

# ENERGYMID

## EM2281/EM2289/EM2381/EM2387/EM2389

### Energy Meters

3-349-867-03  
6/10.20

- Professional energy meter for 2, 3 and 4-wire systems with 5(80) A direct connection or 1(6) A transformer connection (incl. 5(6) A)
- Accuracy class B for industrial and commercial use, as well as for household use with highly demanding requirements
- Cost savings thanks to initial calibration at the factory in accordance with MID, conformity assessment procedure modules B and D
- Configurable, multifunctional variants for acquiring reactive energy and mains quantities
- 4 quadrant measurement (import and export)
- Indicates installation errors: direction of phase rotation, phase failure, reversed transformer polarity, overload
- Universal pulse output (2-fold) with adjustable pulse rate and pulse duration, as well as selectable voltage range
- Communication via integrated interfaces: LON, M-Bus, Modbus RTU, TCP/IP (Modbus TCP, HTTP, BACnet)
- 4 tariffs (hardware-controlled as standard feature), plus 4 additional tariffs (software controlled) with bus (features W1 ... W7)
- Tamper-proof cover, configuration disabling
- Quality product made in Germany



Feature P9

LONWORKS®

M-Bus

ASHRAE BACnet\*

ETHERNET

Modbus

## Applications

The calibrated energy meter can be used to acquire and bill active energy in industrial, household, commercial and building management applications. Relevant values are transmitted to data logging, billing and optimizing systems, as well as to building automation and control technology applications, by means of a pulse output or via a bus interface. Installation itself is extremely simple because the meter detects connection errors, which are indicated immediately. Maximum convenience is assured by displaying active power, which provides immediate information regarding momentary circuit load. If you wish to have more ample information about mains parameters, you have the option of adjusting the functions flexibly to your measuring task.

## Applicable Regulations and Standards

DIN EN 50470-1 VDE 418-0-1	Electricity metering equipment (a.c.) Part 1: General requirements, tests and test conditions – Metering equipment – EMC requirements
DIN EN 50470-3 VDE 418-0-3	Part 3: Particular requirements – Static meters for active energy (class indexes A, B and C)
DIN EN 60529 VDE 0470-1	Test instruments and test procedures – Degrees of protection provided by enclosures (IP code)
DIN 43856	Integrating meters, tariff time-switches and ripple control receivers
DIN EN 62053-31 VDE 0418-3-31	Pulse output devices for electromechanical or electronic meters
DIN EN 62053-23	Electricity metering equipment (a.c.) – Particular require- ments, Part 23: Static meters for reactive energy (classes 2 and 3)

## Multifunctional Variant

Depending on the type of multifunctional variant, the meter is also capable of acquiring reactive power and indicating up to 33 additional measured quantities directly on the display.

As a result, voltage level, utilization of individual phases, reactive power component and the functioning of compensation systems can be evaluated at any time by simply pressing a button without any additional measuring equipment. Refer to the table below for details.

Measuring Function		Accuracy (ref. cond.)	Display (Feature)			
Measured Quantity			M0	M1	M2 <sup>2</sup>	M3 <sup>2</sup>
Active energy (kWh) <sup>1</sup>	EP1 ... EP8, EPtot	±1%	•	•	•	•
Reactive energy (kVarh) <sup>1</sup>	EQtot	±2%	—	—	•	•
Star voltage (V)	U1 <sub>N</sub> , U2 <sub>N</sub> , U3 <sub>N</sub>	0.5% ±1 d	—	•	—	•
Delta voltage (V)	U12, U23, U13	0.5% ±1 d	—	•	—	•
Current per phase (A)	I1, I2, I3	0.5% ±1 d	—	•	—	•
N cond. current (A)	I <sub>N</sub> <sup>3</sup>	1% ±1 d, typ.	—	•	—	•
Active power (kW)	P1, P2, P3, Ptot	1% ±1 d	—	•	—	•
Reactive energy (kVar)	Q1, Q2, Q3, Qtot	1% ±1 d	—	•	—	•
Apparent power (kVA)	S1, S2, S3, Stot	1% ±1 d	—	•	—	•
Power factor (cos phi)	PF1, PF2, PF3, PFtot	1% ±1 d	—	•	—	•
Frequency (Hz)	f	0.05% ±1 d	—	•	—	•
RMS distortion	THD U1, U2, U3		—	•	—	•
	THD I1, I2, I3		—	•	—	•

<sup>1</sup> Total power (kW/kVar) appears in auxiliary display 2 with sign.

<sup>2</sup> Not approved for billing purposes in Switzerland

<sup>3</sup> The greatest current value per phase is used as a reference value for accuracy.

\* Source: ASHRAE – bacnet.org

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## EM2281/EM2289/EM2381/EM2387/EM2389

### Energy Meters

#### Technical Data

##### Measuring Ranges

Voltage		
See order information	100 V ... 500 V	
Allowable deviation	+ 15% / - 20%	
Current		
	Direct Measurement	Transformer
$I_{ref}$	5 A	1 A
Starting current	20 mA	2 mA
$I_{min}$	0.1 A	0.01 A
$I_{max}$	80 A	6 A
Frequency Range		
Nominal frequency	50 Hz	
Cutoff frequency	45 Hz ... 65 Hz	
Accuracy		
Active energy	Class B per DIN EN 50470-3	
Reactive energy	Class 2 per DIN EN 62053-23	

Sampling rate 32 per period, continuous

##### LCD

Type 7-segment characters,  
main display: max. 8-place, height: 5.6 mm,  
auxiliary displays 8-place, height: 5 mm

Display range 0 ... 99999999 digits

Refresh rate Approx. 6/s

Rotation / phase Blinks in case of error

Error Message Error display with background illumination flashing red

**Main display**  
(active energy\* in kWh or MWh)  
(M2/M3: reactive energy\* in kVarh or MVarh)

**Auxiliary display 1** (active power\* in kW or MW)  
(M2/M3: reactive energy or power  
in kVar(h) oder MVar(h)\*)

**Auxiliary display 2**  
(e.g. IN, OUT for import or export)

In case of error: error code alternates with current display

\* EM238x transformer meter: CT and VT are taken into account  
Power: negative sign for export

##### Power Supply

<b>Internal power supply</b>	From measuring voltage: 80 to 115% Ur
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Meter parameters and meter readings are retained by an EEPROM in the event of power failure.

##### Power Consumption

<b>Voltage path, total including supply:</b> < 2 VA	
Per current path	
At $I_{max}$	< 1 VA (direct) < 0.2 VA (transformer)
At $I_{ref}$	< 0.02 VA (direct) < 0.005 VA (transformer)

##### Electrical Safety

Protection class	II per DIN EN 50470
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Nominal insulation voltage	
Inputs	AC 300 V
Output	Features V0, V1, V2, V7, V8, V9: DC 50 V (Bus/S0) Features V3, V4: AC 230 V (pulse)

Insulation test voltage	
Input ↔ output / housing	AC 4 kV
Output ↔ housing	Features V0, V1, V2, V7, V8, V9: 500 V (Bus/S0) Features V3, V4: 4 kV (pulse)

##### Overload Capacity

All meters	Continuous 1.15 $U_r$ and $I_{max}$
Direct connection	5 times 3 s: $U_r$ and 100 A (interval: 5 min.)
Direct connection	1 times 1 s: $U_r$ and 250 A, 10 ms 2400 A
Transformer connection	0.5 s: 20 x $I_{max}$

##### EMC

Electromagnetic compatibility per DIN EN 50470-1	
Surge voltage	6 kV, 1.2/50 $\mu$ s 10+/10- surges
Electrostatic discharge	15 kV (DIN EN 61000-4-2)
Electromagnetic fields	30 V / m (DIN EN 61000-4-3) open-circuit
	10 V / m (DIN EN 61000-4-3) under load
Burst	4 kV/2 kV (DIN EN 61000-4-4)
Conducted interference	10 V (DIN EN 61000-4-6)
Magnetic field and line frequency	0.5 mT (DIN EN 61000-4-8)
Voltage dips	(DIN EN 61000-4-11)
Interference emission	EN 55022 class B

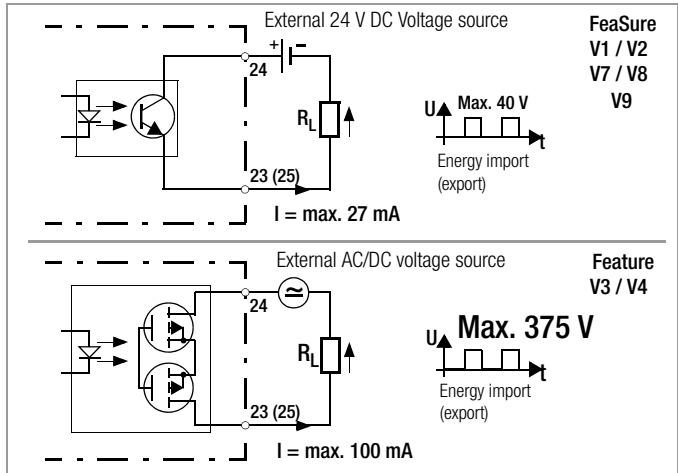
##### Pulse output

By default, the energy meters are equipped with two pulse or one bus output as standard equipment (see below). The pulse outputs are electrically isolated from the measuring circuit by means of an optocoupler.

##### Electrical Values

Pulse generator constants	With direct connection: 1000 pulses per kWh (adjustable with V2/V4) With transformer connection: 1000 pulses per kWh (adjustable with V2/V4)
Pulse Duration	30 ms (adjustable up to 3 s with feature V2, V4)
Interpulse period	> 30 ms
$U_{ext}$	Max. 40 V (375 V with feature V3, V4)
Switching current	Max. 27 mA (100 mA with feature V3, V4)

##### Connection



Type of energy can also be selected with feature V2/V4  
The standard setting is active energy import (23) / export (25).

##### Interfaces

A complete description of the interfaces can be found on the Internet at [www.gossenmetrawatt.com](http://www.gossenmetrawatt.com).

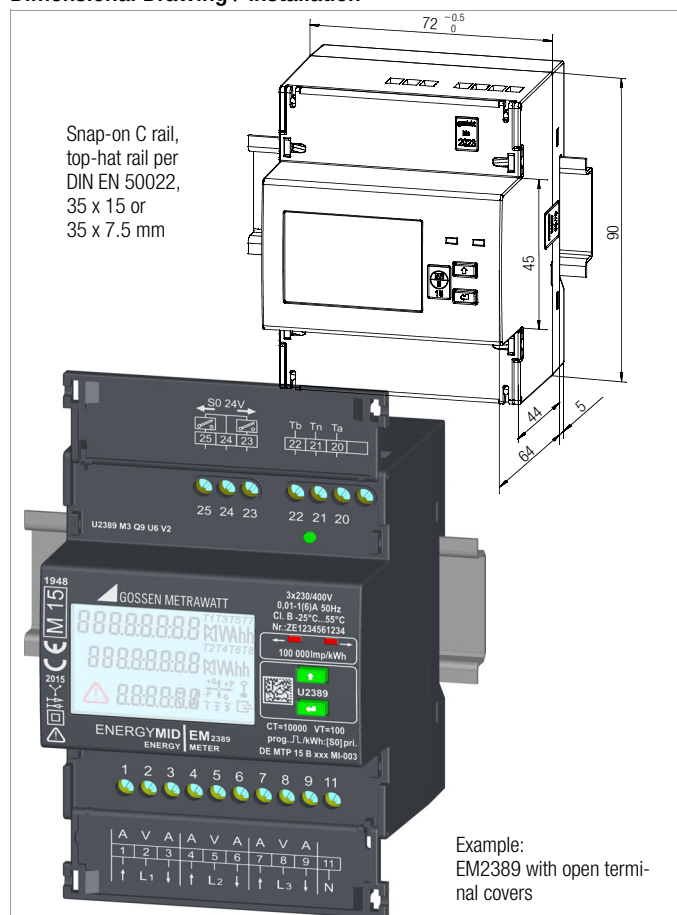
#### Ambient Conditions

Operating temperature range	-25 ... +55 °C
Storage temperature range	-25 ... +70 °C
Relative humidity	< 75% annual average
Elevation	to 2000 m
Deployment	Indoors
mechanical classification	M1
elektromagnetical classification	E2

#### Mechanical Data

Housing		
Material	Lexan polycarbonate per UL94 V0	
Dimensions	Height ≤ 90 mm	
	Overall depth ≤ 70 mm	
	Width 72 <sup>-0.5</sup> mm (4 standard width units)	
Weight	< 0.3 kg	
Mounting	Snap-on C rail, Top-hat rail per DIN EN 50022 or wall mounting	
Protection (built-in device)	front panel: IP 51	
Connections (terminal block)		
	<b>Direct</b>	<b>Transformer</b>
Current input	Solid wire ≤ 16 sq. mm Fine wire ≤ 25 sq. mm or ≤ 16 mm <sup>2</sup> with wire end ferrule	Solid wire ≤ 4 sq. mm
Voltage input	N: solid wire ≤ 2.5 sq. mm	Solid wire ≤ 4 sq. mm
SO pulse output, bus output, tariff input (power utility pulse)	Solid wire ≤ 2.5 sq. mm	Solid wire ≤ 2.5 sq. mm
Protection	IP 20 (protection against ingress of foreign objects ≥ 12.5 mm diameter, no protection against penetration by water)	

#### Dimensional Drawing / Installation

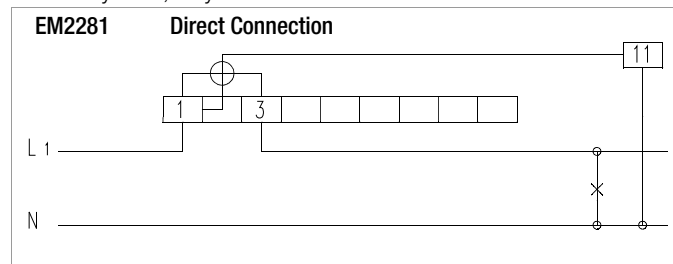


#### Connector Pin Assignments

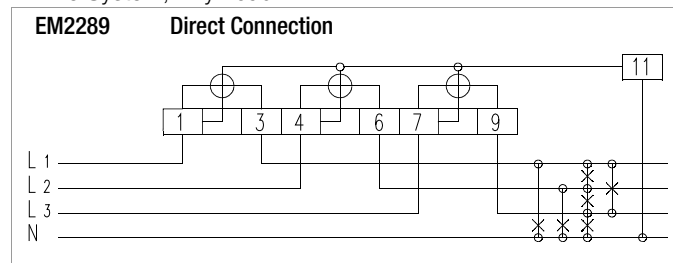
Self-locking screw terminals are utilized and are protected with a tamper-proof terminal cover as a standard feature.

#### Circuit Diagrams

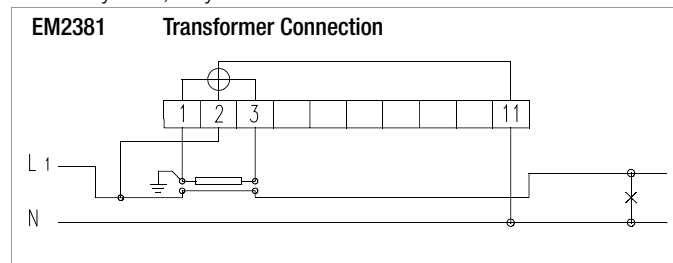
##### 2-Wire System, Any Load



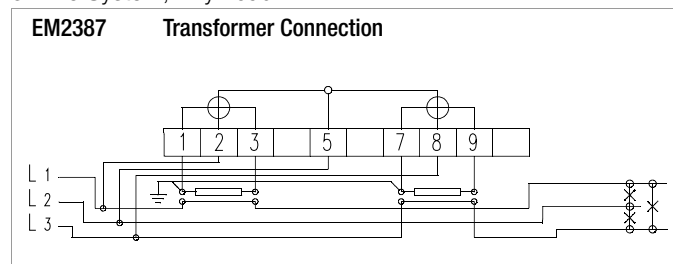
##### 4-Wire System, Any Load



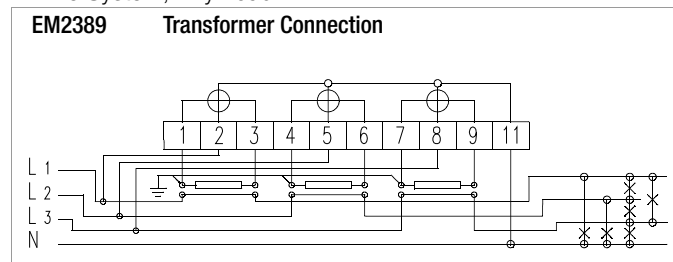
##### 2-Wire System, Any Load



##### 3-Wire System, Any Load



##### 4-Wire System, Any Load



# ENERGYMID

## EM2281/EM2289/EM2381/EM2387/EM2389

### Energy Meters

#### Order Information

Designation		Article Number / Feature				
EM2281 energy meter for 2 wire systems, 230 V, direct 5(80) A		U2281				
EM2289 energy meter for 4-wire systems, any load, direct 5(80) A			U2289			
EM2381 energy meter for 2-wire systems, 230 V, transformer 1(6) A (incl. 5(6) A)				U2381		
EM2387 energy meter for 3-wire systems, any load, transformer 1(6) A (incl. 5(6) A)					U2387	
EM2389 energy meter for 4-wire systems, any load, transformer 1(6) A (incl. 5(6) A)						U2389
Multifunctional Variant / Display	Without	M0	M0	M0	M0	M0
	With U, I, P, Q, S, PF, f, THD, In	M1	M1	M1	M1	M1
	With reactive energy <sup>1</sup>	M2	M2	M2	M2	M2
	With U, I, P, Q, S, PF, f, THD, In & reactive energy <sup>1</sup>	M3	M3	M3	M3	M3
Reference voltage U <sub>n</sub>	100 ... 110 V L-L	—	—	—	U3	U3
	230 V L-N	U5	—	U5	—	—
	400 V L-L	—	U6	—	U6	U6
	500 V L-L	—	—	—	U7	—
MID approval with declaration of conformity	MID approval	P0	P0	P0	P0	P0
	MID approval and calibration certificate	P9	P9	P9	P9	P9
Pulse output	Without (only with bus connection)	V0	V0	V0	V0	V0
	Can be calibrated, 1000 pulses per kWh <sup>2</sup>	S0, standard <sup>3</sup>	V1	V1	V1	V1
	Programmable rate: 1 ... 1000 pulses per kWh sec.	S0, programmable <sup>3</sup>	V2	V2	—	—
	Programmable rate: 1 ... 50,000 pulses per kWh sec. <sup>2</sup>	S0, programmable <sup>3</sup>	—	—	V2	V2
	Can be calibrated, Switching output up to 230 V, 1000 pulses per kWh <sup>2</sup>	230 V, standard <sup>3</sup>	V3	V3	V3	V3
	Switching output up to 230 V, programmable rate 1 ... 1000	230 V, programmable <sup>3</sup>	V4	V4	—	—
	Switching output up to 230 V, programmable rate <sup>2</sup> 1 ... 50,000	230 V, programmable <sup>3</sup>	—	—	V4	V4
	Can be calibrated, 100 pulses per kWh	S0, 130 ms, 100 pulses per kWh <sup>3</sup>	V7	V7	—	—
	Can be calibrated, 100 pulses per kWh, depends on CT x VT with Q9	S0, 130 ms, 100 pulses per kWh <sup>3</sup>	—	—	V7	V7
	Can be calibrated, 1000 pulses per kWh, not with Q9	S0, 130 ms, 1000 pulses per kWh <sup>3</sup>	—	—	V8	V8
Bus connection	None (only with pulse output)	W0	W0	W0	W0	W0
	LON <sup>4</sup>	W1	W1	W1	W1	W1
	M-Bus <sup>4</sup>	W2	W2	W2	W2	W2
	TCP/IP <sup>4</sup> (BACnet <sup>4</sup> , Modbus TCP, HTTP)	W4	W4	W4	W4	W4
Transformer ratios	Modbus RTU <sup>4</sup>	W7	W7	W7	W7	W7
Fixed current/voltage, calibrated main display	CT=VT=1	—	—	Q0	Q0	Q0
Programmable current/voltage, calibrated secondary display	Programmable CT, VT (CT x VT ≤ 100,000)	—	—	Q1	Q1	Q1
Fixed current/voltage, calibrated main display QCT = 1 ... 10,000, QVT = 1 ... 1000, CT x VT ≤ 1 million	CT, VT fixed	—	—	Q9	Q9	Q9
				QCT = _____ QVT = _____	QCT = _____ QVT = _____	QCT = _____ QVT = _____
Counter reading profile	None	Z0	Z0	Z0	Z0	Z0
	Included (only with bus connection)	Z1	Z1	Z1	Z1	Z1

<sup>1</sup> Not approved in Switzerland

<sup>2</sup> In the case of the **U238x** and **Q9**, pulse rates are read out with reference to the primary winding:

Pulse Rate Table	For V1 and V3, calibrated	V7	For V2 and V4, not calibrated
CT x VT	Fixed		Programmable
2 ... 10	1000 pulses per kWh	100	1 ... 1000 pulses per kWh
11 ... 100	100 pulses per kWh	10	0.1 ... 100 pulses per kWh
101 ... 1000	10 pulses per kWh	1	0.01 ... 10 pulses per kWh
1001 ... 10,000	1000 pulses per MWh	100	1 ... 1000 pulses per MWh
10,001 ... 100,000	100 pulses per MWh	10	0.1 ... 100 pulses per MWh
100,001 ... 1,000,000	10 pulses per MWh	1	

<sup>3</sup> cannot be ordered in combination with W1 ... W7

<sup>4</sup> cannot be ordered in combination with V1 ... V9

#### Feature Q1 (only secondary display is calibrated)

Only secondary values (menu selection) may be used for billing purposes.

#### Sample Order

4-wire system, any load, with reactive energy measurement, with MID approval, programmable transformation ratio, input voltage: 400 V, with standard S0 pulse output, no bus connection, no counter reading profile

Designation: U2389 M2 P0 Q1 U6 V1 W0 Z0

# ENERGYMID

## EM2281/EM2289/EM2381/EM2387/EM2389

### Energy Meters

#### Standard Meters with MID Approval and Initial Calibration, (available from stock)

Direct connection, 5(80) A, class B, MID for 4-wire systems, 3 x 230 / 400 V	Feature	Standard (M0)	Multifunctional variant (M1)
Programmable S0 pulse rate	V2, P0, U6	U2289-V012	U2289-V022
LON	W1, P0, U6	U2289-V013	U2289-V023
M-Bus	W2, P0, U6	U2289-V014	U2289-V024
TCP/IP (BACnet, Modbus TCP, HTTP)	W4, P0, U6	U2289-V017	U2289-V027
Modbus RTU	W7, P0, U6	U2289-V018	U2289-V028
Transformer connection, 5(6) A and 1(6) A, class B, MID for 3-wire systems, 3 x 230 / 400 V, programmable CT / VT	Feature	Standard (M0)	Multifunctional variant (M1)
Programmable S0 pulse rate	V2, P0, U6, Q1	U2387-V012	U2387-V022
Transformer connection, 5(6) A and 1(6) A, class B, MID for 4-wire systems, 3x 230 / 400 V, programmable CT / VT	Feature	Standard (M0)	Multifunctional variant (M1)
Programmable S0 pulse rate	V2, P0, U6, Q1	U2389-V011	U2389-V021
LON	W1, P0, U6, Q1	U2389-V016	U2389-V026
M-Bus	W2, P0, U6, Q1	U2389-V015	U2389-V025
TCP/IP (BACnet, Modbus TCP, HTTP)	W4, P0, U6, Q1	U2389-V017	U2389-V027
Modbus RTU	W7, P0, U6, Q1	U2389-V018	U2389-V028

#### Abbreviations and Their Meanings

Symbol	Meaning
CT	Current transformation ratio
CT × VT	Product of CT times VT
EPtot	Total effective energy (for all phases)
EQtot	Total reactive energy (for all phases)
f	Frequency
I1, I2, I3	RMS current value per phase
IN	IN: N conductor current (calculated)
I <sub>max</sub>	Limit current
I <sub>min</sub>	Minimum current value
I <sub>ref</sub>	Reference current (value)
M1 (feature)	Multifunctional variant: measurement of U, I, P, Q, S, PF, f, THD, In
M2 (feature)	Measurement of reactive energy
M3 (feature)	Multifunctional variant: measurement of U, I, P, Q, S, PF, f, THD, In, reactive energy
P1, P2, P3, Ptot	Active power, per phase and total
PF1, PF2, PF3, Pftot	Power factor (cos phi), per phase and total
Q1, Q2, Q3, Qtot	Reactive power, per phase and total
Q1 (feature)	Programmable transformation ratios
Q9 (feature)	Fixed transformation ratios
S1, S2, S3, Stot	Apparent power, per phase and total
S0	Pulse rate, S0 output
THD I1, I2, I3	Current distortion component per phase
THD U1, U2, U3	Voltage distortion component per phase
Un	Reference voltage
U1N, U2N, U3N	Star voltage (RMS)
U12, U23, U13	Delta voltage (RMS)
V2/V4 (feature)	Programmable S0
V9 (feature)	Customer-specific S0 rate
VT	Voltage transformation ratio
W1 ... 7 (feature)	Bus connections
Z1 (feature)	Counter reading profile (only possible with bus)

# ENERGYMID

## EM2281/EM2289/EM2381/EM2387/EM2389

### Energy Meters

#### Comparison of Energy Meters with MID Approval

##### Scope of Features

Meter Family		MID ENERGY METERS <sup>1</sup>					ENERGYMID EM <i>New!</i>				
Nominal current (current limit value)		5(65) A		1(6) A (incl. 5(6) A)			5(80) A		1(6) A (incl. 5(6) A)		
Mains type	2-wire system	U1281		U1381			EM2281		EM2381		
	3-wire system				U1387					EM2387	
	4-wire system		U1289			U1389		EM2289			EM2389
Connection	Direct	✓	✓				✓	✓			
	Via transformer			✓	✓	✓			✓	✓	✓
Input voltage	100 ... 110 V L-L				✓	✓				✓	✓
	230 V L-N	✓		✓			✓		✓		
	400 V L-L		✓		✓	✓		✓		✓	✓
	500 V L-L				✓					✓	
4 quadrant measurement <i>New!</i>		—	—	—	—	—	✓	✓	✓	✓	✓
LCD	1 main and 1 aux. display	✓	✓	✓	✓	✓	—	—	—	—	—
	1 main and 2 aux. displays	—	—	—	—	—	✓	✓	✓	✓	✓
Type	Housing width	125.5 mm (7 standard width units)					72 mm (4 standard width units)		72 mm (4 standard width units)		
Pulse output		1 Pulse output					2 Pulse outputs				
	S0, standard, calibrated	✓	✓	✓	✓	✓	Optional	Optional	Optional	Optional	Optional
	S0, programmable	✓	✓	✓	✓	✓	Optional	Optional	Optional	Optional	Optional
	230 V, standard, calibrated	✓	✓	✓	✓	✓	Optional	Optional	Optional	Optional	Optional
	230 V, programmable	✓	✓	✓	✓	✓	Optional	Optional	Optional	Optional	Optional
	Customer-specific S0, calibrated	✓	✓	✓	✓	✓	Optional	Optional	Optional	Optional	Optional
Transformer ratios	CT = VT = 1, main display for secondary, calibrated	—	—	✓	✓	✓	—	—	✓	✓	✓
	CT, VT programmable aux. display for sec., programmable	—	—	Optional	Optional	Optional	—	—	Optional	Optional	Optional
	Fixed CT, VT, main display for primary, calibrated	—	—	Optional	Optional	Optional	—	—	Optional	Optional	Optional
Approval	MID	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	MID and calibration certificate	Optional	Optional	Optional	Optional	Optional	Optional	Optional	Optional	Optional	Optional
<b>Options</b>											
Multifunctional variants	U, I, P, Q, S, PF, f	Optional	Optional	Optional	Optional	Optional	Optional	Optional	Optional	Optional	Optional
	Reactive energy	Optional	Optional	Optional	Optional	Optional	Optional	Optional	Optional	Optional	Optional
	THD, I <sub>n</sub> <i>New!</i>	—	—	—	—	—	Optional	Optional	Optional	Optional	Optional
Bus connection	LON	Optional	Optional	Optional	Optional	Optional	Optional	Optional	Optional	Optional	Optional
	M-Bus	Optional	Optional	Optional	Optional	Optional	Optional	Optional	Optional	Optional	Optional
	TCP/IP (BACnet, Modbus TCP, HTTP) <i>New!</i>	—	—	—	—	—	Optional	Optional	Optional	Optional	Optional
	Modbus RTU <i>New!</i>	—	—	—	—	—	Optional	Optional	Optional	Optional	Optional
Tariffs <i>New!</i>	4 tariffs (hardware controlled)	—	—	—	—	—	✓	✓	✓	✓	✓
	Additional 4 tariffs via bus <sup>2</sup>	—	—	—	—	—	Optional	Optional	Optional	Optional	Optional
24 V DC auxiliary power		Optional	Optional	Optional	Optional	Optional	—	—	—	—	—
Counter reading profile <i>New!</i>		—	—	—	—	—	Optional	Optional	Optional	Optional	Optional

<sup>1</sup> See separate data sheet for order information: U1281/U1289/U1381/U1387/U1389

<sup>2</sup> Not included in MID scope of approval