A2000
Multifunctional Power Meter

- Measurement of current, voltage, active, reactive and apparent power, power factor, active and reactive energy, harmonic distortion and harmonics

- Precision measured values with error limits of greater than 0.25% for U and I

- Depending upon model, capable of communications with Profibus-DP, LONWORKS interface or RS 485 interface with Modbus RTU and other protocols

- Front panel dimensions: 144 x 144 mm

- Minimal installation depth of less than 60 mm

- Good legibility thanks to the high contrast, 14 mm LED display

- Continuous recording of selected measured values for load profile and statistical purposes (optional)

- Interference recording function with high speed recording of events and pre-event history (optional)

- Electrically isolated current inputs

- Two limit value contacts which can be assigned as desired to measured values

QUALITY MANAGEMENT SYSTEM

DQS Certified per
DIN EN ISO 9001 Reg.-No.1262

Applications

The measuring instrument is used for the analysis of alternating current systems, in particular where conventional analog measuring instruments included in distribution systems no longer fulfill continuously growing demands. This is especially applicable where harmonic distortion and harmonics are crucial in addition to current, voltage and power.

As a further range of applications, the meter is also capable of eliminating combined use of measuring instruments which are operated simultaneously along with conventional recorders and fault indicators. In combination with current and voltage transformers, the instrument performs the most important measurements required in low and medium-voltage systems.

Analog outputs, limit values and interfaces are available for the monitoring and processing of measured values. A time curve is simultaneously recorded for up to 12 measured values if the instrument version with integrated memory is utilized. Important measured values can be monitored continuously over a long period of time, or recording can be triggered for a specified duration by an event. In the case of event controlled recording, it is also possible to record the pre-history which lead up to the event at the same speed. This provides the user with a comprehensive overview of the pre-history which has resulted in an error. The instrument thus fulfills the function of a fault recorder significantly better than conventional paper chart recorders.

Applicable Regulations and Standards

IEC/EN 61010-1 / VDE 0411 Part 1	Safety requirements for electrical equipment for measurement, control and laboratory use
DIN 43864	Current interface for pulse transmission between impulse meters and tariff devices (for pulse output)
IEC/EN 61326-1	Electrical equipment for measurement, control and laboratory use, EMC requirements, interference emission
IEC/EN 61326 / A1	Electrical equipment for measurement, control and laboratory use, EMC requirements, interference immunity
IEC/EN 60529/VDE 0470 Part 1	Protection provided by enclosures (IP code)

Function and Operational Principle

The measuring instrument acquires instantaneous values for star-connected voltages and currents at three-phase electrical systems. If no neutral is available, the instrument automatically creates a virtual neutral point. The speed at which measured values are logged depends upon the respective line frequency. Each measured value is updated 32 times per period, which allows for the acquirement of measuring signals of up to the 15th harmonic.

After these values have been stored to memory, analysis and calculation of data such as delta and star-connected currents and voltages begin, as well as the determination of parameters for power, power factor, energy, harmonic distortion and harmonics. The values are calculated in accordance with DIN 40110 Part 1 and 2.

All calculated values are available to the display, the serial interface, the analog outputs and the limit value monitoring system.

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Data Storage

Up to 12 measured values can be selected for storage to memory. The measuring instrument acquires these measured values once every 300 ms and stores them first to intermediate memory. These values are then averaged in accordance with the selected sampling rate and are stored to permanent memory as mean values. The sampling rate is adjustable from 300 ms to max. 30 minutes. Recording is triggered by means of internally selected limit values. The duration of the recording can be set within a range of 1 minute to 4 days. Several events can thus be stored to memory, one after the other. The trigger level which starts the recording can be set to either 0%, 25%, 50% or 75% for the duration of any given recording. This provides the user with an overview of the pre-history of the event which triggered recording, including time and date.

Continuous recording is also possible.

The memory has a capacity for up to 63,000 values. The maximum possible duration of a recording depends upon the number of recorded measured values (1 to 12), and the sampling rate at which they are to be recorded (0.3 s to 30 min).
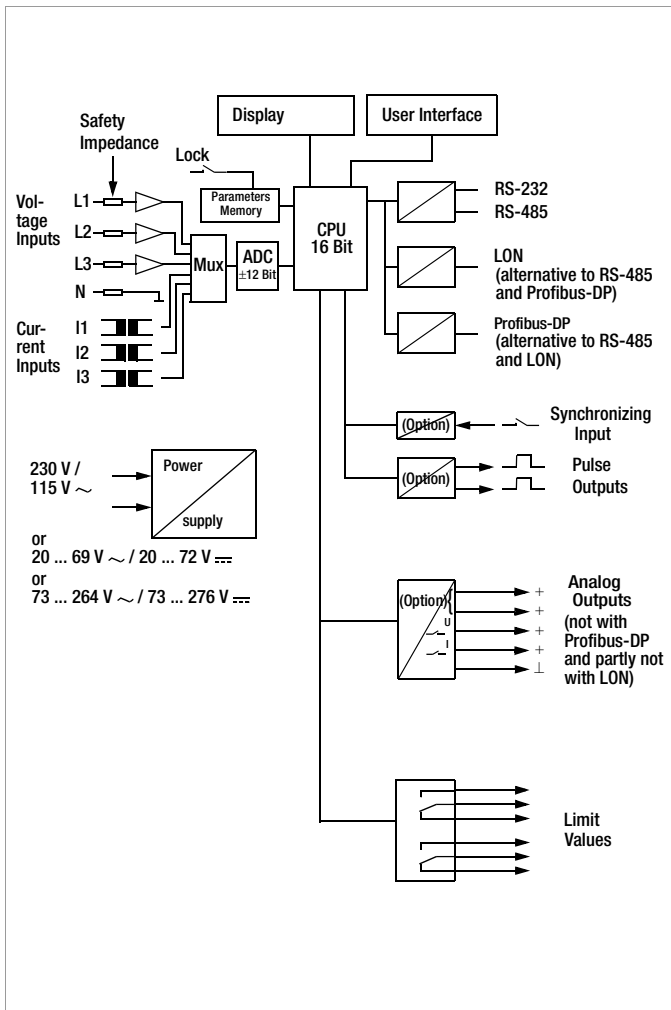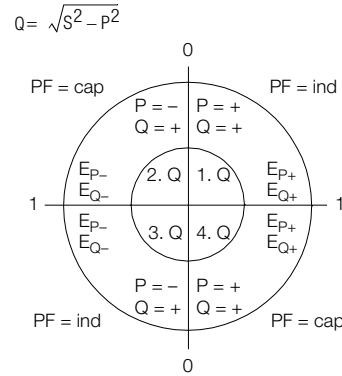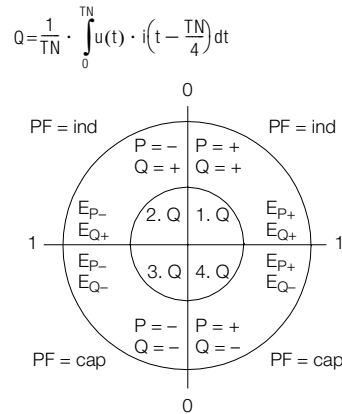

Figure 1 Schematic Diagram

Representation of Values for Power and Power Factor According to the Selected Parameters Configuration

$d \iota n$ = calculation of reactive power per DIN 40110 without + or − sign

$$Q = \sqrt{S^2 - P^2}$$

$S \iota G n$ = calculation of reactive power with + or − sign

$$Q = \frac{1}{TN} \cdot \int_0^{TN} u(t) \cdot i\left(t - \frac{TN}{4}\right) dt$$

$c o \Pi P$ = compensating reactive power (reactive power is only produced if current and voltage have different + or – signs)

$$Q = -\frac{2}{TN} \cdot \int_0^{TN} u(t) \cdot i(t) dt$$
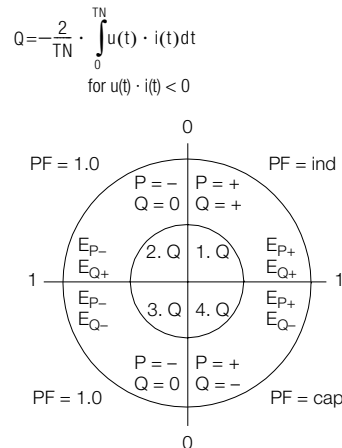
for $u(t) \cdot i(t) < 0$

Figure 2 Values for Power and Power Factor

Energy Display

The instrument is equipped with eight energy meters for the display of energy values. The following energy values appear at these displays upon shipment from the factory:

– Active energy for phases 1, 2 and 3,
  as well as for the overall system

– Reactive energy for phases 1, 2 and 3,
  as well as for the overall system

The meters can be reconfigured to display the following energy values during instrument configuration:

Active energy,	high tariff,	import for the overall system
Active energy,	low tariff,	import for the overall system
Active energy,	high tariff,	export for the overall system
Active energy,	low tariff,	export for the overall system
Reactive energy,	high tariff,	import for the overall system
Reactive energy,	low tariff,	import for the overall system
Reactive energy,	high tariff,	export for the overall system
Reactive energy,	low tariff,	export for the overall system

Switching from high to low tariff can be accomplished either by means of the synchronization input, an external contact or the data logger's internal clock (only possible if the instrument version with data logger is utilized).

Serial Interface

As standard equipment, the measuring instrument is provided with an RS 232 and an RS 485 interface. Both interfaces use the same protocol, which can be selected as desired.

The GMC device bus per DIN draft 19244, protocol per EN 60870 and Modbus RTU are available. A baud rate or 1200, 2400, 4800, 9600 or 19,200 can be selected. The address can be set within a range of 0 to 254, and parity can be set to even, odd, none or space.

Several measured values are always transmitted with one data word, allowing for especially fast transmission.

In the versions with LONWORKS interface the serial interface RS 485 has been dimensioned for the LONWORKS interface. No additional settings are required for LON.

In the versions with Profibus DP the serial interface RS 485 has been dimensioned for the Profibus DP. The selected address is valid for the RS 232, as well as for the Profibus DP. Addresses greater than or equal to 126 are interpreted as Profibus address 126, and can thus be used to allow for the assignment of an address to the instrument via the Profibus.

The selected baud rate only applies to the RS 232 interface for these instrument versions. The master determines transmission speed for the Profibus. The A2000 can be operated at the Profibus DP at transmission speeds of up to 12 mega-baud.

LONWORKS Interface

The power meters can be alternatively equipped with a LON interface. In this case, the LONWORKS interface replaces the RS 485. The RS 232 interface is still used for configuring parameters and for reading out the contents of the data memory. The optional data logger can be used with these instrument versions as well, in which case the read-out of recorded data is accomplished via the RS 232 interface.

Profibus DP

In the Profibus DP version the serial interface is used only for the Profibus. All measurement data, except for values stored to the data logger, can be read out via the bus link. Transmission speeds of up to 12 mega-baud are possible. The standard Profibus 9-pin plug is used to connect these measuring instruments to the Profibus DP.

Programming

The instrument can be programmed either with the keys at the front panel or via serial interface. All selected values remain in memory, even if mains failure should occur.

All programmed parameters, except for the limit values, can be protected against inadvertent change with a switch (*LOCK*) at the instrument's rear panel.

This assures that the instrument configuration is not changed during limit value selection.

Alternatively, the LOCK switch can be programmed to protect all parameters, including the limit values, against unauthorized modification.

The following values can be set during programming:

Type of Electrical System

4-wire unbalanced load or
3-wire unbalanced load or
3-wire balanced load

The energy meters can be configured to display active and reactive energy for phases L1, L2 and L3, as well as for the overall system, or active and reactive energy for the overall system subdivided into energy import and export, and high and low tariff.

Inputs

Secondary Transformer Current	5 A or 1 A	
Primary Transformer Current	1 A	
	5 A to 5000 A in	5 A steps
	to 50000 A in	50 A steps
	to 150000 A in	500 A steps
Secondary Transformer Voltage	From 100 V to 500 V in 1 V steps	
Primary Transformer Voltage	From 100 V to 100 kV in 100 V steps to 750 kV in 1 kV steps	
Time Period for Mean Power Values	External via synchronizing input or internally adjustable from 1 to 60 minutes	
Synchronizing Input	External, or operation with internal mean value generation, adjustable from 1 to 60 minutes	
Synchronizing Input Function	Synchronization of mean values, tariff switching or external control of the limit values relays	

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Outputs

Limit Value Monitoring	– Monitored measured values (sources) – Min-max characteristics – Hysteresis – Alarm message storage, on/off – Limit value
2 or 4 Analog Outputs	– Measured values which influence the analog outputs – Output range 4 ... 20 mA, 0 ... 20 mA, ± 20 mA, 0 ... 10 V, 2 ... 10 V or ± 10 V – Analog range with lower and upper rang values (independent of measuring range)
Pulse Outputs for Active or Reactive Energy	– Export, Import – Overall energy or energy from the individual phase conductors – Active or reactive energy – Pulse rate: 1 ... 1000 pulses per kWh in steps of 1 1000 ... 5000 pulses per kWh in steps of 10 The same pulse rates can be used for MWh as well.
Serial Interfaces	Either GMC device bus, EN 60870 or Modbus RTU protocol Attention: RS 232 and RS 485 use the same protocol. Addresses with values ranging from 0 to 254 Baud rate: 1200, 2400, 4800, 9600 or 19,200 Parity: even, odd, none or space

The measuring instrument is configured with the following parameters at the factory:

All parameters can be subsequently changed by the user.
The encoding switch for securing selected parameters against change is set at the factory to allow for parameter changes.

Type of Electrical System

Configuration	4-wire unbalanced (The energy meters display active and reactive energy for phases L1, L2 and L3, as well as for the overall system.)

Inputs

Current	second. transformer current 5 A primary current same as secondary (= ratio 1:1)
Voltage	secondary phase conductor voltage at the transformer 500 V primary phase conductor voltage same as secondary (= ratio 1:1)
Synchronizing Pulse	internal, mean value over 15 min.

Outputs

Limit Value 1	Measured value:	I_{L1}
	set to:	5 A
	No hysteresis	
	Relay closes when exceeded	
	No storage of alarm messages	
Limit Value 2	Measured value:	U_{L1}
	set to:	240 V
	No hysteresis	
	Relay closes when exceeded	
	No storage of alarm messages	
Analog Output 1	Meas. value:	Overall active power
	Range:	Import 0 ... 2000 W
	Output Value:	4 ... 20 mA
Analog Output 2	Meas. value:	Overall reactive power
	Range:	Import 0 ... 1000 Var
	Output Value:	4 ... 20 mA
Analog Output 3 (optional)	Meas. value:	I_{L2}
	Range	0 ... 5 A
	Output Value:	4 ... 20 mA
Analog Output 4 (optional)	Meas. value:	U_{L2}
	Range:	0 ... 250 V
	Output Value:	4 ... 20 mA
Pulse Output 1 (optional)	Meas. value:	overall system Active Energy Import 10 pulses per kWh
Pulse Output 2 (optional)	Meas. value:	overall system Active Energy Export 10 pulses per kWh

Serial Interfaces

Address	250
Baud Rate	9600
Protocol	GMC device bus
Parity	even

Characteristic Values

Display

Type	7 segment LED
Display Color	red
Character Height	13.2 mm
Display Range	max. 9999
Energy	max. 999999999

Input

Voltage Measurement	
Conductor – Conductor	0 ... 500 ... 550 V, 40 ... 70 Hz
Conductor – N (Earth)	0 ... 290 ... 320 V, 40 ... 70 Hz
Overload	1.2-fold
Input Impedance	> 4 MΩ
Current Measurement	0 ... 1 ... 1.2 A
	0 ... 5 ... 6 A
Overload	1.4-fold permanent
	30 A / 10 s
	100 A / 3 s
Internal Consumption	< 150 mW
Measurement	32 samples per period and measured values with mean value generation over 16 periods
	4 quadrant operation
Measurement Value Display	The selected parameters for current and voltage transformers are taken into consideration for displayed measured values.
Meas. Error of	
Current and Voltage	± 0.25% of nom. value ± 1 digit
Power	± 0.5% of nom. value ± 1 digit
Power Factor	± 0.02 for U and I > 10% of nom. value
Frequency	± 0.02 Hz
Energy	± 0.5% with nom. values for current and voltage
Synchronization Pulse	The synchronizing input recognizes floating contact. ON: < 10 Ω, OFF: > 10 MΩ

Outputs

Relays	One changeover contact per limit value
Switching Capacity	∼ / ⎓ 250 V, 2 A
	500 VA / 50 W (nominal load)
Service Life	> 500000 switching cycles
Hysteresis	Adjustable for each relay from ± 0 to ± 100 digits
Analog Outputs	
Range and Values	Measured values can be freely selected for analog outputs and read-out

Output Quantity	Configurable	
	current	0 / 4 ... 20 mA / ± 20 mA
	voltage	0 / 2 ... 10 V / ± 10 V
Output Load, Current	max. 500 Ω	
Output Load, Voltage	< 20 mA	
Resolution	0.1% of control range, or in accordance with resolution for ranges of less than 1000 digits	
Error Limits	± 0.5% of nom. value with current	
	± 1.0% of nom. value with voltage	
Load Impedance Effect		
for Voltage	no effect to > 10 KΩ	
for Current	< 0.8 µA / Ω (0 ... 250 ... 500 Ω)	
Pulse Output		
Contact	open emitter	
Current	ON 10 mA ... 27 mA	
	OFF < 2 mA	
External Voltage	8 ... 30 V	
Pulse Duration	100 ms	
Interpulse Period	min. 10 ms	
Error Limits	± 0.5% with nom. values for current and voltage (= max. power)	
Interfaces	RS 232 and RS 485 alternative: RS 232 and LON or RS 232 and Profibus-DP	
Protocols for RS 232 and RS 485	adjustable: GMC device bus (DIN Draft 19244), EN 60870 or Modbus (RTU)	

Power Supply

Supply Voltage	230 V / 115 V ∼ ± 10% 45 ... 65 Hz
	20 V ... 69 V ∼ 45 ... 450 Hz
	20 V ... 72 V ⎓ or
	73 V ... 264 V ∼ 45 ... 450 Hz
	73 V ... 276 V ⎓
Power Consumption	max. 15 VA

The instrument is not equipped with an integrated circuit breaker. Therefore, during installation, care should be taken to ensure that
– the building where the instrument is installed includes a circuit breaker,
– the circuit breaker is positioned in close proximity to the instrument and is easily accessible to the operator,
– it is clearly marked as a circuit breaking device for the instrument.

Mechanical Design

Dimensions	144 x 144 x 67.1 mm
Panel Cutout	138 [+1] x 138 [+1] mm
Installation Depth	max. 59.5 mm
Protection	front panel IP 54 rear panel IP 20
Protection Class	II

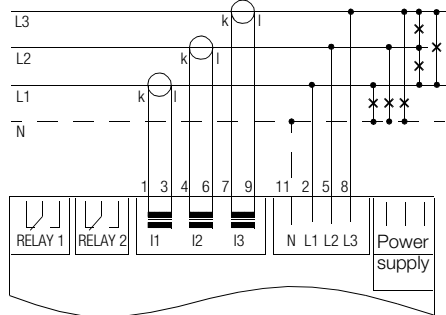See dimensional drawing on page 7.

A2000
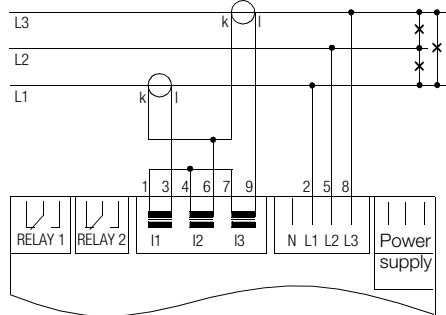# Multifunctional Power Meter
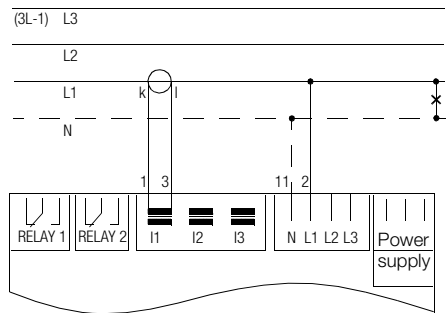
Terminal Assignments

Current Inputs

Connection with 3 Current Transformers
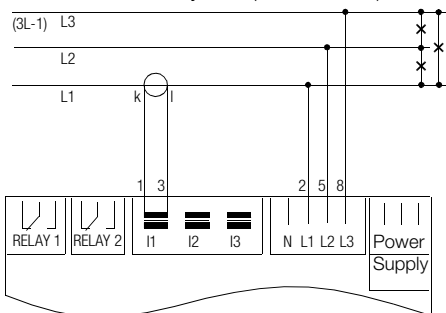in 3 or 4-Phase Mains System (4L)

Connection with 2 Current Transformers
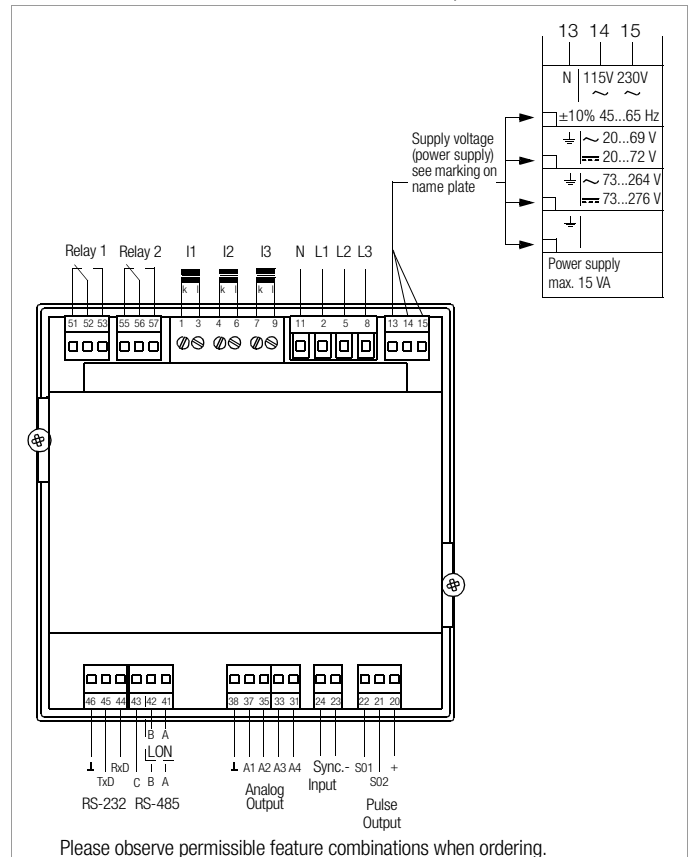in 3-Phase Mains System (3L)

Connection with 1 Current Transformer
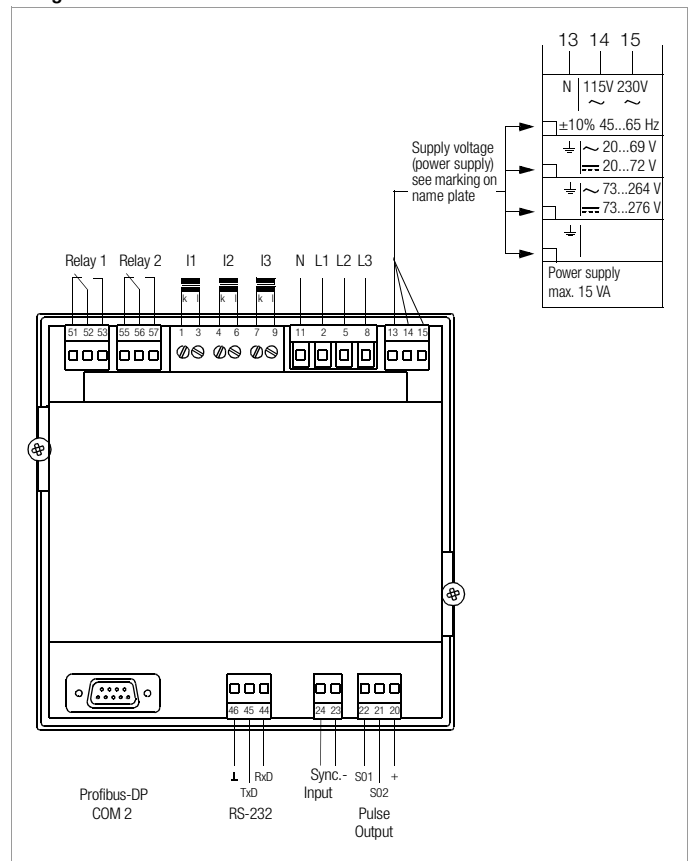in 4-Phase Mains System (identical load, $I_N = 0$)

Connection with 1 Current Transformer
in 3-Phase Mains System (identical load)

Variants with RS 232 and RS 485 Serial Interface, or with LON and RS 232
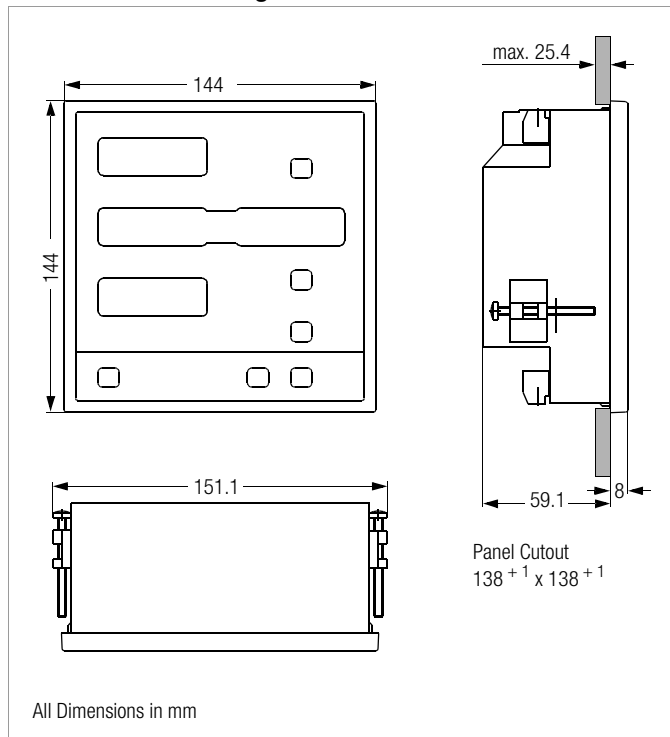

Please observe permissible feature combinations when ordering.

Design with Profibus-DP and RS-232 Serial Interface

Dimensional Drawing

All Dimensions in mm

Panel Cutout
138 $^{+1}$ x 138 $^{+1}$

Standard Equipment

**Power meters without data memory
(without optional data logger):**
Measuring instruments without data logger are shipped with operating instructions in either German, English or French.

**Power meters with data memory
(with optional data logger):**
In addition to the measuring instrument and operating instructions, in either German, English or French, power meters with data logger also include a floppy disk with METRAwin®10/A2000 software and an adapter with a subminiature plug (for connection to a PC via extension cable).

Accessory Software

METRAwin®10/A2000
Software for read-out and processing of measured values as they occur, or values from the data logger in the A2000 multifunctional power meter, and for configuring parameters at the A200.
This software runs under Windows 95/98/ME, Windows NT and 2000.

- Read-out of measured values
  from the power meter's data logger
- Continuous recording of measured values
  over a given period of time
- Display of measured values
  – as a function of time in line recorder format,
  – in tabular form,
  – digitally as individual values or
  – analog or as bar graphs
- Freely selectable time intervals
- Identification of curves for the recognition of individual measured value sequences
- Simple, clear parameters configuration for the A2000
- Parameters configurations
  for frequently recurring setups can be saved to memory
- Measured values can be exported
  to other Windows programs
- Mathematical functions

Software Description

Data Acquisition and Display
METRAwin®10/A2000 provides for an unambiguous display of the contents of the data memory from the A2000. Alternatively, measured values can be continuously queried from the measuring instrument by the software, and stored to a data file.

METRAwin®10/A2000 summarizes values from the data logger or online recorded values in tabular form, and documents minimum and maximum values with date and time as well.

All measured values can be plainly represented as a function of time with a yt graph. The time scale can be expanded or contracted to allow for optimal representation. The cursor can be placed at the corresponding position within the time scale for precision readings.

Measured values can also be displayed digitally. Up to four measured values can be displayed at the monitor simultaneously in digital form.

Instrument Configuration with METRAwin®10/A2000
METRAwin®10/A2000 plainly displays all of the functions and possible settings included in the power meter in various windows. The desired parameter values are entered to the corresponding fields and are subsequently uploaded to the power meter.

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Order Information

Designation		Configuration Options Article Number / Feature		
A2000 Multifunctional Power Meter		A2000	A2000	A2000
Serial Interface	with RS-232 and RS-485	L0	–	–
	with LON and RS-232	–	L1	–
	with Profibus-DP and RS-232	–	–	L2
Analog Outputs	2 analog outputs	A0	A0	–
	4 analog outputs	A1 [1]	–	–
	without analog output	–	–	A2
Data Logger	without data logger	R0	R0	R0
	with data logger	R1 [1] [2]	R1 [1]	R1 [1]
Pulse Output / Synchronizing Input	without pulse output and without synchronizing input	P0	–	P0
	2 pulse outputs and 1 synchronizing input	P1	P1	P1
Supply Voltage	230 / 115 V $\sim$	H0	H0	H0
	20 … 69 V $\sim$ / 20 … 72 V $=$	H1	H1	H1
	73 … 264 V $\sim$ / 73 … 276 V $=$	H2	H2	H2
Manufacturer's Certificate / Test Report	without certificate	U0	U0	U0
	with certificate and test report	U1	U1	U1
Operating Instructions	German (standard)	W0	W0	W0
	English	W1	W1	W1
	French	W2	W2	W2

[1] only in combination with Feature P1

[2] only in combination with Feature A1

Accessories

Designation	Article Number
METRAwin®10/A2000 with adapter – software for the transmission of measured values and for instrument configuration	Z305A
Interface cable RS-232, approx. 2 m long	GTZ3241000R0001

Standard Units

The following measuring instruments can be shipped as standard units. Only the article number needs to be indicated.

Designation		Instrument and Features Combination	Article Number
A2000	with 230 V / 115 V $\sim$ supply voltage, with 2 analog outputs, with RS-232 and RS-485 interfaces, with operating instructions in German	A2000 H0 A0 P0 R0 L0 U0 W0	A2000-V001
A2000	with 230 V / 115 V $\sim$ supply voltage, with 4 analog outputs, with 2 pulse outputs and 1 synchronizing input, with RS-232 and RS-485 interfaces, with operating instructions in German	A2000 H0 A1 P1 R0 L0 U0 W0	A2000-V002
A2000	with 230 V / 115 V $\sim$ supply voltage, with 4 analog outputs, with 2 pulse outputs and 1 synchronizing input, with data logger, with RS-232 and RS-485 interfaces, with operating instructions in German	A2000 H0 A1 P1 R1 L0 U0 W0	A2000-V003
A2000	with 230 V / 115 V $\sim$ supply voltage, with 2 analog outputs, with 2 pulse outputs and 1 synchronizing input, with LON and RS-232 interfaces, with operating instructions in German	A2000 H0 A0 P1 R0 L1 U0 W0	A2000-V004
A2000	with 230 V / 115 V $\sim$ supply voltage, with 2 pulse outputs and 1 synchronizing input, with Profibus-DP and RS-232, with operating instructions in German	A2000 H0 A2 P1 R0 L2 U0 W0	A2000-V005

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