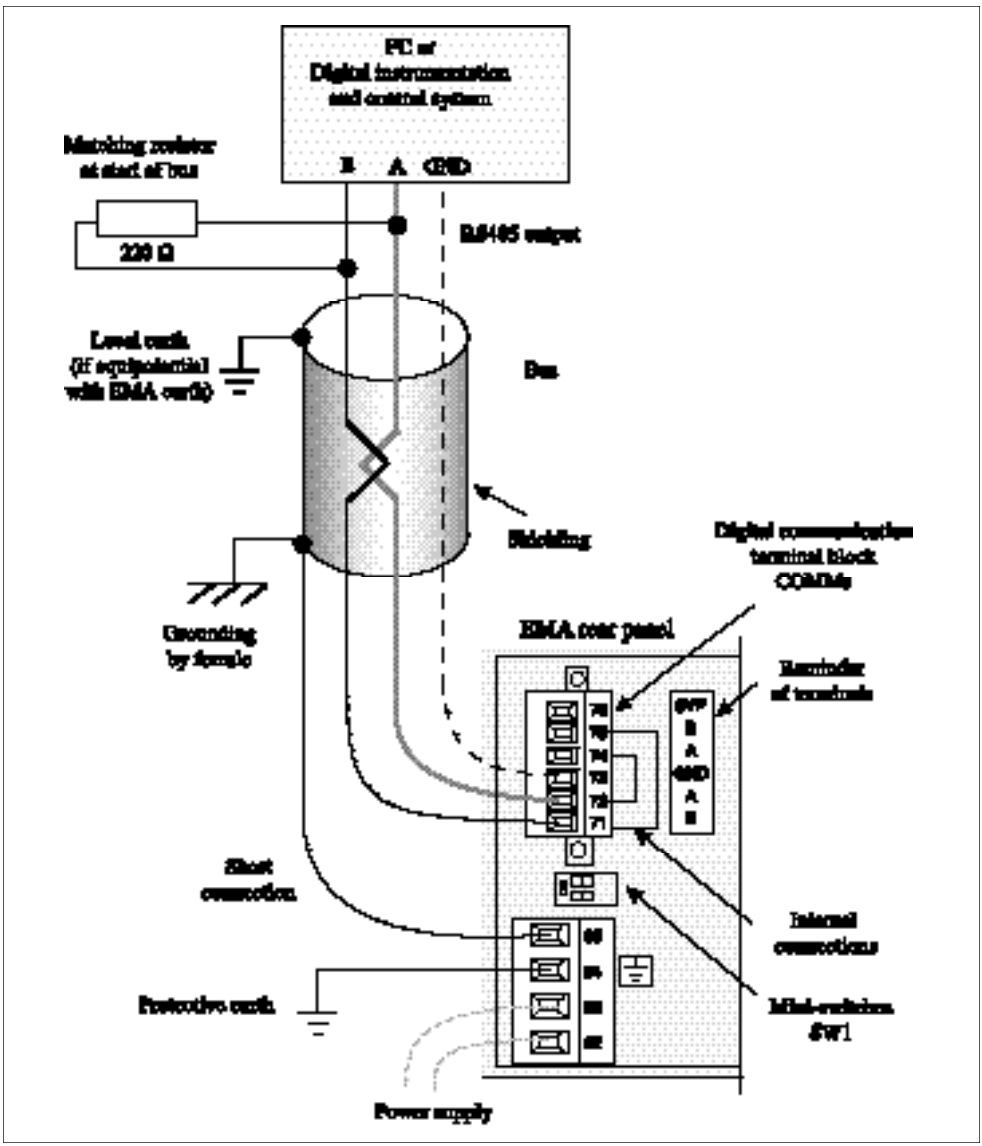

Figure 2-9 Example of digital communication wiring

Matching and polarisation resistors

In order to protect against possible line reflections, a matching resistor termination resistor must be fitted to **each end** of the bus.

The value of the resistor depends on the characteristic impedance of the line (**R = 120** Ω to **220** Ω).

Polarisation resistors are used to set the output state of the receivers when at rest (no communication).

Two mini-switches **SW1.1** and **SW1.2** are provided on the EMA communications bus to **insert three internal resistors** at the **end** of the bus, for matching and polarisation.
They are located on the rear panel, between the communications and AUX~ terminal blocks.

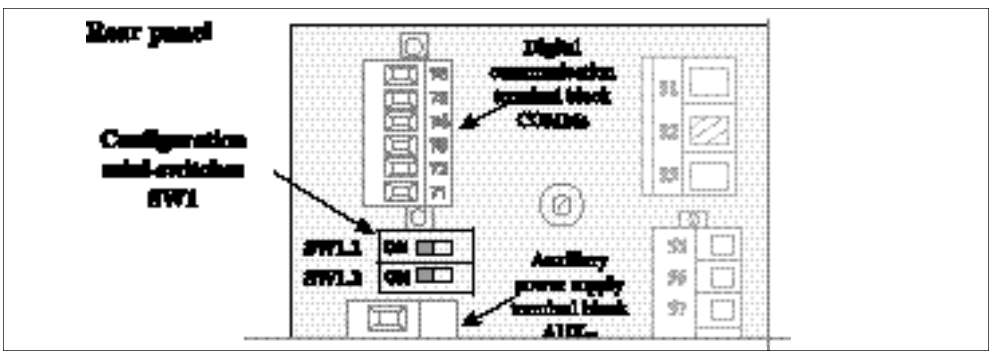

Figure 2-10 Location of SW1 resistor configuration mini-switches.

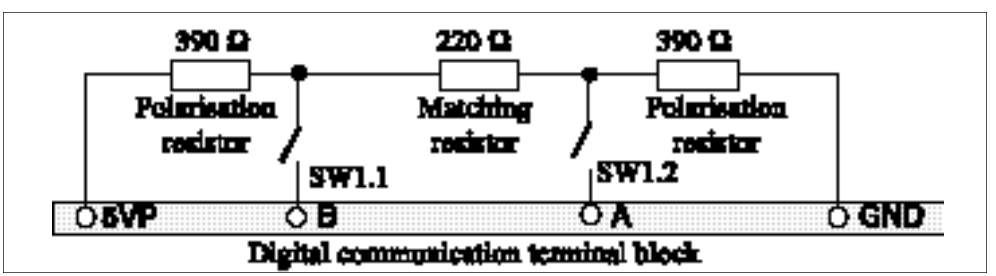

Figure 2-11 Internal connections of matching and polarisation resistors.

Caution!

- Mini-switches **SW1.1** and **SW1.2** are set to **OFF** when shipped from the factory.
- If the EMA monitoring unit is the **only** unit on the bus or is the **last** unit connected to the communication bus (at the **end** of the bus)
  set mini-switches **SW1.1** and **SW1.2** to **ON**
- If the EMA monitoring unit is **not** the **only** unit on the bus or is **not** the **last** unit connected to the communication bus (at the **end** of the bus)
  set mini-switches **SW1.1** and **SW1.2** to **OFF**

COMMISSIONING

Flow char t

Commissioning simply involves **powering up** the unit, after **installing**, **wiring** and **checking the characteristics** of the unit **in accordance with this manual**.

Two types of message page will be displayed:

- after powering up the auxiliary power supply, the EMA identification page is displayed
- after connecting the measurement signals, the pages for each channel can be displayed by scrolling using the push button on the front panel

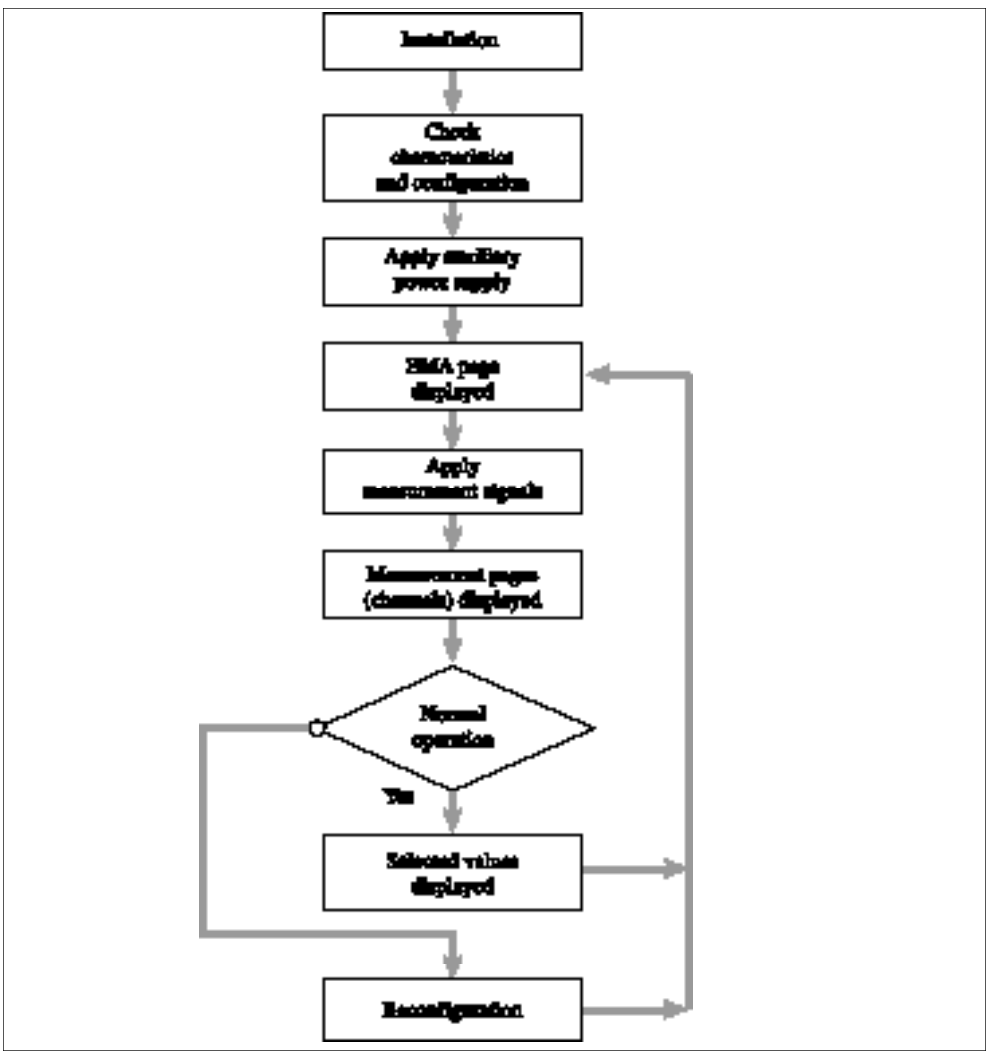

Figure 2-12 Commissioning flow chart

Checking the characteristics

Caution!

Before powering up, make sure that the **product code** corresponds to the code ordered and that the characteristics of the EMA unit are **compatible with the facility.**

Mains supply and voltage measurement inputs

- The **frequency** of the supply must be the **same** as the frequency of measured inputs.
- The **nominal value** of the supply voltage must be compatible with the voltage **configured** in the **factory**, as ordered.
- The rms voltage measured must not exceed the maximum rms value accepted by the EMA: **550 V**.

Caution!

Never use the EMA unit with a supply voltage greater than the specified value, as this could damage protection components and/or internal circuitry.

Checking the wiring

Danger!

Before checking the wiring, ensure that the measurement and control cables are isolated from voltage sources.
Check that the protective earth cable is connected to the unit's earth terminal.

Danger!

The wiring must be checked by personnel authorised to work with low voltage equipment in an industrial environment.

Check that a suitable device, ensuring that the unit can be electrically separated from the supply, is installed upline to enable work to be performed safely.

Powering up

Caution!

The monitoring unit power supply should be powered up **before** or **at the same time as** the measurement circuits.

Chapter 3

DIGITAL COMMUNICATIONS

Contents Page

GENERAL

EMA monitoring units are fitted with digital communications as standard.

This enables four main functions to be performed:

- configuring the communications protocol parameters (using Modbus only)
- configuring the monitoring unit's bus address
- controlling the state of the monitoring unit
- monitoring all values measured and alarms

The digital link uses the **RS485** physical data transfer layer standard and the **Profibus-DP** or **Modbus®** protocols.

The protocol is selected when the unit is ordered but may be **reconfigured** on site.

After any changes to the digital communications parameters, the unit must be shut down and powered up again to take the parameters into account.

The communication bus is **isolated** from all other inputs.

Message transfers use 'Master / Slave' mode.

The monitoring unit always operates as a 'Slave', and the supervision system or PLC acts as 'Master'.

All exchanges involve a request from the master and a response from the slave.

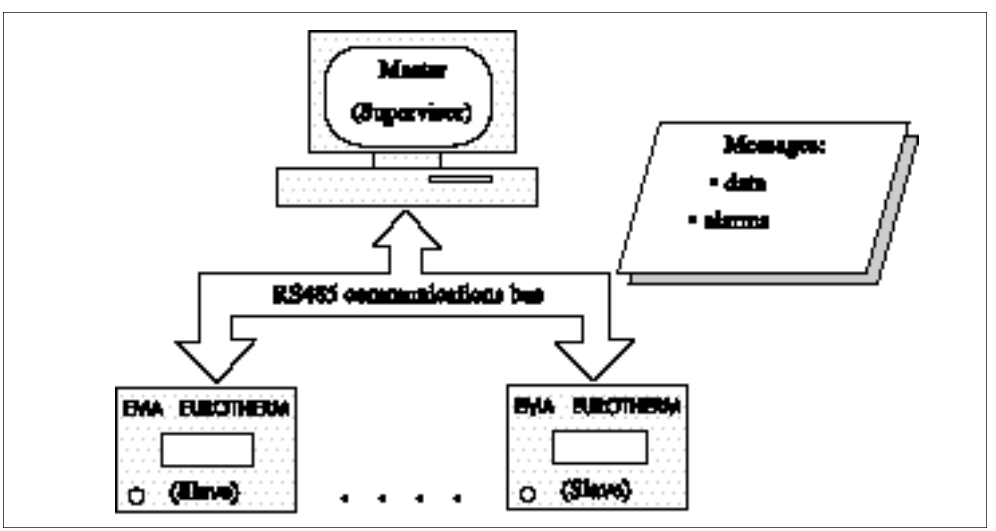

Figure 3-1 Organisation of data transfers

PROFIBUS-DP PROTOCOL

Specifications for the **PROFIBUS-DP** (**P**rocess **F**ield **B**us **D**ecentralized **P**eriphery) protocol are defined in the following standards:

EN 50170 / DIN 19245 / Part 3.

Important: A detailed description of Profibus-DP operation is given in the 'EMA: Communication Manual', ref. HA176197 ENG.

Transmission frames use binary characters with even parity
Character format: 1 start bit - 8 data bits - 1 parity bit -1 stop bit.

The following transmission rates are available:
9.6, 19.2, 93.75, 187.5, 500 and 1500 kbaud with auto baud rate detection.

Addressing

The physical address (**address of the monitoring unit on the bus used**) is set by configuration:

- either using the supplied configuration program (for a PC running Windows 95/98 or NT)
- or using the Profibus **Set_Slave_Address** function from the link Master, provided the monitoring unit is the only device on the bus and is in the wait for parameters phase (**WPRM**).

Important!

As shipped from the factory, the default address configured on the EMA is
32 (decimal)
This address may be reconfigured by the user.
After the EMA's address is changed, the new address is only taken into account **after** the unit is next powered up.

In normal operation the following addresses may be used:

4 to **125**

Addresses **0** to **3** are generally reserved for the Master.

Address **126** is not accepted by the EMA.

Address **127** is reserved for broadcasting in accordance with the Profibus standard.

State diagram

The state diagram for data transfers using a read / write process comprises **four states** (see figure 3–2):

- powering up
- waiting for parameters
- waiting for configuration
- transfer of parameter data

Powering up

After powering up, the unit enters a **wait phase** with two sequences:

- parameter setting
- configuration.

Parameter settings

This is the **wait for parameter message** phase (**WPRM**).
In this phase, the configuration may be read (**Get_Cfg**).
A diagnostic request (**Slave_Diag**) is allowed.

The parameter setting frame **(Set_Prm)** contains the following information:

- system parameter settings (**PNO** identification, acceptance of synchronisation modes, watchdog time, etc.).
- data parameter settings (parameters designated by the master to be accessible for cyclic reading).

Also, as described in the 'Addressing'section above, during the **WPRM** phase the EMA's address may be changed using the **Set_Slave_Address** function.

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

Important!
EMA parameter settings are fixed and unique for all devices.

Configuration

This is the **wait for configuration message** phase (**WCFG**).
The configuration message specifies the structure of the input and output buffers.
Parameter setting (**Set-Prm**) and diagnostic requests (**Slave_Diag**) are permitted.

Any other type of message will be rejected during the wait for configuration phase.
In a given installation, the monitoring unit can only receive a configuration change message (**Check_Cfg**) from the master which set its parameters.

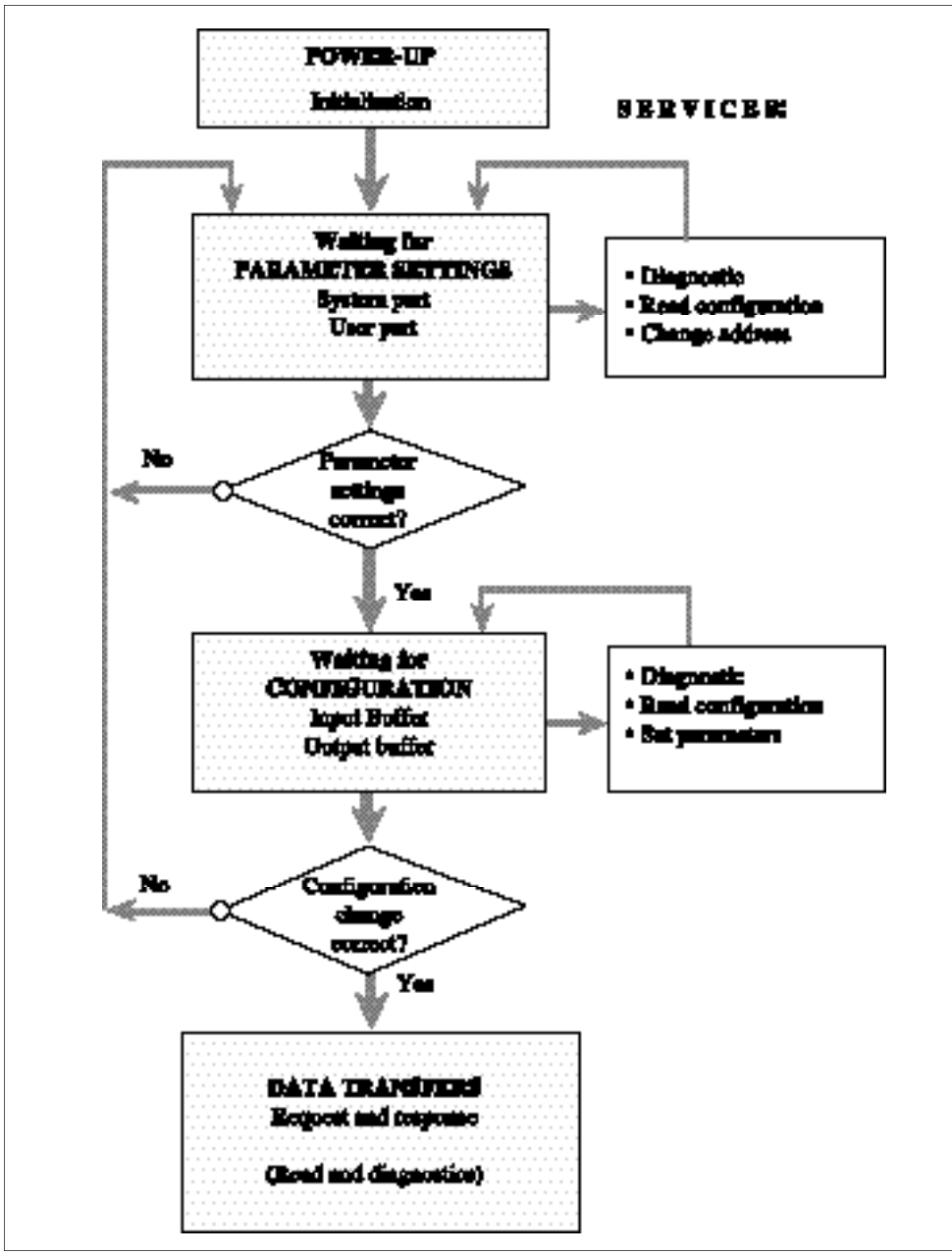

Figure 3-2 State diagram for read/write procedure using Profibus-DP protocol

Data transfer

Once the parameter settings and configuration have been accepted, in the data exchange phase (**DXCHG**), the EMA monitoring unit is ready to send data to the master which set its parameters and configured it.

The following types of data may be transferred during the **DXCHG** phase:

- Diagnostic **(Slave_Diag)**

- Parameter settings and Configuration:
  - Read configuration **(Get_Cfg)**
  - Check configuration **(Check_Cfg)**
  - Set parameters **(Set_Prm)**

- Process data transfer:
  - Request and response **(Data_Exchange)**
  - Multiple data read **(Read_Input)**; rarely used
  - Read back outputs **(Read_Output)**; rarely used.

- Control of transmission modes **(Global_Control)**.

MODBUS® PROTOCOL

The **Modbus®** protocol is a binary serial (or RTU) protocol.

Important: A detailed description of Modbus® operation is given in the 'EMA: Communication Manual', ref. HA176197 ENG.

Transmission frames use binary characters.
Character format: 1 start bit - 8 data bits - 1 stop bit.

No parity or even parity is used. In the latter case the bytes are coded using 9 bits.

Transmission speeds available: **9.6** or **19.2 kbaud**.

Addressing

To communicate with the EMA monitoring unit and access the measurements, the **Modbus®** protocol uses:

- the EMA's physical address
- the EMA's internal addresses for the actual measurements.

The physical address (**address of the monitoring unit on the bus used**) is set using the supplied configuration program (for a PC running Windows 95/98 or NT):

Important!

As shipped from the factory, the default address configured on the EMA is **32 (decimal)**
This address may be reconfigured by the user.
After the EMA's address is changed, the new address is only taken into account **after** the unit is next powered up.

In normal operation, addresses **1** to **247** may be used for the the monitoring unit's **physical address**.

The unit's internal addresses for the various **values measured** are shown in the table below:

Value Measured	**V_1**	**I_1**	**V_2**	**I_2**	**V_3**	**I_3**	**V_4**	**I_4**	**V_5**	**I_5**	**V alarms**	**I alarms**
Address in EMA	100	101	102	103	104	105	106	107	108	109	110	111

Table 3-1 Modbus® addresses for values measured

DIAGNOSTIC LEDs

The state of Profibus DP communications is indicated by **two LEDs** on the EMA front panel.

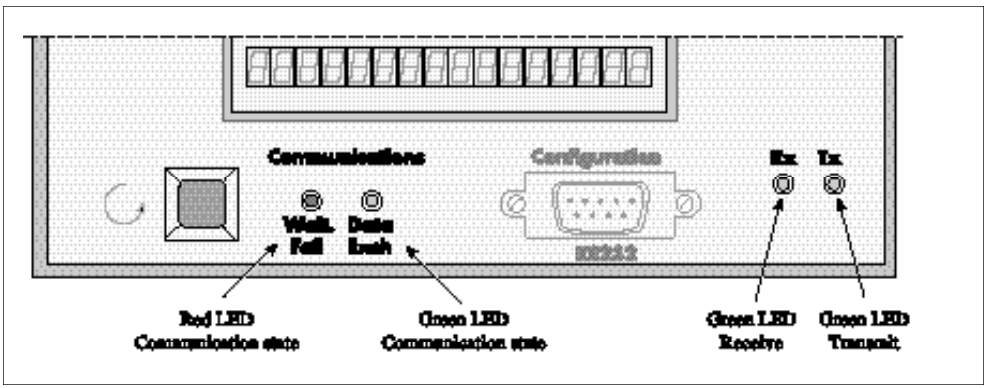

Figure 3-3 Layout of LEDs on EMA front panel

'Communications' LEDs

When the **green** LED ('**Data Exch**') is **lit**, the communication processor is **sending data** on the bus (DXCHG phase).

The **red** LED ('**Wait Fail**') flashes during the **initialisation** phase. Once this phase is complete it indicates the state of communications:

- Red LED **lit**: Serious error
- Red LED **flashing**: Profibus-DP: waiting for parameter settings or configuration (flashes at the same rate as during initialisation).
  Modbus®: Waiting for communication.
- Red LED **off**: No power supply or
  Data transfer **(DXCHG)** in progress.

'Transmission' LEDs

The **green** LED ('**Rx**') is lit when data is being received.

The **red** LED ('**Tx**') is lit when data is being transmitted.

Important!

For further information please consult the 'EMA: Communication Manual', ref. HA176197 ENG.

Chapter 4

CONFIGURATION AND DISPLAY

Contents Page

CONFIGURATION

Types of configuration

Two types of configuration are required for using the monitoring unit:

- configuration of the unit (hardware and software configuration)
- configuration of digital communications if the Profibus-DP protocol is used (see the manual 'EMA: Digital Communication", ref. HA 176197 ENG).

Hardware configuration of monitoring unit

The EMA monitoring unit is shipped with the following characteristics **configured** in accordance with the **product code** defined when the unit was ordered:

- auxiliary supply **voltage** (115 V or 230 V)
- current input **rating** (1 A or 5 A)
- communication **protocol** (Profibus DP or Modbus)
- number of measurement channels (see ordering code).

These characteristics **cannot be modified** by the user.
They represent the EMA's **physical configuration**.

Flow char t

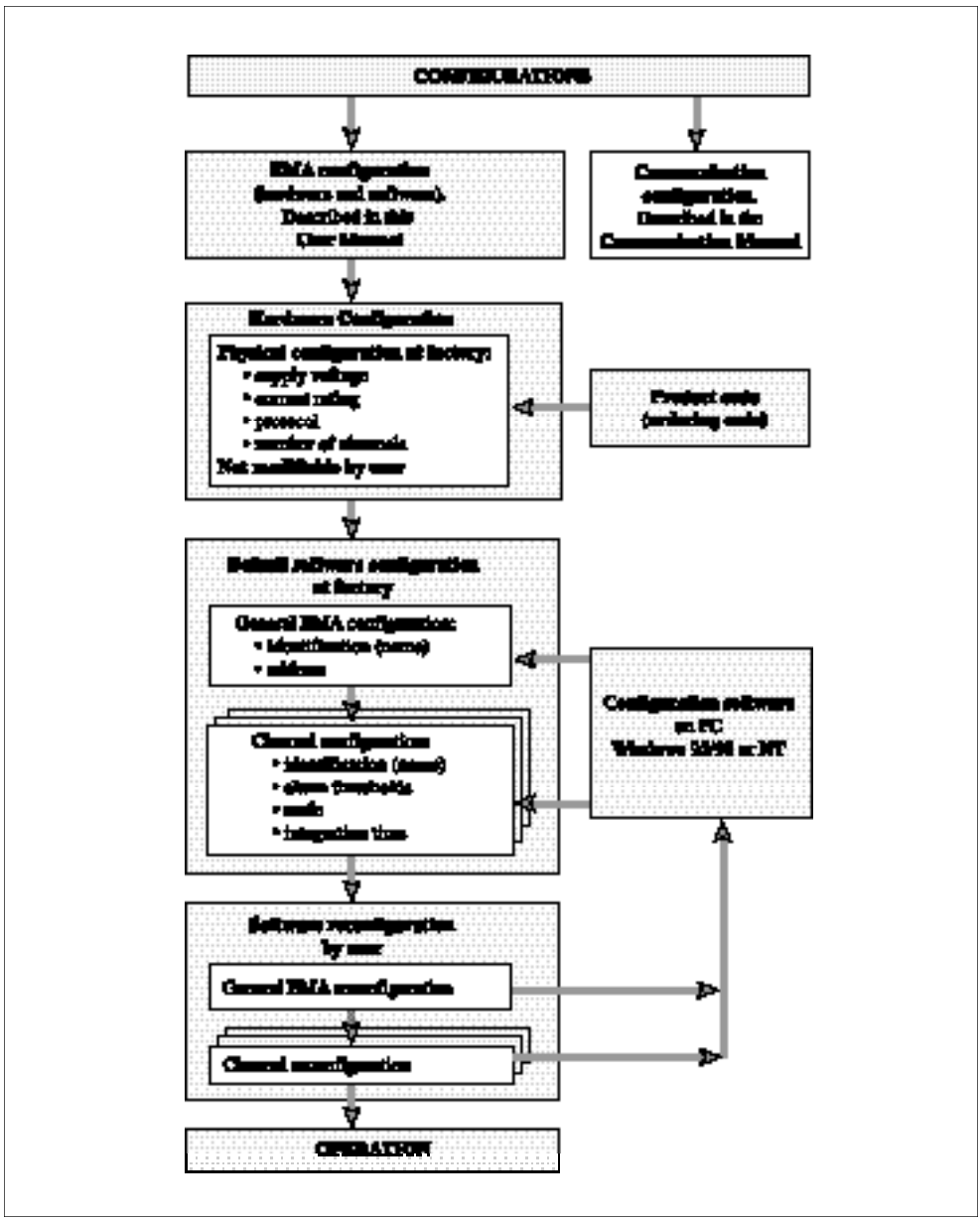

Figure 4-1 EMA monitoring unit configuration flow chart

Software configuration of monitoring unit

Configuration program

The EMA monitoring unit is configured using a configuration program **supplied as standard** with the EMA on a **3½" diskette**.

The program on the diskette is available in the following languages:
French, **English**, **German**, **Spanish** and **Italian**.

Important: If the configuration program language is changed, all the configurable parameters are restored to their **default values** (factory configuration).

This configuration program enables the configuration parameters to be entered without needing to use codes, while Profibus or Modbus communication is active (**ON-LINE**).
The parameters configured are then loaded into the monitoring unit.

The configuration program can set the following parameters for both Profibus and Modbus:
- monitoring unit address
- various identifiers
- scale adjustment:
  - 75% to 125% for voltage measurement channels
  - 1 A to 20000 A for current measurement channels
- high and low alarm thresholds
- integration time

The following parameters can only be set for the Modbus protocol:
- baud rate
- parity
- time-out

The configuration program runs on a **PC** (**Windows 95** / **98** or **NT** required).

A standard **RS232c** serial port on the PC (with the configuration program installed) should be connected to the **9 pin female Sub-D** connector (labelled '**Configuration**') on the EMA **front panel**.

A **Male / Female** direct pin to pin cable should be used.

The PC's **serial port** should be **configured** as follows:
- transmission rate: 19.2 kbaud
- number of data bits: 8
- stop bits: 1
- parity bits: none
- flow control: none.

The details of this configuration are given in the '**Readme**' file on the program diskette.

The configuration program enables the user to **save** any configuration file on the PC and retrieve saved configuration files to configure other units with an **identical configuration**.

Configuration files may be displayed on screen or printed (see control buttons).

Default configuration

General configuration

Two parameters which describe the general characteristics of the EMA are configured by default in the factory:

- the **identification** of the monitoring unit, set by default to: **EMA**
- the **address** of the monitoring unit on the bus, set by default to: **32** (decimal).

The EMA's **identification** can be **reconfigured** if necessary to contain:

- another unit name,
- the identification of the installation monitored and/or
- other information determined by the user (see examples below).

16 characters are reserved for the identification.

The monitoring unit's identification may be **reconfigured** using the configuration program in the workshop or on site, with the unit operating or not.

The EMA's **address** can be **reconfigured** as follows:

for the Profibus-DP protocol: between addresses **4** and **125**
for the Modbus® protocol: between addresses **1** and **247**.

The identification and address parameters are set on the first configuration page (see example in figure 4-2 below).

Measurement channel configuration

The **specific** parameters for each measurement channel are set to **default** values in the factory and can be **reconfigured** by the user.

Channel	Parameter	Permitted value(s)	Default value
All channels	Integration time	1 s; 2 s; 5 s; 10 s; 20 s; 40 s; 80 s; 160 s; 320 s; 640 s; 1300 s	1 s
Current channels	Current measurement channel identification	Any (up to 8 characters)	I1, I2, I3, I4, I5
	Scale adjustment	from 1 A to 20000A *	500 A
	Current alarm low threshold	from 0 A to adjusted scale value *	
	Current alarm high threshold	from 0 A to adjusted scale value *	500 A
Voltage channels	Voltage measurement channel identification	Any (up to 8 characters)	U1, U2, U3, U4, U5
	Scale adjustment	from 75% to 125% **	100%
	Voltage alarm low threshold	from 0 V to 550 V **	0 V
	Voltage alarm high threshold	from 0 V to 550 V **	500 V

Table 4-1 Measurement channel configuration

*) Current values can be adjusted with the following **increments**:
1 A between 0 A and 500 A
10 A between 510A and 5000 A
100 A between 5100 A and 20 000 A
) Voltage values can be adjusted by **increments of **1 V** (**1%**).

The measurement channel identification shown in the table may be reconfigured to contain any user-defined information.

Scale adjustment

Scale adjustments can be used to:

- obtain a **direct reading** of process currents, taking account of the **transformation ratio** of the current transformers used.
- obtain a **direct reading** of voltages measured indirectly (via a **resistor divider** or **voltage transformer**).

To adjust the display of rms currents and voltages for **direct reading**, the 'Scale Adjustment' parameter of the corresponding input must be adjusted using the configuration program.

Example 1. Current scale adjustment

Rating (**R**) of current inputs (see product code): **5 A**.
Current input **I3** uses a current trasnformer with a transformation ratio of:

$$\mathbf{K_I = 250\ A / 5\ A = 50}$$

The current scale adjustment (**SA**) for channel **I3** should be set to;

$$\mathbf{SA_{I3} = K_I \times R = 50 \times 5\ A = 250\ A}$$

Example 2. Voltage scale adjustment

The input for channel **V2** is used to measure voltage via a resistor divider $\mathbf{K_{RD} = 8 : 10}$.
The voltage scale adjustment for channel **V2** should be set to:

$$\mathbf{SA_{V2} = \frac{1}{K_{PD}} \times 100\% = \frac{1}{8 : 10} \times 100\% = 125\%}$$

Example 3. Exact voltage reading

The scale adjustment for input channel **V1** is set to **SA% = 108%**
The signal (after transformation) on input **V1** is **219.3 V**.
The correct voltage V1 displayed is:

$$\mathbf{V_1 = V_1 \times \frac{SA\%}{100\%} = 219.3\ V \times \frac{108\%}{100\%} = 236.8\ V}$$

Integration time adjustment

The integration time for the measurements determines the **stability** of the **readings**, and varies depending on the **waveforms** measured.

The value of the integration time must take account of the lowest frequencies in the signal measured. This in turn depends on the **firing mode** of the thyristors controlling the electric load.

The following recommendations can be applied when measuring values controlled by thyristor units:

Thyristor firing mode	Typical integration time values
No modulation (sinusoidal operation)	1 s to 5 s
Phase angle (firing angle variation)	2 s to 20 s
Burst firing (modulation by complete cycles for typical base time of 15 cycles)	160 s to 1300 s
Standard single-cycle (modulation by complete cycles with base time of 1 cycle)	20 s to 160 s
Advanced single-cycle (modulation by complete cycles with base time of 1 cycle and possibility of not firing for half a cycle)	20 s to 160 s

Table 4-2 Selection of measurement integration time

The integration time values are **chosen** according to the **signal** to be measured and the monitoring unit's **response time**.

If the integration time is too **high**, readings will be **stable** but will only track variations in the signal measured **slowly**.

If the integration time is too **low**, readings will track variations in the signal to be measured **quickly** but will be marred by **fluctuations**.

Configuration examples

Some examples of EMA configuration pages are given below. They are presented in the form of screen captures from a PC running the configuration program.

Example 1: Monitoring unit identification

Unit identification: Furnace 8
Default bus address (factory configuration): 32
Bus address reconfigured by client: 50
(new address prepared but not yet confirmed)
Protocol: Profibus-DP

The corresponding screen is shown in figure 4-2.

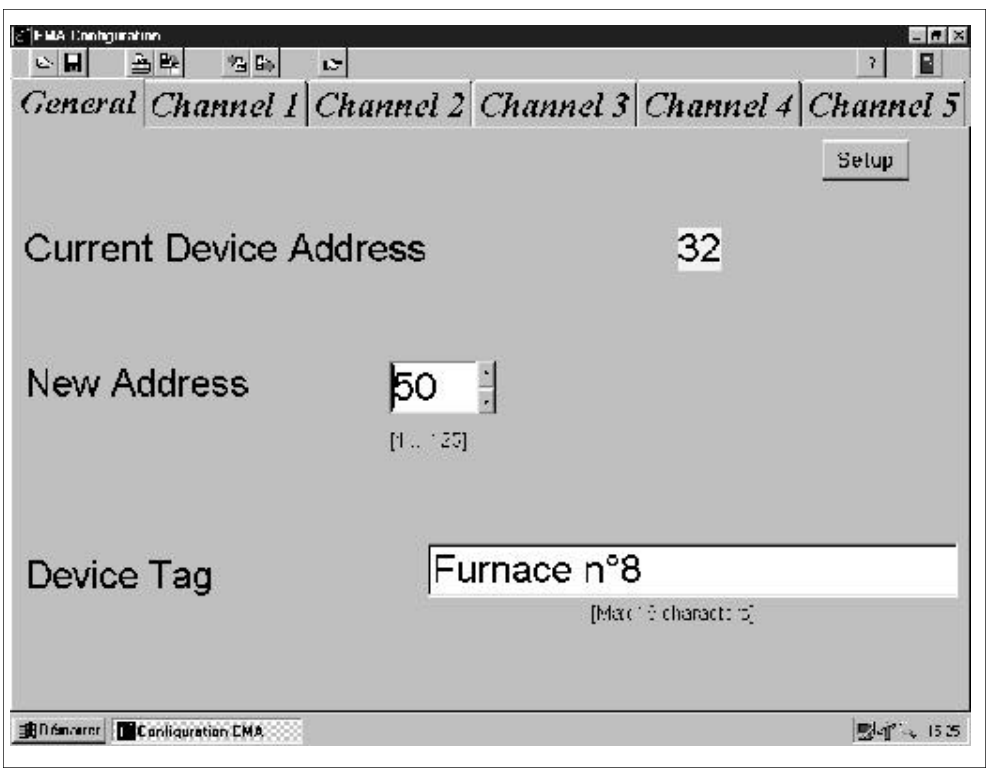

Figure 4-2 Screen capture of initial configuration page (Profibus protocol)

Example 2: Monitoring unit protocol and configuration

The identification and addresses correspond to the example above

Program language: English
Communication:
Protocol: Modbus®
Communication speed: 19.6 kbaud
Parity: None

Note!

To access the configuration shown, press the '**Setup** ' button.

The corresponding screen is shown in figure 4-3.

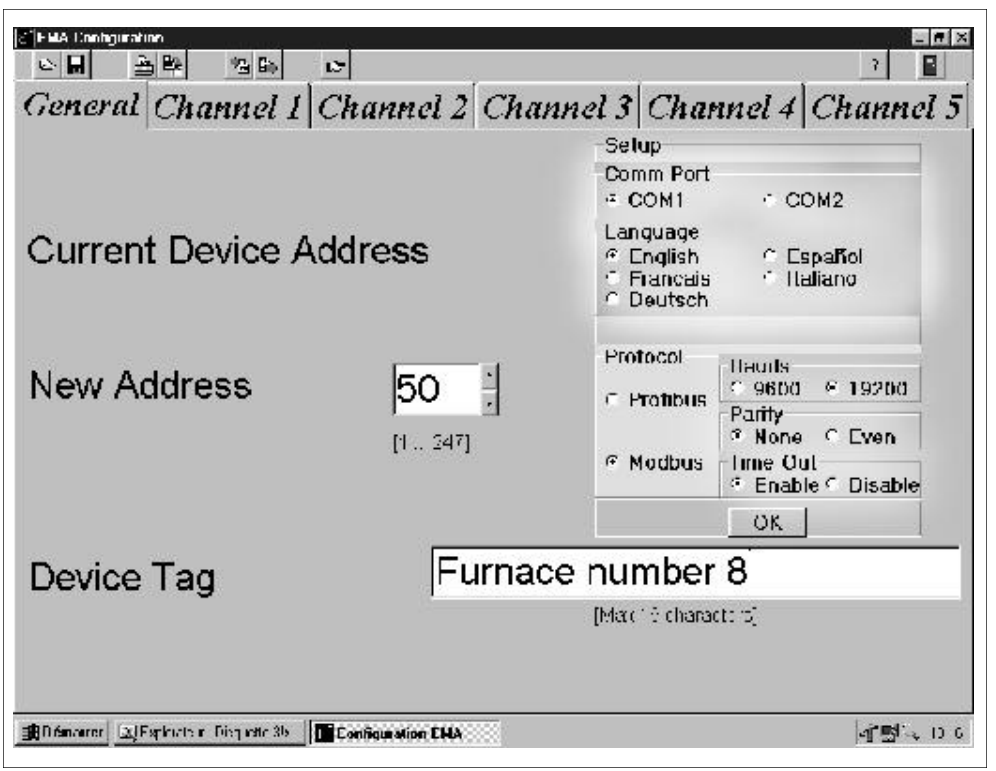

Figure 4--3 Screen capture showing protocol and program language configuration (Modbus protocol)

Example 3: Measurement channels

The **voltage** and **current** measurement channels with the same number (1 to 5) are configured on the same page in the program.

Channel 5. Voltage
Identification of channel V5: Voltage measurement for **resistor 21**
Voltage scale adjustment: 100%
Voltage threshold alarms: Low threshold: 200 V; High threshold: 250 V
Measurement integration time: 20 s.

Channel 5. Current
Identification of channel I5: Current measurement for **resistor 13**
Current scale adjustment: 300 A
Current threshold alarms: Low threshold: 25 A; High threshold: 290 A
Measurement integration time: 1 s.

The corresponding screen is shown in figure 4-4

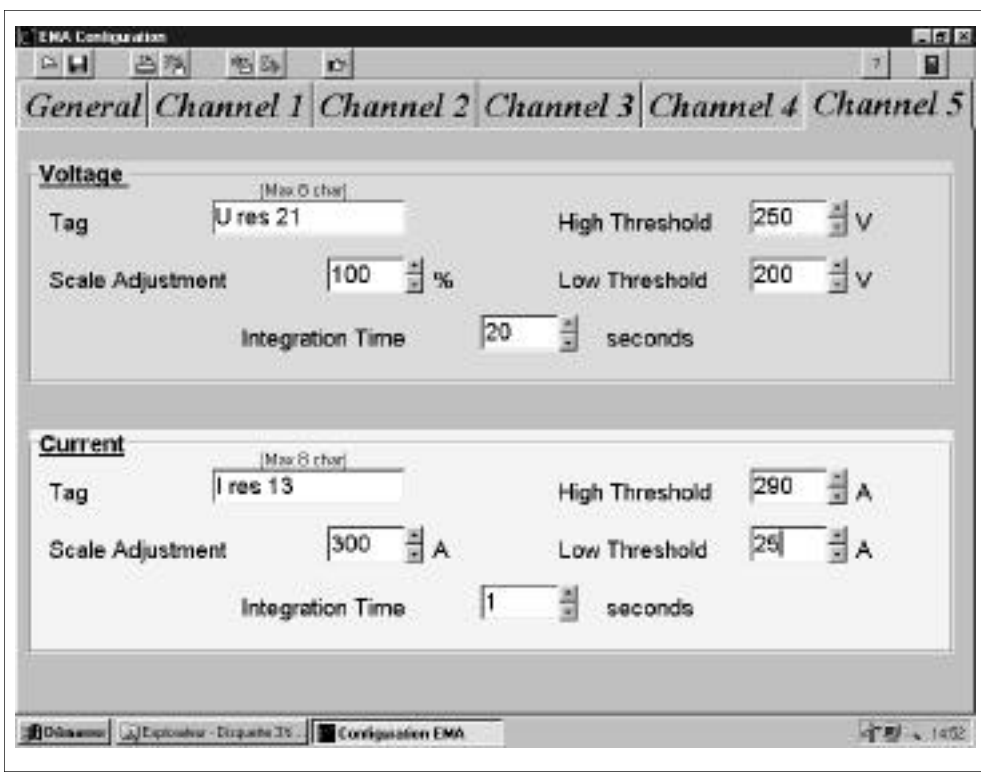

Figure 4-4 Configuration screen for channels V5 and I5 (Modbus or Profibus)

Control buttons

The buttons at the top of the configuration screen (see figure 4-5) are used for the seven control operations.

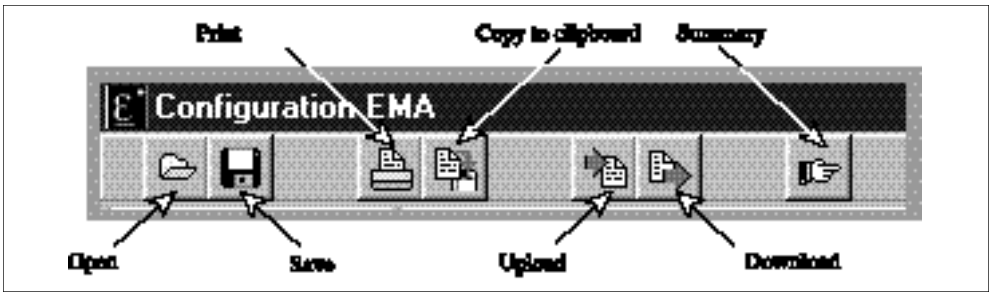

Figure 4-5 Control buttons

Open
This button **loads** the **complete** configuration for an EMA unit.

Save
This button **saves** the configuration defined for an EMA unit to **disk** for later **re-use** (e.g. cloning).

Print
Produces a **paper** copy of the complete configuration defined.

Clipboard
Inserts an **image** of the current sheet onto the clipboard.

Upload
Retrieves the complete configuration from the EMAunit connected, to allow cloning, modification, saving or printing.

Download
This command sends the configuration defined into the EMA unit (opposite of the previous operation).
To enable the parameters transmitted to be fully stored, wait for **10 seconds** after downloading before switching off the EMA.

Summary
Displays the configuration defined on **one text page**.
This command does not allow the configuration parameters to be changed.
To obtain a summary of the configuration for the unit connected to the configuration PC, first perform an upload.

LOCAL DISPLAY

The local display presents information:

- for the EMA monitoring unit
- for each of the 10 measurement channels (5 voltage and 5 current).

The LCD display has 2 lines of 16 characters.

The display has 11message pages describing the state of the unit and communications.
A push button is used to scroll through the various pages.

Monitoring unit

The first display page shows the unit's identification:

- name tag: 16 characters on the first line
- bus address: 16 characters on the second line

This page is displayed as soon as the unit is switched on.
The information on the identification page corresponds to the monitoring unit configuration.

Example 1 Default configuration

Monitoring unit name: **EMA**

Address of unit on communications bus: **32** (decimal).

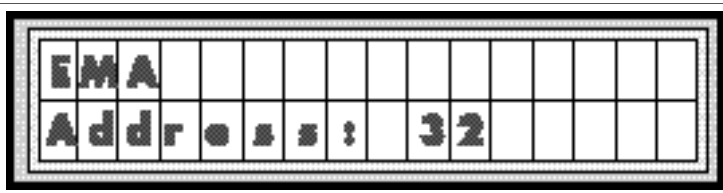

Figure 4-6 Monitoring unit default identification message

Example 2 Reconfiguration by user

Monitoring unit associated with furnace 8, heating zone 3.

Address of unit on communications bus: **52** (decimal).

(the example corresponds to the general configuration shown in figure 4-2).

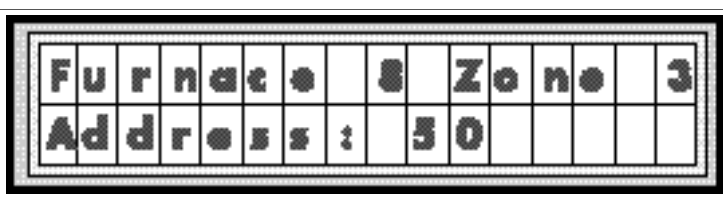

Figure 4-7 Monitoring unit identification message with customer identification

Measurement channels

Display pages 2 to 11 include the following information:

- the channel identification (first 8 characters of first line)
- the communications status in Profibus mode (e.g. DXCG) or the protocol type in Modbus mode (characters 9 to 16 of first line)
- measured value and measurement unit (first 8 characters of second line)
- threshold overshoot alarms with messages shown in table 4-3 (characters 9 to 16 of second line)

Alarm type		**Name**	**Display Message**
Value monitored	**Threshold**		
Voltage	Low	UnDer Voltage	**UDV**
	High	OVer Voltage	**OVV**
Current	Low	UnDer Current	**UDC**
	High	OVer Current	**OVC**
Voltage and current	No overshoot: value greater than low threshold and less than high threshold	OK	**OK**

Table 4-3 Alarm messages

Example measurement displays

Example 1

The example corresponds to the current measurement channel configuration shown in figure 4-4.

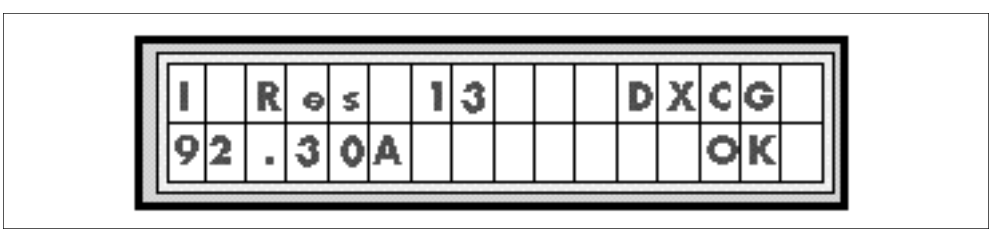

Figure 4-8 Example message display page for current channel

Description of display page

Channel identification: I Res 13 = resistor 13 current measurement
Communication protocol: Profibus. Bus state: Data eXChanGe (DXCG)
Current measured: 92.3 A
No alarms.

Example 2
The identification and alarms for the channel correspond to figure 4-4.

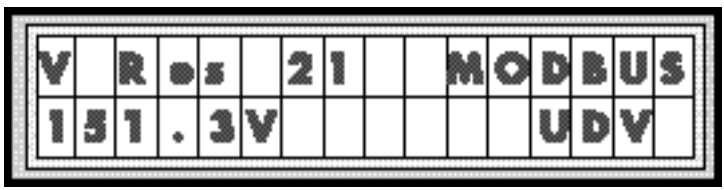

Figure 4-9 Messages for voltage channel in alarm state

Description of display page

Channel identification: V res 21 = resistor 21 voltage measurement
Communication protocol: Modbus
Voltage measured: 151.3 V
Under low voltage threshold: UDV

Example 3
Current threshold alarm

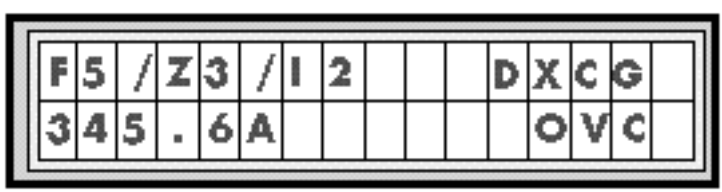

Figure 4-10 Messages for current channel in alarm state

Description of display page

Channel identification: F5 / Z3 / I2 = furnace 5, zone 3, current measurement channel 2
Communication protocol: Profibus. Bus state: Data eXChanGe (DXCG)
Current measured: 345.6 A
Over high current threshold: OVC.

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