EM24

Energy analyzer for three-phase systems

Description

Three- phase energy analyzer for DIN- rail mounting with configuration joystick, frontal selector and LCD display. Direct connection up to 65A or via current and voltage transformers. It can be equipped with 2 digital outputs (pulse transmission or alarm function). In alternative the Modbus RTU or Dupline communication port and 3 digital input or the M-Bus communication. .

Benefits

- **Time saving set-up,** by frontal joystick and selector.
- **Error- proof installation,** by self- power supply and phase sequence detection.
- **Easy variable scrolling,** by means of the front joystick.
- **Wide interfacing capability,** choosing among 2 pulse outputs, the RS485, the M-Bus, Dupline or the Ethernet communication port.
- **Extended energy measurements,** using total/partial or total/multi-tariff metering.
- **Flexible installation,**by means of the direct connection up to 65 A or the connection of 5 A current transformers.
- **Extended alarm control,** on any available variable by means of up to two digital outputs.
- **Accurate measurement,** it is compliant with the international accuracy standard EN IEC 62053-21, and the EN IEC 61557- 12 performance requirements (active power and active energy).
- **Legal metrology,** guaranteed by the MID approval.

Applications

EM24 is the perfect solution in any application, specially in building and industrial automation where energy and main electrical variables monitoring is required.

EM24 is particularly suited for:

- energy efficiency monitoring
- cost allocation
- fiscal/legal sub-billing

Main functions

- Measurement of energy consumption and main electrical variables of single-phase, two-phase or three-phase loads.
- Display of single phase measurements and total measurements.
- Transmission of data via serial communication (Modbus RTU, M-Bus or Dupline)
- Transmission of energy consumption via pulse output (optional).
- Easy connection function.

Main features

- Energy measurements: total and partial kWh and kvarh or based on 4 different tariffs; single phase measurements
- Gas, cold water, hot water, kWh remote heating measurements via digital inputs
- TRMS measurements of distorted sine waves (voltages/currents)
- Data encryption (a unique key will be provided for any device in a sealed envelope included in the instrument box)
- Compliant with EN IEC 61557-12 performance requirements (active power and active energy)

Structure

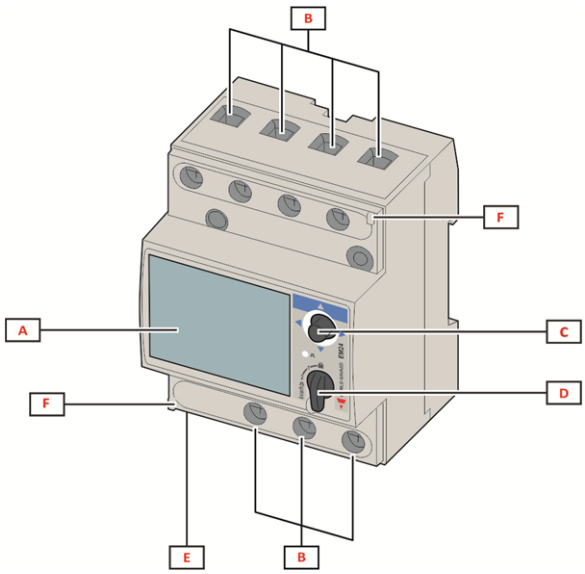


Fig. 1 *Direct connection*

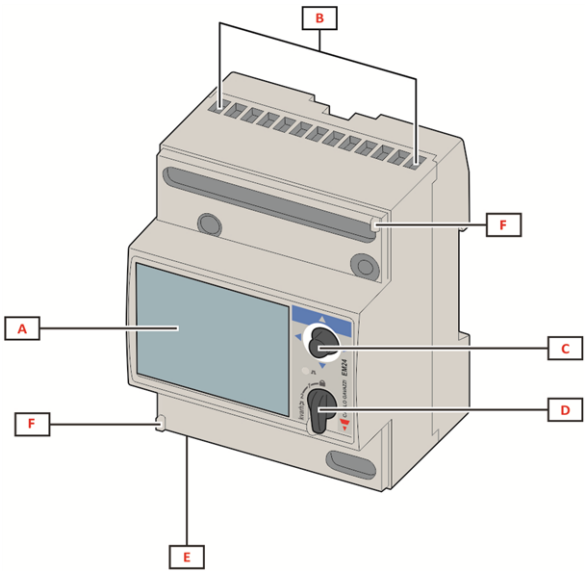


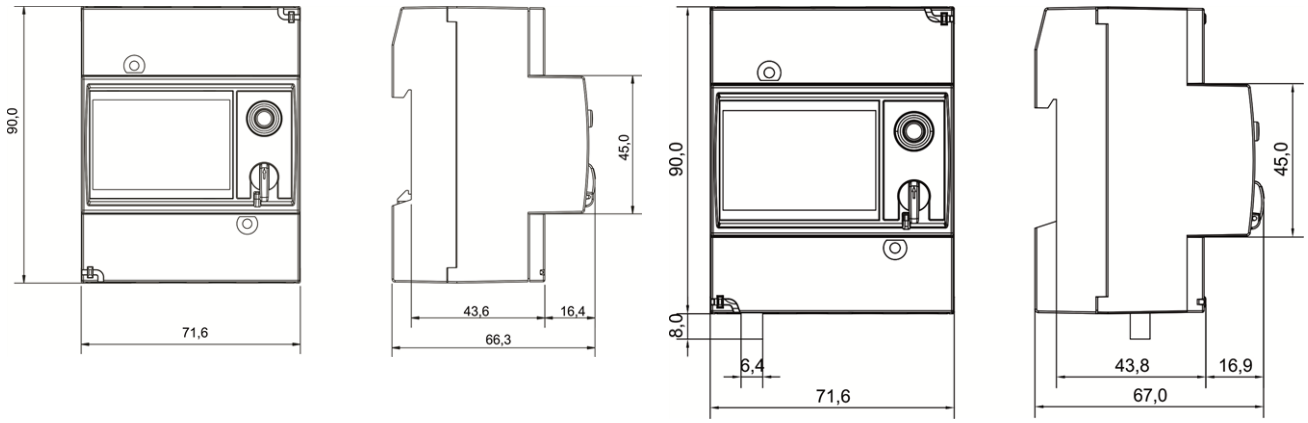
Fig. 2 *CT connection*

Area	Description
A	LCD display
B	Voltage/current connections
C	Joystick
D	Selector with pin for MID seal (programming block)
E	Inputs/outputs or communication port
F	Pins for MID seal (protection covers included)
H	SMA connector cable (2 m)

Features

General

Protection degree	Front: IP50. Terminals: IP20
Terminals	AV2/AV9 models: Measurement inputs: 2.5 to 16 mm^2 / 1.7 to 3 Nm; Other inputs: 1.5 mm^2 / 0.4 to 0.8 Nm AV5/AV6 models: Measurement inputs and other inputs: 1.5 mm^2 max. / 0.4 to 0.8 Nm
Overvoltage category	Cat. III
Utilisation category	UC2
Pollution degree	2
Noise rejection (CMRR)	100 dB, from 42 to 62 Hz
Mounting	DIN rail
Weight	400 g (packaging included) 800 g with external antenna (packaging included)



Environmental specifications

Operating temperature	From -25 to +55 °C / from -13 to +131 °F
Storage temperature	From -30 to +70 °C / from -22 to +158 °F

NOTE: R.H. < 90 % non-condensing @ 40 °C / 104 °F.

Input and output insulation

Type	Measuring inputs	Relay outputs	Open collector outputs	Communication port and digital inputs	Dupline	Self power supply	Auxiliary power supply
Measuring inputs	-	4 kV	4 kV	4 kV	4 kV	0 kV	4 kV
Relay outputs	4 kV	-	-	-	-	4 kV	4 kV
Open collector outputs	4 kV	-	-	-	-	4 kV	4 kV
Communication port and digital inputs	4 kV	-	-	-	-	4 kV	4 kV
Dupline	4 kV	-	-	-	-	4 kV	4 kV
Self power supply	0 kV	4 kV	4 kV	4 kV	4 kV	-	-
Auxiliary power supply	4 kV	4 kV	4 kV	4 kV	4 kV	-	-

Compatibility and conformity

Directives	2011/65/EU (RoHs) 2014/53/EU (RED)
Standards	**Electromagnetic compatibility (EMC) - emissions and immunity**: EN IEC 62052-11 **Electrical safety**: EN IEC 61010-1, EN 50470-1 (MID), UL 61010-1 **Accuracy**: EN IEC 62053-21, EN IEC 62053-23, EN 50470-3 (MID), EN IEC 61557-12 (active power and active energy, MID models only) **Pulse outputs**: EN IEC 62053-31, DIN 43864
Approvals	CE UKCA c UL us LISTED **MID** (PF only) (UL508: AV5 and AV6 except M2)

Electrical specifications

Voltage - MID models			
Voltage inputs	AV2	AV9	AV5
Voltage connection	Direct		
Rated voltage L-N (from U_n min. to U_n max.)	133 to 230 V	230 V	230 V
Rated voltage L-L (from U_n min. to U_n max.)	230 to 400 V	400 V	400 V
Voltage tolerance	-20%, +15%		
Input impedance	Refer to “Power supply”		
Frequency	50 Hz		

Voltage - Non MID models (according to EN IEC 62052-11)				
Voltage inputs	AV2	AV9	AV5	AV6
Voltage connection	Direct			Direct or via VT
Rated voltage L-N (from U_n min. to U_n max.)	133 to 230 V	230 V	230 V	57.7 to 120 V
Rated voltage L-L (from U_n min. to U_n max.)	230 to 400 V	400 V	400 V	100 to 240 V
Voltage tolerance	-20%, +15%			
Input impedance	Refer to “Power supply”		>1600 kΩ	
Frequency	50/60 Hz			

Voltage - Non MID models (according to UL)		
Voltage inputs	AV5	AV6
Voltage connection	Direct	Direct or via VT
Rated voltage L-N (from U_n min. to U_n max.) All models except M2	230 to 347 V	57.7 to 144 V
Rated voltage L-L (from U_n min. to U_n max.) All models except M2	400 to 600 V	100 to 250 V
Voltage tolerance	-20%, +15%	
Input impedance	Refer to “Power supply”	>1600 kΩ
Frequency	50/60 Hz	

Current				
Current inputs	AV2	AV9	AV5	AV6
Current connection	Direct		Via CT	
Rated current (I_n)	-		5 A	
Base current (I_b)	10 A		-	
Minimum current (I_{min})	0.5 A		0.05 A	
Maximum current (I_{max})	65 A		10 A	
Start-up current (I_{st})	0.04 A		0.01 A	
Overload	Continuous: 65 A @50 Hz For 10 ms: 1950 A @50 Hz		Continuous: 10 A @50 Hz For 500 ms: 200 A @ 50 Hz	
Short circuit withstand	For 10 ms: 4500 A according to EN IEC 62052-31:2015		-	
Input impedance	< 1.1 VA		< 0.6 VA	
Crest factor	4 (92 A max. peak)		3 (15 A max. peak)	

Maximum CTxVT ratio				
Current inputs	AV2	AV9	AV5	AV6
Non-MID models	-	-	4629	14529
MID models	-	-	3150	-

Power supply

Non MID models				
	AV2	AV9	AV5	AV6
Type	Self power supply		D: 115/230 V ac, +/-15%, 50/60Hz L: 24 to 48 V ac/dc; ac: +/-15%, 50/60Hz, dc: +/-20%	
Consumption	IS and DP: < 12 VA / 2 W Others: < 20 VA / 1 W		D: < 2.5 VA / 1.5 W L: < 2.5 VA / 1 W	

MID models			
	AV2	AV9	AV5
Type	Self power supply		
Consumption	IS and DP: < 12 VA / 2 W Others: < 20 VA / 1 W		<4.5 VA / 2.9 W
	W1: 2.7 VA / 1.8 W		

Measurements

Method	TRMS measurements of distorted waveforms
Sampling	1600 samples/s @50 Hz 1900 samples/s @60 Hz

Available measurements

Active energy	Unit	System	Phase	Note
Imported (+) Total	kWh+	●	●	
Imported (+) partial	kWh+	●	-	
Exported (-) Total	kWh-	●	-	
Imported (+) by tariff (IS, DP)	kWh+	●	-	T1, T2, T3, T4

Reactive energy	Unit	System	Phase
Imported (+) Total	kvarh+	●	-
Imported (+) partial	kvarh+	●	-
Exported (-) Total	kvarh-	●	-
Imported (+) by tariff	kvarh+	●	-

Electrical variable	Unit	System	Phase
Voltage L-N	V	●	●
Voltage L-L	V	●	●
Current	A	-	●
DMD MAX	A	●	-
Active power	kW	●	●
DMD	kW	●	-
#DMD MAX	kW	●	-
Apparent power	kVA	●	●
DMD	kVA	●	-
DMD MAX	kVA	●	-
Reactive power	kvar	●	●
Power factor	PF	●	●
Frequency	Hz	●	-
Run hour meter	h	●	-

Measurement mode

Depending on the APPLICATION setting, a different selection of variables is available on the display (see manual) and the energy calculation is worked out as follows:

- Standard: both kWh+ and kWh- are available;
- EC: easy connection function, the power is always integrated (both in case of positive and negative power).

In MID analyzers the calculation depends on the model:

- PFA: Easy connection, the total energy totalizer (kWh+) is certified according to MID;
- PFB: only the total positive totalizer (kWh+) is certified according to MID. The negative energy totalizer is available but not certified according to MID.

Energy metering

For every measuring interval time, the energies of the single phases are summed; according to the sign of the result, the positive (kWh+) or negative totalizer (kWh-) is increased.

Example:

P L1= +2 kW, P L2= +2 kW, P L3= -3 kW

Integration time = 1 hour

+kWh=(+2+2-3)x1h=(+1)x1h=1 kWh

-kWh=0 kWh

Measurement accuracy

Current	AV2	AV9	AV5	AV6
From 0.5 A to 2 A	2 ±(0.5% rdg + 3dgt)		-	-
From 2 A to 65 A	±(0.5% rdg + 1dgt)		-	-
From 0.05 A to 1 A	-	-	±(0.5% rdg + 3dgt)	
From 1 A to 10 A	-	-	±(0.5% rdg + 1dgt)	

Phase-phase voltage	AV2	AV9	AV5	AV6
In the range U_n	±(1% rdg +1dgt)			

Phase-neutral voltage	AV2	AV9	AV5	AV6
In the range U_n	±(0.5% rdg +1dgt)			

Active and apparent power	AV2	AV9	AV5	AV6
From 1.0 A to 65.0 A (PF=0.5 L, 1, 0.8 C)	±(1% rdg +1dgt)		-	
From 0.5 A to 1.0 A (PF=1)	±(1.5% rdg +1dgt)		-	
From 0.25 A to 10 A (PF=0.5 L, 1, 0.8 C)	-		±(1% rdg +1dgt)	
From 0.05 A to 0.25 A (PF=1)	-		±(1.5% rdg +1dgt)	

Reactive power	AV2	AV9	AV5	AV6
From 1.0 A to 2.0 A (sinϕ=0.5 L, 0.5 C) From 0.5 A to 1.0 A (sinϕ=1)	±(2.5% rdg + 1 dgt)		-	
From 2.0 A to 65.0 A (sinϕ=0.5 L, 0.5 C) From 1.0 A to 65.0 A (sinϕ=1)	±(2% rdg + 1 dgt)		-	
From 0.25 A to 0.5 A (sinϕ=0.5 L, 0.5 C) From 0.1 A to 0.25 A (sinϕ=1)	-		±(2.5% rdg + 1 dgt)	
From 0.5 A to 10 A (sinϕ-ϕ=0.5 L, 0.5 C) From 0.25 A to 10 A (sinϕ=1)	-		±(2% rdg + 1 dgt)	
Active energy	Class 1 (EN IEC 62053-21) Class B (EN 50470-3) (MID)			
Reactive energy	Class 2 (EN IEC 62053-23)			

Frequency	
From 45 to 65 Hz	±0.1 Hz

Measurement accuracy according to EN IEC 61557-12 (MID models)	
Active power	Performance class 1
Active energy	Performance class 2

Display

Type	LCD
Refresh time	< 750 ms
Description	3 rows: 1st: 8 digits (7 mm) 2nd: 4 digits (7 mm) 3rd: 4 digits (7 mm)
Variable readout	Instantaneous: 4 digits, min.: 0.000, max.: 9999 Energy: 8 digits (imported), 7 digits (exported), min.: 0.00, max.: 99 999 999

LED

Model	CT*VT	Weight (kWh per pulse)
AV5/AV6	≤ 7	0.001
	> 7 ≤ 70.0	0.01
	> 70 ≤ 700.0	0.1
	> 700	1
AV2/AV9	N/A	0.001

Digital outputs/inputs

Digital outputs: static output (O2)

Connection type	Screw terminals
Maximum number of outputs	2
Type	Open collector
Function	Pulse output or alarm output
Features	V_{ON} 1.2 V dc, max. 100 mA V_{OFF} 30 V dc max
Configuration parameters	Output function (pulse/alarm) Output normal status Pulse weight (0.001 to 10 kWh/pulse or kvarh/pulse) Pulse duration (30 or 100 ms) Linked variable Alarm delay
Configuration mode	Via joystick

Digital outputs: relay output (R2)

Configuration parameters	Screw terminals
Maximum number of outputs	2
Type	relay (SPST)
Function	Pulse output or alarm output
Features	AC-1: 5 A@250 V ac DC-12: 5 A@24 V dc AC-15: 1.5 A @ 250 V ac DC-13: 1.5 A @ 24 V dc
Configuration parameters	Output function (pulse/alarm) Output normal status Pulse weight (0.001 to 10 kWh/pulse or kvarh/pulse) Pulse duration (30 or 100 ms) Linked variable Alarm delay
Configuration mode	Via joystick

Digital inputs (IS, DP)

Number of inputs	3
Functions	Remote status (IS) DMD synchronization (IS) Pulse counting Tariff management (IS)
Frequency	20Hz max., duty cycle 50%
Pulse weight	From 0.001 to 999.9 m3 or kWh per pulse
Contact measuring voltage	5 V dc +/- 5%
Contact measuring current	10 mA max.
Input impedance	680 Ω
Open contact resistance	≥500 kΩ
Closed contact resistance	≤100 Ω
Configuration parameters	Input function Pulse weight
Configuration mode	Via joystick or UCS software (IS)

Communication ports

RS485 port (IS)

Protocols	Modbus RTU
Devices on the same bus	Max 160 (1/5 unit load)
Communication type	Multidrop, bidirectional
Connection type	2 wires
Configuration parameters	Modbus address (from 1 to 247) Baud rate (4.6/9.6 kbps) 1 stop bit, no parity
Refresh time	< 750 ms
Configuration mode	Via joystick or UCS software

M-Bus (M1, M2)

Protocols	M1: M-Bus according to EN13757-3:2005 M2: M-Bus according to EN13757-3:2013
Driver input capability	1 unit load
Communication type	One-drop, directional
Connection type	2 wires
Configuration parameters	Primary address (1 to 247) Baud rate (0.3/ 2.4 / 9.6 kbps)
Configuration mode	Via joystick

Dupline port (DP)

Protocols	Dupline
Connection type	2 wires
Dupline data format	3 1/2 dgt BCD
Full scale value	selectable from 1.999 to 1999 M
Used channels	depending on the number of variables
Multiplexer	A1 to A4 G1 to H8 (1st group of 16 variables) I1 to J8 (2nd group of 16 variables) K1 to L8 (3th group of 16 variables) M1 to N8 (4th group of 16 variables) O1 to P8 (5th group of 16 variables)
Available variables	all, except for the “max” variables
Configuration para-meters	Dupline inputs Dupline counters Dupline analogue variables Dupline output
Configuration mode	Via joystick

Counters	
Function	Multiplexer for counter values
Number of counters	6 per instrument, 128 per network
Counter range	0... 99 999 999
Used channels	B to F
Multiplexer	B2 to B8
Reset	B1
Value	C1 to F8
Counter reset	enable/disable function for all the counters
Available counters	kWh tot, -kWh tot, kvarh tot, -kvarh tot, kWh t1, kWh t2, kWh L1, kWh L2, kWh L3, counter dig. in. 1, counter dig. in. 2, counter dig. in. 3, Counter

Input (synchro/tariff)	
Function	Monostable (push-button), realtime
Used channels	A5

Input (synchro/tariff)	
Working mode	selectable: none Wdmd synchronization total and partial energy meter (kWh, kvarh) managed by time periods (t1-t2).

Outputs (alarms)	
Function	monostable
Used channells	selectable (A1 to P8). No control that the selected channels are not used for counters or analog variables
Number of alarms	2 per instrument
Alarm modes	up alarm, down alarm
Set-point adjustment	from 0 to 100% of the display scale
Hysteresis	from 0 to full scale
On-time delay	0 to 255 s
Output status	normally energised
Available variables	all, except for the “max” variables

Analogue variables	
Function	Multiplexer for analogue values
Number of variables	8 per instrument, 80 per network

Connection Diagrams

Three-phase with neutral (4-wire)

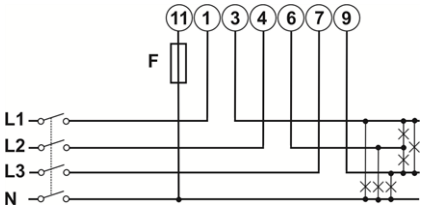


Fig. 3 *AV2, AV9*

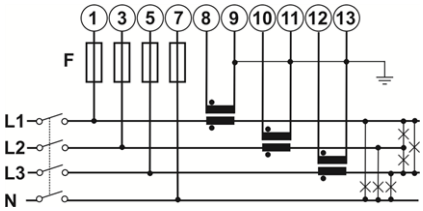


Fig. 4 *AV5, AV6*

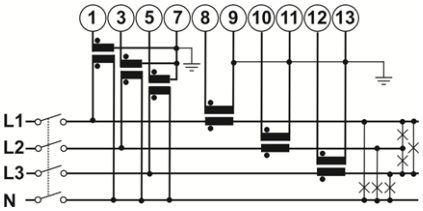


Fig. 5 *AV6*

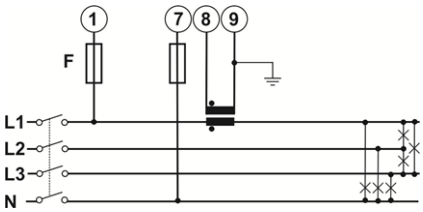


Fig. 6 *AV5, AV6 balanced load*

Three-phase without neutral (3-wire)

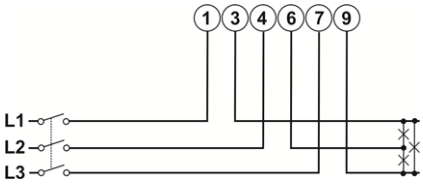


Fig. 7 *AV2, AV9 (except IS, R2)*

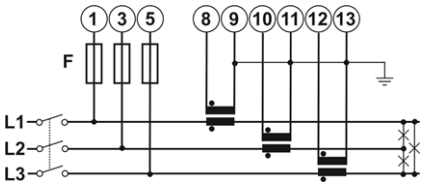


Fig. 8 *AV5, AV6*

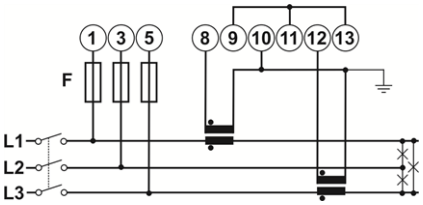


Fig. 9 *AV5, AV6*

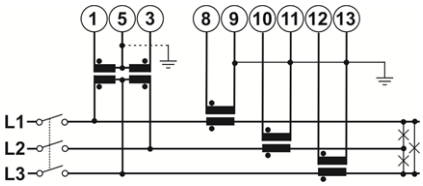


Fig. 10 *AV6*

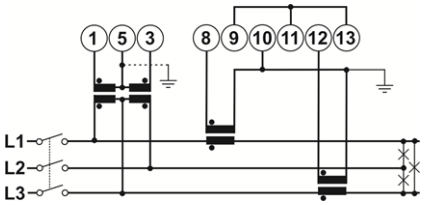


Fig. 11 *AV6*

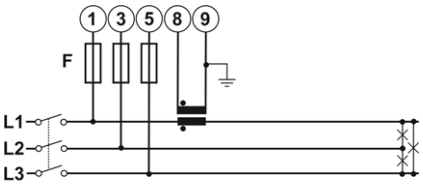


Fig. 12 *AV5, AV6 balanced load*

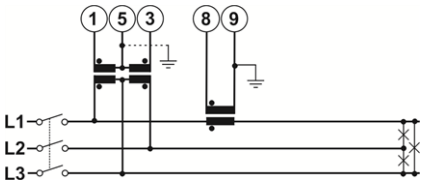


Fig. 13 *AV6 balanced load*

Two-phase system with neutral (3-wire)

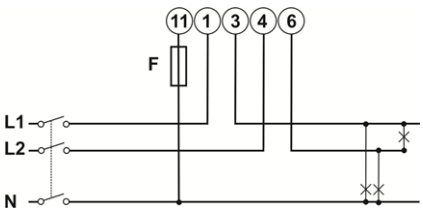


Fig. 14 *AV2, AV9*

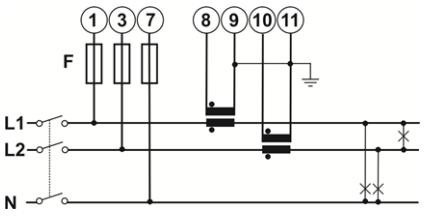


Fig. 15 *AV5, AV6*

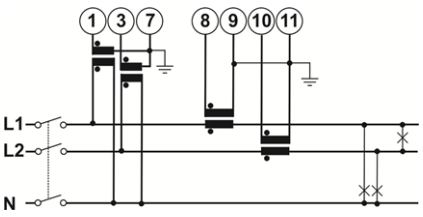


Fig. 16 *AV6*

Single-phase (2-wire)

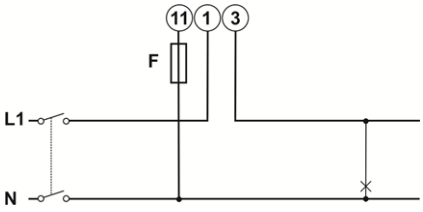


Fig. 17 *AV2, AV9 (except IS, R2, M1)*

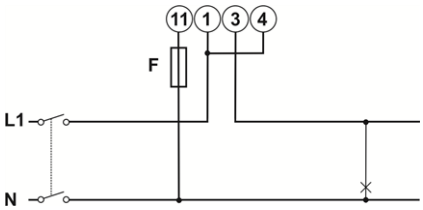


Fig. 18 *AV2, AV9 (IS, R2, M1)*

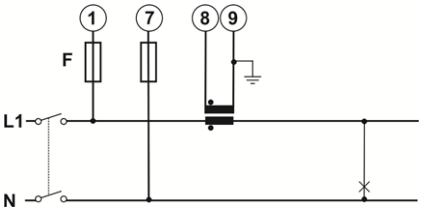


Fig. 19 *AV5, AV6*

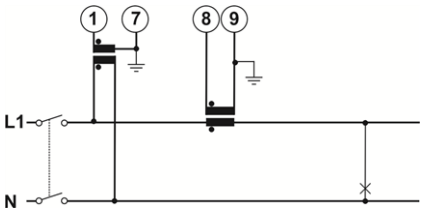


Fig. 20 *AV6*

NOTE: F=315 mA/250 mA time-delay

Power supply

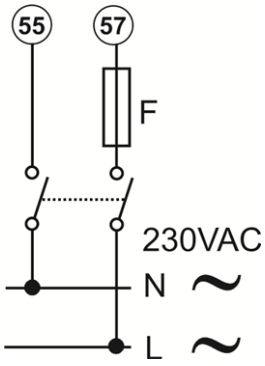


Fig. 21 *D option. F = 250 V, 50 mA*

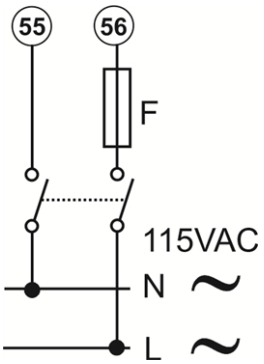


Fig. 22 *D option. F = 250 V, 100 mA*

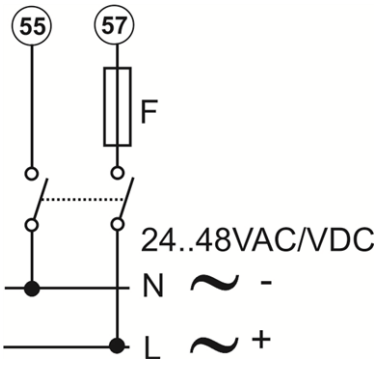


Fig. 23 *L option. F = 250 V, 200 mA*

Static outputs and relay outputs

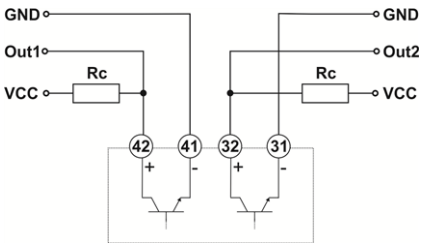


Fig. 24 *Static outputs, GND reference*

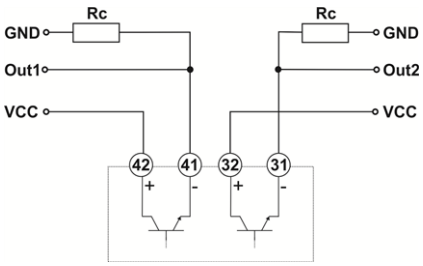


Fig. 25 *Static outputs, VDC reference*

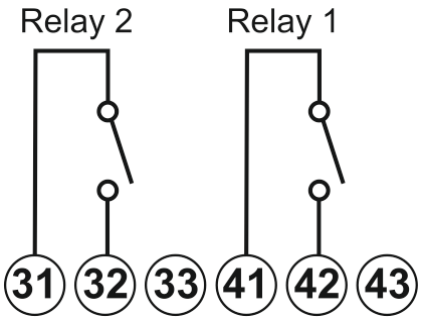


Fig. 26 *Relay outputs*

Digital inputs, RS485 and Dupline ports

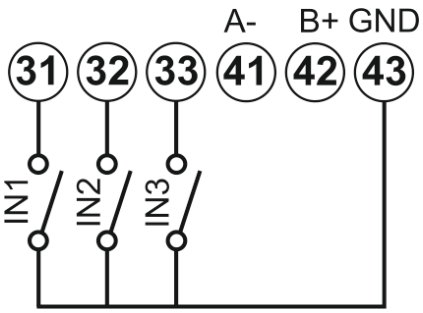


Fig. 27 *Digital inputs*

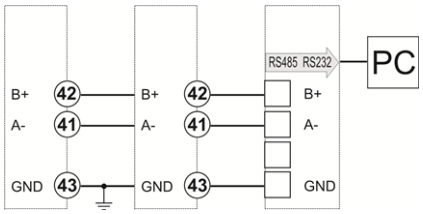


Fig. 28 *RS485 port*

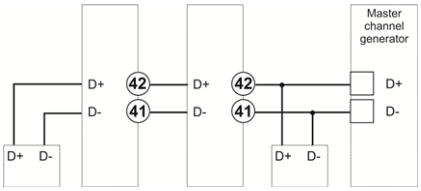


Fig. 29 *Dupline port*

M-Bus

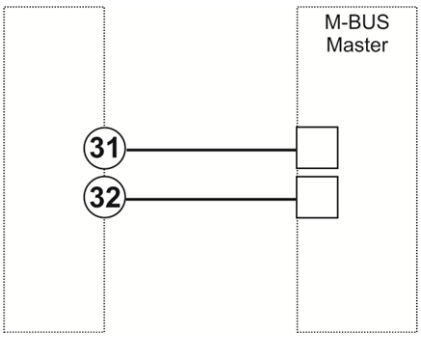


Fig. 30 *M-Bus port*

MID connection diagrams

Three-phase with neutral (4-wire)

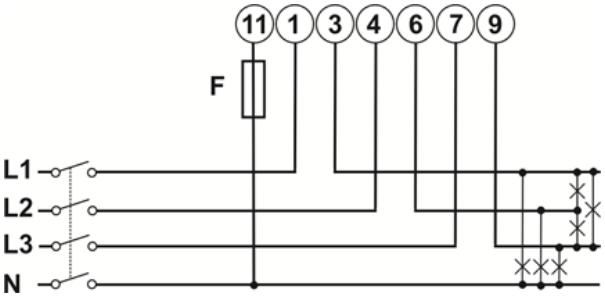


Fig. 31 *AV2, AV9*

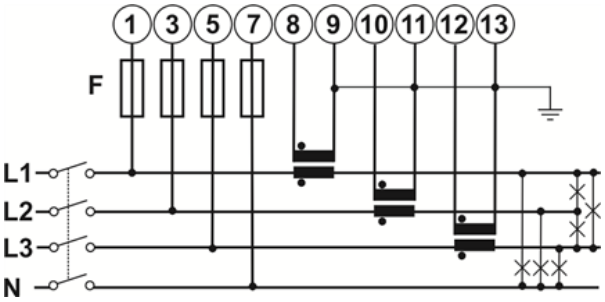


Fig. 32 *Type*

Note: F=315 mA

References

Order code

Non MID models

Component name/part number	I/O communication	Voltage inputs	Current inputs	Power supply
EM24DIN AV9 3X XX X	none	230V L-N 400V L-L	10 (65) A	Self power supply

Component name/part number	I/O communication	Voltage inputs	Current inputs	Power supply
EM24DIN AV9 3X R2 X	2 relay outputs	230 V L-N 400 V L-L	10 (65) A	Self power supply

Component name/part number	I/O communication	Voltage inputs	Current inputs	Power supply
EM24DIN AV5 3D O2 X	2 static outputs	23 0V L-N 400 V L-L	5 (10) A via CT	115/230 V ac
EM24DIN AV5 3L O2 X	2 static outputs	230 V L-N 400 V L-L	10 (65) A	From 24 to 48 V ac/dc
EM24DIN AV9 3X O2 X	2 static outputs	230 V L-N 400 V L-L	10 (65) A	Self power supply

Component name/part number	I/O communication	Voltage inputs	Current inputs	Power supply
EM24DIN AV6 3D DP X	3 digital inputs + Dupline	From 57.7 to 120 V L-N From 100 to 208 V L-L	5 (10) A via CT	115/230 V ac
EM24DIN AV6 3L DP X	3 digital inputs + Dupline	From 57.7 to 120 V L-N From 100 to 208 V L-L	5 (10) A via CT	From 24 to 48 V ac/dc
EM24DIN AV9 3X DP X	3 digital inputs + Dupline	230 V L-N 400 V L-L	10 (65) A	Self power supply

Component name/part number	I/O communication	Voltage inputs	Current inputs	Power supply
EM24DIN AV6 3D IS X	3 digital inputs + RS485 Modbus RTU	From 57.7 to 120 V L-N From 100 to 208 V L-L	5 (10) A via CT	115/230 V ac
EM24DIN AV6 3L IS X	3 digital inputs + RS485 Modbus RTU	From 57.7 to 120 V L-N From 100 to 208 V L-L	5 (10) A via CT	From 24 to 48 V ac/dc
EM24DIN AV9 3X IS X	3 digital inputs + RS485 Modbus RTU	230 V L-N 400 V L-L	10 (65) A	Self power supply

Component name/part number	I/O communication	Voltage inputs	Current inputs	Power supply
EM24DIN AV9 3X M1 X	M-Bus according to EN 13757-3 (2005)	230 V L-N 400 V L-L	10 (65) A	Self power supply

Component name/part number	I/O communication	Voltage inputs	Current inputs	Power supply
EM24DIN AV9 3X M2 X	M-Bus according to EN 13757-3 (2013)	230 V L-N 400 V L-L	10 (65) A	Self power supply

MID models

Component name/part number	I/O communication	Voltage inputs	Current inputs	Power supply
EM24DIN AV2 3X XX PFA **EM24DIN AV2 3X XX PFB**	none	230 V L-N 400 V L-L	10 (65) A	Self power supply
EM24DIN AV9 3X XX PFA **EM24DIN AV9 3X XX PFB**	none	230 V L-N 400 V L-L	10 (65) A	Self power supply

Component name/part number	I/O communication	Voltage inputs	Current inputs	Power supply
EM24DIN AV9 3X O2 PFA **EM24DIN AV9 3X O2 PFB**	2 static outputs	230V L-N 400V L-L	10 (65) A	Self power supply

Component name/part number	I/O communication	Voltage inputs	Current inputs	Power supply
EM24DIN AV9 3X IS PFA **EM24DIN AV9 3X IS PFB**	3 digital inputs + RS485 Modbus RTU	230 V L-N 400 V L-L	10 (65) A	Self power supply

- PFA: Easy connection, the total energy totalizer (kWh+) is certified according to MID;
- PFB: only the total positive totalizer (kWh+) is certified according to MID. The negative energy totalizer is available but not certified according to MID.

Further reading

Information	Where to find it
User manual - IS	https://www.gavazziautomation.com/fileadmin/images/PIM/MANUALS/ENG/EM24_IS_IM_USE.pdf
Installation instruction - IS	https://www.gavazziautomation.com/fileadmin/images/PIM/MANUALS/ENG/EM24_IS_IM_INST.pdf
User manual - M1/M2	https://www.gavazziautomation.com/fileadmin/images/PIM/MANUALS/ENG/EM24_M1_M2_USE.pdf
Installation instruction - M1/M2	https://www.gavazziautomation.com/fileadmin/images/PIM/MANUALS/ENG/EM24_M1_M2_IM_INST.pdf
Instruction manual - other versions	https://www.gavazziautomation.com/fileadmin/images/PIM/MANUALS/ENG/EM24_IM.PDF

CARLO GAVAZZI compatible components

Purpose	Component name/part number	NOTES
Monitor data from several analyzers	VMU-C	See relevant datasheet
Collect data from wireless M-Bus devices and transmit data via Modbus TCP/IP	SIU-MBM-02	See relevant datasheet