



INSTALLATION AND USER MANUAL

EMT430 · EMT431 · EMT432

Three-phase power analyzer

English · Revision 1



MODEL

EMT430

Self-powered from the measuring inputs



MODEL

EMT431

Auxiliary power supply 90–350 VDC / 85–265 VAC



MODEL

EMT432

SELV power supply 10–36 VDC / 19–26 VAC



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1 INTRODUCTION

1.1 Product description

EMT430, EMT431 and EMT432 are three-phase power analyzers with a 320x240 pixel colour graphic display, RS485 port, Ethernet, USB, SD card, Wifi, NFC, pulse output and RTC. Current inputs from 5 A (1 A) CTs or from CTs with 333 mV voltage output / Rogowski coils. The three models share measurements, communication and software functions; they differ in the type of power supply and in a few features listed in the following table.

- **EMT430** – self-powered from the measuring inputs: 85 - 265 VL-N, 150 - 450 VL-L.
- **EMT431** – auxiliary power supply 90 - 350 VDC or 85 - 265 VAC.
- **EMT432** – SELV power supply 10 - 36 VDC or 19 - 26 VAC.

1.2 Models and main differences

Model comparison			
Parameter	EMT430	EMT431	EMT432
Power supply	Self-powered (from the voltage inputs)	Auxiliary, single-phase from the grey terminal	SELV, single-phase from the red terminal
Supply voltage	85 - 265 VAC L-N 150 - 450 VAC L-L DC / 45 - 65 Hz	90 - 350 VDC 85 - 265 VAC	10 - 36 VDC 19 - 26 VAC
Consumption	< 3,5 W		
Active energy class	class C (EN50470-1/3) class 0.2 S (EN62053-22)		
Reactive energy class	class 0.5 S (EN62053-24)		
Insulation power supply / measuring inputs	not insulated	1500 VRMS	4 kVRMS
Dimensions	90x61x72 mm		
Digital inputs (optional)	3 inputs up to 3.2 kHz (option)	1 input up to 3.2 kHz (option)	3 inputs up to 3.2 kHz (option)
Expansions	Din / LORA		

1.3 Product features

- Accuracy $\pm 0.2\%$ RDG
- Bidirectional energy meter
- TRMS measurement of distorted waveforms (voltage/current)
- Neutral current calculation
- One output (opto-MOS) for alarms or pulses
- Wifi Station and Access Point (Modbus TCP)
- Ethernet (Modbus TCP)
- RS485 serial output (Modbus RTU)
- NFC
- Logging via USB or SD card (or internal memory) with timestamp
- 2.2" 16-bit 320x240 pixel colour display with capacitive touch screen

- Sampling rate: 6400 samples/s @ 50 Hz
- Size: 4 DIN modules
- Chronos CTs can be paired directly via the App to correct signal phase shift and amplitude
- Full harmonic analysis (amplitudes and phases)
- Two versions: for current-output CTs 5 A (or 1 A) or voltage-output CTs (333 mV/Rogowski)
- Built-in integrator for Rogowski coils
- Available in two variants: BASE, FULL

1.4 Symbols

	DANGER: Failure to follow the instructions may cause damage to property, people or animals.		WARNING, DANGEROUS VOLTAGE: Live electrical voltage. Disconnect the power supply before working on the device.
	DOUBLE INSULATION: Class II equipment. No earth connection is required.		WEEE: Do not dispose of with household waste. Take to an authorised collection centre.

2 MEASUREMENTS AND RECORDINGS

Measurements and recordings are the same for EMT430, EMT431 and EMT432 and depend only on the version (BASE or FULL).

Real-time measurements	BASE	FULL
VRMS LL and VRMS LN [V]	•	•
IRMS [A]	•	•
Active power P [W]	•	•
Reactive power Q [VAR]	•	•
Apparent power S [VA]	•	•
Cos ϕ	•	•
Tan ϕ	•	•
Crest factor	•	•
Frequency [Hz]	•	•
Internal temperature [°C]	•	•
Phase sequence	•	•
RSSI Wifi	•	•

Counters	BASE	FULL
Active energy [Wh] (pos, neg, total)	•	•
Reactive energy [VARh] (pos, neg, total)	•	•
Apparent energy [VAh] (pos, neg, total)	•	•
Installation time [h]	•	•

Average, maximum and minimum values	BASE	FULL
VRMS LL average, maximum and minimum	•	•
VRMS LN average, maximum and minimum	•	•
IRMS average, maximum and minimum	•	•
Active power P average, maximum and minimum	•	•
Reactive power Q average, maximum and minimum	•	•
Apparent power S average, maximum and minimum	•	•
Cos ϕ average, maximum and minimum	•	•
Crest factor average, maximum and minimum	•	•
Frequency average, maximum and minimum	•	•
Peaks on voltage VLL	•	•
Peaks on voltage VLN	•	•
Peaks on currents I	•	•
MAX demand	•	•
Configurable moving average on P, P_plus, P_neg, Q_plus_ind, Q_plus_cap, Q_neg_ind, Q_neg_cap	•	•

Logging and connectivity	BASE	FULL
Logging of real-time measurements, exportable via webserver		•
Oscilloscope function accessible via RS485		•

Logging and connectivity	BASE	FULL
Oscilloscope function accessible via webserver		•
Direct connection via MQTT		•

Power quality	BASE	FULL
Voltage harmonics up to the 63rd order		•
Current interharmonics up to the 63rd order		•
Power quality:		•
- Undervoltages		•
- Overvoltages		•
- Voltage dips		•
Oscilloscope function via webserver and RS485		•
Distortion power factor		•
Voltage THD, TDD		•
Current THD, TDD		•
Efficiency between phase 1 and phase 2		•
K-factor		•

3 TECHNICAL SPECIFICATIONS

3.1 Power supply

Power supply specifications			
	EMT430	EMT431	EMT432
Type	Self-powered	Auxiliary power supply	SELV power supply
Power supply type	From the voltage measuring inputs	Single-phase from the terminal	Single-phase from the red terminal
Voltage	85 - 265 VAC (L-N) 150 - 450 VAC (L-L)	90 - 350 VDC 85 - 265 VAC	10 - 36 VDC 19 - 26 VAC
Operating frequency	45 - 65 Hz		
Consumption	< 3,5 W		
Cable cross-section	2.5 mm ² or less with FG16 cable (or equivalent)		

3.2 Measuring inputs

Input specifications (common to all models)	
Voltage	
Rated voltage range L-N	85 - 265 VAC
Rated voltage range L-L	150 - 450 VAC
Operating frequency	DC / 1 - 65 Hz
Current	
Connection	With 5 A (1 A) current-output CTs or voltage-output CTs (333 mV / Rogowski)
CTs with current output	
Starting current (I _{st})	5 mA
Minimum current (I _{min})	50 mA
Rated current (I _n)	5 AAC
Maximum current (I _{MAX})	6 AAC
Crest factor	< 4 (20 APK MAX)
Impedance	< 1 VA per phase
Overload for 500 ms	40 AAC
CTs with voltage output	
Starting voltage (V _{st})	0.33 mVAC
Minimum voltage (V _{min})	3.33 mVAC
Rated voltage (V _n)	333 mVAC
Maximum voltage (V _{MAX})	500 mVAC
Crest factor	< 3 (1 VPK MAX)
Impedance	220 kΩ
Overload for 500 ms	6 VPK

3.3 Accuracy

Accuracy (@25 ± 5 °C; frequency = 50 Hz)		Update times
Frequency	± 0.01 Hz (45..65 Hz)	100 ms
Voltage	± 0.1% rdg	Configurable from 1 to 65535 periods (from 20 ms to 21.8 minutes at 50 Hz)
Current	± 0.1% rdg	
Active and apparent power (PF = 0.5L .. 0.5C)	± 0.1% rdg (In or Vn from 5% to 100%) ± 0.2% rdg (In or Vn from 1% to 5%)	
Reactive power (sinφ = 0.5L .. 0.5C)	± 0.1% rdg (In or Vn from 5% to 100%) ± 0.2% rdg (In or Vn from 1% to 5%)	
Active energy	class C according to EN50470-1/3; class 0.2 S according to EN62053-22	
Reactive energy (when measured, see below)	class 0.5 S according to EN62053-24	
Power factor	± (0.001 + 1%(1.00 - PF))	
Bandwidth (-3 dB)	> 2 kHz	Not applicable
Thermal drift	< 100 ppm/°C	100 ms
THD	± 0,3%	
Harmonics	± 1% amplitude up to the 16th harmonic ± 2% amplitude from the 17th to the 63rd harmonic ± 5° phase shift up to the 16th harmonic ± 10° phase shift from the 17th to the 63rd harmonic	

3.4 General specifications

General specifications	
Operating temperature	-25 °C ... +65 °C
Storage temperature	-40 °C ... +85 °C
Humidity	10 ... 90% non-condensing
Altitude	Up to 2000 m a.s.l.
Measurement category	III 300 V
Overvoltage category (installation)	III
Insulation	EMT430: 0 kVRMS between power supply and measuring inputs (self-powered); 4 kVRMS between RS485 and measuring inputs; 4 kVRMS between power supply and RS485 EMT431: 1500 VRMS between power supply and measuring inputs; 4 kVRMS between RS485 and measuring inputs; 4 kVRMS between power supply and RS485 EMT432: 4 kVRMS between power supply and measuring inputs; 4 kVRMS between RS485 and measuring inputs; 1.5 kVRMS between power supply and RS485
Enclosure	
Connections	1 × screw terminal, 3.5 mm pitch, 3 poles 1 × screw terminal, 7.5 mm pitch, 4 poles 2 × screw terminals, 5 mm pitch, 6 poles 1 × RJ45 connector for Ethernet
Dimensions	90x61x72 mm
Material	PBT, grey
IP protection rating	IP20

General specifications	
Environmental pollution degree	Pollution degree 2
Mounting	On DIN rail, ready for bus mounting (connector not included)
Configuration	Via built-in webserver Via Cloud (FULL version only)
Overcurrent protection devices	External fuses; slow-acting fuses > 250 V, < 1 A recommended

3.5 Standards

Standards	
Electrostatic discharge (EN 61000-4-2)	8 kV contact 15 kV air
Radiated immunity (EN 61000-4-3)	10 V/m
Electrical fast transient (EFT) immunity (EN 61000-4-4)	2 kV
Surge immunity (EN 61000-4-5)	2 kV on the power supply 1 kV on the current measuring inputs, RS485 and digital output
Conducted disturbance immunity (EN 61000-4-6)	10 V
Conducted and radiated emissions (EN 55032)	Class B
Safety	EN61010-1; EN61010-2-030
Certifications	 

3.6 RS485 port

RS485 port	
Protocol	Modbus RTU
Number of addresses	Up to 247 (default 1)
Baudrate	From 1200 to 115200 baud (default 9600)
Configuration parameters	Address Baudrate Parity Stop bit
Connection	via 3-pole terminal, 3.81 mm pitch
Cable cross-section	0.2 mm ² or less recommended. Belden 9841 cables or equivalent recommended

3.7 Ethernet port

Ethernet port	
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Ethernet port	
Protocol	Modbus TCP HTTP MQTT SNTP
Number of clients	Up to 10
Speed	10/100 Mbit/s
Related functions	Webserver Firmware update Communication Waveform display (FULL version only) Logging (FULL version only) MQTT (FULL version only)
Configuration parameters	IP address Subnet mask Gateway address TCP port DHCP MQTT Transmission power

3.8 Wifi port

Wifi port	
Protocol	Modbus TCP HTTP MQTT
Number of clients	Up to 10
Frequency	2.4 GHz 802.11 b/g/n
Related functions	Webserver Firmware update Communication Logging MQTT (FULL version only)
Configuration parameters	IP address Subnet mask Gateway address TCP port DHCP MQTT

3.9 Software functions

Software functions	
Measurement type	TRMS
Sampling rate	6400 samples/s @ 50 Hz 7680 samples/s @ 60 Hz
Measurement update	Programmable via software Default: every 50 cycles (AC) MAX: 65535 cycles
Transformation ratios	CT and VT default 1.0; configurable via software or the APP

Software functions

Transformation delays	0.0° @ 50 Hz default; configurable via software or the APP
Minimum display threshold	Configurable for voltage, current and power
Internal calendar	Both via NTP and via RTC. When the module is off, the RTC is powered by a 1220 coin cell battery, which can be replaced by lifting the display cover.

3.10 Digital output

Digital output

Use	Alarm or pulses/kWh
Number	1
Type	Solid state (opto-MOS)
Rating	< 40 V, < 100 mA
Connection	Via screw terminal, 5 mm pitch
Cable cross-section	0.2 mm ² or less recommended. Belden 9841 cables or equivalent recommended

3.11 Digital inputs (optional)

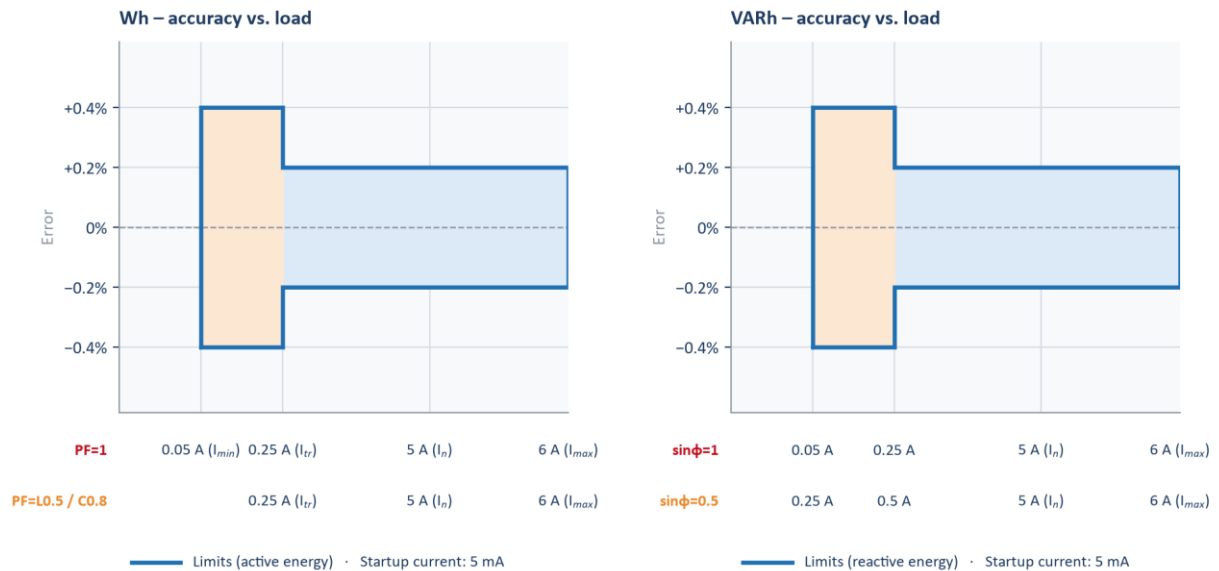
Digital inputs

Number	3 (D1, D2, D3) + GND (1 for EMT432)
Maximum frequency	3.2 kHz
Type	Inputs for dry contacts or NPN output from PLC
Maximum voltage	24 VDC
Reading	Via Modbus (registers status_digital_input and totalizer_1/2/3) Inputs page of the webserver

4 ADDITIONAL INFORMATION

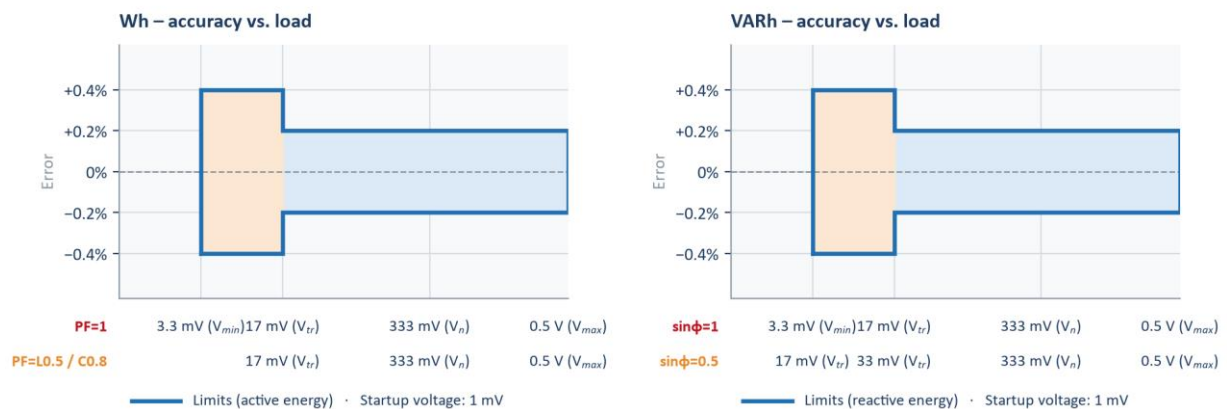
4.1 Accuracy (according to EN50470-3 and EN62053-24)

CTs with current output



Wh and VARh accuracy as a function of load – CTs with current output (startup current: 5 mA)

CTs with voltage output



Wh and VARh accuracy as a function of load – CTs with voltage output (startup voltage: 1 mV)

Note: reactive power accuracy is guaranteed when the instrument is set to calculate Q using the Budeanu formula.

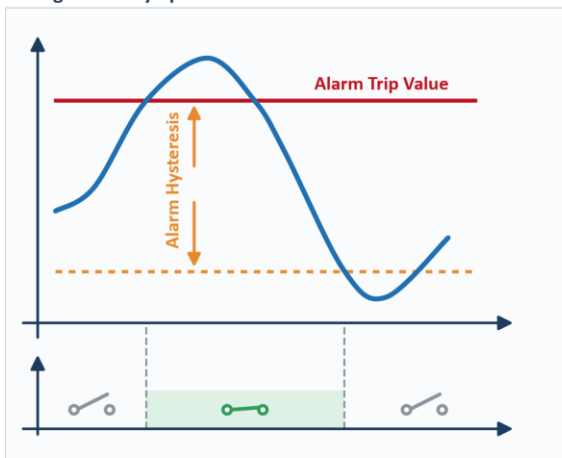
4.2 Digital output

The digital output can be set to work as an alarm or as a pulse output.

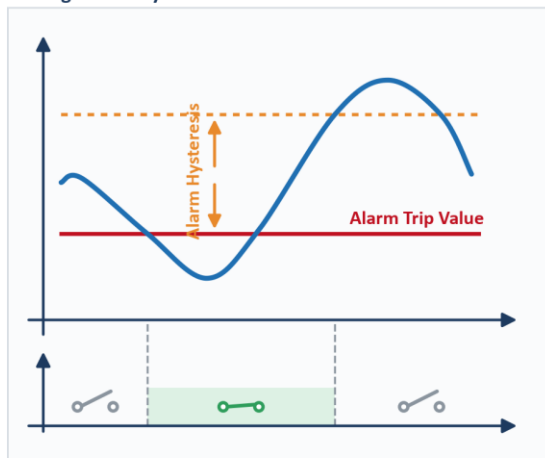
Alarms

Rising: normally open contact. Falling: normally closed contact. Window: contact closed between the thresholds, or contact closed outside the thresholds.

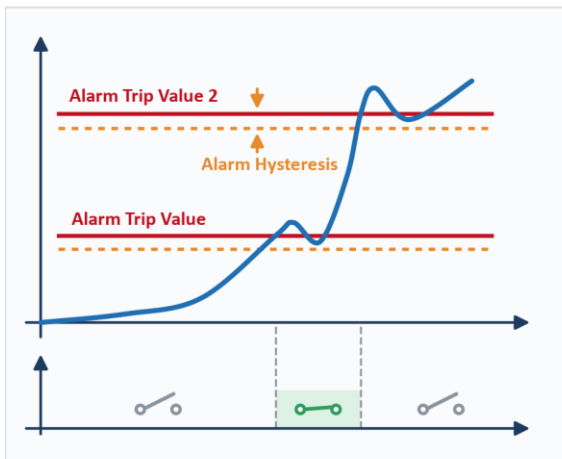
Rising: normally open contact



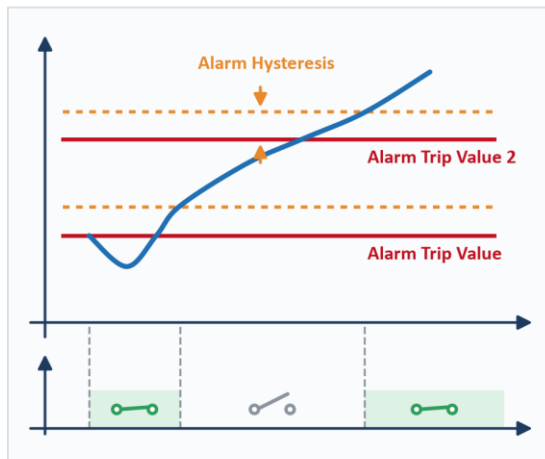
Falling: normally closed contact



Window: contact closed between the thresholds



Window: contact closed outside the thresholds

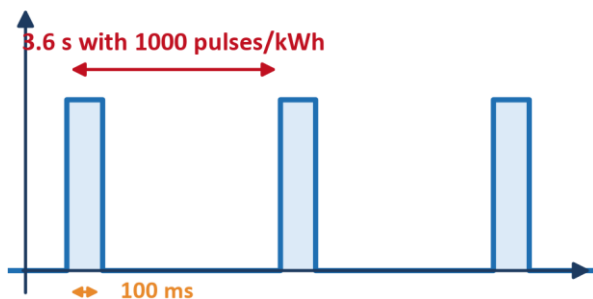


Alarm operation (Alarm Trip Value / Alarm Hysteresis)

Note: the buzzer can be associated with the alarms to obtain an audible alarm.

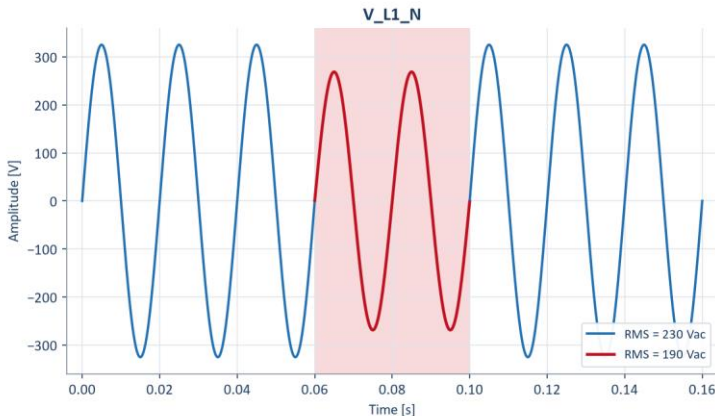
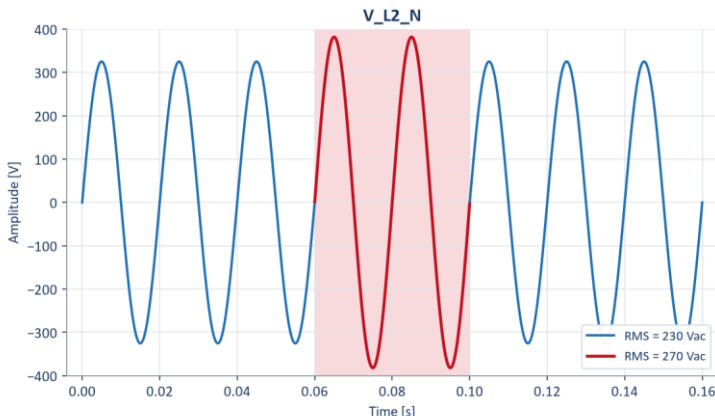
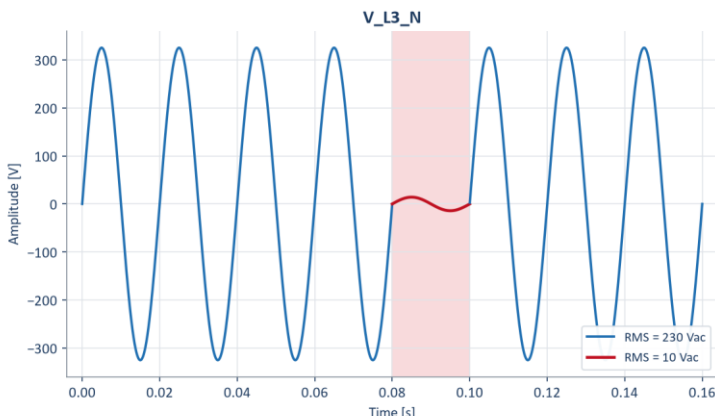
Pulse output

Pulse output as an alternative to the alarm digital output. Example: with 1000 pulses/kWh, 100 ms pulses.

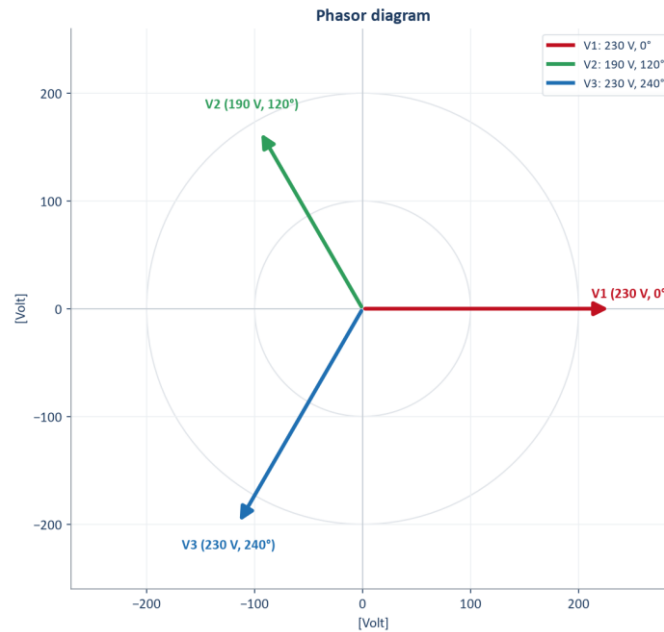


4.3 Power Quality

Examples of events recorded by the instrument:

Event	Recorded values (example)
SAG  Amplitude [V] Time [s] RMS = 230 Vac RMS = 190 Vac	Type: Sag Value: 190 V Query: 1 (V_L2_N) Duration: 40 ms
SWELL  Amplitude [V] Time [s] RMS = 230 Vac RMS = 270 Vac	Type: Swell Value: 270 V Query: 2 (V_L2_N) Duration: 40 ms
INTERRUPTION  Amplitude [V] Time [s] RMS = 230 Vac RMS = 10 Vac	Type: Interruption Value: 10 V Query: 3 (V_L3_N) Duration: 20 ms

4.4 Unbalance



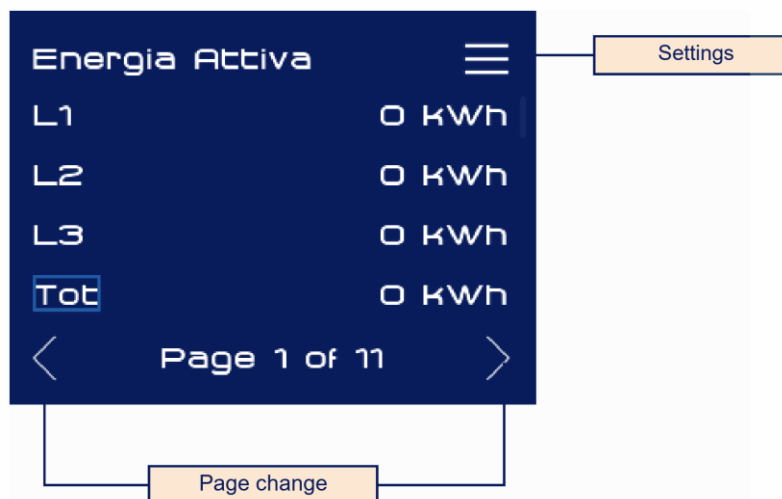
Phasor diagram – example with Unbalance: 6.15%

4.5 Real-time waveforms

The analyzer can record up to 10 waveforms (3 phase-to-neutral voltage channels, 3 phase-to-phase, 4 line currents). 128 samples are acquired for each period; sampling is at 6400 sps @ 50 Hz. The waveforms can be displayed directly via the webserver. The values can also be accessed via Modbus registers, either through RS485 (Modbus RTU) or through Wifi or Ethernet (Modbus TCP, recommended).

4.6 Graphical interface

The touch display shows the measurements on several pages: the arrows at the bottom change page, the icon at the top right opens the settings.



Graphical interface: page change and access to settings

4.7 Calculation formulas

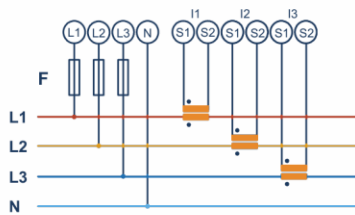
Phase variables	System variables	Energy metering
<i>RMS voltage</i>	<i>Average voltage</i>	<i>Active energy</i>
$V_i = \sqrt{\frac{1}{N} \sum_{i=1}^N (v_{Li})^2}$	$V_{AVG} = \frac{V_1 + V_2 + V_3}{3}$	$Wh_i = \int_{t_1}^{t_2} P_i(t) dt \approx \Delta t \sum_{n_1}^{n_2} P(n)_i$
<i>RMS current</i>	<i>Average current</i>	<i>Reactive energy</i>
$I_i = \sqrt{\frac{1}{N} \sum_{i=1}^N (i_{Li})^2}$	$I_{AVG} = \frac{I_1 + I_2 + I_3}{3}$	$VARh_i = \int_{t_1}^{t_2} Q_i(t) dt \approx \Delta t \sum_{n_1}^{n_2} Q(n)_i$
<i>Active power</i>	<i>Three-phase active power</i>	<i>Apparent energy</i>
$P_i = \frac{1}{N} \sum_{i=1}^N v_{Li} \cdot i_{Li}$	$P_{3PH} = P_1 + P_2 + P_3$	$VAh_i = \int_{t_1}^{t_2} S_i(t) dt \approx \Delta t \sum_{n_1}^{n_2} S(n)_i$
<i>Apparent power</i>	<i>Three-phase apparent power</i>	<i>Voltage unbalance</i>
$S_i = V_i \cdot I_i$	$S_{3PH} = S_1 + S_2 + S_3$	$V_{UNB} = \frac{MAX(V_i - V_{AVG})}{V_{AVG}}$
<i>Reactive power</i>	<i>Three-phase reactive power</i>	Where: i = phase considered (L1, L2 or L3); P = active power; Q = reactive power; t1, t2 = start and end of the metering period; n = time unit; t = time unit width; n1, n2 = first and last time unit in the metering period.
$Q_i = \frac{1}{N} \sum_{i=1}^N v_{Li} \cdot \widehat{i_{Li}} \quad \text{Budeanu}$ $Q_i = \sqrt{S_i^2 - P_i^2} \quad \text{triangle}$	$Q_{3PH} = Q_1 + Q_2 + Q_3$	
<i>Power factor</i>	<i>Three-phase power factor</i>	
$\cos \phi_i = \frac{P_i}{S_i}$	$\cos \phi_{3PH} = \frac{P_{3PH}}{S_{3PH}}$	

5 WIRING DIAGRAMS

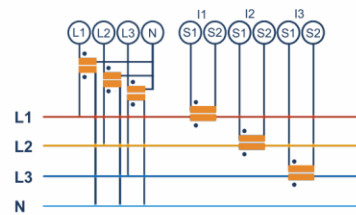
5.1 Measuring inputs

The wiring diagrams of the measuring inputs are common to all models.

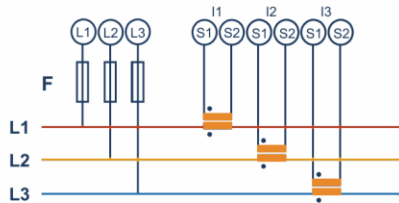
Three-phase, 4 wires, connection with 3 CTs



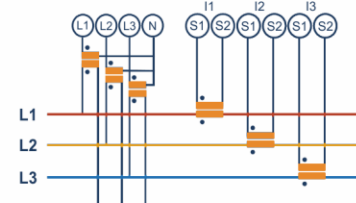
Three-phase, 4 wires, with 3 CTs and 3 VTs



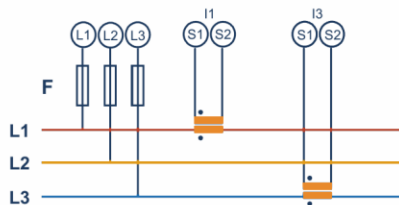
Three-phase, 3 wires, connection with 3 CTs



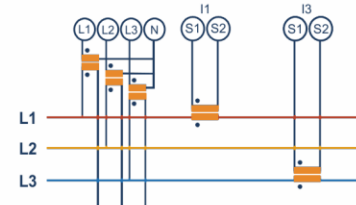
Three-phase, 3 wires, with 3 CTs and 3 VTs



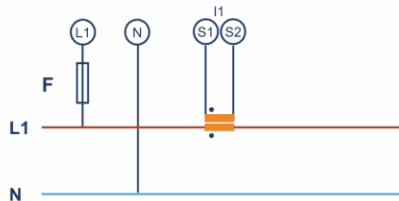
Three-phase, 3 wires, with 2 CTs (Aron)



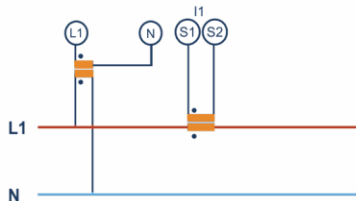
Three-phase, 3 wires, 2 CTs and 3 VTs (Aron)



Single-phase, 2 wires, connection with 1 CT

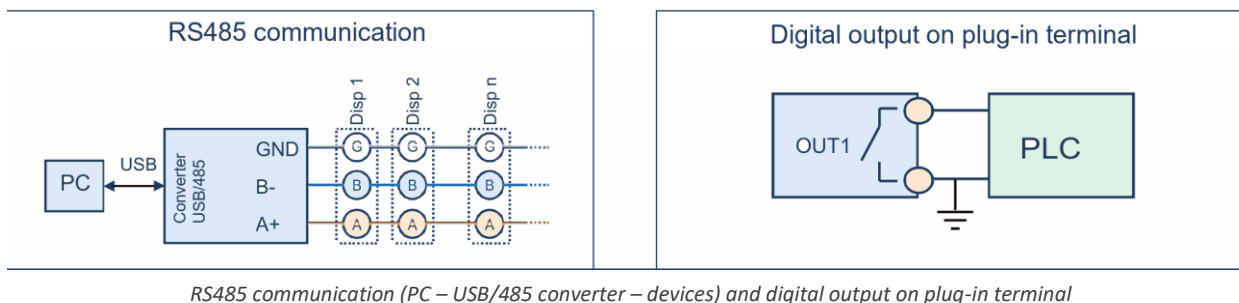


Single-phase, 2 wires, with 1 CT and 1 VT



Three-phase 4-wire, three-phase 3-wire, Aron and single-phase connections, with and without VTs (F = protection fuse)

5.2 RS485 communication and digital output



5.3 Power supply

Power supply connection			
	EMT430	EMT431	EMT432
Connection	No dedicated power terminal: the instrument is powered from the voltage inputs (L-N).	POW terminal: 90 - 350 VDC / 85 - 265 VAC	POW terminal (red): from SELV power supply 10..36 VDC / 19..26 VAC

Power supply

EMT431 power supply

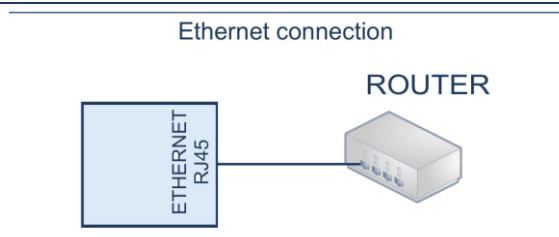
Power supply

EMT432 power supply

5.4 Digital inputs (DIN option)

Digital inputs connection	The digital inputs work up to 3.2 kHz. They are inputs for dry contacts or NPN output from PLC and accept up to 24 VDC. They can be read via Modbus (registers status_digital_input and totalizer_1/2/3) or on the Inputs page of the webserver.
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5.5 Ethernet connection



If the connection is correct, the green LED (LINK) is steady on and the yellow LED (ACTIVITY) flashes intermittently.

5.6 Installation, safety and maintenance warnings

N.B.: since the instrument is class II, according to standard EN 61140:2004-05 "Protection against electric shock - Common aspects for installation and equipment - Equipotential bonding", earthing the instrument is forbidden, to avoid damaging the device and reducing the safety of the installation.

- Device intended exclusively for indoor installation in an electrical panel (degree of protection provided by the panel).
- The device must be connected downstream of a circuit breaker or disconnector that is easily accessible and marked as the disconnecting device of the equipment.
- The unit does not require any cleaning or decontamination by the user.
- All maintenance, inspection or service activities must be carried out exclusively by personnel authorised by Chronos.

6 FIRST CONNECTION

6.1 With firmware up to and including rev 006

To connect to the instrument via Wifi, follow these steps:

1. Using a smartphone, connect to the Access Point exposed by the instrument (by default **EMT43x_SerialNumber**, for example EMT431_SerialNumber). Password: "**123456789**".
2. Disable mobile data.
3. Open a browser (e.g. Chrome) and enter the address **192.168.4.1**.
4. Enter user name and password: **"admin"**, **"admin"**.
5. In the built-in webserver, on the Wifi connections page, enter the SSID and password of the Wifi network to be used.
6. Restart the instrument, which will then be visible directly from the local network. If the connection was successful, the Wifi icon on the front of the instrument turns white. To check correct operation, access the internal webserver, where the main electrical quantities can be monitored; they should match the expected values.

6.2 With firmware from rev 007

To connect to the instrument via Wifi, follow these steps:

1. Using a smartphone, connect to the Access Point exposed by the instrument (by default **EMT432-WifiAP-SerialNumber**). Password: the one shown on the label as **PW AP**.
2. Disable mobile data.
3. Open a browser (e.g. Chrome) and enter the address **https://192.168.4.1**.
4. Enter user name **"admin"** and the password shown on the label as **PW WEB**.
5. In the built-in webserver, on the Wifi connections page, enter the SSID and password of the Wifi network to be used.
6. Restart the instrument, which will then be visible directly from the local network. To check correct operation, access the internal webserver, where the main electrical quantities can be monitored; they should match the expected values.

7 ORDER CODES

EMT43x – Input type – Version – Expansion (EMT432 only)

Series	Input type	Version	Expansion (EMT432 only)
EMT430 = self-powered EMT431 = power supply 90-350 VDC / 85-265 VAC EMT432 = SELV power supply 10-36 VDC / 19-26 VAC	I = 5 A (1 A) CT V = 333 mV CT / Rogowski	BASE = base model FULL = model with advanced electrical analysis, logging and MQTT	DIN = 3 digital inputs 3.2 kHz (only one DIN for EMT432) LORA = LoRa expansion

Examples

Code	Description
EMT430 I FULL	EMT430 with 5 A CT input, model with advanced analysis and logging
EMT431 I FULL	EMT431 with 5 A CT input, model with advanced analysis and logging
EMT430 I FULL DIN	EMT430 with 5 A CT input, model with advanced analysis and logging, with 3 digital inputs

CHRONOS SRL

Registered office Via Germania 7 - int 6 35010 Vigonza (PD) VAT no. / Tax code: 05248100280 SDI: M5UXCR1 PEC: chronos-pec@pec.it	Operational headquarters Via Ceresina 11/E 35030 Selvazzano Dentro (PD) Phone: +39 049 2274996 Email: info@chronos-tech.it
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