GE
Grid Solutions

iSTAT i4MC & i4MV
Single-Phase Transducers

Manual

Publication reference: i4MC&V/EN/M/C

1.   SAFETY SECTION

This Safety Section should be read before commencing any work on the equipment.

1.1   Health and Safety

The information in the Safety Section of the product documentation is intended to ensure that products are properly installed and handled in order to maintain them in a safe condition. It is assumed that everyone who will be associated with the equipment will be familiar with the contents of the Safety Section.

1.2   Explanation of symbols and labels

The meaning of symbols and labels may be used on the equipment or in the product documentation, is given below.

Caution: refer to product documentation

Caution: risk of electric shock

Protective/safety *earth terminal

Functional *earth terminal
Note: This symbol may also be used for a protective/safety earth terminal if that terminal is part of a terminal block or sub-assembly e.g. power supply.

*NOTE: The term earth used throughout the product documentation is the direct equivalent of the North American term ground.

2.   INSTALLING, COMMISSIONING AND SERVICING

⚠ **Equipment connections**

Personnel undertaking installation, commissioning or servicing work on this equipment should be aware of the correct working procedures to ensure safety. The product documentation should be consulted before installing, commissioning or servicing the equipment.

Terminals exposed during installation, commissioning and maintenance may present a hazardous voltage unless the equipment is electrically isolated.

If there is unlocked access to the rear of the equipment, care should be taken by all personnel to avoid electrical shock or energy hazards.

Voltage and current connections should be made using insulated crimp terminations to ensure that terminal block insulation requirements are maintained for safety. To ensure that wires are correctly terminated the correct crimp terminal and tool for the wire size should be used.

Before energising the equipment it must be earthed using the protective earth terminal, or the appropriate termination of the supply plug in the case of plug connected equipment. Omitting or disconnecting the equipment earth may cause a safety hazard.

The recommended minimum earth wire size is $2.5mm^2$, unless otherwise stated in the technical data section of the product documentation.

Before energising the equipment, the following should be checked:

−   Voltage rating, frequency and polarity

−   VT ratio and phase sequence

−   CT circuit rating and integrity of connections;

−   Protective fuse rating;

−   Integrity of earth connection (where applicable)

−   Supply voltage

−   External switch or circuit-breaker must be included in the installation for disconnection of the devices' auxiliary power supply. It must be suitably located and properly marked for reliable disconnection of the device when needed.

Important: A current transformer secondary should be shorted before connecting the transducer.

3.   EQUIPMENT OPERATING CONDITIONS

The equipment should be operated within the specified electrical and environmental limits.

3.1   Current transformer circuits

Do not open the secondary circuit of a live CT since the high level voltage produced may be lethal to personnel and could damage insulation.

be installed with the correct polarity, to avoid possible damage to the equipment.

3.2   Insulation and dielectric strength testing

Insulation testing may leave capacitors charged up to a hazardous voltage. At the end of each part of the test, the voltage should be gradually reduced to zero, to discharge capacitors, before the test leads are disconnected.

3.3   Opening Enclosure

There are no customer replaceable PCB cards or components within the enclosure, so the enclosure should not be opened.

4.   DECOMMISSIONING AND DISPOSAL

Decommissioning: The auxiliary supply circuit in the relay may include capacitors across the supply or to earth.   To avoid electric shock or energy hazards, after completely isolating the supplies to the relay (both poles of any dc supply), the capacitors should be safely discharged via the external terminals prior to decommissioning.

Disposal: It is recommended that incineration and disposal to water courses is avoided. The product should be disposed of in a safe manner. Any products containing batteries should have them removed before disposal, taking precautions to avoid short circuits.   Particular regulations within the country of operation, may apply to the disposal of lithium batteries.

5.   TECHNICAL SPECIFICATIONS

5.1   Protective fuse rating

The recommended maximum rating of the external protective fuse for this equipment is 6A, Red Spot type or equivalent, unless otherwise stated in the technical data section of the product documentation.

Insulation class:	IEC 61010-1: 2001 Class II EN 61010-1: 2001 Class II	.
Insulation Category (Over voltage):	IEC 61010-1: 2001 Category III EN 61010-1: 2001 Category III	Distribution level, fixed installation. Equipment in this category is qualification tested at 5kV peak, 1.2/50 µs, 500 Ω, 0.5J, between all supply circuits and earth and also between independent circuits.
Environment:	IEC 61010-1: 2001 Pollution degree 2 EN 61010-1: 2001 Pollution degree 2	Compliance is demonstrated by reference to generic safety standards.
Product Safety: $C\:E$	2006/95/EC EN 61010-1: 2001	Compliance with the European Commission Low Voltage Directive. Compliance is demonstrated by reference to generic safety standards.

CONTENT

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1.   INTRODUCTION

1.1   General

i4MC & **i4MV** (**i4MC/V)** are single phase transducers aimed at the medium voltage and low voltage market segments throughout the world.

i4MC/V offers:

•   High accuracy measurements

•   A cost-effective solution for Medium Voltage and Low Voltage markets

•   Modbus protocol for integrating into control systems.

•   CE certification

1.2   KEY MESSAGES

•   The iSTAT   **i4MC/V** provides Class 0.5 measurement of Current or Volts, and Frequency

•   **i4MC/V** allows communication to MODBUS based systems that are widely used by industrial and utility customers worldwide.

ISTAT – **THE standard** measurement platform

•   Multiple advanced configuration features fitted as standard.

•   Comprehensive choice of features for measurement applications – to satisfy all metering, measurement and data recording and power quality applications

•   Flexible programmable software (**QDSP**) allows off line and on line settings and data interpretation

•   Complete and informative documentation, **QDSP** also includes help information.

•   A choice of different input and output options.

Simple to fit, **simple** to set, **simple** to connect

1.3   ISTAT i4Mx Family

The **i4Mx** family consists of 3-phase and single phase transducers all of which are 0.5% multifunction instruments. **This manual details the single phase transducer models i4MC and i4MV**

1.3.1   **i4MV** class 0.5 Voltage Transducer.

i4MV is intended for measuring and monitoring single-phase voltages, both phase-neutral and phase-phase. The voltage input is electrically insulated from the system by means of a voltage transformer. It measures true RMS voltage values by means of fast sampling of the input voltage signals, which makes it suitable for acquisition of transient events. A built-in microcontroller calculates the measurands (voltage, frequency) from the measured signals. The measurands can then be converted into load independent DC current or voltage which is proportional to the true RMS measured value.

1.3.2   **i4MC** class 0.5 Current transducer

i4MC is intended for measuring and monitoring single-phase electrical power networks. The input current is electrically insulated from the system by means of a current transformer. It measures true RMS current value by means of fast sampling of the input current signals, which makes it suitable for acquisition of transient events. A built-in microcontroller calculates the measurands (current, frequency) from the measured signals. The measurands can then be converted into load independent DC current or voltage which is proportional to the true RMS measured value.

1.3.3   Software:

The same software is used for configuring the device as on all iSTAT communicating products.

- **QDSP Standard** for setting and browser software

- **QDSP** also offers additional features such as upgrading from a secure web site for both the **QDSP** software and the transducer firmware.

1.4   Measurements

i4MC/V is ideally suited to applications where continuous monitoring of a single phase system is required.

1.5   Hardware features

i4MC/V has a Red LED indicator showing that power is on.

i4MC/V has a universal auxiliary supply and an auto ranging current or voltage measurement input so that it can be used in most site conditions without the need to specify this information at the order stage.

1.6   Communications

i4MC/V can be supplied with either RS232 or RS485 communications via screw terminals, which has to be defined at the time of ordering.   The communications are used for programming the transducer or for monitoring measurements.

In addition a USB port (mini type) is always provided on the underside of the **i4MC/V** for programming the transducer before installation.   The USB port cannot be used when the **i4MC/V** is installed on the DIN Rail.

Note: The USB port has only Basic Insulation and can only be used when there is no wiring connected to the main terminals.

Note: The Cover over the USB connector must be fitted prior to installation or storage, if not the Warranty on the product will be void.

1.7   Inputs and Outputs

i4MC/V is fitted with one analogue output circuit which is fully programmable over the ranges 0 - 20mA and 0 - 10V.

2.   HARDWARE

2.1   The Product

1 – Analogue output

2 – Auxiliary supply

3 – Voltage or
Current inputs

4 – Communications
port

5 – Power ON LED
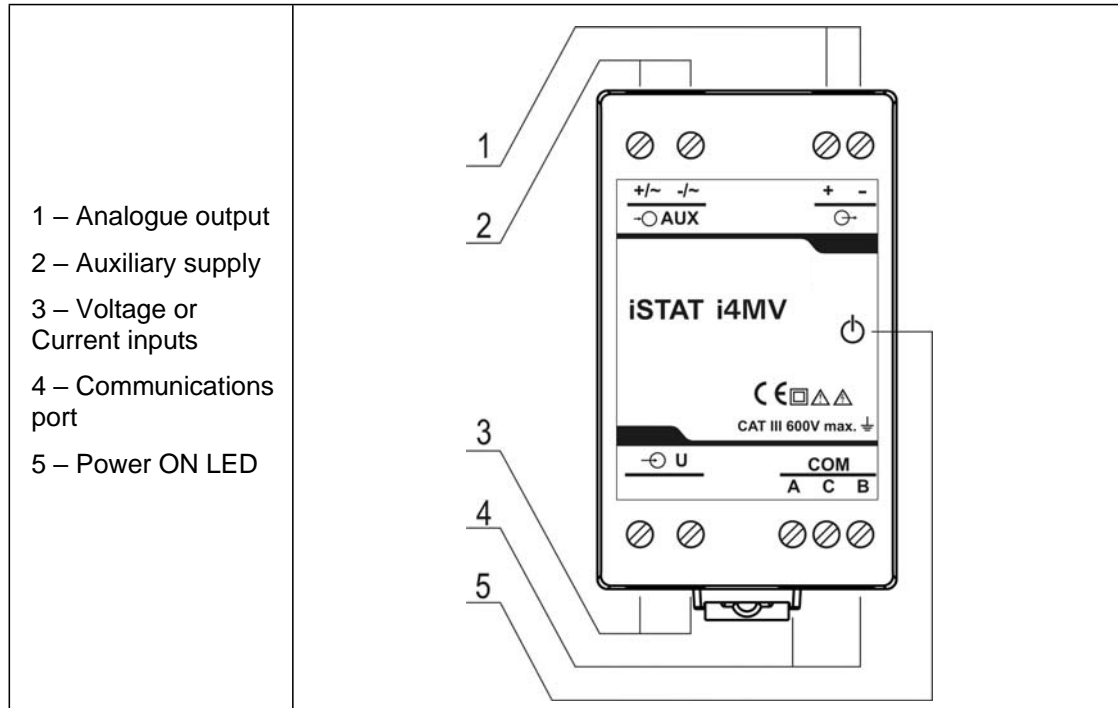
FIGURE 2-1: I4MV SHOWING CONNECTIONS

2.2   Mounting

The **i4MC/V** measuring transducer is designed for DIN rail mounting. It should be mounted on a 35 mm DIN rail by means of a plastic fastener. Before installation the fastener should be in open position (pulled). After the device is in place, the fastener is locked (pushed) to closed position.

2.3   Connections

The use and connection of the **i4MC/V** involves the handling of dangerous currents and voltages. Only a qualified person should therefore perform the connection.

Before use: Check voltages and phase rotation, supply voltage and nominal frequency.

Check protective fuse rating (the recommended maximum rating of the external protective fuse for this equipment is 6A - Red Spot type or equivalent).

Warning: Wrong or incomplete connection of supply, measurement or other terminals can cause incorrect measurements, malfunction or damage to the device.

Note: After connection, settings have to be performed via communication (connection mode, current and voltage transformers ratio …).

2.4   Communications

The **i4MC/V** can be supplied with no communications, RS232 or RS485 communications, which must be specified when ordering. The communication protocol available is Modbus RTU, which enables the remote viewing of measurements and the viewing and setting of system parameters.

2.4.1   RS232 or RS485 communications

The **i4MC/V** transducers can be supplied with either a RS232 or RS485 port (COM) via terminals.

Connection information for COM will be shown on a label as depicted in table 2-1.

The connection of RS232 communications is usually between the **i4MC/V** and a PC, the maximum connection length is 15 metres.

RS485 communications enables simultaneous connection to a maximum of 32 communicating devices; two-wire RS485 only is used. For RS485 communications, the PC will require either an internal RS485 communications port or an external RS232/RS485 or USB/RS485 interface. In both cases the device must provide automatic RS485 data flow control. The maximum connection length is 1000 metres. Conductors A and B should be terminated with a 120Ω terminating resistor on the units at each end of the RS485 network.

Connection Label	

COM
RS232   Rx | 21
        ⏚ | 22
        Tx | 23
	COM
	RS485 A | 21
	        NC | 22
	        B | 23

TABLE 2-1: RS232 AND RS485 CONNECTIONS

2.4.2   USB communications

The **i4MC/V** transducer is always supplied with a USB port on the underside, under a removable plastic cover, for programming using an USB type mini B connector.

Note: The USB port has only Basic Insulation and can only be used when there is no wiring connected to the main terminals.

Note: The Cover over the USB connector must be fitted prior to installation or storage, if not the Warranty on the product will be void.

USB communication serves as a fast peer-to-terminal data link. The instrument is detected by the host as a USB 2.0 compatible device.

See the QDSP manual for details of how to connect using the USB port.

2.4.3   Communication connection details
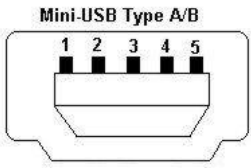
Connector	Terminals	Position	RS232	RS485
SCREW TERMINAL		21	Rx	A
		22	GND	NC
		23	Tx	B
USB-mini B	Mini-USB Type A/B 1 2 3 4 5	Standard USB 2.0 compatible cable recommended (Type mini B plug)		

TABLE 2-2: COMMUNICATIONS

2.5 Analogue output

The **i4MC/V** is supplied with one analogue output, which can be set within the range 0 - 20mA or 0 - 10V. The analogue output can be configured to represent any of the instantaneous measured values. The outputs can be set via the communications link.

The analogue module has two terminals (see TABLE 2-3).

OUTPUT			Analogue output module with analogue output, proportional to measured quantities. The outputs may be either short or open-circuited. They are electrically insulated from each other and from all other circuits.
0...20 mA	+ ○	15	
0...10 V	− ○	16	

TABLE 2-3: ANALOGUE OUTPUT

2.6 Auxiliary Supply

The **i4MC/V** Measuring transducer has a universal (AC/DC) auxiliary power supply.

Connection details and ratings are shown on a label as detailed in TABLE 2-4.

AUX			Connection of universal power supply to terminals 13 and 14
24...300 V DC	→○		
40...276 V AC	+/~L	13	
45...65 Hz			
< 4 VA	−/~N	14	

TABLE 2-4: AUXILAIRY SUPPLY

NOTE: FOR SAFETY PURPOSES IT IS IMPORTANT THAT BOTH WIRES (LINE AND NEUTRAL) ARE FIRMLY CONNECTED. THEY SHOULD BE CONNECTED ONLY TO THE DESIGNATED TERMINALS AS SHOWN ON THE LABEL ABOVE AS WELL AS ON THE FRONT LABEL OF THE TRANSDUCER.

2.7 Measurement Inputs

The Voltage input of the **i4MV** can be connected directly to low-voltage networks or via an appropriate voltage transformer to medium or high voltage networks.

The Current inputs of the **i4MC** can be connected directly to low-voltage networks or via a current transformer.

The wiring connections are shown in section 7.

The **i4MC/V** has an auto-ranging voltage or current input with nominal values of 500V and 5A.

3.   SETTINGS

3.1   Introduction

Instrument settings can be remotely modified with the QDSP software, when connected to a PC.

3.2   QDSP Software

QDSP is a software tool for complete monitoring of measuring instruments, connected to a PC via serial or USB communication. A user-friendly interface consists of five segments: devices management, instrument settings, real-time measurements, data analysis and software upgrading. The QDSP software is available free of charge.

A separate QDSP manual is available that defines the operation of QDSP in detail.

3.2.1   Devices Management

The communications parameters for any connected device can be modified. Also included are browsers which scan the communications networks attached to the PC and identify all of the devices connected with their addresses and communications parameters. This can be done on RS232, RS485 or USB (programming only) connections.

3.2.2   Instrument settings

The instrument settings are organized in a tree structure and they can be modified simply as required. In addition to transferring settings to the instrument, QDSP can also store the data to settings files and read it back when required.

3.2.3   Real time measurements

All measurements can be displayed in real time in a table.

If further processing of the measurement data is required it can be copied via a clipboard and inserted into standard Windows formats.

3.2.4   Software upgrading

It is suggested that the latest version of QDSP should always be used and if the system is also connected to the internet if will define if an upgrade is available for download.

3.3 Setting Procedure

In order to modify the settings with QDSP the current parameters must be loaded first. Instrument settings can be acquired via a communications link or they can be loaded off-line from a file on a local disk. The QDSP contains sample settings files for each product variant that can be downloaded to show the range of settings available for the specific product. These files can be modified and then stored under a different name allowing an instrument configuration to be generated off-line without an instrument attached, and downloaded at a later date.

Settings are displayed in the QDSP setting window, the left part displays a hierarchical tree structure of settings, the right hand part displays parameter values of the chosen setting group, see Figure 3-1.
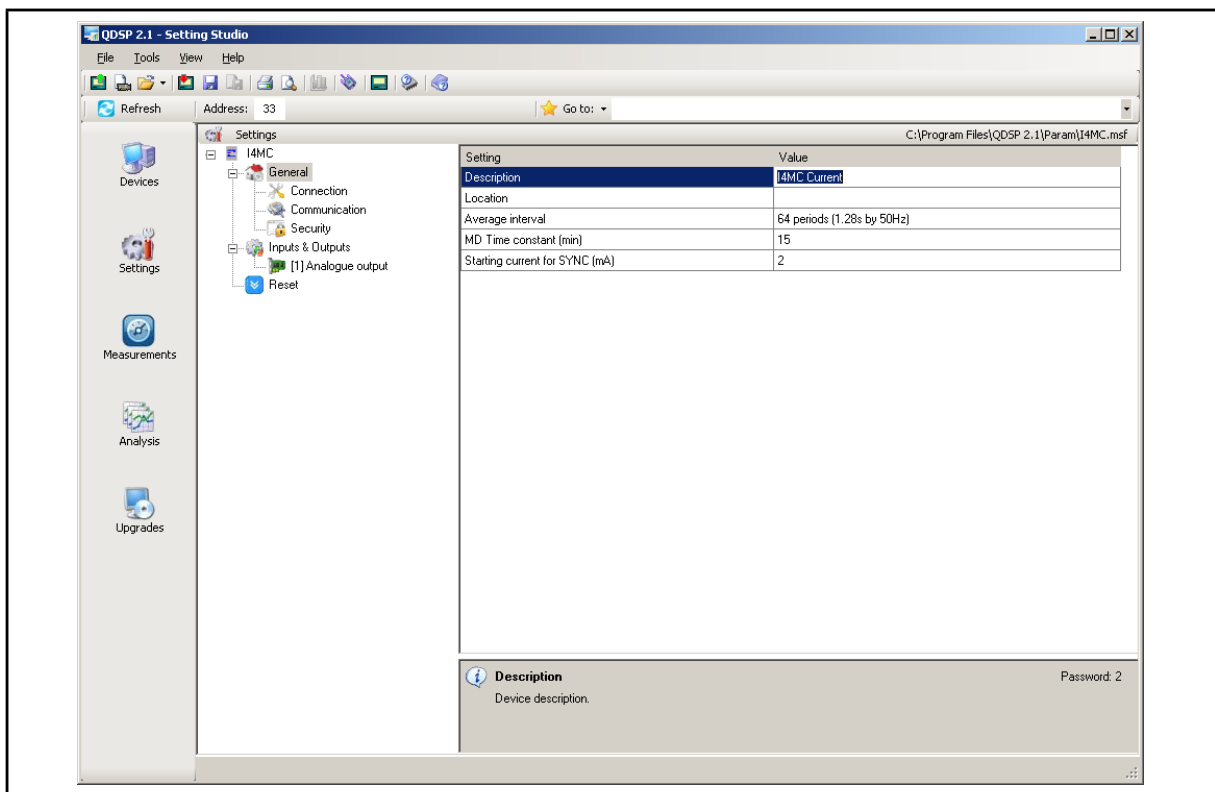
FIGURE 3-1: QDSP INTERFACE

3.4 General Settings

General Settings are essential for the operation of the measuring transducer. They are divided into three additional sublevels (Connection, Communication and Security).

3.4.1 Description and Location

These are two parameters that are extended for easier recognition of a particular instrument. They allow for the identification or location to be defined where measurements are performed.

3.4.2 Average Interval

The averaging interval defines the refresh rate of measurements for communications display.

3.4.3 Maximum Demand calculation (MD mode)

The **i4MC** provides maximum demand values using the Thermal function.

3.5 Connection

The setting of the connection parameters must reflect the actual applications or the measurements will not be valid.

All of the settings in this section should be defined before the settings for the analogue and alarm outputs, as changes to this section may automatically change the measurements and output settings
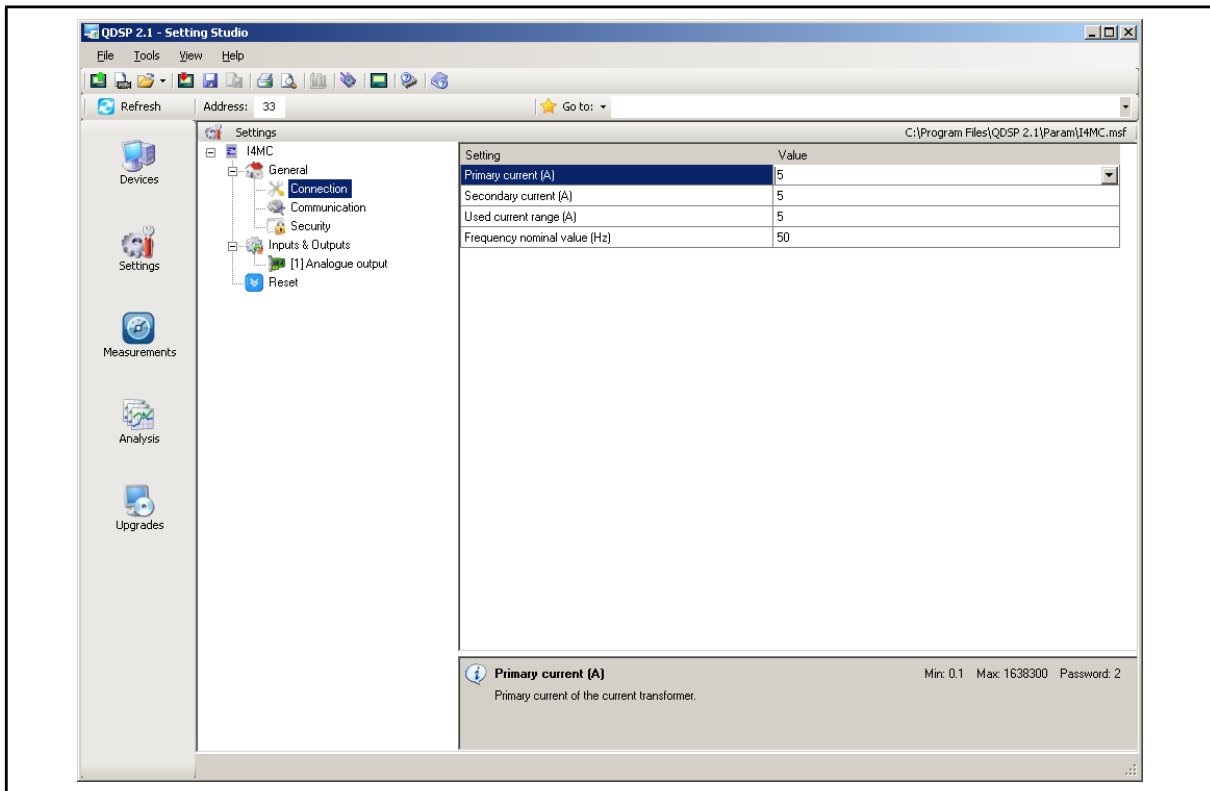
FIGURE 3-2: CONNECTION

3.5.1 Setting of current or voltage ratios

The details of the application must be known to define these settings; all other measurements depend on them. Values with up to 5 numerical digits and a maximum of 3 decimal places can be input.

Settings range	VT primary	VT secondary	CT primary	CT secondary
Maximum value	1638,3 kV	13383 V	1638,3 kA	13383 A
Minimum value	0,1 V	1 mV	0,1 A	1 mA

3.5.2 Used Voltage or Current Range

The setting of this range is connected with the setting of the analogue output. Using a value that matches the expected measurement range (with overload) will achieve the highest quality of measurements.

If the 'Used' ranges are changed after the analogue settings have been defined, then the analogue settings will be modified automatically, as defined below. It may be necessary to modify the settings for the analogue output.

The 'Used' ranges are used to set the default scaling for the analogue output, which can be subsequently changed to meet the application requirements. Internally the analogue settings are also stored as a percentage of the 'Used' ranges. If the 'Used' ranges are subsequently changed the analogue output settings will be correspondingly changed to maintain the settings as the same percentage of the 'Used' range.

3.5.3 Nominal Frequency

A valid frequency measurement is within ± 32Hz of the nominal frequency. This setting is only used for alarms.

3.6   Communication

The settings displayed depend on the hardware options on the specific instrument connected or the settings in the specific settings file that is being worked on off-line.

3.6.1   Serial Communication parameters (COM1)

These parameters are important for the correct operation in RS485 networks or connections with PC via RS232 communications. Factory settings for communication are #33\19200 (or 115200),n,8,2 (address 1 to 247\data rate 2400 to 115200 b/s, parity, data bits, stop bit).

3.6.2   Modbus Table of Addresses

With this setting a MODBUS table for measurements and settings is defined. MODBUS addresses for measurements and settings can be compatible with previous family of transducers (i400) or with the more advanced family of transducers (i500).

3.6.3   USB Communications

The transducer will be identified as a USB device when connected to a USB port on the PC, refer to the separate QDSP manual for details of the driver installation.

Note: The USB port has only Basic Insulation and can only be used when there is no wiring connected to the main terminals.

Note: The Cover over the USB connector must be fitted prior to installation or storage, if not the Warranty on the product will be void.

3.7   Security

Parameter settings are divided into 2 groups regarding security level:

1.   If the passwords are set to 'AAAA' (default) there is no restriction to the access of parameter settings.

2.   At the first level (PL1), the settings for MD can be accessed.

3.   At the second level (PL2), access is given to all parameter settings.

4.   A Backup password (BP) is used if the passwords at level 1 (PL1) and level2 (PL2) have been forgotten, and it differs for each device depending on the serial number of the instrument. The BP password is available from Technical Support and is entered instead of password PL1 and/or PL2. The serial number is stated on the product label or can be read with QDSP and must be supplied when requesting the BP.

3.7.1   Password setting

A password consists of four capital letters taken from the British alphabet from A to Z. When setting a password, only the letter being set is visible, while the others are covered with an asterisk.

Two passwords (PL1, PL2) and the time after which they become active, can be set.

3.7.2   Password modification

A password can be modified; however only the password whose access has been unlocked (password entered) can be modified.

To disable a password previously set, modify the password back to 'AAAA'.

3.8   Analogue output

3.8.1   Analogue output module

The analogue output is fully programmable.

3.8.1.1   Output parameter

Define the Measured or calculated parameter that is to be output on the specific analogue output.

3.8.1.2   Output range

The analogue output can be configured to one of six hardware output ranges within which the analogue output will operate. To ensure the highest accuracy for the output, the range selected should be the lowest that covers the required analogue output range.

DC current output	DC voltage output
0…1 mA	0…1 V
0…5 mA	
0...10 mA	0…10 V
0...20 mA	

3.8.1.3   Output Signal

Defines the actual range and output curve shape of the required analogue signal. Up to 5 break points can be programmed to achieve the required curve.
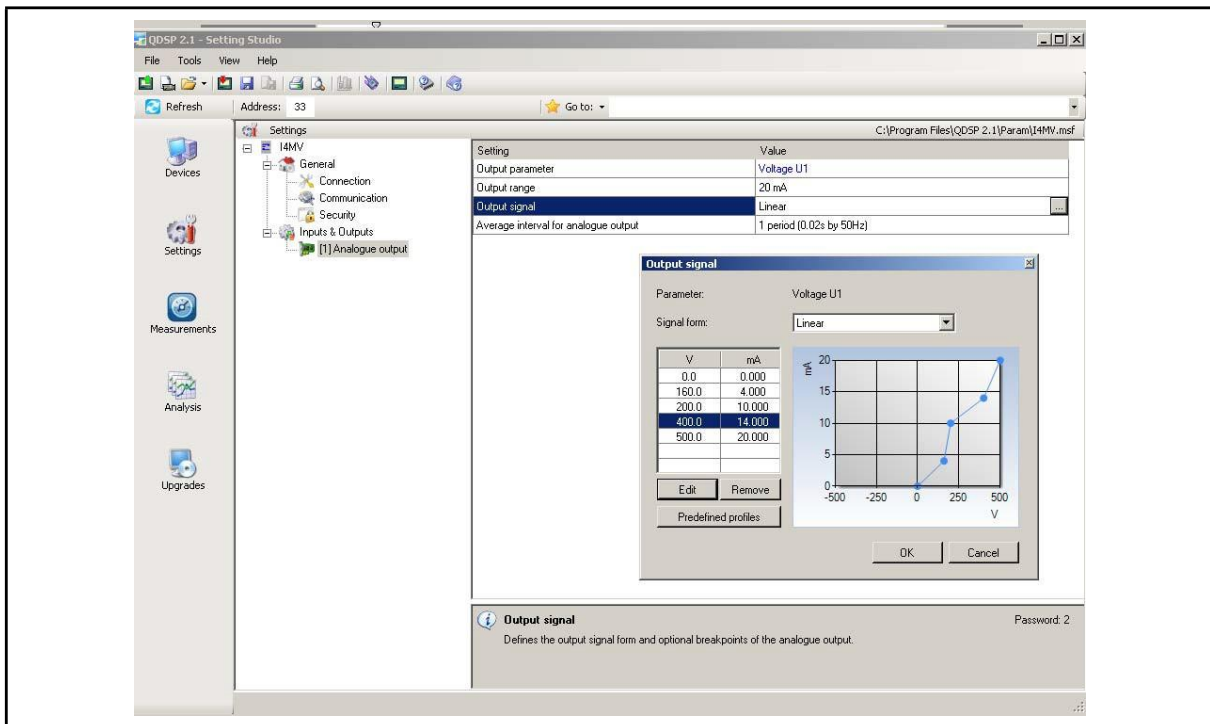
FIGURE 3-7: ANALOGUE OUTPUT SETTINGS

If the Analogue output signal is modified from the full linear range, the accuracy of the output may be reduced due to the reduction in the overall output range.

Note: If the 'Used' ranges are changed after the analogue settings have been defined, then the analogue settings will be modified automatically, see section 3.5.2. It may be necessary to subsequently modify the settings for the analogue outputs.

3.8.1.4   Average interval for analogue output

Defines the time interval over which the measurement used for an analogue output will be averaged.

3.9   Reset Operations

3.9.1   Reset MD values on **i4MC**

           Current and stored MD's are reset.

3.9.2   Reset the last MD period on **i4MC**

           Current MD value is reset.

4. INSTRUMENTATION

4.1 Measurements

With the increase in harmonics present in today's power systems, due to the increased use of electronic loads such as computers, variable frequency drives, etc. it is important, when accurate monitoring of electrical parameters is required, to use a measuring technique that allows for their presence. Conventional measurement methods, that use a mean sensing technique, respond to the mean or average of the input waveform. This is only accurate when the input waveform approaches a pure sinusoid.

The **i4MC/V** uses a true RMS (root-mean-square) measurement technique that provides accurate measurement with harmonics present up to the 63rd harmonic (at 50Hz). The **i4MC/V** reads 128 samples per cycle (at 50Hz) and the true RMS measurement is obtained using these sampled values. At higher signal frequencies the number of samples reduces and the number of harmonics included in the calculations is also reduced.

4.2 Glossary

The following terms are used:

TABLE 4-1: GLOSSARY	
Term	Explanation
RMS	Root Mean Square value
Flash	Type of a memory module that keeps its content in case of power supply failure
MODBUS	Industrial protocol for data transmission
QDSP	Software for iSTAT family
AC	Alternating current
THD	Total harmonic distortion
MD (maximum demand)	Measurement of average values in time interval
Sample factor (Mv)	Defines a number of periods for measuring calculation on the basis of measured frequency
Averaging interval (Mp)	Defines frequency of refreshing displayed measurements on the basis of a Sample factor

4.3 Supported Measurements

The following tables show the measurements available on the **i4MC** and **i4MV**; all values are available over the communications

TABLE 4-2: i4MC
Current I_1
Frequency f
THD of current I_1
Internal temperature
Dynamic Demand I_1
Max Demand since last reset I_1

TABLE 4-3: i4MV
Voltage U_1
Frequency f
THD of voltage U_1
Internal Temperature

The equations defining the calculated values are detailed in Appendix B

4.3.1   Voltage

The **i4MV** measures the RMS value of the voltage (U) connected to the meter.

4.3.2   Current

The **i4MC** measures the true RMS value of the phase current (I) connected to the unit.

4.3.3   Frequency

The system frequency is calculated from the time period of the measured voltage (**i4MV**) or current (**i4MC**).

4.3.4   Harmonics(THD)

The percentage total harmonic distortion (%THD) value is the ratio of the sum of the powers of the harmonic frequencies above the fundamental frequency to the power of the fundamental frequency. This sum of the powers is a geometric total, formed by taking the square root of the sum of the squares of the amplitude of each of the harmonics.

The **i4MC** provides %THD values for the phase current, and the **i4MV** %THD value for the voltage.

4.3.5   Maximum demands (MDs)

The **i4MC** stores the maximum demand value since last reset of the current, and also provides the current or 'dynamic' maximum demand.

4.3.6   Average demands

4.3.6.1 Thermal Demand

The thermal demand option will provide an exponential thermal characteristic, based on the bimetal element principal. Maximum demand since last reset and the dynamic Maximum Demand are stored in the **i4MC**.

A time constant (t. c.) can be set from 1 to 255 minutes and is 6−time thermal time constant (t..c. = 6 * thermal time constant).

Example:

Mode: Thermal function
Time constant: 8 min.
Current MD and maximal MD: Reset at 0 min.

Thermal function
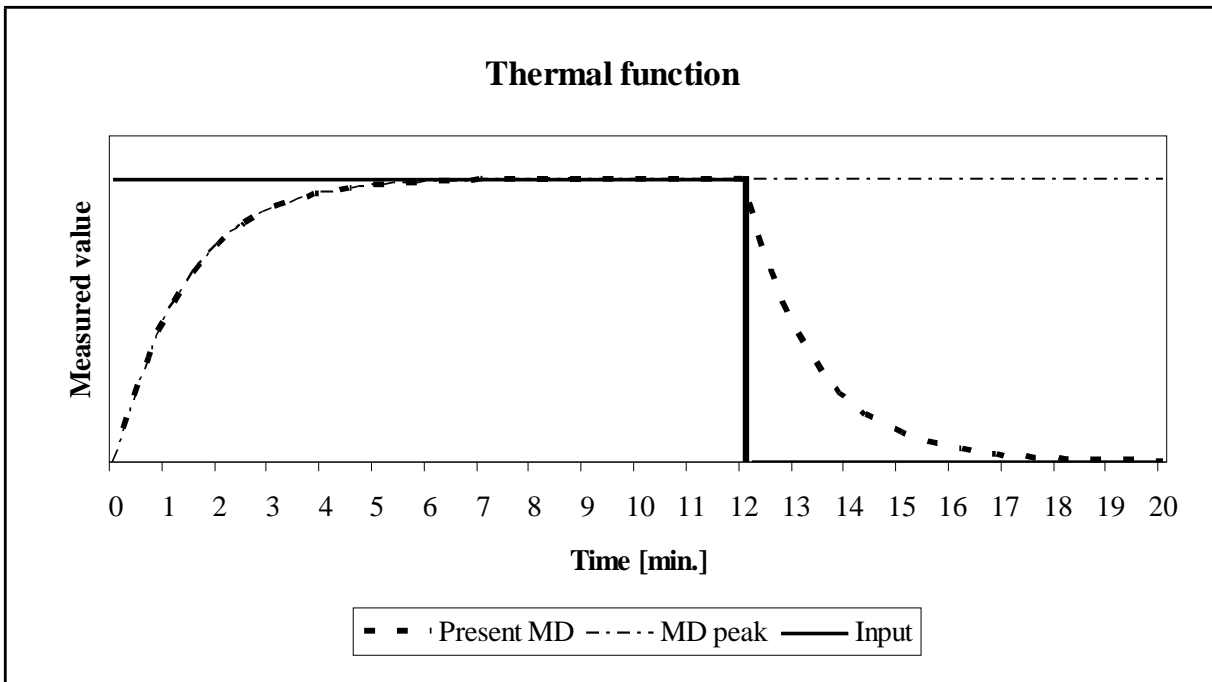
5. COMMUNICATIONS

5.1 Communications ports

The **i4MC/V** is optionally fitted with a primary communications (COM) port

COM can be RS232 or RS485

The communications port can be used for settings and the monitoring of data.

The communication parameters of the **i4MC/V** can be obtained by using the 'Scan the network' feature in the QDSP setting software.

5.2 QDSP Setting and Monitoring Software

See the separate QDSP Manual for details of how to Install and use the QDSP Software.

5.3 MODBUS

Two versions of MODBUS register tables are available:

VERSION 1: Compatibility with advanced family of transducers (i500)

VERSION 2: Compatibility with previous family of transducers (i400)

For details, see Appendix A

6.   TECHNICAL DATA

INPUTS AND SUPPLY		
Voltage Input (i4MV)	Nominal voltage (Un)	230V
	Rating	57.7 ……230V
	Overload	277V permanently
		2 x Un for 10 seconds
	Minimum range	10mV sinusoidal
	Burden	<0.5 VA
Current Input (i4MC)	Nominal current (In)	5A
	Rating	1A/5A
	Overload (thermal)	15A continuously
	(acc. to IEC/EN 60 688)	$20 \times I_N$; $5 \times 1s$
	Minimal range	2mA sinusoidal
	Maximum range	12.5A sinusoidal
	Burden	<0.3 VA
Frequency	Nominal Frequency (Fn)	50/ 60Hz, 400Hz
	Measuring range	16 to 400Hz
Power Supply Universal		
	AC voltage range	40 to 276Vac
	Frequency range	45 to 65Hz
	DC voltage range	24 to 300Vdc
	Burden	< 5VA
	Power on transient current	< 20A 1ms

CONNECTIONS	
Permitted conductor cross sections	Conductor cross section
Voltage terminals	0.325 … 2.5 mm^2 (22 – 14 AWG) one conductor
Current terminals	0.325 … 2.5 mm^2 (22 – 14 AWG) one conductor
Supply	0.325 … 2.5 mm^2 (22 – 14 AWG) one conductor
I/O Modules and Communications	0.325 … 2.5 mm^2 (22 – 14 AWG) one conductor

ACCURACY		
RMS Current (I_1) – i4MC	5A	0.5 (0.3**)
RMS Voltage (U_1) – i4MV	62.5V, 125V L-N	0.5 (0.3**)
	250V L-N	0.5 (0.3**)
	500V L-N	0.5 (0.3**)
Frequency (actual)	50/60 Hz	0.02Hz
Nominal Frequency Range	16….400 Hz	0.02
THD	5 to 500V	0.5
	0.1 to 10A	0.5
	0 to 400%	0.5

Total accuracy (measurements and analogue output) according to IEC/EN 60688. Accuracy is defined as percentage of reading of the measurement except when it is stated as an absolute value.

(** - accuracy on communication)

ANALOGUE OUTPUT		
General	Linearization	Linear, Quadratic
	No. of break points	5
	Output value limits	± 120% of nominal output
	Response time	Input $\rightarrow$ output < 100ms
	Residual ripple	< 1 % p.p.
DC Current output		
	Output range values	0…100%
	0…1 mA	Range 1
	0…5 mA	Range 2
	0...10 mA	Range 3
	0...20 mA	Range 4
	Other ranges	Programmable using QDSP
	Burden voltage	10 V
	External resistance	$RB_{max} = 10 \text{ V} / I_{outN}$
DC Voltage output		
	Output range values	0…100%
	0…1 V	Range 5
	0…10 V	Range 6
	Other ranges	Programmable using QDSP
	Burden current	10 mA
	External resistance	$RB_{min} = U_{outN} / 10 \text{ mA}$

COMMUNICATION			
	RS232	**RS485**	**USB**
Type of connection	Direct	Network	Direct
Max. connection length	3 m	1000 m	3 m
Number of bus stations	−	≤ 32	−
Terminals	Screw terminals		USB-mini B
Insulation	Protection class II, 500V_{ACRMS} 1 min		**Basic Isolation only**
Transfer mode	Asynchronous		
Protocol	MODBUS RTU		
Transfer rate	2.400 to 115.200 bit/s		USB 2.0

ELECTRONIC FEATURES		
Response time	Input to communications	Calculated during averaging interval setting (8 to 256 periods), resetting (64 periods) typically 1.28 seconds at 50Hz
Status LED		
PWR	Red	Instrument power ON

SAFETY FEATURES	
Protection	Protection Class II
Installation category	CAT III: 600Vrms, Measurement Inputs CAT III: 300Vrms, Auxiliary Supply In compliance with EN61010-1:2001
Pollution degree	2
Test voltage	$U_{AUX} \leftrightarrow$ Output, COM: 3320 VAC_{rms} U, I inputs $\leftrightarrow$ Output, COM, U_{AUX} 5200 VAC_{rms} Output$\leftrightarrow$COM: 500 VAC_{rms}
EMC	Directive on electromagnetic compatibility 2004/108/EC In compliance with EN 61326-1
Protection	In compliance with EN60529:1997 IP20

AMBIENT CONDITIONS		
	Climatic	Usage group II
	Ambient Temperature	-10…<u>15…45</u>…55°C Acc. To IEC/EN 60688
	Temperature	Operation -30 to +70C Storage -40 to +70C
	Humidity	≤ 93%RH non condensing
	Altitude	≤ 2000m

MECHANICAL	
Dimensions	W45 × H75× D105 mm
Max. conductor cross section for terminals	2,5 mm^2 with pin terminal 4 mm^2 solid wire
Vibration withstand	7g, 3…100 Hz, 1 oct/min
	10 cycles in each of three axes
Shock withstand	300g, 8ms pulse
	6 shocks in each of three axes
Mounting	Rail mounting 35 × 15 mm
	acc. to DIN EN 50 022
Enclosure material	PC/ABS
Flammability	Acc. to UL 94 V-0
Weight	170 g

7.   WIRING DIAGRAMS

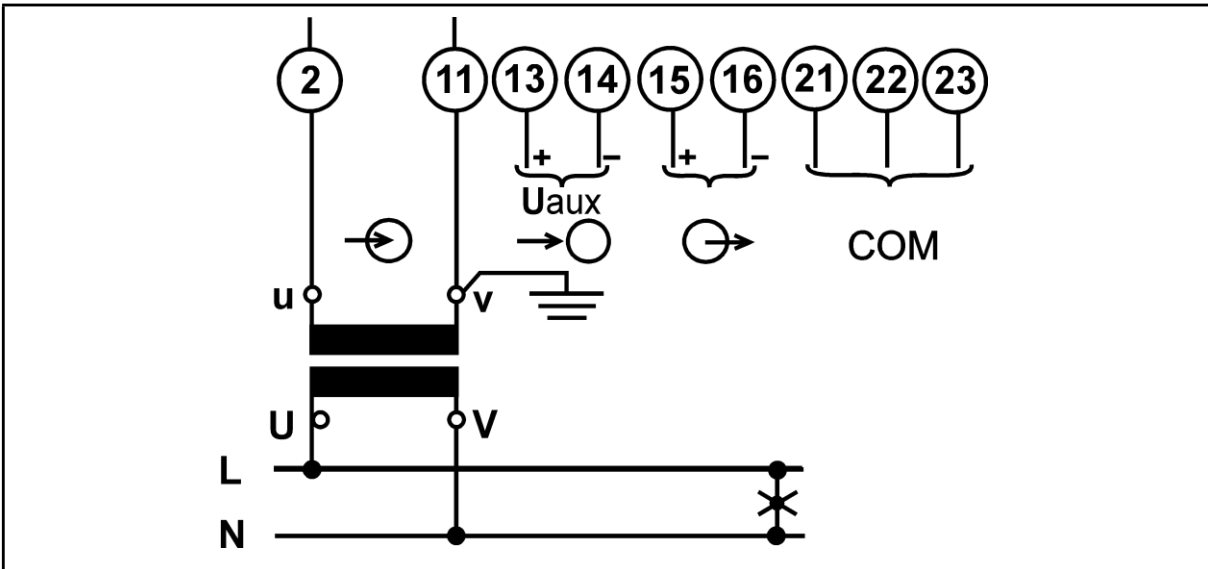

FIGURE 10-1: EXTERNAL WIRING DIAGRAM: I4MV
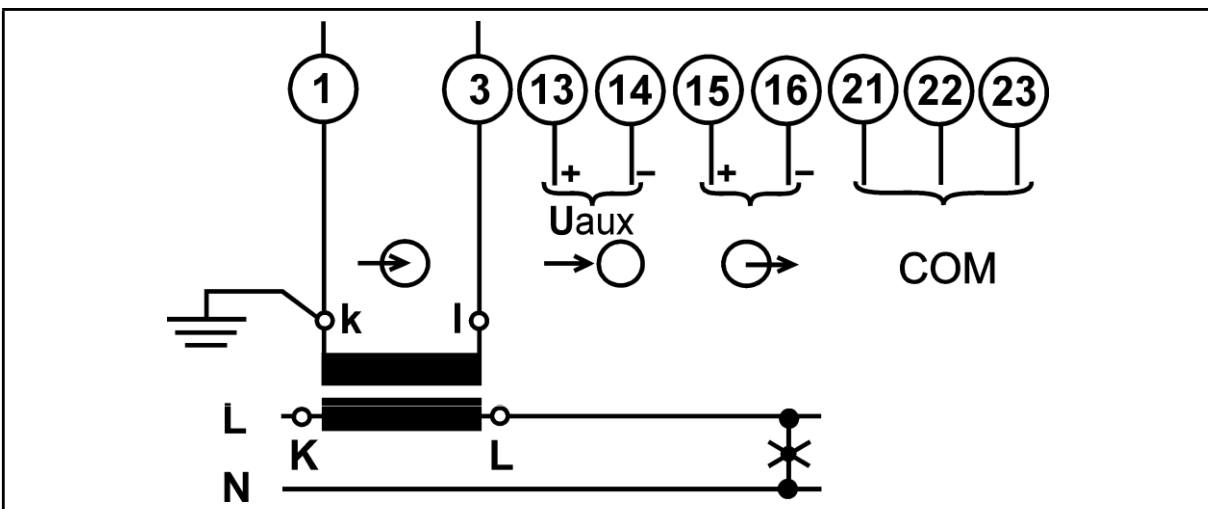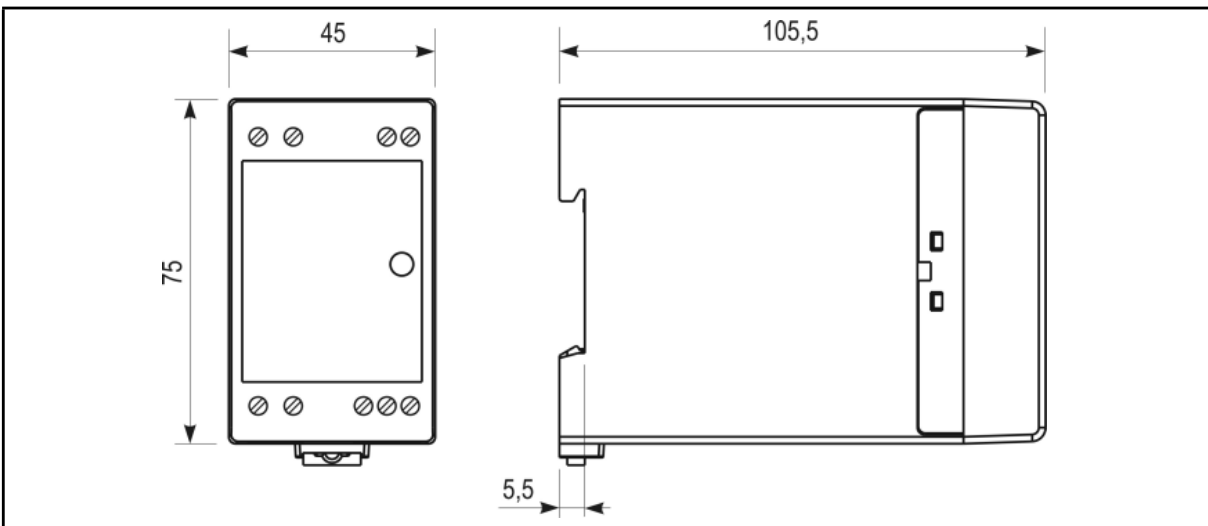

FIGURE 10-2: EXTERNAL WIRING DIAGRAM: I4MC

FIGURE 10-4: ENCLOSURE DIMENSIONS

8.   RELATED DOCUMENTS

Ref	Document
1	i4MT Multifunction Transducer Manual
2	QDSP Technical Manual

9.   APPENDIX A: MODBUS COMMUNICATION PROTOCOL

Modbus is enabled via RS232 and RS485 (not USB). The response is the same type as the request.

Two versions of MODBUS register tables are available:

VERSION 1: Compatibility with advanced family of transducers (i500)

VERSION 2: Compatibility with previous family of transducers (i400)

Modbus protocol enables operation of device on Modbus networks. For device with serial communication the Modbus protocol enables point to point (for example Device to PC) communication via RS232 communication and multi drop communication via RS485 communication. Modbus protocol is a widely supported open interconnect originally designed by Modicon.

The memory reference for input and holding registers is 30000 and 40000 respectively.

VERSION1: i500 compatible

Register table for the actual measurements for **i4MV**

Parameter	MODBUS		
	Register		Type
	Start	End	
Frequency	30105	30106	T5
U1	30107	30108	T5
U1 THD%	30182		T16
Internal Temperature	30181		T17

Register table for the actual measurements for **i4MC**

Parameter	MODBUS		
	Register		Type
	Start	End	
Frequency	30105	30106	T5
I1	30126	30127	T5
I1 THD%	30188		T16
Internal Temperature	30181		T17
DYNAMIC DEMAND VALUES			
I1	30502	30503	T5
MAX DEMAND SINCE LAST RESET			
I1	30518	30519	T5

VERSION2: i400 compatible

Register table for the actual measurements for **i4MV**

Parameter	MODBUS		
	Register		Type
	Start	End	
FREQUENCY	30049	30050	T5
U1	30057	30058	T5
U1 THD%	30639		T16
Internal Temperature	30126		T17

Register table for the actual measurements for **i4MC**

Parameter	MODBUS		
	Register		Type
	Start	End	
Frequency	30049	30050	T5
I1	30076	30077	T5
I1 THD%	30645		T16
Internal Temperature	30126		T17
DYNAMIC DEMAND VALUES			
I1	30175	30176	T5
MAX DEMAND SINCE LAST RESET			
I1	30207	30208	T5

Data types decoding

Type	Bit mask	Description
T1		Unsigned Value (16 bit)
		Example: 12345 = 3039(16)
T2		Signed Value (16 bit)
		Example: -12345 = CFC7(16)
T3		Signed Long Value (32 bit)
		Example: 123456789 = 075B CD 15(16)
T4		Short Unsigned float (16 bit)
	bits # 15…14	Decade Exponent(Unsigned 2 bit)
	bits # 13…00	Binary Unsigned Value (14 bit)
		Example: 10000*102 = A710(16)
T5		Unsigned Measurement (32 bit)
	bits # 31…24	Decade Exponent(Signed 8 bit)
	bits # 23…00	Binary Unsigned Value (24 bit)
		Example: 123456*10-3 = FD01 E240(16)
T6		Signed Measurement (32 bit)
	bits # 31…24	Decade Exponent (Signed 8 bit)
	bits # 23…00	Binary Signed value (24 bit)
		Example: - 123456*10-3 = FDFE 1DC0(16)
T7		Power Factor (32 bit)
	bits # 31…24	Sign: Import/Export (00/FF)
	bits # 23…16	Sign: Inductive/Capacitive (00/FF)
	bits # 15…00	Unsigned Value (16 bit), 4 decimal places
		Example: 0.9876 CAP = 00FF 2694(16)
T9		Time (32 bit)
	bits # 31…24	1/100s 00 - 99 (BCD)
	bits # 23…16	Seconds 00 - 59 (BCD)
	bits # 15…08	Minutes 00 - 59 (BCD)
	bits # 07…00	Hours 00 - 24 (BCD)
		Example: 15:42:03.75 = 7503 4215(16)
T10		Date (32 bit)
	bits # 31…24	Day of month 01 - 31 (BCD)
	bits # 23…16	Month of year 01 - 12 (BCD)
	bits # 15…00	Year (unsigned integer) 1998..4095
		Example: 10, SEP 2000 = 1009 07D0(16)
T16		Unsigned Value (16 bit), 2 decimal places
		Example: 123.45 = 3039(16)
T17		Signed Value (16 bit), 2 decimal places
		Example: -123.45 = CFC7(16)

10. APPENDIX B: CALCULATIONS & EQUATIONS

10.1 Definitions of symbols

No	Symbol	Definition
1	M_v	Sample factor
2	M_P	Average interval
3	U_f	Phase voltage (U_1, U_2 or U_3)
4	U_{ff}	Phase-to-phase voltage (U_{12}, U_{23} or U_{31})
5	N	Total number of samples in a period
6	n	Sample number ($0 \leq n \leq N$)
7	x, y	Phase number (1, 2 or 3)
8	i_n	Current sample n
9	u_{fn}	Phase voltage sample n
10	u_{fFn}	Phase-to-phase voltage sample n
11	φ_f	Power angle between current and phase voltage f (φ_1, φ_2 or φ_3)

10.2 Equations

Voltage

$$U_f = \sqrt{\frac{\sum_{n=1}^{N} u_n^2}{N}}$$

Phase voltage

N − 128 samples in one period (up to 65 Hz)

N − 128 samples in M_v periods (above 65Hz)

Example: 400 Hz → N = 7

Current

$$I_{RMS} = \sqrt{\frac{\sum_{n=1}^{N} i_n^2}{N}}$$

Phase current

N − 128 samples in a period (up to 65 Hz)

N − 128 samples in more periods (above 65 Hz)

THD

$$I\ THD(\%) = \frac{\sqrt{\sum_{n=2}^{N} In^2}}{I_1} \cdot 100$$

Current THD

I_1 − value of first harmonic

n − number of harmonic

$$U\ THD(\%) = \frac{\sqrt{\sum_{n=2}^{N} Un^2}}{U_1} \cdot 100$$

Voltage THD

U_1 − value of first harmonic

n − number of harmonic

Imagination at work

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