ROGOWSKI COIL

Introduction

What's it ?

Advantages / disadvantages

Rogowski coil VS standard CT

IME & ROGOWSKI COIL

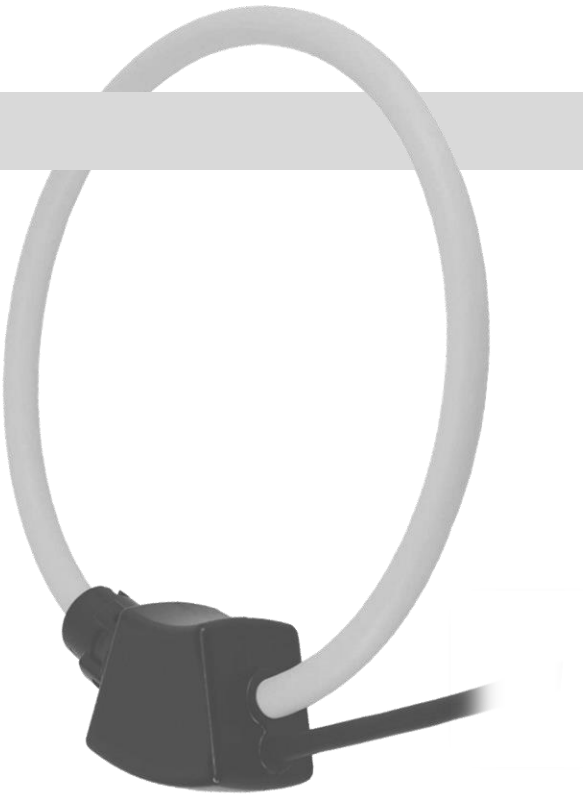
ROGOWSKI COIL

The ROGOWSKI COIL previously was only a 'laboratory curiosity, now it's a versatile measuring system with many applications throughout industry and in research

The ROGOWSKI COILS are special current transformers used to measure alternating currents and impulsive currents.

The denomination *ROGOWSKI* is named by Walter Rogowski (7 May 1881 – 10 March 1947), a German physicist of Polish origin who bridged the gap between theoretical physics and applied technology in numerous areas of electronics.

What’s it?



The

Rogowski coil

is a set composed by a coil and an accessory.

These instruments have been used from a lot of years for the detection and measurement of electric current.

They are based on a simple principle

the **FARADAY LAW**

A toroid coil without a magnetic core is placed around a current conductor; the variable magnetic field produced by the current induces a voltage at the terminals coil.

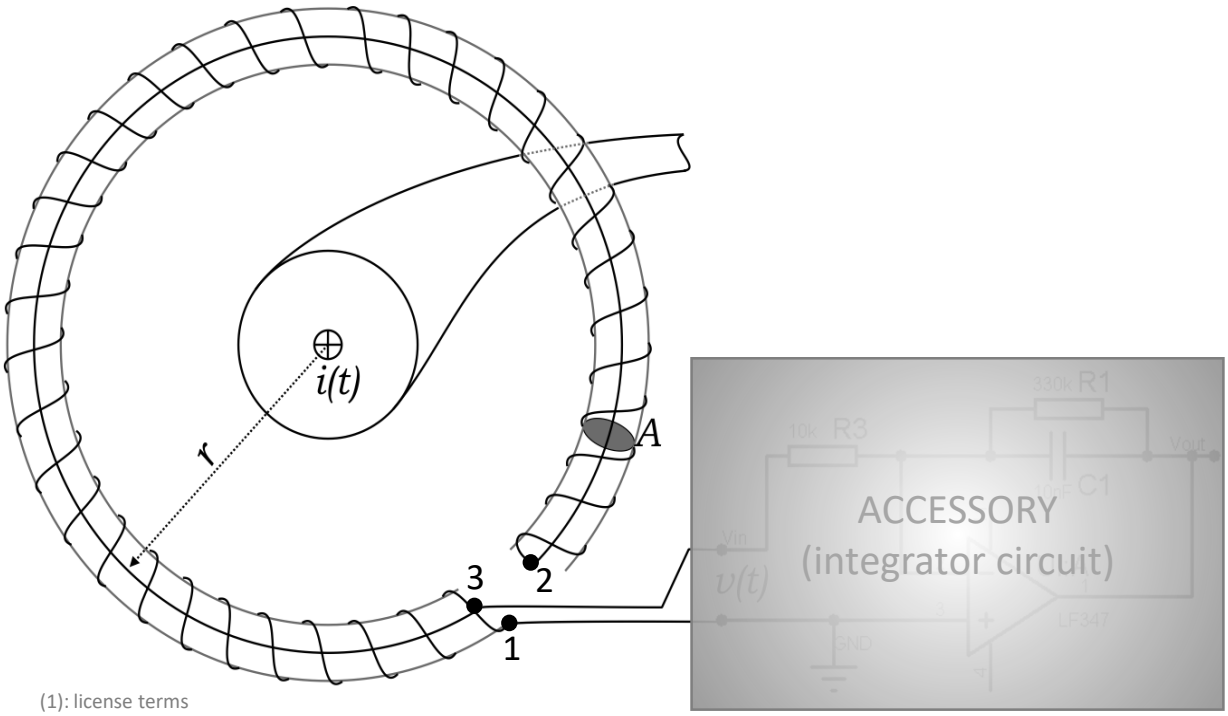
This voltage output is proportional to the variation of the current.

By an accessory (an integrator circuit) you can have the current value, as it’s proportional to the variation.

As the ROGOWSKI COIL functioning is based on Faraday's law of induction, the Rogowski coil works only in AC application.

What’s it?

It consists of a helical coil of wire (wound on a support) with one end (see point 1) returning (see the point 2) to the origin end (see point 3) through the center of the coil, so that both terminals are at the same part of the coil: in this way one end of the coil is available to be wrapped around the conductor whose current is to be measured.

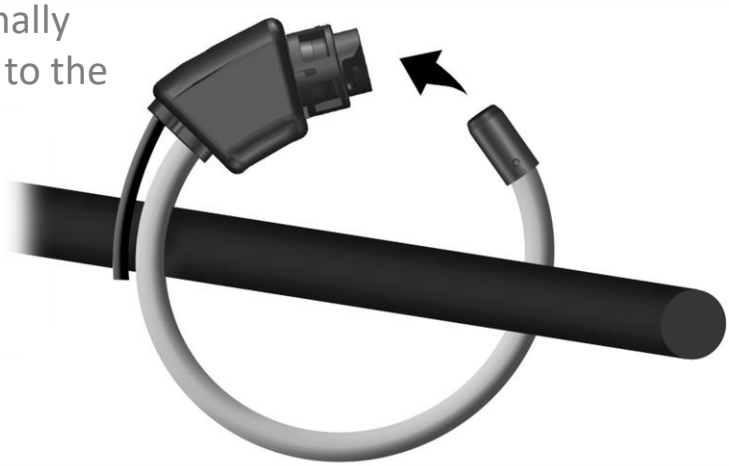


(1): license terms

As the induced voltage in the coil is proportional to the current variation (derivative) in the conductor, the output of the Rogowski coil is usually connected to an integrator circuit (electrical or electronic) providing an output signal that is proportional to the current.

What’s it?

The free end of the coil is normally plugged into a socket adjacent to the cable connection in a way that allows it to be unplugged: in this way the coil can be wrapped around the conductor carrying the current to be measured.



By accurate winding technologies, designed for these applications, the coils are produced so that the output value is little influenced by the position of the current conductor inside the toroid, but it’s good rule to center the conductor.

It is good practice to make the coil as small as possible within the electrical and physical limits of the equipment.

The winding and the coil cable must then be shielded.

A correct winding technique,
the density of the winding,
the diameter of the coil,
the rigidity of the winding
are fundamental to preserve the insensitivity to external fields (for example, generated by the near current conductors) and the low sensibility to the position of the measured conductor

Advantages ? Disadvantages?

Advantages

HANDY

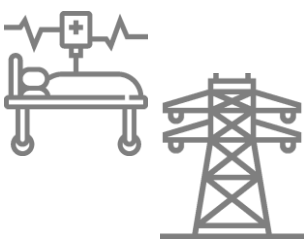
The coils are opened and flexible, so they can be wrapped around the bar or cable.

Easy & quick installation by a click.

You can install the Rogowski coil without long plant downtime: you can switch off the plant only for few minutes

Working time reduced, 1/6 less reduction of intervention time

You can operate where power disconnection isn't possible (hospitals, public lines,...): very short operating downtimes, only when really necessary



Advantages ? Disadvantages?

Advantages

COMPACT

Smaller overral dimensions and more lightweight than the standard CTs:

For high currents, standard CTs need a lot of windings to keep the output current constant. So a Rogowski coil is smaller than an equivalent standard CT

LINEARITY

The coil contains no saturable components and the output increases linearly in proportion to the current variation (derivative) till up to the operating limit determined by voltage breakdown:

it’s linear also for high current application, like soldering machine, electric power transmission.

Linearity makes Rogowski coils easy to calibrate because a transducer can be calibrated at any convenient current level and the calibration will be accurate for all currents including very large ones.

Advantages ? Disadvantages?

Advantages

LOW INDUCTANCE VALUE

It’s suitable in case of rapid current change (nanoseconds) due the low inductance value.

LOW VOLTAGE

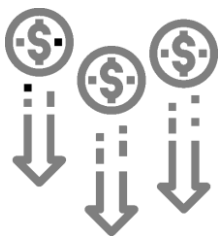
The output provide a LOW VOLTAGE level, so high operating freedom

No danger in case of open secondary.

ECONOMICAL

10% - 30% reduction of managing cost (purchasing, shipment, storage)

Low construction cost

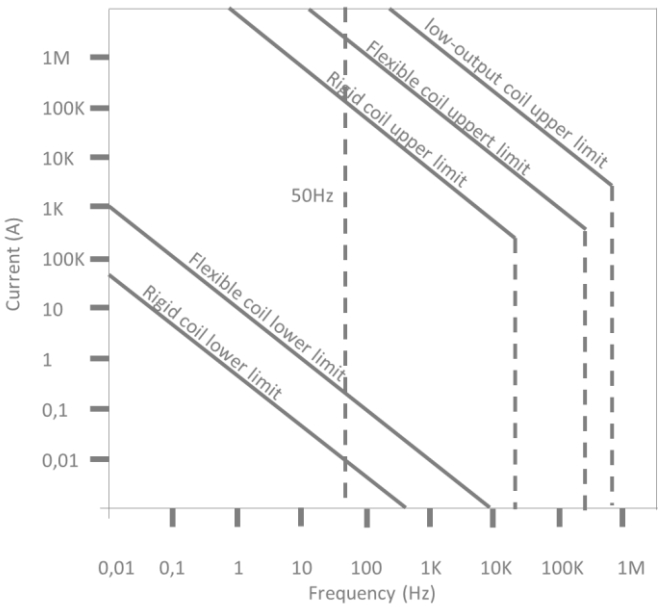


Advantages ? Disadvantages?

Disadvantages

FREQUENCY

Upper limits: The direct output from the coil depends on the rate of change of current. For sufficient high currents and frequencies the output can be large enough to cause a voltage breakdown. Coils with a low mutual inductance are best for high currents and frequencies.



Lower limits:
At low currents and low frequencies the direct output from the coil is very low and the usefulness of the current transducer is limited by the effects of noise. You can remedy this issue by winding the coil several times around the conductor or by special filters.

SENSITIVITY

Compared with current transformer, Rogowski coil has lower sensitivity due to lack of high permeability core.

ACCESSORY

Rogowski coil requires integrator circuit for current replication. This integrator circuit may decrease the resolution

Advantages ? Disadvantages?

Disadvantages

TEMPERATURE

The material's thermal expansion of the support on which the winding is wound can alters the inductance of the coil and the resistance change can influence the output.

If the coil is wound on:
→ **Rigid former:** the temperature effects are reasonably easy to predict and it is possible to study a system so that the expansion and resistance change balance each other.
→ **Flexible former:** the influence of temperature on the inductance is more complex:

for **small temperature** excursions the mutual inductance can change when the coil is hot but it will return to its original value when the coil is cold.

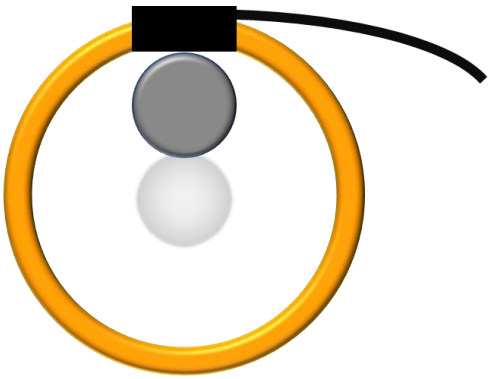
for **larger temperature** excursions the expansion of the material causes the elongation of the winding or of the central conductor. If the winding stretches, the mutual inductance increases with increasing temperature. If the centre conductor stretches, the mutual inductance reduces with increasing temperature.

In designing Rogowski coil measuring systems there is often a conflict between designing to achieve a low temperature coefficient and designing for a flat frequency response.

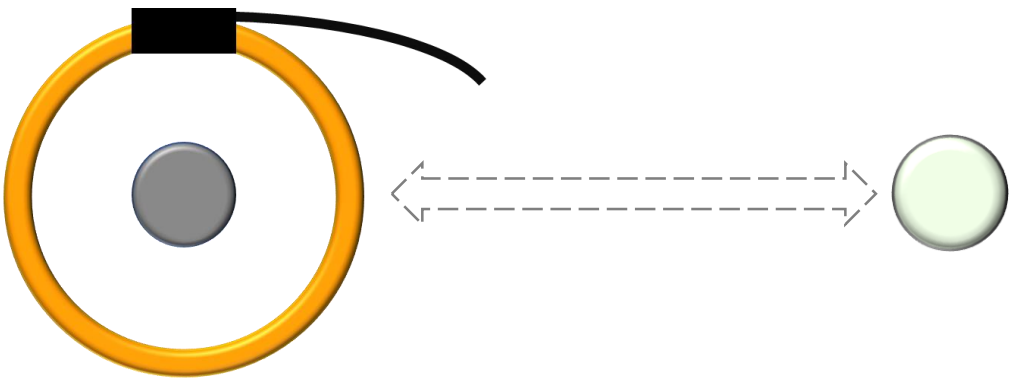
Optimizing performance

Center the cable in the coil window

Rogowski coil are usually calibrated with the conductor centered in the CT window, but in the practice often the CTs lean on the conductor which can introduce measurement errors. Moving the CT in different position you can reduce the errors.



Disturbance of other conductor



Compatibly with the available operating space and with retrofitting needs, good rule is keep any other conductors (those you do not wish to measure) as far away from the Rogowski coil

Rogowski coil VS standard CT

Construction logic

The ROGOWSKI COIL is a circular coil uniformly wound on non-ferrous magnetic material
→ no hysteresis effect, almost zero phase error;
→ no magnetic saturation phenomenon, so the measurement range can be from several amperes to hundreds of kiloamperes of current

A standard CURRENT TRANSFORMER is a device that converts the large current at the primary side into the small current at the secondary side according to the electromagnetic induction principle.

Rogowski coil VS standard CT

Architecture

The ROGOWSKI COIL has an easy architecture, without any direct connection with the measured current

A standard CURRENT TRANSFORMER is composed of a closed core and winding. The primary winding turns are very few, which are in series in the circuit of the current to be measured.

Application

The Rogowski coil are usefull in the power monitoring and power quality industry. The applications for power quality measurements range from monitoring office equipment to utility distribution equipment.

Due the handling features, the Rogowski coil are suggested in retrofitting application, and in the main electrical line.

Very used in short-circuit testing of electric generators and as sensors in protection systems of electrical plants.

Application

TIPS & PILLS

Highly disturbed line (switched load, inverter,…) could alter the declared performance of the device

Based on installation needs, centering and positioning are recommended

If you cannot disconnect the line the Rogowski coils is recommended : very short operating downtimes, few minutes only

If your installation needs compactness, lightness, handling, economy Rogowski are recommended

IME & ROGOWSKI COIL

…and IME can help you in the ROGOWSKI COIL world?

IME from many years have the ROGOWSKI KIT in the production range, composed by NEMO + COIL
The KIT are available in

NEMO 4module + ROGOWSKI COIL
(80MM – 142mm – 190mm)

NEMO 96X96 + ROGOWSKI COIL
(80MM – 142mm – 190mm)

The coils are directly connected to the meter, without any other transducer and they can measure up to 5kA.

A wide display showing the main measurement units, active / reactive energy in accuracy class 1 (IEC 61557-12),
the Total Harmonic Distortion up to 50th harmonic, crest factor

Communication RS485 Modbus RTU, pulse output, alarm are available

By a DATA LOGGER / ETHERNET INTERFACE and / or IME software WEBSERVER you can supervise your installation and record the consumption

IME & ROGOWSKI COIL

Connection via dedicated rogowski coils for single and three-phase network, 3 or 4-wires.
Phase sequence correction, diagnostic
It makes available active or reactive energy counting of the pulse output to integration of consumption supervision systems.
For supervision systems, through the model with output RS485 communication ModbusRTU, you can transmitted on the network main electrical parameters in addition to the energy consumption.
2 active digital inputs for tariff counting (4 registers) or external pulse counting.

Functions
- Neutral and phase current
- Phase and linked voltage
- Min. and max. phase voltage
- THDV
- Voltage Harmonic analysis
- Voltage crest factor
- Phase angle between voltage
- Neutral and phase current
- Current demand and current max. demand
- Average current
- THDI
- Current Harmonic analysis
- Current crest factor
- Phase angle between current
- Active, reactive phase power
- Power demand and power max. demand
- Positive and negative active and reactive energy
- Power factor
- Phase angle between current and voltage
- Frequency
- Run hour meter, count start with voltage or power present

Cat. Nos.	KIT Nemo D4-Le + 3 Rogowski coils			
	Input (A) /RC**	Input* (V)	Auxiliary supply	Output
KRNEMOD4LE080	from Rogowsky sensor Ø 80mm²	80…500	80...265Vac 100...300Vdc	Pulse or alarm + RS485 ModBus RTU/TCP
KRNEMOD4LE142	from Rogowsky sensor Ø 142mm	80…500	80...265Vac 100...300Vdc	Pulse or alarm + RS485 ModBus RTU/TCP
KRNEMOD4LE190	from Rogowsky sensor Ø 190mm	80…500	80...265Vac 100...300Vdc	Pulse or alarm + RS485 ModBus RTU/TCP

* Three-phase input 80…500V, Single -phase input 50…290V
** 3 current ranges that can be selected on each KIT: 20...1000A, 60...3000A, 100...5000A

Technical features

TECHNICAL NOTES	NT889
INPUT	
Three-phase voltage (V)	80...500 (phase-phase)
Single-phase voltage (V)	50...290V
Current rating	20...1000A, 60...3000A, 100...5000A
External VT ratio	primary voltage max 1200V
Reference frequency	50Hz
Frequency tolerance	45...65Hz (fn 50Hz)
Type of measurement	true RMS
Harmonic content	up to the 40th harmonics (45...65Hz)
Voltage rated burden (VA)	≤ 0,2VA (phase-neutral)
AUXILIARY SUPPLY	
Rated value Uaux	80...265Vac - 48Vac
Reference frequency	50 or 400Hz (automatic selection)
Frequency tolerance	45…65Hz (fn 50Hz) or 360...440Hz (fn 400Hz)
Rated burden	≤ 2,5VA (230Vac backlight 30%)
Rated value Uaux	100...300Vdc - 20...60Vdc
Rated burden	≤ 2,5W (24Vdc backlight 30%)
ACCURACY	
CONFORMITY ACCURACY WITH EN/IEC 61557-12	- Voltage: cl.0,5 - Current: cl. 0,5 - Active energy: cl.1 - Reactive energy cl.1 - Active power cl.1 - Reactive power cl.1 - Apparent power cl.1 - Frequence ± 0,1 Hz - THD (up to 40th harmonic) Harmonics single cl.1
DISPLAY	
Type of display	LCD backlighted
Digit height	5/7mm
Energy resolution	depending on the RC/VT ratio**
MECHANICAL FEATURES	
Housing	4 modules DIN 43880 (35mm)
Housing material	self-extinguishing policarbonate
Protection degree	IP20 terminals/ IP54 front frame
Connections type	screw terminals
Rigid cable	output - max 4mm² input - max 6mm²
Flexible cable	output - max 2,5mm² input - max 4mm²
ENVIRONMENTAL CONDITIONS	
Nominal temperature range	-5…55°C
Limit range for storage and transport	-25…70°C
Suitable for tropical climates	yes
Max.power dissipation*	≤5W

** kRCx kVT MAXIMUN DISPLAY
200...999 99999999kWh/kvarh
1000...9999 999999,99MWh/Mvarh
kRC = 200 for range 200...1000A
= 600 for range 600...3000A
= 1000 for range 100...5000A

Output

ENERGY PULSES S0 EN/IEC 62053-31	
Type	Optorelay with potential-free
Contact range	27 Vcc/ca-50mA
Assignable energy	Active or reactive energy
Pulse weight	selectable 10Wh/Varh...10MWh/MVarh
Pulse duration	selectable from 50 to 500ms
ALARM	
Type	Optorelay with potential-free
Contact range	27 Vcc/ca-50mA
Type alarm	min. or max
RS485 COMMUNICATION	
Protocol	MODBUS RTU/TCP
Standard	RS485-3-wire
Baud rate	selectable 4800…38400 bit/s

IME & ROGOWSKI COIL

Connection via dedicated Rogowski coils for single and three-phase network, 3 or 4-wires
Can be accessorised with an additional modules.
It makes available active or reactive energy counting of the pulse output to integration of consumption supervision systems.
For supervision systems, through the model with output RS485 communication ModbusRTU, you can transmitted on the network main electrical parameters in addition to the energy consumption.

Functions
- Phase and linked voltage
- Min. and max. phase voltage
- THDV
- Voltage Harmonic analysis
- Voltage crest factor
- Neutral and phase current
- Current demand and current max. demand
- Average current
- THDI
- Current Harmonic analysis
- Current crest factor
- Active, reactive phase power
- Power demand and power max. demand
- Positive and negative active and reactive energy
- Power factor
- Frequency
- Run hour meter, count start with voltage or power present

Cat. Nos.	KIT Nemo 96HDLe + 3 Rogowski coils			
	Input (A) /RC**	Input* (V)	Auxiliary supply	Output
KRNEMOHDLE080	from Rogowsky sensor Ø 80mm	80…500	80...265Vac 110...300Vdc	Pulse + RS485 ModBus RTU/TCP + 1 additional modules
KRNEMOHDLE142	from Rogowsky sensor Ø 142mm	80…500	80...265Vac 110...300Vdc	Pulse + RS485 ModBus RTU/TCP + 1 additional modules
KRNEMOHDLE190	from Rogowsky sensor Ø 190mm	80…500	80...265Vac 110...300Vdc	Pulse + RS485 ModBus RTU/TCP + 1 additional modules

* Three-phase input 80…500V, Single -phase input 50…290V
** 3 selectable current range: 20…1000A, 60…3000A, 100…5000A

Cat. Nos.	Additional modules
	Descriptions
IF96001	Module RS485 Modbus RTU/TCP
IF96012	Module RS485 Modbus RTU/TCP + memory
IF96002	Module RS232 Modbus RTU/TCP
IF96007A	Module Profibus EN50170 - DP0
IF96009	Module LonWorks
IF96013	Module M-Bus EN1434-3
IF96014	Module RS485 BACnet MS-TP
IF96015	Module Ethernet

Technical features

TECHNICAL NOTES	NT890
INPUT	
Three-phase voltage (V)	80...500 (phase-phase)
Single-phase voltage (V)	50...290V
Current rating	20...1000A, 60...3000A, 100...5000A
External VT ratio	primary voltage max 1200V
Continuous overload	1,2In
Istantaneous overload	20Imax/0,5s
Reference frequency	50Hz
Frequency tolerance	45...65Hz (fn 50Hz)
Type of measurement	true RMS
Harmonic content	up to the 50th harmonics
Voltage rated burden (VA)	≤ 0,1VA (phase-neutra)
Current rated burden (VA)	≤ 1VA (for phase)
AUXILIARY SUPPLY	
Rated value Uaux	80...265Vac
Reference frequency	50 or 400Hz (automatic selection)
Frequency tolerance	45…65Hz (fn 50Hz) or 360...440Hz (fn 400Hz)
Rated burden	≤ 2,5VA (230Vac backlight 30% without external modules)
Rated value Uaux	100...300Vdc
Rated burden	≤ 3,5W (without modules, 110Vdc)
ACCURACY	
CONFORMITY ACCURACY WITH EN/IEC 61557-12	- voltage: cl.0,5 - Current: cl. 0,5 - Active energy: cl.1 - Reactive energy cl.1 - Active power cl.0,5 - Reactive power cl.1 - Apparent power cl.1 - Frequence ± 0,1Hz - THD cl.1
DISPLAY	
Type of display	LCD backlighted
Digit height	8/12mm
Energy resolution	depending on the RC/VT ratio**
MECHANICAL FEATURES	
Housing	flush mounting (panel cutout 92x92mm)
Front frame	96x96mm
Housing material	self-extinguishing policarbonate
Protection degree	IP20 terminals/ IP54 front frame
Connections type	screw terminals
Rigid cable	max 4,5mm²
Flexible cable	max 2,5mm²
ENVIRONMENTAL CONDITIONS	
Nominal temperature range	-5…55°C
Limit range for storage and transport	-25…70°C
Suitable for tropical climates	yes
Max.power dissipation*	≤5W

* for switchboard thermal calculation
** kRCx kVT MAXIMUN DISPLAY
200...999 99999999kWh/kvarh
1000...9999 999999,99MWh/Mvarh
kRC = 200 for range 200...1000A
= 600 for range 600...3000A
= 1000 for range 100...5000A

Output

ENERGY PULSES S0 EN/IEC 62053-31	
Type	Optorelay with potential-free
Contact range	27 Vcc/ca-50mA
Assignable energy	Active or reactive energy
Pulse weight	selectable 10Wh/Varh...10MWh/MVarh
Pulse duration	selectable from 50 to 500ms
RS485 COMMUNICATION	
Protocol	MODBUS RTU/TCP
Standard	RS485-3-wire
Baud rate	selectable 4800…38400 bit/s
ADDITIONAL MODULES	
N. max installable module	1
Installation position	A

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