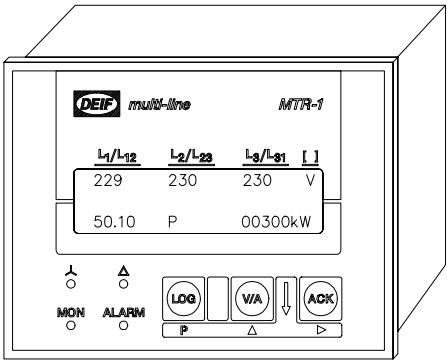
User's Manual

Multi transducer type MTR-1

multi-line

4189300002M



- *All 3-phase AC_{RMS} measurements in one unit:*
  - *U_{RMS}, I_{RMS} True RMS measurements*
  - *P, Q, S, cos-phi, f*
  - *KWh*
- *3 programmable analog outputs*
- *1 programmable pulse output*
- *Display showing all measurements in engineering values*
- *Optional serial output for all measured values*

CE

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List of contents

This manual relates to version 1.4x (VERSIONS 1.40….1.49)

1. Warnings, legal information and notes to CE-marking

This manual gives general guidelines on how to install and operate the MTR-1. Installing and operating the MTR-1 implies work with dangerous currents and voltages. Therefore this should only be done by qualified personnel. DEIF A/S takes no responsibility for operation or installation. If there is any doubt about how to install or operate the system on which the MTR-1 is measuring, the company responsible for the installation or the operation must be contacted.

The MTR-1 is CE-marked with respect to the EMC directive for residential, commercial and light industry plus industrial environment. This covers all environment types where MTR-1 normally can be used.

The MTR-1 is CE-marked with respect to the low-voltage directive for up to 300 V phase to ground voltage, installation category (overvoltage category) III and pollution degree 2. 300 V phase to ground voltage corresponds to 480 V phase to phase voltage in 4-wire networks and 500 V phase to phase voltage in 3-wire networks.

The connections for current trafoes (terminals 6-13) are specially plugable connections.

Important: Be sure to short circuit current trafoes before disconnecting the current trafoes by unplugging these terminals.

The package contains the following items:

- Multi-line MTR-1 unit
- User's manual
- In the event of serial communication option, a special user's manual for serial communication and a disk with a communication programme for PCs are included.
- The MTR-1 should be fitted with fixing clamps on the side for mounting in the switchboard. The plugable connections on the rear should all be fitted with connectors for mounting the wiring.

2. Application and functionality summary

The MTR-1 multi transducer is a microprocessor-based measuring unit providing measurement of all electrical values on a 3-phase or 1-phase network. It is used in any kind of installation where measurements on power systems are required.

All the measurements are showed in the built-in display and furthermore all measurements can be transmitted to other applications as:

3 analog outputs
and
1 pulse output
and
a serial output (option)

MTR-1 can substitute several transducers in all electric measuring applications, and can be used both as a normal transducer where the analog output is connected to a local control system, and as a remote value reading unit where all measured values are passed to the remote control system via the serial interface.

MTR-1 can measure on all network topologies with/without neutral and with both balanced and unbalanced load. MTR-1 contains all necessary measuring circuits and presents all values on a LC display. Messages are presented in clear text, all measuring values in engineering units.

The MTR-1 is a flexible and menu-programmed unit enabling the user easily to adapt the unit to the application in question. Programming procedures are password protected.

Please see appendix 1 for detailed explanation of the measuring technology utilising digital signal processing.

2.1 Connection diagram

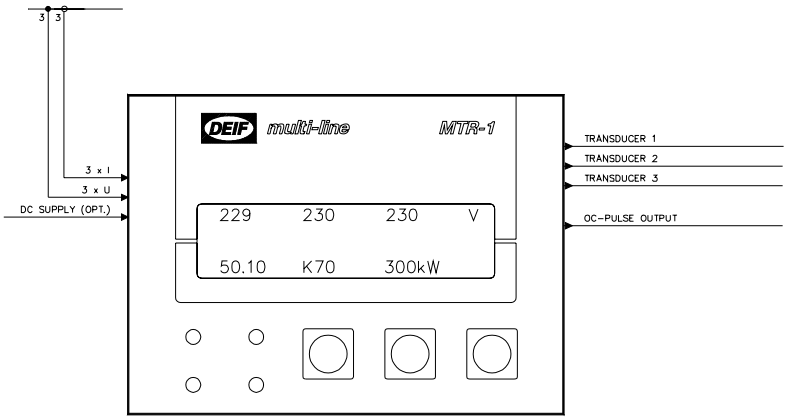


Figure 1: Principle diagram of connecting MTR-1.

3. Options

Option A1: Remote value reading
- RS 232 remote value reading of all values measured by MTR-1. Siemens 3964, RK512 with standard telegram.

Option A2: Remote value reading
- RS 485 remote value reading of all values measured by MTR-1. Modbus RTU protocol with standard telegram.

Remote value reading with other serial communication interface standards is available on request.

Option B0: 12V DC power supply
Option B1: 24V DC power supply
Option B2: 48V DC power supply
Option B3: 110V DC power supply
Option B4: 220V DC power supply

4. Operation of display, pushbuttons and LEDs

MTR-1 can be operated in two different modes: "normal mode" and "parameter entering mode". Normal mode is used to display measuring values and parameter entering mode is used to programme the unit to the desired functionality.

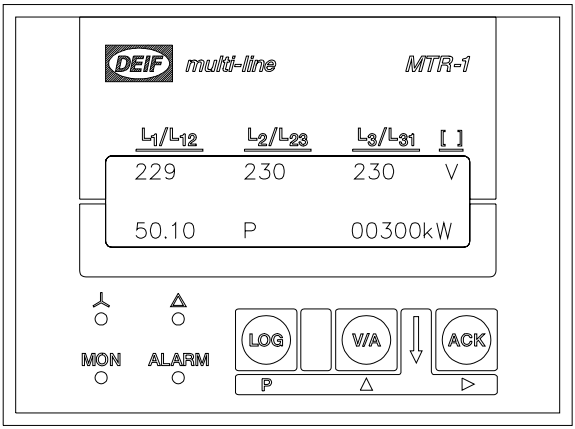


Figure 2: LC-display

4.1 LC-display

MTR-1 has a 2-line green LC display containing the following information:

In normal mode the upper line reads phase to phase voltage, phase to neutral voltage or currents in the 3 phases. In case of a 1-phase network, phases 2 and 3 will read 0 in the voltage and current measurements, and phase to phase voltages will all read 0.

In normal mode the lower line reads frequency and the scrolling menu of other measured values, which are:

Value measured	**Display reading**	
Active power	P	
Cos phi	Cos	
Reactive power	Q	(not displayed for 1-phase network)
Apparent power	S	
Average phase-phase voltage	U	(not displayed for 1-phase network)
Highest phase-phase voltage	Uhi	(not displayed for 1-phase network)
Lowest phase-phase-voltage	ULo	(not displayed for 1-phase network)
Average current	I	(not displayed for 1-phase network)
Highest current	IHi	(not displayed for 1-phase network)
Lowest current	ILo	(not displayed for 1-phase network)
Active power, phase 1	P1	(not displayed for 1-phase network)
Active power, phase 2	P2	(not displayed for 1-phase network)
Active power, phase 3	P3	(not displayed for 1-phase network)
Energy counter		(The unit kWh is shown after the energy measurement)

The energy counter is updated every 3rd minute.
In parameter entering mode both lines show information relating to the adjusted parameter.

The LC display contrast/brightness can be adjusted by the potentiometer placed on the left side of the MTR-1. The adjustment is accessible without opening the unit. The display is illuminated for easy reading in dark environments. When the temperature is rising or falling the LCD contrast/brightness changes slightly, and if MTR-1 is operated in extreme temperature conditions an adjustment of contrast/brightness as described above may be necessary.

4.2 LEDs

MTR-1 has 4 LEDs on the front showing different operating information.

LED	Colour	Function
"Δ"	Yellow	The upper line of the display shows phase-phase voltages
"Y"	Yellow	The upper line of the display shows phase-neutral voltages
"Δ", "Y"	OFF	The upper line of the display shows current
"MON"	Green	The measuring circuits are running
"ALARM"	Red	The measuring circuits have detected an error

4.3 Pushbuttons

MTR-1 is operated through the 3 pushbuttons below the display. The 3 pushbuttons have different meanings in the two operating modes: "normal operation" and "parameter entering mode". The functional names of the 3 pushbuttons in normal mode are shown inside the pushbuttons, and the functional names of the 3 pushbuttons in parameter entering mode are shown below the pushbuttons.

By pressing the two pushbuttons "ACK" and "V/A" simultaneously the two operating modes will change. If the unit is left in parameter entering mode it will automatically change to normal mode after 2 minutes if the pushbuttons are not activated. An overview of the operating principle of the display and pushbuttons in the two operating modes is shown in figure 3.

4.4 Operation principle for display and pushbuttons

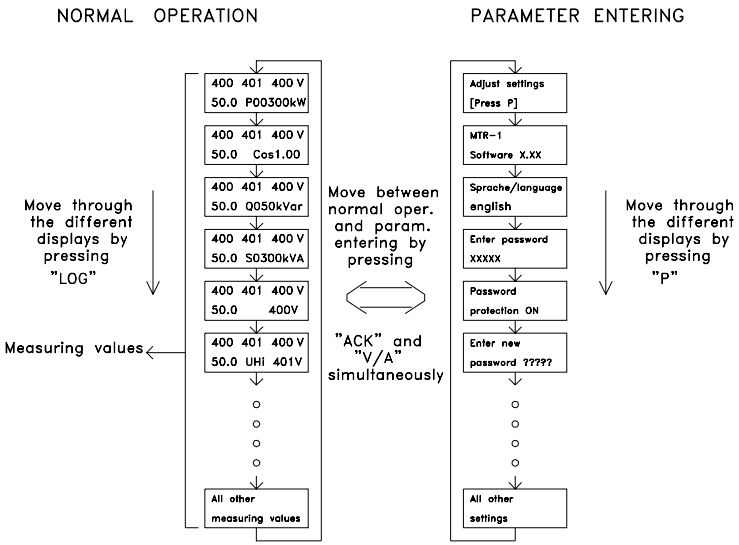


Figure 3: Principle of operation

"LOG" (normal operation)	Scrolling through the readings on the second line in the display shown in the list above.
"V/A" (normal operation)	Scrolling through phase to phase voltages, phase to neutral voltages or currents shown on the first line of the display.
"ACK" (normal operation)	(No function in this version of MTR-1)
"P" (parameter entering)	Scrolling through parameters which can be adjusted. When pressing the button, the display will jump to the next parameter, which can be adjusted. When a value has been adjusted, pressing the button "P" programmes the value, which has been adjusted into the memory. This means that the button "P" must be pressed twice to jump to the next parameter after a parameter has been adjusted.
"▲" (parameter entering)	Pressing the button will make the number underlined by the blinking cursor to increase by 1 (within the allowed limits of the parameter).
"▶" (parameter entering)	Pressing the button will scroll through the different positions in the number, which is adjusted. If the adjusted parameter is not a number but a choice between different possibilities (eg. "yes" or "no"), pressing " " will scroll through the different possible settings.

5. Terminal list

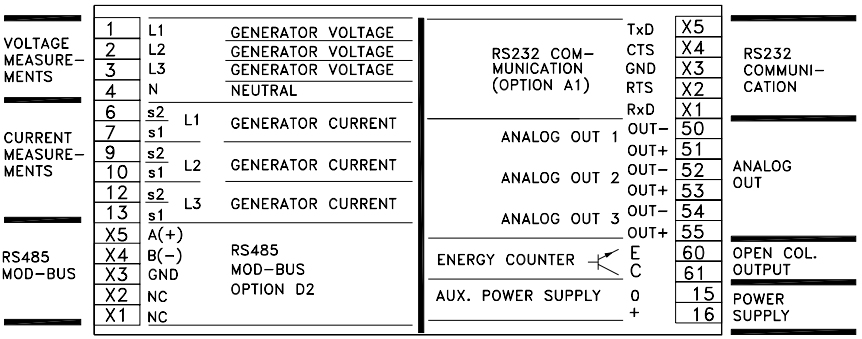
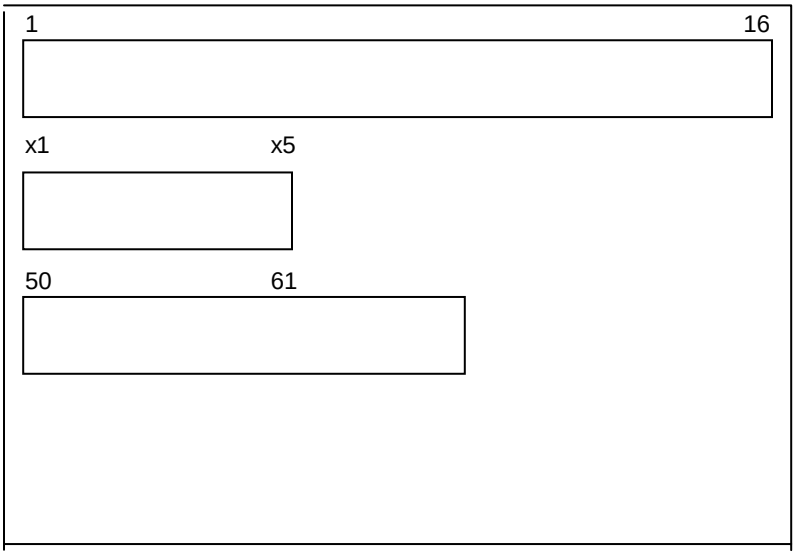


Figure 4: Terminal overview

5.1 Overview of the terminals

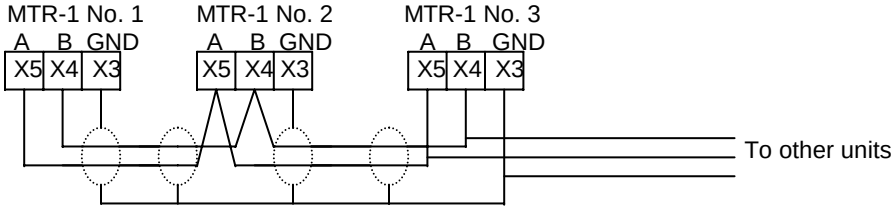
Terminal no.	In/Out	I/O Type	Signal name	Description
1 2 3 4	L1 L2 L3 Neutral	AC V input	Generator voltage	3-phase generator voltage with or without neutral, 100/110 or 250...450 VAC. If Neutral is connected to generator it shold also be connected to earth with a short lead as close to the MTR-1 as possible.
6 7	S2 S1	AC I input	Generator current phase L1	/1A or /5A current transformer input.
9 10	S2 S1	AC I input	Generator current phase L2	/1A or /5A current transformer input.
12 13	S2 S1	AC I input	Generator current phase L3	/1A or /5A current transformer input.
15 16	0 +	Supp.	Supply	Power supply standard AC or optional DC supply, max 6W. For AC supplies the indicated polarity is not applicable.
50 51	- +	0/4…20mA - 20…0…20mA	Analog output 1	Function and scaling can be set from display.
52 53	- +	0/4…20mA - 20…0…20mA	Analog output 2	Function and scaling can be set from display.
54 55	- +	0/4…20mA - 20…0…20mA	Analog output 3	Function and scaling can be set from display.
60 61	E C	Open collector	Energy pulse out	Scaling can be set from display.

Terminal no.	In/Out	I/O Type	Signal name	Description
X1 X2 X3 X4 X5		RxD RTS GND CTS TxD	Serial single-drop comm.	Serial comm. RS 232 (Option A1). Must be connected through shielded twisted pair cable. RxD and TxD in one pair and RTS and CTS in another pair. Shield must only be connected to ground on one end of the cable, preferably to the opposite end of MTR-1.
X1 X2 X3 X4 X5		NC NC GND B(-) A(+)	Serial multi-drop communication	Serial comm. RS 485 Modbus RTU. Must be connected through shielded twisted pair cable.



5.2 RS 485 multidrop Modbus

Shielded twisted pair cable (min. 0.5 mm^2) must be used.



Terminals X1 and X2 : Do not use.

6. Wiring diagrams

6.1 AC input connections

When ordering MTR-1 the correct range of AC-inputs must be specified. It is possible to set current and voltage trafo specifications in the display. Different network connections can be selected in the display settings. They must be connected as shown below.

NOTE: Fuse in all AC voltage connections: Max. 2A slow-blow.

The size of current transformer must be selected to match the normal current from the current transformer secondary side as close as possible to MTR-1 nominal current at full load. If not, performance degredation must be expected.

6.1.1 Connection diagrams

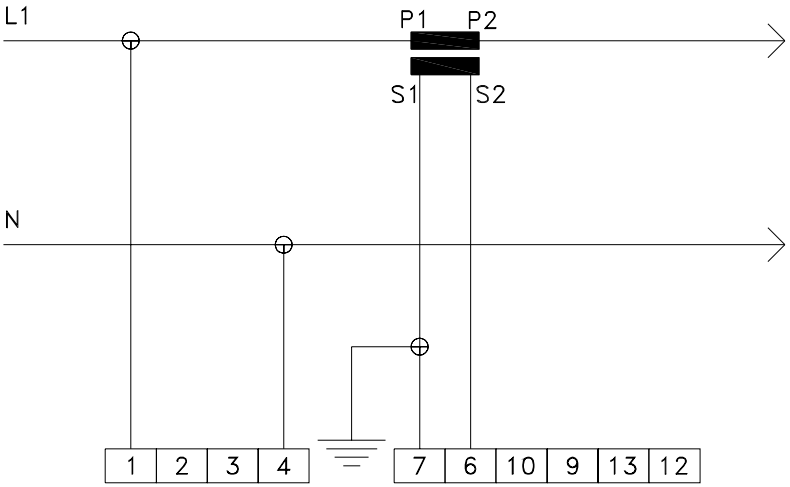


Figure 5: Connection of **1W** single phased network

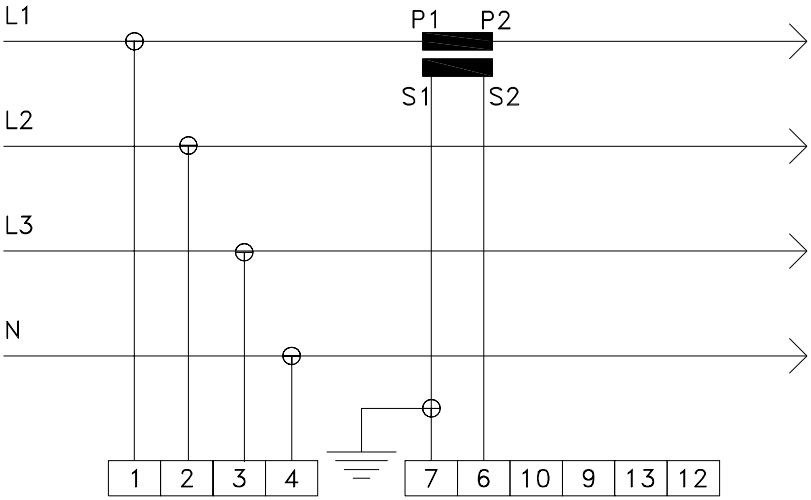


Figure 6: Connection of **1W4** 3-phase network, 4-wire, balanced load

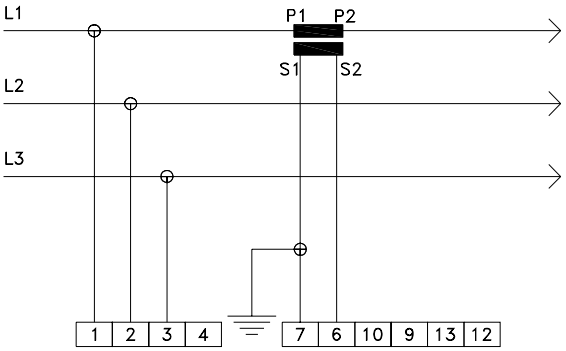


Figure 7: Connection of **1W3** 3-phase network, 3-wire, balanced load

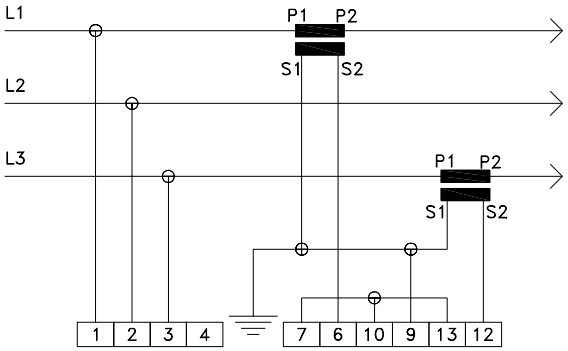


Figure 8: Connection of **2W3**, 3-phase network, 3-wire, unbalanced load

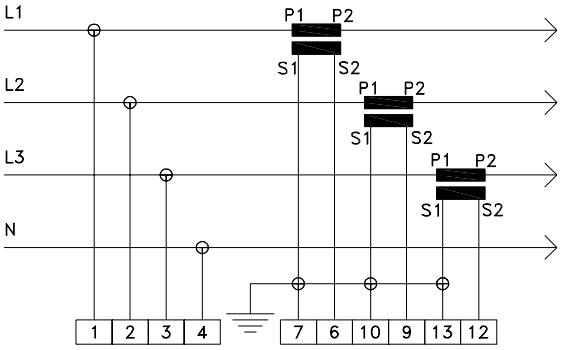


Figure 9: connection of **2W4**, 3-phase network, 4-wire unbalanced load

7. Commissioning

This paragraph gives general guidelines on how to set up the product MTR-1. Installing and operating MTR-1 implies working with dangerous current and voltages, and therefore this should only be done by qualified personnel. DEIF takes no responsibility for operation or installation of MTR-1. If there is any doubt about how to install or operate the system on which MTR-1 measures the company responsible for installation or operation must be contacted.

Before commisioning: Check phases for correct voltage and correct rotary field.

Warning: Missing or incorrect voltage and other input fails may lead to malfunction and damage of the unit.

For further explanations regarding setting the different parameters and their functions: See paragraph 9 "Programming parameters".

1. Connect power supply.

2. Push the butttons ”ACK” and "V/A" simultaneously to swap between normal operation mode and parameter setting mode.

   Follow the instructions below to change any parameter needed.

   Push the buttons ”ACK” and "V/A" and again to return to normal operation mode.

3. Programme general parameters like connection type and trafo specifications. General parameters are explained in paragraph 9.4.

   Check all measured voltages and currents in the display by pressing the "V/A" button and thereby scrolling through all measurements. Check measured frequency in the display.

4. Check measured power in the display by pressing the "LOG" button until the measured power appears in the display. If some measured values are not correct, check the generator current and the voltage connections for correct current direction and rotary field.

5. Set up the analog output type and output range for each of the 3 analog outputs. See paragraph 9.5.

6. Check the analog outputs by sweeping through 3 to 10 measuring points inside the measuring range of each output.

7. Set up the energy pulse output. See paragraph 9.5.

8. Finalize the commisioning by writing all programmed parameters into the tables in paragraph 9 and setting password ON to protect the settings entered into the unit.

8. Technical data

Accuracy:	Class 0,5 acc. to IEC 688 (Modbus class 1.0).
Operating temp.:	-20…+70°C (LC-display, however –20…+60°C).
Climate:	Class HSE, to DIN 40040.
Measuring voltage:	100/110 VAC to 450 VAC ±20% consumption max. 0,15 VA per phase.
Measuring current:	../1 or ../5 A, consumption max. 0.1 VA per phase. max. overcurrent 1,5 x $I_{nom.}$ continously (measured), max 20 x $I_{nom.}$ for 1s. (not measured).
Measuring frequency:	30…70Hz.
Aux. supply:	Standard: 85-231VAC ±20%, max. 6W. Optional: 12-24-48-110-220V DC –25/+30%, max. 6W.
Analog output:	Analog transducer outputs (0)4…20mA or –20…0…20mA, max. load: 400Ω.
Open collector output:	Max. 30mA "ON" current. Max. 27V "OFF" voltage.
Safety:	To EN 61010-1. Installation category (overvoltage category) III, 300V. Pollution degree 2.
Galvanic separation:	Between all current inputs and between current inputs and remaining circuits. Between analog outputs and remaining circuits. Between open collector output and remaining circuit.
EMC:	To EN 50081-1/2 og EN 50082-1/2.
Housing:	DIN 43700, W x H x D: 96 x 72 x 165mm. Cutout: 92 x 68mm.
Connections:	Max. 2,5mm² (supply, measuring voltage and measuring current). Max. 1,5mm² (analog outputs, open collector output and serial interface).
Protection:	IP21, Front: IP 52. To IEC 529 and EN 60529.
Weight:	Dependent on version, approx. 0.5 kg.

9. Dimensions

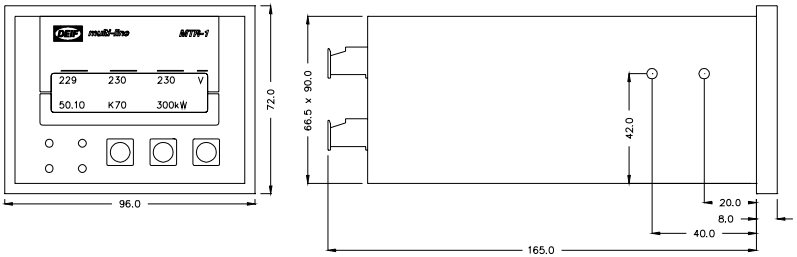


Figure 10: All dimensions in mm

10. Programming parameters

In the following it is described how MTR-1 is programmed to the desired functionality. Each of the parameters, which can be changed, is explained in details.

This part of the manual is intended as a reference manual, which explains all parameters in the order they appear on the display. It is not meant as a programming guide which must be read before any parameters are entered.
Programming MTR-1 is highly self-explaining and this part of the manual should therefore be used as a reference when further explanations are needed.

It is recommended to use the blank column "commissioning value" in each of the tables with parameters below to write down your own settings after commisioning. This will make it easier to track down the changes after commissioning or to reprogram the unit, if this should be necessary.

The display texts shown below are in English. If German display texts are chosen, a different display dialogue is to be expected.

10.1 Select parameter entering mode

By pushing the buttons "ACK" and "V/A" simultaneously the unit swaps between normal operating mode and parameter entering mode. The functions of the buttons "LOG", "V/A" and "ACK" are changed to the indications below the buttons, i.e.:

"LOG" turns to "P"
"V/A" turns to "▲"
"ACK" turns to "▶"

The "MON" LED will flash.

The first thing shown in the display in parameter entering mode is:

"Adjust settings, [press P]"

After pressing "P" the software version is displayed.

The functionality of each of the buttons is explained in details in paragraph 4.3 "Pushbuttons".

If no parameter setting input has been set for 2 min. the MTR-1 will return to the normal operating mode.

To make keying of values easier, all the buttons have a "sweep" function. By holding down a button a fast sweep through values can be made.

To return to a known set of parameters, the unit can be programmed to factory settings (shown in the tables below) by holding down all 3 pushbuttons for 20 sec., when the unit is in the start of parameter entering mode, and the display shows "Adjust settings, [press P]".

When factory settings are programmed, the display will show "settings load".

Warning: Be careful when using this function. All programmed parameters, which differ from factory setting, will be lost. Reprogramming to factory settings cannot be done when the unit is in normal operating mode.

10.2 Language selection

Display	Factory set	Commi-sioning value	Description
SPRACHE/LANGUAGE English	English		Can be switched between English and German

10.3 Password protection

The password prevents unauthorised entering into the part of the parameter-entering mode where commisioning parameters are adjusted. The password is a 5-digit code number.

On time of delivery, the password protection is OFF, and without the setting "password ON", the parameter setting will remain unprotected. It is, however, highly recommended to enable the password protection after end of parameter setting.

Display	Factory set	Commi-sioning value	Description
Enter password XXXXX	00001		This display is only shown when password is set ON in the menu below.
When a wrong password is entered, the display below is shown, and the unit returns to the ”enter password” display when P is pressed.			
Wrong password! Press ”P”			Nothing can be programmed here.
When a correct password is entered, the display below is shown.			
Password Protection OFF			Can be programmed ”ON” or ”OFF”.
Enter new Password ?????			Here it is possible to change the password. Be sure to note the new password every time it is changed. After coding a new password the coded password is substituted with ????? in the display when "P" is pressed. Remember to press "P" the second time to move to next parameter.

10.4 General parameters

Display	Factory set	Commi-sioning value	Description
Volt. Transformer Secondary XXXV	100V		50V…480V
Volt. Transformer Primary XX, XXkV	00.40kV		00.10V…65.00kV Note version 01 0.1V...650kV
Current transf. XXXX/X	1000/5		10/5…9990/5. The secondary on the current trafo can be either 5 or 1 depending on which current trafo option is ordered, but the secondary current trafo value cannot be changed after order.
Connection type XWX	2W4		Can be set to 1W, 1W4, 1W3, 2W3 or 2W4. The different couplings are shown in paragraph 6.1.1.

10.5 Analog output and pulse output configuration

It is possible to change what measured value is put to the 3 different outputs, and it is also possible to scale the output range and change the output signal type.

The different measured signals, which it is possible to put on the analog outputs, are:

Measured value	Display showing
Voltage neutral-phase 1	Vol 1
Voltage neutral-phase 2	Vol 2
Voltage neutral-phase 3	Vol 3
Average neutral-phase voltage	V N-ph
Highest neutral-phase voltage	V N-ph H
Lowest neutral-phase voltage	V N-ph L
Voltage phase 1-phase 2	Vol 1-2
Voltage phase 2-phase 3	Vol 2-3
Voltage phase 3-phase 1	Vol 3-1
Average phase-phase voltage	V ph-ph
Highest phase-phase voltage	V ph-ph H
Lowest phase-phase voltage	V ph-ph L
Frequency	Freq
Directional current phase 1	Cur (+/-) 1
Directional current phase 2	Cur (+/-) 2
Directional current phase 3	Cur (+/-) 3
Directional average current	Cur (+/-)
Directional highest current	Cur (+/-) H
Directional lowest current	Cur (+/-) L
Active power	Power
Reactive power	Re. Pow
Apparent power	Ap. Pow
Cos phi	Cos phi

Display	Factory set	Commi-sioning value	Description
Pulse/kWh Logic negative			Can be set to either positive or negative. Determines the output signal type of the open collector energy counter output. Negative means that the output transistor is ON during the counting pulse. Positive means that the output transistor is OFF during the counting pulse.
Active energy Pulse/kWh XXX,X			0,1...150,0 Sets the scaling of the pulse output. The Energy counter in the display can count up to 4000 GWh, whereupon the counter will restart from 0.
Reset kWh/kvarh ON			Can be set to either ON or OFF. When set to ON the energy counter in the display can be reset to 0 by pressing the two buttons "LOG" and "V/A" simultaneously in 10s. When the two buttons are pressed the LED "MON" will start flashing. When the energy counter is reset the LED will stop flashing when the buttons are no longer pressed.
Analog. Output 1 OFF	OFF		Can be set to OFF, 0..20mA, 4..20mA or -20..0..+20 mA. Changes the output type. The displays below showing settings for analog output 1 will not be shown when analog output 1 is set to OFF.
Analog. Output 1 Signal Power	Power		Changes what measured value will be shown on the output. Can be set to the different values shown above.
Analog. output 1 low point XXXXXX			Defines scaling of analog output 1 together with the next setting by defining what measured value corresponds to the lowest output level on the analog output. E.g.: 0mA = 0kW.
Analog. output 1 High point XXXXX			Defines scaling of analog output 1 together with the previous setting by defining what measured value corresponds to the highest output level on the analog output. E.g.: 20mA = 2000kW.
Analog. output 2 OFF	OFF		Can be set to OFF, 0..20mA, 4..20mA or -20..0..+20 mA. Changes the output type. The displays below showing settings for analog output 2 will not be shown when analog output 2 is set to OFF.
Analog. output 2 Signal Power	Power		Changes what measured value will be shown on the output. Can be set to the different values shown above.

Display	Factory set	Commi-sioning value	Description
Analog. output 2 low point XXXXX			Defines scaling of analog output 2 together with the next setting by defining what measured value corresponds to the lowest output level on the analog output. E.g.: 0mA = 0kW.
Analog. output 2 High point XXXXX			Defines scaling of analog output 2 together with the previous setting by defining what measured value corresponds to the highest output level on the analog output. Eg: 20mA = 2000kW.
Analog. output 3 OFF	OFF		Can be set to OFF, 0..20mA, 4..20mA or -20..0..+20 mA. Changes the output type. The displays below showing settings for analog output 3 will not be shown when analog output 3 is set to OFF.
Analog. output 3 Signal Power	power		Changes what measured value will be shown on the output. Can be set to the different values shown above.
Analog. output 3 low point XXXXX			Defines scaling of analog output 3 together with the next setting by defining what measured value corresponds to the lowest output level on the analog output. E.g.: 0mA = 0kW.
Analog. output 3 High point XXXXX			Defines scaling of analog output 3 together with the previous setting by defining what measured value corresponds to the highest output level on the analog output. E.g.: 20mA = 2000kW.

10.6 Modbus address

The MTR-1 Modbus RTU protocol is for a slave unit. Please refer to the manual "Serial interface, Multi-Line" for further explanations.

Display	Factory set	Commi-sioning value	Description
Device number Modbus 002	002		001…255. Address for the Modbus communication. Be careful not to use the same number more than once, as this will result in communication errors.
Baudrate 19200 baud	19200		1200-2400-4800-9600-19200 baud Selectable
Parity None	None		None-even-odd parity selectable

Display	Factory set	Commi-sioning value	Description
Stopbits one	one		one-two stopbits selectable
Delay to send MOD-bus 20.0 ms	20.0 ms		00,2…50.0 ms MOD bus response delay

10.7 Factory settings

This password gives access to factory settings, which cannot be operated by customers. Do not operate this display.

Display	Factory set	Commi-sioning value	Description
Fact. Password [Press P] XXXXX			DO NOT OPERATE, press "P"

11. Order specifications

Current and voltage measuring input range, power supply and options must be specified when ordering MTR-1.

Order specification for MTR-1 consists of the following:

MTR-1 - V - X - Y - Z,

where V, X, Y and Z are as follows:

Code	Function	Options
V	Determines the measuring voltage input	”1”: means voltage transformer 110 VAC or 100 VAC input. ”4”: means up to 450 VAC direct voltage input.
X	Determines the current trafo secondary	”1”: means current trafo 1A secondary. ”5”: means current trafo 5A secondary.
Y	Determines the power supply	”2”: means 85 to 231 VAC ±20% power supply. Nothing means DC supply as specified by options.

Z	Determines the options:	"A1": means serial interface RS 232 with Siemens 3964 standard protocol. "A2". means serial interface RS 485 with Modbus RTU standard protocol "B0": means 12 VDC power supply –25/+30%. "B1": means 24 VDC power supply –25/+30%. "B2": means 48 VDC power supply –25/+30%. "B3": means 110 VDC power supply –25/+30%. "B4": means 220 VDC power supply –25/+30%.

12. Appendix 1: Measuring principle

MTR-1 is based on a modern digital signal processing platform, where all current and voltage signals are digitally sampled and all measured values are calculated from the sampled signals. This ensures a very accurate measuring system, which also measures harmonics in voltage, current and power. MTR-1 will measure up to 500Hz (10th harmonic of a 50Hz system). From 500 Hz to 2600Hz (52nd harmonic of a 50Hz system) MTR-1 will measure the harmonics in the signal with slightly reduced accuracy.

The digital measuring principle will also give a faster response compared to conventional analog systems. All measuring signals will be updated for every period (20 ms@50Hz) and it is therefore possible to have output responses faster than 100 ms (1 measuring period + output stabilisation time).

All voltages and currents are calculated as true RMS values by the formula:
u_n and i_n are the sampled values and N is the number of samples during one period of the input signal.

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

In the same way the active power P is defined as:

$$P = \sum_{n=1}^{N} \frac{u_n \bullet i_n}{N}$$

N is the number of samples during the latest period of the voltage input signal.

cos(φ) is measured directly as cosinus to the measured angle between current and voltage. Current and voltage signals are effectively filtered before cos(φ) is measured, so the measured angle is only affected by the fundamental frequency.

Reactive power is measured on basis of sin(φ) measurement, phase to phase voltage and generator current.

sin(φ) is only measured for phase 1 and the total reactive power is therefore measured as 3 times the reactive power measured in phase 1. This implies that reactive power can only be measured correctly in 3-phase networks.

$$Q = \sqrt{3} \bullet U_{RMS} \bullet I_{RMS} \bullet \sin\varphi$$

When measuring on 1-phase networks the reactive power measurement will not be present on the display or as output value.

Errors and changes excepted