Bulletin 1405 (M620) Operating Instructions

Overview

The MiniPowermonitor (1405-M620) measures all the important parameters of 3-phase power lines in low-voltage AC power applications. The measurements are indicated on a 3-line display, one parameter at time, either by auto-sequencing or by manual access. There are 6 parameter groups:

- Line-to-line voltages
- Line-to-neutral voltages
- Instantaneous, time-averaged and peak currents
- Real power per phase, apparent power per phase, total real and apparent power, and 3-phase power factor
- Power factor (Cos ϕ) per phase
- Net real energy: per phase and total for all 3 phases

Phase voltages are monitored continuously for under- and over-voltage conditions, and when such a condition is detected, an alarm relay is activated. Energy units are also transmitted as relay pulses. Relay contacts are connected via rear panel terminal points.

Measured values for each of the 3 phases are indicated simultaneously on bright red 7-segment LED displays, 14 mm high, arranged in 3 horizontal lines of 5 digits each. The displayed values can be easily read even in high ambient light conditions, at substantial viewing distances, and at acute viewing angles.

The left-most 7-segment digit on each of the three lines functions as a limited alphanumeric indicator. These digits, along with the LED status lamps on the right of the instrument front panel, indicate either which measurement parameter is being displayed at any instant, or the set-up status.

The instrument is operated through three key-switches (“-“, “F”, and “+”) arranged in a row at the bottom right of the front panel. These keys are used for instrument set-up, and for manual selection of displayed measurements. Different functions are selectable using the function (“F”) key-switch, by keeping it pressed for varying lengths of time. The left-most character of the lowest display line indicates the selected function.

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External connections to the instrument are terminated on plug-in connector blocks with spring-clamp wire terminals, at the rear of the instrument. Phase voltage connections are terminated on a 7-pin connector block. Another 12-pin connector block is used for the current transformer inputs, and alarm and energy pulse relay outputs.

The instrument's operating power supply is drawn from a separate 120V or 240V ac power supply input, through an additional 3-pin connector block. An optional 400V or 480V version of the unit is available with operating power drawn from two of the phase voltage input lines (L1 - L2). Therefore the M620 can be used with either 3-wire (3 phase) or 4-wire (3 phase and neutral) power systems.

The M620 is a compact instrument, with a 96 x 96 mm front panel, and a depth of approximately 85 mm.

Installation

Only qualified personnel should install and wire this equipment. Refer to the following safety guidelines prior to installation.

ATTENTION

Only qualified personnel, following accepted safety procedures, should install and wire the MiniPowermonitor. Before beginning any work, disconnect all sources of power and verify that they are de-energized and locked out. Failure to follow these instructions may result in personal injury or death, property damage or economic loss.

ATTENTION

Never open a current transformer (CT) secondary circuit with primary current applied. Wiring between the CTs and the MiniPowermonitor should include a shorting terminal block in the CT secondary circuit. Shorting the secondary with primary current present allows other connections to be removed if needed. An open CT secondary with primary current applied produces a hazardous voltage, which can lead to personal injury, death, property damage or economic loss.

1. Install your MiniPowermonitor within a suitable enclosure. Make sure the enclosure provides adequate clearance for ventilation and wiring of the module. Refer to Dimensions on page 17 for dimensions and spacing guidelines for the MiniPowermonitor.

2. Determine your wiring mode and install wiring between the MiniPowermonitor and your power system. Refer to Electrical Connections on page 3 for more information.

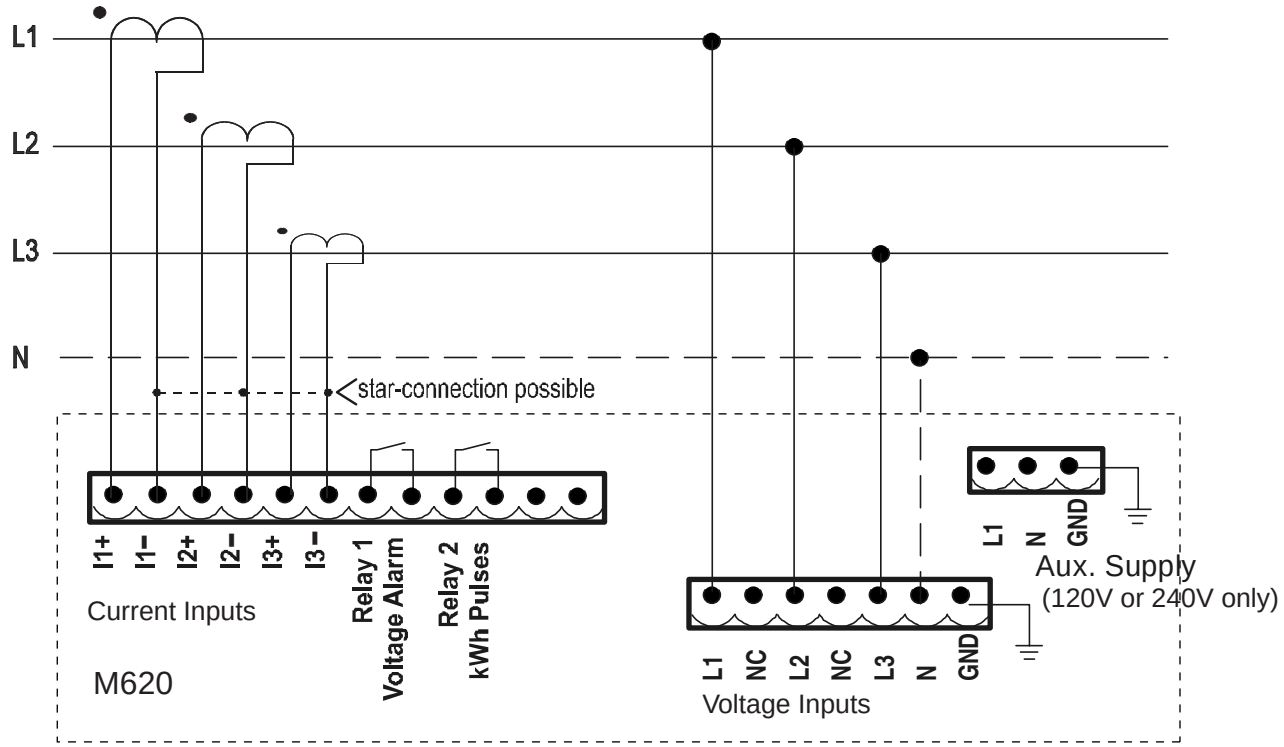
3. Configure the instrument settings to match those used in your power system connections. Refer to Instrument Set-Up on page 11 for more information.

Grounding

MiniPowermonitors do not need to be grounded because of the isolated enclosures. Follow all local requirements for grounding of PT and CT secondaries.

Electrical Connections

Electrical connections are terminated on two plug-in connector blocks with spring-clamp wire terminals, at the rear of the instrument. These connector blocks, 7- and 12-pin respectively, can accept wire sizes from 28 to 14 AWG (0.08 to 2.5 sq.mm).



TIP Pins 2 and 4 (counting from the left side) of the 7-pin connector are not used: no external wires should be connected to these terminals!

CT Connection: Careful consideration should be given when connecting the secondary of the CT to the current inputs of the MiniPowermonitor. Extended lengths of connection wire will cause the VA rating of the CT to increase and will create higher common mode input voltage. It is recommended that the wire size be selected to limit the impedance to 200 milliohms. Exceeding this limit may cause current readings to become less accurate when using a star connection.

Aux Supply: With this option, instrument power is supplied by a separate 120V or 240V line, independent of the measured power lines. A third connector block (3-pin, spring-clamp terminals type) is added at the rear with this option.

IMPORTANT Units are rated 120V or 240V but not both. A 120V unit will not accept 240V, and a 240V unit will not accept 120V.

A unit with the 120V supply option is not designed to operate on 240V or any other voltage. Likewise, a unit with the 240V supply option is not designed to operate on 120V or any other voltage. Units designed for 400V and 480V operation do not have an auxiliary supply connection and receive power from the measurement line. Ensure that each unit is properly supplied with a power source that matches the voltage designation of your unit.

Relay Output Connections

Alarm and energy pulse relay contact connections are made to the spring-clamp wire terminals on the 12-pin connector block, as follows:

Table 1 Alarm and Energy Pulse Relay Contact Connections

Alarm:	Terminals 7 - 8
Energy pulses:	Terminals 9 - 10

Measurement Operations

Immediately after the instrument is switched on, the software version is first displayed for 8 seconds, after which the measured values are displayed. The measured parameter that is displayed when the instrument is switched on will be the main displayed parameter group that was on display when the instrument was switched off. This will happen regardless of whether the instrument was in the "constant parameter" or auto-sequencing display mode at that time the instrument was switched off.

In the "constant parameter" display mode, any one of the 6 parameter groups can be manually selected, by forward or backward sequential stepping, using the "+" or "-"keys. Only that parameter will be displayed, until another parameter is manually selected, or the instrument is switched to auto-sequencing display mode. Some of the parameter groups (current, power, and energy) have a main displayed parameter and also additional parameters within the same group. The additional parameters can be accessed when the instrument is displaying the main parameter of that group. For example, when the instrument is displaying current measurements, the main parameter displayed is instantaneous phase currents, while the additional parameters are time-averaged phase currents and peak phase currents. For power measurements, the main parameters displayed are real power for each phase. The additional parameters in this group are apparent power of each phase, total real and apparent power, and 3-phase power factor. When the instrument is displaying the main parameter of a group, the additional parameters within that group can be scrolled using the "F" key.

Measurement Modes

The functions of the instrument are accessed as follows:

Table 2

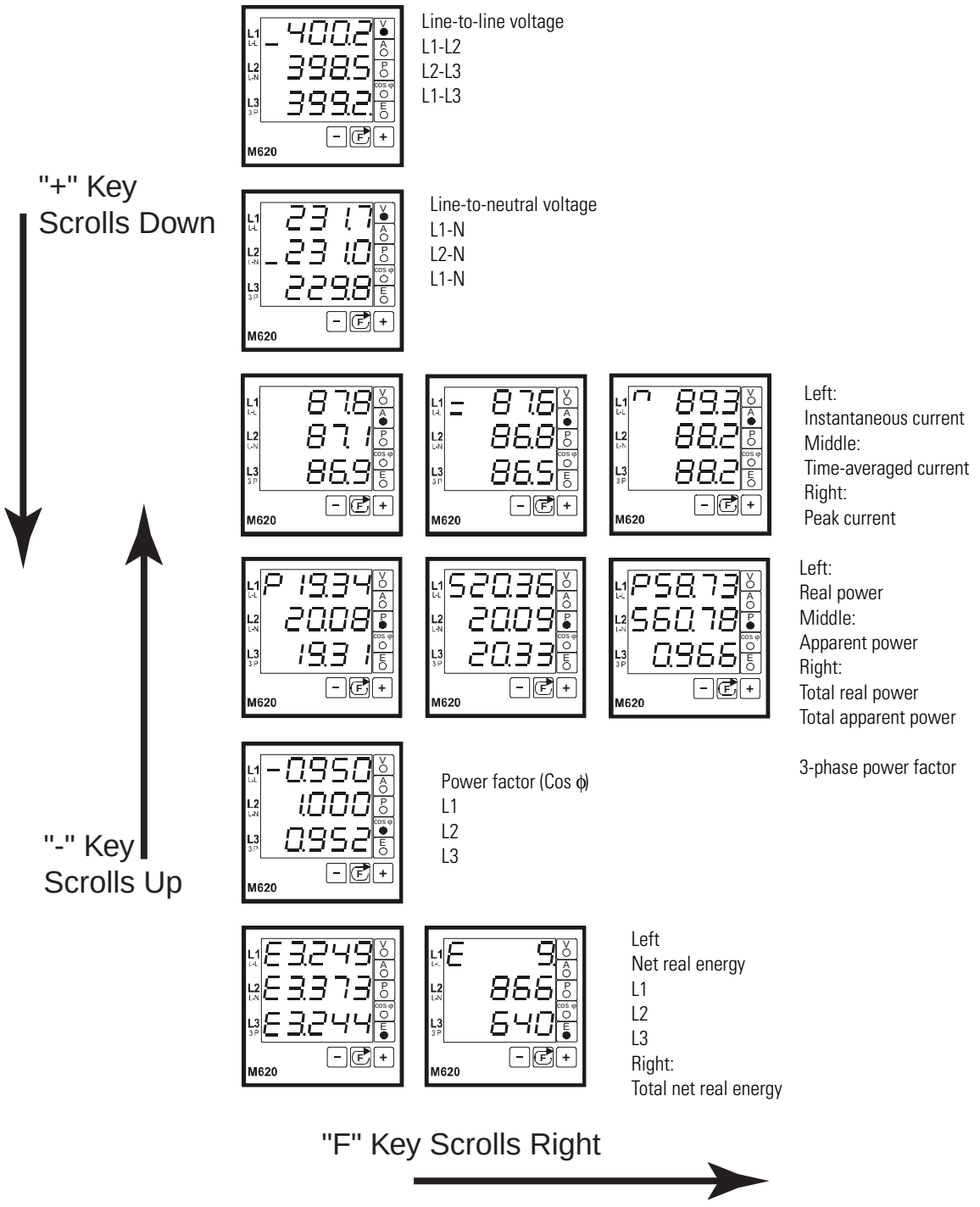
Key		Function Indication	Key Press Duration
"+"	Skip to the next measured parameter		Short
	Auto-sequencing display mode: enable / disable	- "r"	Long
	Re-set average and peak values	- "c"	Very long
"F"	Sequentially display one parameter type: e.g., current		Short
	Enter set-up mode		Very long
"-"	Go back to the previous displayed parameter		

The instrument measures voltage and current for each of three phases in an alternating sequence of 2 seconds each. This corresponds to the integrating time of the A/D converter circuits. At the same time, the values of power, power factor (Cos f), and energy consumption are computed. The energy value is computed for each phase over the integration period, and the accumulated values are stored in memory.

The measured voltage values are continuously evaluated for over- and under-voltage occurrences, and the energy transfer rate is converted to an output pulse rate. Voltage limit alarms and energy unit pulses are transmitted by relay contacts.

In the auto-sequencing displayed mode, the displayed parameter change every 6 seconds. The user can halt the auto-sequencing of displayed parameters, so that one desired parameter is displayed continuously. Independent of the sequencing mode, the measured values are updated and displayed in 2-second intervals.

The measured values of the electrical parameters are available with six analog retransmission outputs (4-20 mA) (optional). Details of these analog outputs are found on page 19.


"+" Key
Scrolls Down
"-" Key
Scrolls Up
"F" Key Scrolls Right
M620
Line-to-line voltage
L1-L2
L2-L3
L1-L3
Line-to-neutral voltage
L1-N
L2-N
L1-N
Left:
Instantaneous current
Middle:
Time-averaged current
Right:
Peak current
Left:
Real power
Middle:
Apparent power
Right:
Total real power
Total apparent power
3-phase power factor
Power factor (Cos ϕ)
L1
L2
L3
Left
Net real energy
L1
L2
L3
Right:
Total net real energy

Auto-Sequencing Display Mode

In this display mode, the instrument automatically switches the displayed values from one parameter group to the next, at intervals of 6 seconds, cycling continuously through all 6 parameter groups.

Any of the additional parameters can be selected instead of the main parameter. Thereafter only the selected additional parameter will be displayed when the turn of that parameter group comes up during display sequencing. For example, if time-averaged phase currents are selected in the current (I) parameter group, only these values will be displayed when it is the turn of this group during auto-sequencing. Irrespective of the specific parameter selected for display within each group, the total period of the display cycle for the 6 parameter groups remains constant.

Line-to-neutral voltages and line-to-line voltages are treated as separate parameter groups, so that both these parameters are always displayed during auto-sequencing.

Examples of all the parameter displays, and parameters grouping, are illustrated on the next page.

Analog Outputs

The M620 is also available with six analog retransmission outputs. These outputs can be user programmed for 0-20 mA or 4-20 mA, and assigned to any of the measured power-line measured variables. These outputs are electrically isolated from the rest of the instrument's circuits. Each output has a positive polarity. A common return line at 0 V potential is used for all analog outputs. Each output can drive a load of up to 250 ohms, with output voltage of up to 5V dc. These outputs may be connected in parallel.

Analog Output Connections

Connections to all analog outputs (1 to 6, depending on the option) are made via a 9-pin D-sub connector. The female socket is on the rear panel. A matching male connector with a patch cable is used for external connections. Pin assignments are as follows:

Table 3

Output	Pin	Output	Pin
Output 1	Pin 1	Output 2	Pin 2
Output 3	Pin 3	Output 4	Pin 4
Output 5	Pin 5	Output 6	Pin 6
Output GND	Pins 7, 8, 9		

Output Of Measured Variables

The measured values Voltage and Power Factor are scaled to half, and the mid-point of each of these variables is the mid-point of the output signal (selected mA current. range). The output ranges are as follows:

Table 4

Voltages L-L	$V = V_{nominal}$	Mid-point +/- 100 V
Voltages L-N	$V = V_{nominal} / 3$	Mid-point +/- 100 V
Power factor	(Cos ϕ)Cos ϕ = 1	Mid-point +/- 0.5
	Capacitive > mid-point	inductive < mid-point

The measured values of Current and Power are represented full-scale by the output signal (selected mA current range):

Table 5

Current	Full Scale = $I_{nominal}$
Power	Full Scale = $(V_{nominal} / \sqrt{3}) \bullet I_{nominal}$

With the output range set to 0 to 20 mA, the relationships are:

Table 6

Line-to-line voltages (V_{L-L})	$10\ mA + (V - V_{nominal}) \bullet 1\ mA / 10V$
Line-to-neutral voltages (V_{L-N})	$10\ mA + (\sqrt{3} \bullet V - V_{nominal}) \bullet 1\ mA / 10V$
Currents	$20\ mA \bullet I / I_{nominal}$

Table 6

Power (per phase)	$20\ mA \bullet PX / (V_{nominal} / \sqrt{3} \bullet I_{nominal})$
Total power	$20\ mA \bullet P / (V_{nominal} \bullet I_{nominal} \bullet \sqrt{3})$
Power factor	$10\ mA + 10\ mA \bullet ((1 - \cos f) / 0.5$ (capacitive) $10\ mA - 10\ mA \bullet ((1 - \cos f) / 0.5$ (inductive)

With the output range set to 4 to 20 mA, the relationships are:

Table 7

Line-to-line voltages (V_{L-L})	$4\ mA + 8\ mA + (V - V_{nominal}) \bullet 0.8\ mA / 10V$
Line-to-neutral voltages (V_{L-N})	$4\ mA + 8\ mA + (\sqrt{3} \bullet V - V_{nominal}) \bullet 0.8\ mA / 10V$
Currents	$4\ mA + 16\ mA \bullet I / I_{nominal}$
Power (per phase)	$4\ mA + 16\ mA \bullet PX / (V_{nominal} / \sqrt{3} \bullet I_{nominal})$
Total power	$20\ mA \bullet P / (V_{nominal} \bullet I_{nominal} \bullet \sqrt{3})$
Power factor	$4\ mA + 8\ mA + 8\ mA \bullet (1 - \cos f) / 0.5$ (capacitive) $4\ mA + 8\ mA - 8\ mA \bullet (1 - \cos f) / 0.5$ (inductive)

Instrument Set-Up

For instrument set-up, numeric values are entered in one of two ways.

For some setting, a continuously variable value is to be entered. In this case, the right-most digit of the display line blinks when a numeric value is to be altered. The value of each digit is changed in succession.

Table 8

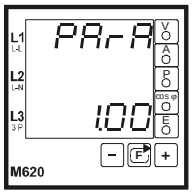
Key	Description
"+" key:	Scrolls a value of the currently blinking digit, from 0 through 9
"-"key:	Shifts to the next digit
"F" key:	Leaves the currently displayed value, and skips to the next setting

For other settings, a specific value is to be selected from a pre-programmed list of values. Digits do not blink, in this case.

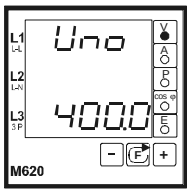
Table 9

Key	Description
"+" key:	Scrolls to the next higher value, of a list of fixed values
"-"key:	Scrolls to the next lower value, of a list of fixed values
"F" key:	Leaves the currently displayed value, and skips to the next setting

To enter into setting mode, the "F" key is kept pressed for 2.4 seconds, while the instrument is switched on. When this is done, the displays are initially unlit for a few seconds, and then the setting mode prompt ("PArA"), and the software version number are displayed. When the "F" key is released, the prompt for the first setting parameter appears: "Uno", which is the prompt for nominal voltage range selection.

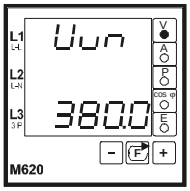


Begin settings
Indicates software version

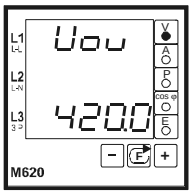


Select nominal voltage

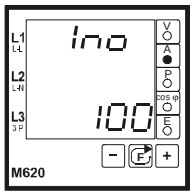
Repeatedly pressing the “F” key causes the prompts for the other parameters to be displayed in succession. If the settings are to be selected from a limited number of fixed values (e.g. the initial values of the energy counters, or the analog retransmission output ranges) only index characters are displayed.



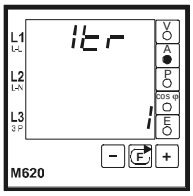
Set undervoltage alarm voltage limit
Range: 000.0 to 650.0 volts



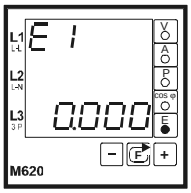
Set overvoltage alarm voltage limit
Range: 000.0 to 650.0 volts

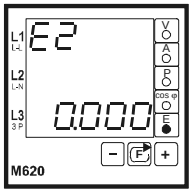


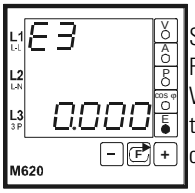
Select primary current transformer value.
Selectable values: 1, 2.5, 5, 10, 15, 20, 25, 30, 40, 50, 60, 75, 80, 100, 125, 150, 200, 250, 300, 400, 500, 600, 750, 800, 1000, 1200, 1250, 1500, 1600, 1800, 2000, 2500, 3000, 4000 amperes



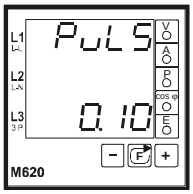
Select current transformer output range 1A or 5A



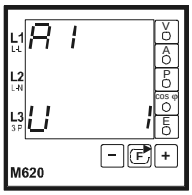


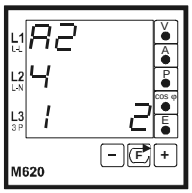


Set initial energy counter values
Range: 0000.000 to 0999.999 Mwh
When the value reaches 1000.000 Mwh, the energy counter resets to zero. Overflow condition is indicated by "c".



Select the energy pulse output rate
Selectable values: 0.00, 0.01, 0.10, 1.00, 10.0, 100 kWh/pulse
No pulse output if vale 0.00 is selectable

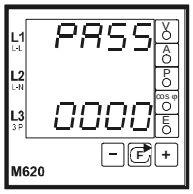




Similarly for analog outputs A3 through A6s

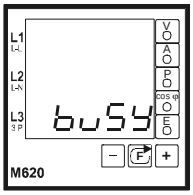
Assign optional analog outputs to measure parameters:
"-" key: V, n, I, =, c
"+" key: Phase 1, 2, or 3
"F" key: A1 to Ax
Analog output range:
Left: 0 to 20 mA
Right: 4 to 20 mA

The changed setting values are stored only when a password code is entered. The default password code is “3136”. After all the setting parameters are stepped through, the prompt “PASS” is displayed. If no password code or a wrong password code is entered, the instrument will exit the setting mode without storing any changes to the previous settings.

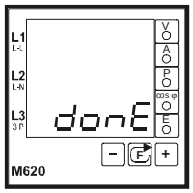


Enable storage of changed settings

Enter the password code



Store the changed settings



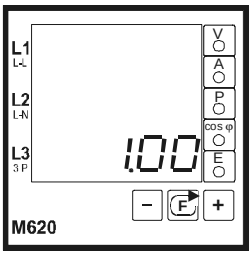
Settings done

Display Functions

The following display related functions are described below.

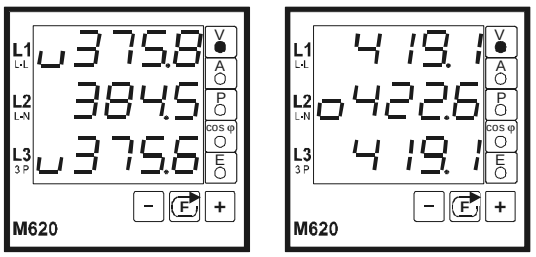
- Version indication
- Under- and overvoltage alarm indication
- Enabling / disabling the auto-sequencing display mode
- and re-setting peak values
- Re-set energy counters

Version indication: The software version of the instrument is indicated by this display, which determines the features and functions built into the instrument. This number should be stated if and when information or technical assistance is requested relating to this instrument.



Version number displayed at start

Under- and overvoltage alarm indication: If any of the phase voltages cross either of the user-programmed undervoltage or overvoltage limits, not only is the alarm relay activated, but also the alarm condition is indicated on the instrument display panel. An undervoltage condition causes the character "u" to blink in the left-most digit position to the left of the corresponding phase voltage display. An overvoltage condition is similarly indicated by the blinking character "o". These alarm indications are independent of the measuring range.

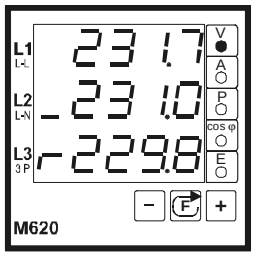


Under and overvoltage alarm indication

Enabling / disabling the auto-sequencing display mode and re-setting peak values: The "+" key has three functions, depending on the duration for which this key is pressed, and indicated by a function character at in the bottom left digit position. These functions are selected sequentially when this key is kept pressed for different durations.

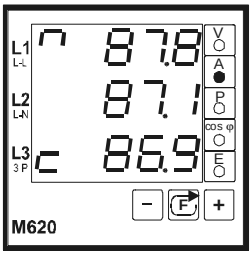
Table 10

Key Switch	Function	Function Indication	Key Press Duration
"+"	Skip to the next measured parameter		Approx. 0 to 2 seconds
	Auto-sequencing display mode: enable / disable	- "r"	Approx. 2 to 4 seconds
	Re-set peak current values	- "c"	Approx. 4 to 8 seconds



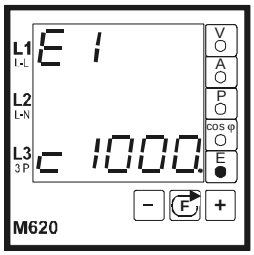
Auto-sequencing display enabled/disabled

The display can be manually skipped to the next measured parameter in the sequence, regardless of whether the auto-sequencing display mode is enabled or disabled. Similarly, the stored peak current values can be deleted at any time.



Reset peak current value

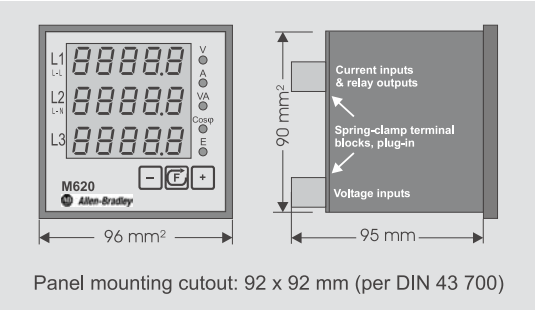
The setting of the initial values of the energy counters can be used for simply resetting any of them to zero, while the instrument is in set-up mode. To do this, first the "-"key is used to shift the digit to the left-most position. Then the "+" key is pressed to scroll the digit from 0 upward, until the function character "c" appears in the bottom left digit position. Since the counter capacity is limited to 0999.999 MWh, when it reaches 1000.000 MWh, it causes the counter to overflow, automatically resetting it to 0000.000 MWh. This value is then locked and stored by pressing the "F" key. Energy counting then starts from 0000.000 MWh. This setting is to be done for all three energy counters separately.



Reset energy counter

Dimensions

Panel cut-outs should be 92 x 92 mm (3.6 x 3.6 in).



Panel mounting cutout: 92 x 92 mm (per DIN 43 700)

Specifications

Table 11 Measured Parameters

Voltage, RMS (Vrms)	V_{L1-L2} / V_{L2-L3} / V_{L3-L1} V_{L1-N} / V_{L2-N} / V_{L3-N}
Instantaneous current Average current (15 min.) Peak current	I_{L1}, I_{L2}, I_{L3} I_{L1}=, I_{L2}=, I_{L3}= I_{L1}^, I_{L2}^, I_{L3}^
Real power	P_{L1}, P_{L2}, P_{L3}
Apparent power	S_{L1}, S_{L2}, S_{L3}
Total power (P, S, 3-Phase Power Factor)	P_S, S_S, P_S/S_S (power factor)
Power factor (Cos ϕ)	Cos_{L1}, Cos_{L2}, Cos_{L3}
Net real energy, per phase energy, total energy	E_{L1}, E_{L2}, E_{L3}, E_S
Energy counter range per phase	1000.000 MWh
Measuring rate	Approx. 0.5 measurements / second
Update time	2 seconds

Table 12 General Parameters

Input impedance Voltage input, per phase	2 Mohm
Input load Current, 1A and 5A	0.02 ohm
Nominal voltage	per catalog number version Units with separate 120V or 240V supply: 600V Units powered from 400V measurement line: 400V Units powered from 480V measurement line: 480V
Nominal current input	1 A or 5 A
Overload current rating Nominal current input 5A	2 x, continuous

Table 12 General Parameters

Temperature coefficient	< 0.01% / K
Temperature - Operating	+5 to +50°C (+41 to +122°F) (ambient)
Temperature - Storage	-20 to +70°C (-4 to +158°F)
Frequency range	47 to 63 Hz
Power consumption	Approx. 3 W
Weight	Approx. 0.3 kg
Front dimensions	96 x 96 mm
Breakdown rating	Per DIN 41700
Panel insertion depth	85 mm
Panel mounting fasteners	Screw clamps
Panel cutout dimensions	92 mm x 92 mm +/- 0.8 mm
Spacing between cutouts	4 mm (minimum), 20 mm (typical)
Protection class	Enclosure IP 20 (IP 65 with optional protective hood(1)) Terminals IP 00
Agency Certifications	UL, CE

(1) The optional hood, catalog number 1405-PRO, can be ordered separetly. Contact your Rockwell Automation distributor for additional information.

Table 13 Digital Displays

Type	7-segment LED, red
Lines x characters	3 x 5
Character height	14 mm

Table 14 Relay Outputs

Alarm	Logic: contacts open on alarm
Energy pulses	Contacts close: 128 ms / 128 ms
Energy pulse output rate	Selectable: 0.01, 0.10, 1.00, 10.0, 100 kWh/pulse (0.0 disables)
Contacts rating Voltage	250Vac; 220V dc
Load:	60 VA; 60 W

Table 15 Measurement Accuracy and Range

Parameter	Percent of Reading	Nominal Value	Operating Range	Maximum Limit
Volts	±1%	240V rms	10V rms to 347V rms L-N or 17V rms to 600V rms L-L	400V rms L-N or 690V rms L-L
Current	±1%	5 Amps	0.1 Amps to 8 Amps	10 Amps
Power and Energy	±2%	n/a	n/a	n/a
Power Factor	±0.2%	n/a	n/a	n/a

Product Approvals

UL/CUL

cULus Listed, File E96956, per UL508, the Standard for Industrial Control Equipment.

CE Certification

If this product bears the CE marking, it is approved for installation within the European Union and EEA regions. It has been designed to meet the following directives.

EMC Directive

This product is tested to meet Council Directive 89/336/EEC Electromagnetic Compatibility (EMC) and the following standards, in whole, documented in a technical construction file:

- EN 50081-2 - Generic Emission Standard, Part 2 - Industrial Environment
- EN 61000-6-2 - Generic Immunity Standard, Part 2 - Industrial Environment.

This product is intended for use in an industrial environment.

Low Voltage Directive

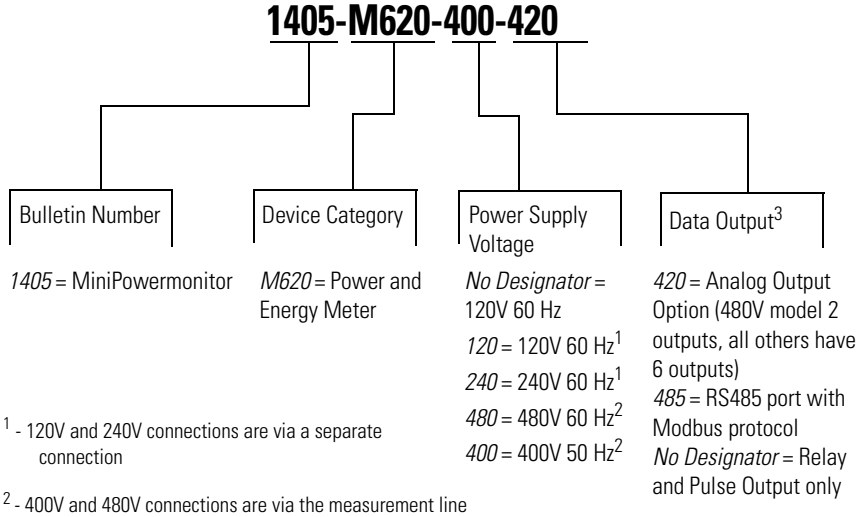
This product is tested to meet Council Directive 73/23/EEC Low Voltage, by applying the safety requirements of EN/IEC 61010-1.

This equipment is classified as open equipment and must be installed (mounted) in an enclosure during operation as a means of providing safety protection.

International Standard IEC 529 / NEMA / UL 508 Degree of Protection

The MiniPowermonitor is rated as IP10 degree of protection per International Standard IEC 529. It is considered an open device per NEMA and UL 508.

Catalog Number Explanation



[1] - 120V and 240V connections are via a separate connection

[2] - 400V and 480V connections are via the measurement line

3 - M620 current is 1A / 5A programmable

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