



PAM410 and 420

Phase angle meter and Multi function meter

User guide

PAM 410/420

Phase Angle Meter / Multi Function Meter

User guide

NOTICE OF COPYRIGHT & PROPRIETARY RIGHTS

© 2013-2023, Megger Sweden AB. All rights reserved.

The contents of this manual are the property of Megger Sweden AB. No part of this work may be reproduced or transmitted in any form or by any means, except as permitted in written license agreement with Megger Sweden AB. Megger Sweden AB has made every reasonable attempt to ensure the completeness and accuracy of this document. However, the information contained in this manual is subject to change without notice, and does not represent a commitment on the part of Megger Sweden AB. Any attached hardware schematics and technical descriptions, or software listings that disclose source code, are for informational purposes only. Reproduction in whole or in part to create working hardware or software for other than Megger Sweden AB products is strictly prohibited, except as permitted by written license agreement with Megger Sweden AB.

TRADEMARK NOTICES

Megger® and Programma® are trademarks registered in the U.S. and other countries. All other brand and product names mentioned in this document are trademarks or registered trademarks of their respective companies.

Megger Sweden AB is certified according to ISO 9001 and 14001.

Postal address:

Megger Sweden AB
Box 724
SE-182 17 DANDERYD
SWEDEN

Visiting address:

Megger Sweden AB
Rinkebyvägen 19
SE-182 36 DANDERYD
SWEDEN

T +46 8 510 195 00
E seinfo@megger.com

www.megger.com



Contents

1 General

.....	6
1.1 Description	6
1.2 Mains and power	6
Mains adapter.....	6
Battery charging.....	6
Battery inside	6

2 Safety

.....	7
2.1 Safety instructions.....	7
2.2 Symbols on the instrument	7

3 Panels

.....	8
3.1 Instrument panels	8
Front panel	8
Top panel.....	8

4 Phase angle measurements

.....	9
4.1 General application.....	9
4.2 Phase angle between voltages N-L1 and N-L2 9	
4.3 Phase angle between voltages N-L1 and L3-L2	10
4.4 Phase angle between voltages N-L1 and L2-L3	10
4.5 Phase angle between voltages L1-N and L3-L2	11
4.6 Phase angle between voltage N-L1 (U1) and current L1 (I2).....	11
4.7 Secondary testing of relay protection systems 12	
4.8 Directional testing of relay protection systems 12	

5 Timing (PAM420)

.....	13
5.1 Activating using voltage sense	13
Detect voltage presence	13
Detect voltage absence	13
5.2 Activating using contact sense	13
Closing contact.....	13
Open contact.....	13

6 Voltage current and frequency (PAM420).....

Voltage	14
Current	14
Voltage – Current.....	14

7 Calibration

.....	15
7.1 Standard calibration	15
Equipment needed.....	15
Calibration procedure	15
7.2 Check procedure after calibration	16
Voltage	16
Current	16
Phase angle.....	16
7.3 Timer	16

8 Specifications

.....	17
8.1 SPECIFICATIONS PAM420	17

1 General

1.1 Description

PAM410 and 420 are specifically designed for measurements on electrical power systems. The phase angle is calculated from the relationship between two power signals, either two currents or two voltages, or any combination. Current signals up to 25 amps and voltage signals up to 500 volts can be applied directly to the instrument. The current input range can be extended with the use of external current transformers.

The PAM420 has more functions. In addition to phase angle it is capable of displaying: voltage, current, frequency and timing.

	PAM410	PAM420
Phase Angle	X	X
Current		X
Voltage		X
Frequency		X
Timer		X
Chargeable batteries	X	X

1.2 Mains and power

Mains adapter

Model Skynet Electronic SNP-A02C

Input 100-240 V, 50/60 Hz

Output 9 V DC, 1.8 A

Battery power

Auto off

The instrument display backlighter is automatically turned off if not operated within 10 minutes (battery operated).

Auto off in TIMER mode – PAM420 only

You can chose if the instrument shall turn off automatic or not.

- 1] Press the MODE button for > 2 sec and select the status for Auto off by toggling Yes / No.

Battery charging

Use only the supplied mains adapter for charging. Charging time is approximately 4 hours.

Battery symbol on display

	Battery OK
 Blinking	Battery need charging

LED on Instrument (ON/OFF button)

Charging	blinking green
Fully charged	fixed green light

Note *The Instrument cannot be turned off while charging.*



Important

Old / worn out batteries should not be thrown away, they must be returned to the supplier or to a recipient for recycling of battery products. Illegal disposal can be harmful to human health and the environment.

Battery inside

This product is not intrinsically safe. Do not use in an explosive atmosphere

This instrument contains a lithium battery.

Do not pierce, damage, disassemble or modify the battery.

The battery contains safety and protection devices, which if tampered with may cause the battery to generate heat, rupture or ignite.

If the battery is suspected to be faulty – do not ship it, either separately or inside an instrument.

The instrument must be powered off and securely packaged before shipping.

Do not heat or dispose of the battery in a fire.

Do not subject the battery to strong impact, mechanical shock or excessive heat.

Do not short-circuit or reverse the polarity of the battery.

2 Safety

2.1 Safety instructions



Important

Read the manual and comply with the following instructions before using the instrument.

Always comply with local safety regulations.



Warning

Do not attempt to service the instrument yourself. Opening or removing covers may expose you to dangerous voltage. If you attempt to service the instrument yourself the warranty is no longer valid.

Do not use any accessories that are not intended for use together with the instrument.

If an external current transformer, e.g. current clamp, is used together with the instrument, make sure not to exceed max current (25 A) on the current inputs.

If the fuse blows, the open circuit will allow voltage on the current transformer's secondary side to increase to dangerous levels.

Voltage inputs are to be considered as CAT I if only one test lead is connected to the instrument voltage input and to a hazardous voltage.



Important

Always turn the equipment off before connecting.

Always use manufacturer approved and supplied cable sets.

Do not expose the instrument to rain or moisture.

Use a damp cloth for cleaning. Do not use liquid cleaners or aerosol cleaners.

Refer all servicing, including the exchange of fuses, to Megger authorized personnel.

If you need to return the instrument, please use either the original crate or one of equivalent strength

This equipment contains lithium batteries. Please follow current legislation for restrictions during shipment."

2.2 Symbols on the instrument



Caution, refer to accompanying documents.



WEEE, Waste Electrical and Electronic Equipment. Please utilize your local WEEE collection facilities in the disposition of this product and otherwise observe all applicable requirements.

The unit can also be returned to Megger at any time at no charge for the disposal.



Double insulated, does not require a safety connection to electrical earth (ground).

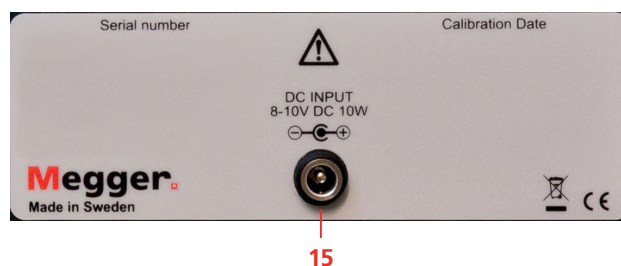
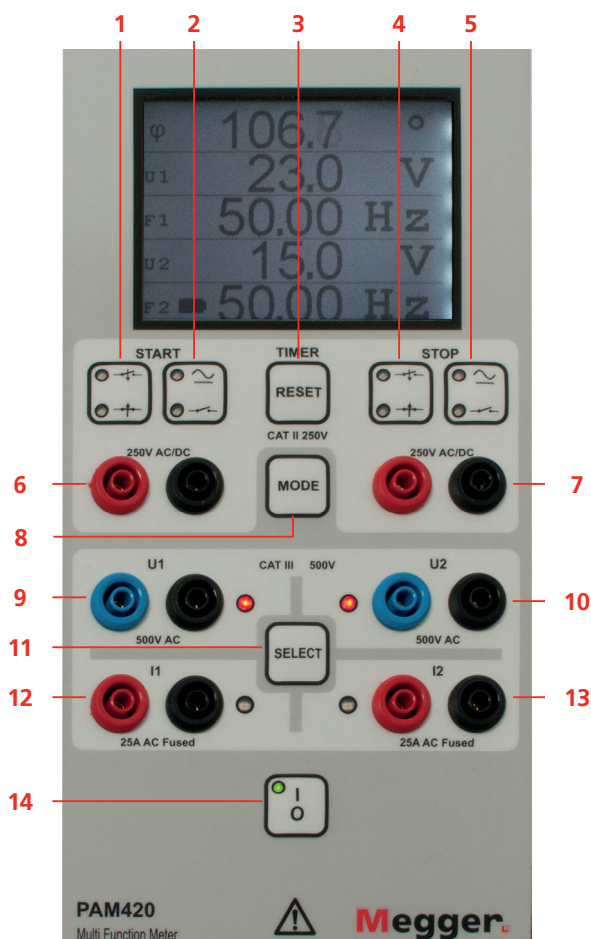
3 Panels

3.1 Instrument panels

Front panel

Note *The numbers 1 to 8 are for PAM420 only*

- 1 Button for selecting timer START condition:
Detect voltage presence / Detect voltage
absence or
Closing contact / Open contact
- 2 Button for selecting timer START condition:
Voltage / Contact
- 3 Button for resetting of timer
- 4 Button for selecting timer STOP condition:
Detect voltage presence / Detect voltage
absence or
Closing contact / Open contact
- 5 Button for selecting timer STOP condition:
Voltage / Contact
- 6 Start inputs
- 7 Stop inputs
- 8 Button for section of measurement mode:
Timer / Phase Angle Meter, I, U and f - Meter
(analog measurements)
- 9 Phase angle input for voltage (U1)
- 10 Phase angle input for voltage (U2)
- 11 Button for selection of criteria for phase
angle measurement
- 12 Phase angle input for current (I1)
- 13 Phase angle input for current (I2)
- 14 Button for switching instrument On/Off
- 15 Input for battery charger



Pam410 panel

4 Phase angle measurements

4.1 General application



Important

Read the manual and comply with the Safety instructions before using PAM410/420.

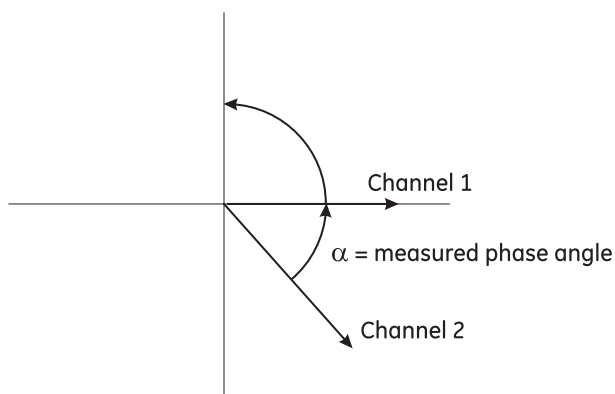
Always comply with local safety regulations.

The instrument is constructed with two equal measuring channels, where each channel can be used for either current or voltage measuring. Phase angles can also be measured between two voltages, between two currents or between current and voltage.

The phase angle is measured between U1 and U2. These channels are galvanic separated.

Current and voltage input on the same channel for example I1 and U1 are not to be connected at the same time.

The measuring magnitude on channel 2 is shown angular always after channel 1

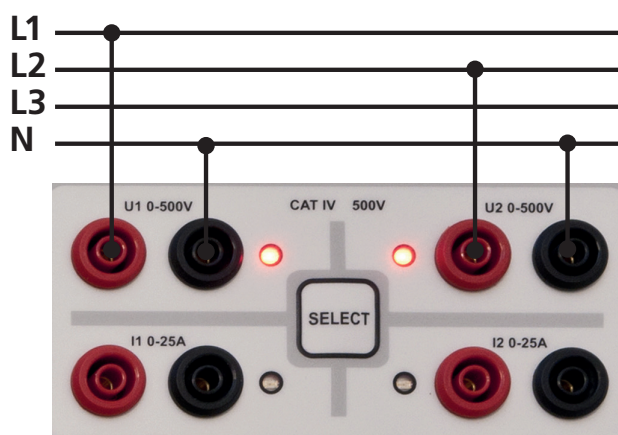


4.2 Phase angle between voltages N-L1 and N-L2

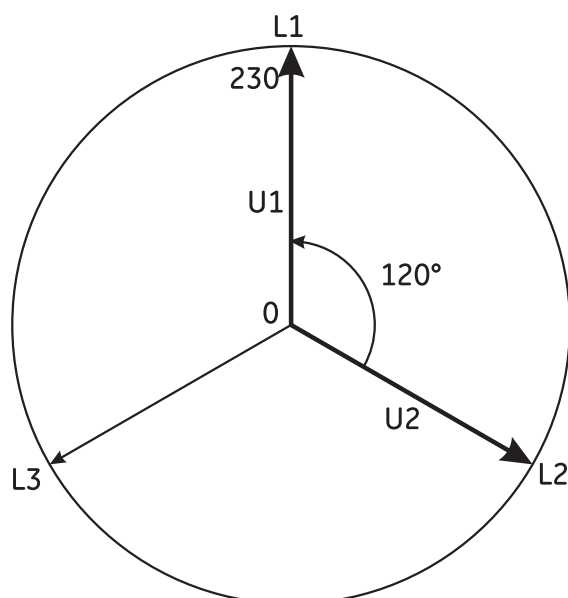
1] Connect as follows:

U1	U2
L1 to input U1 (red)	L2 to input U2 (red)
N to input U1 (black)	N to input U2 (black)

2] Repeatedly press the SELECT button until the U1 and U2 LEDs are lit.



3] Read the result on the display
Example: The displayed phase angle value is 120°.



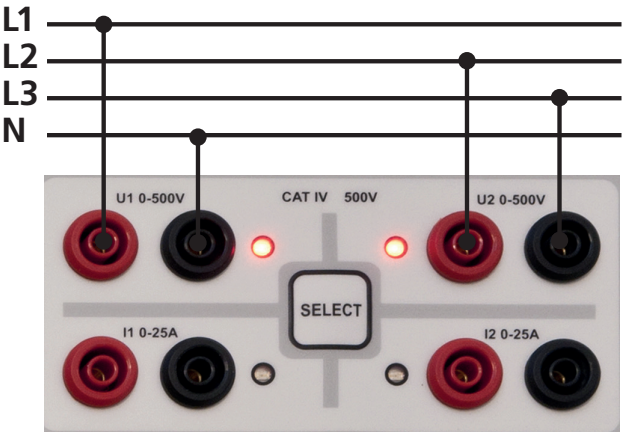
The instrument shows 120° where U2 is after U1 in phase.

4.3 Phase angle between voltages N-L1 and L3-L2

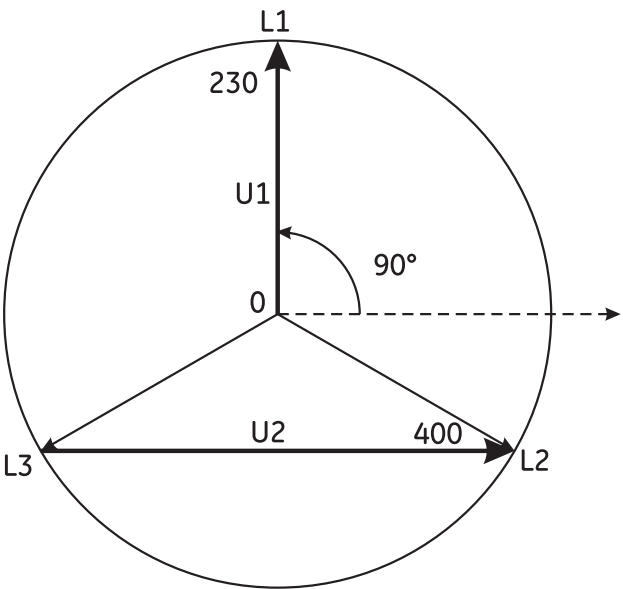
1] Connect as follows:

U1	U2
L1 to input U1 (red) N to input U1 (black)	L2 to input U2 (red) L3 to input U2 (black)

2] Repeatedly press the SELECT button until the U1 and U2 LEDs are lit.



3] Read the result on the display
Example: The displayed phase angle value is 90°.



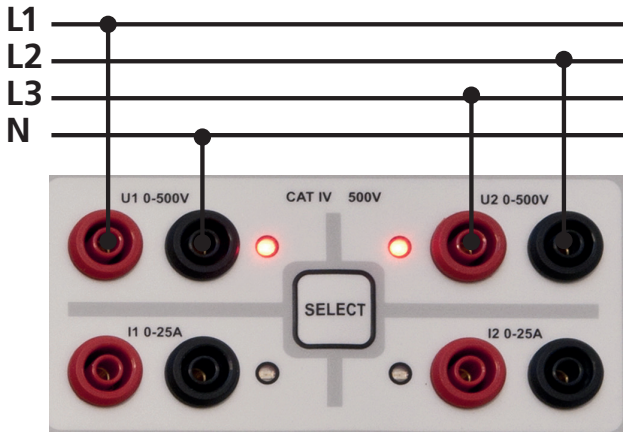
The instrument shows 90° where U2 is after U1 in phase.

4.4 Phase angle between voltages N-L1 and L2-L3

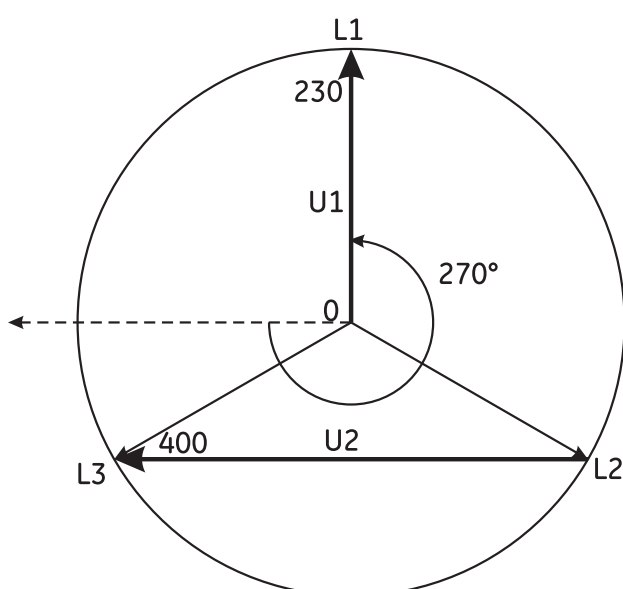
1] Connect as follows:

U1	U2
L1 to input U1 (red) N to input U1 (black)	L3 to input U2 (red) L2 to input U2 (black)

2] Repeatedly press the SELECT button until the U1 and U2 LEDs are lit.



3] Read the result on the display
Example: The displayed phase angle value is 270°.



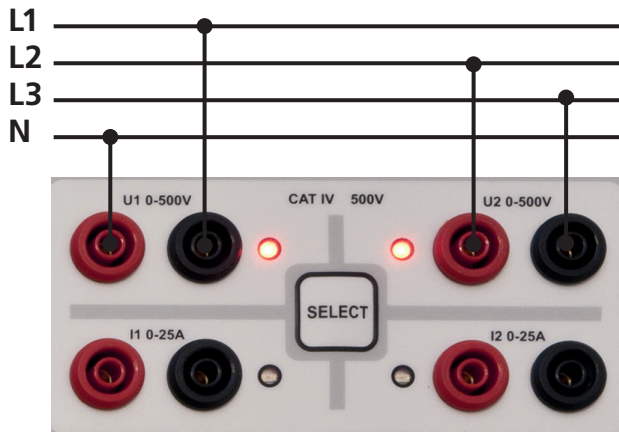
The instrument shows 270° where U2 is after U1 in phase.

4.5 Phase angle between voltages L1-N and L3-L2

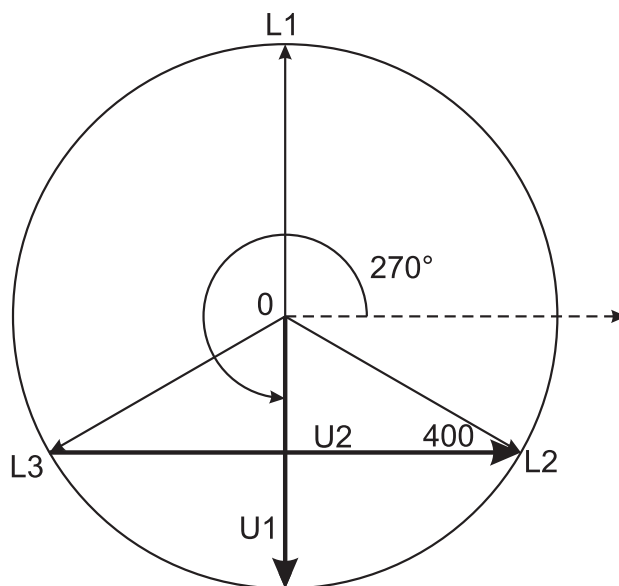
1] Connect as follows:

U1	U2
L1 to input U1 (black) N to input U1 (red)	L2 to input U2 (red) L3 to input U2 (black)

2] Repeatedly press the SELECT button until the U1 and U2 LEDs are lit.



3] Read the result on the display
Example: The displayed phase angle value is 270°.



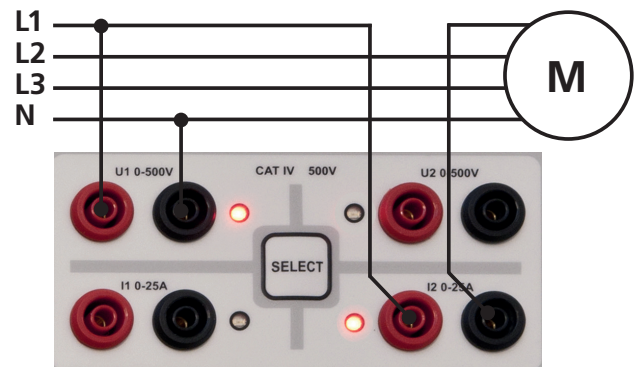
The instrument shows 270° where U2 is after U1 in phase.

4.6 Phase angle between voltage N-L1 (U1) and current L1 (I2)

1] Connect as follows:

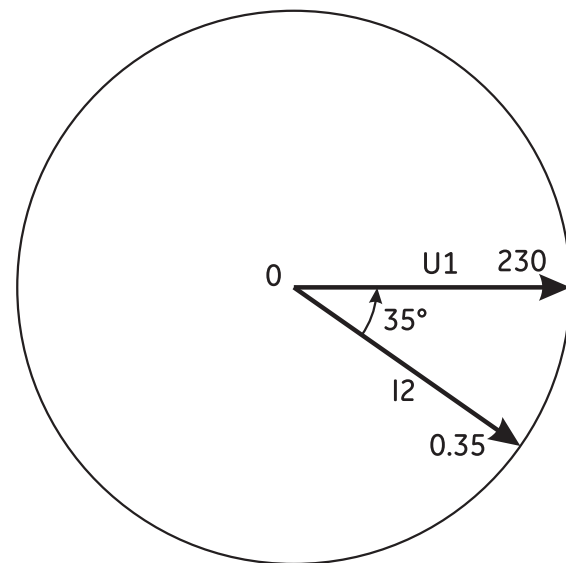
U1	I2
L1 to input U1 (red) N to input U1 (black)	L1 to input I2 (red) L1 (motor) to input I2 (black)

2] Repeatedly press the SELECT button until the U1 and U2 LEDs are lit.



3] Read the result on the display.

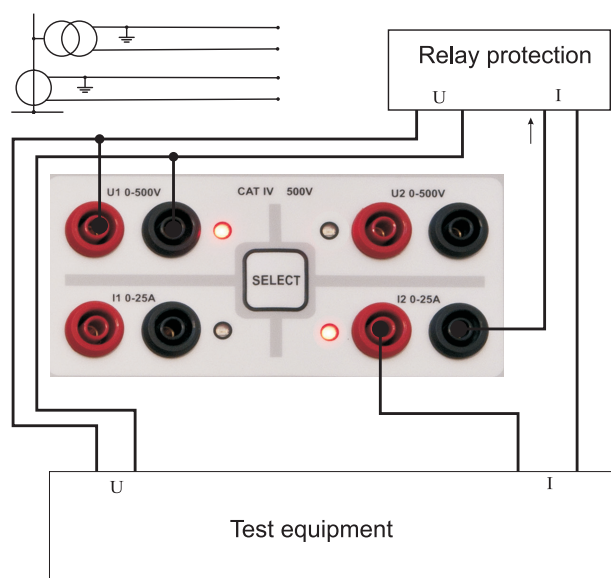
Motor current 0.35 A



The instrument shows about 30 – 50° depending on the load of the motor where I2 is after U1 in phase.

4.7 Secondary testing of relay protection systems

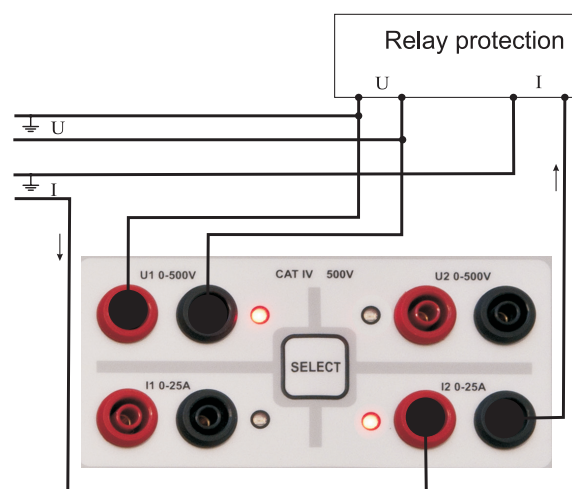
At secondary testing of a relay protection to verify that the protection gives tripping in between given angle range can be done by using the phase angle meter. Relay protection and connections to testing device are controlled thereby.



Secondary testing

4.8 Directional testing of relay protection systems

After installing the object, control the connections between test cut and measuring transformers through directional testing with the help of the phase angle meter. Connect the instrument with the same connection as at the secondary test. With knowledge about actual power direction, it can be determined whether the protection is correct connected.



5 Timing (PAM420)

5.1 Activating using voltage sense

Detect voltage presence



Detect voltage absence



5.2 Activating using contact sense

Closing contact



Open contact



Any combination of start and stop can be selected. The reset button sets the time to zero, and enables a new start.

Example

If you want to measure the operation time for a 24 V DC contactor with 110 V DC over a closing contact under load.

- 1] Set the START buttons as "Detect voltage presence".
- 2] Connect the start leads across the contactor coil (regardless of polarity).
- 3] Set the STOP buttons as "Detect voltage presence".
- 4] Connect the stop leads across the load (regardless of polarity). If it is desired to measure directly at the contact, set the stop buttons as "Detect voltage absence".

6 Voltage current and frequency (PAM420)

Voltage

- 1] Press SELECT button to activate the correct inputs.



One voltage – Measuring input U1

φ	- - - . -	°
U1	228.1	V
F1	50.02	Hz
U2	0.0	V
F2	- - - . -	Hz

Two voltages – Measuring inputs U1+U2

φ	180.0	°
U1	228.1	V
F1	50.01	Hz
U2	230.2	V
F2	49.99	Hz

Current

- 1] Press SELECT button to activate the correct inputs.



One current – Measuring input I1

φ	- - - . -	°
I1	5.0	A
I2	0.0	A

Two currents – Measuring inputs I1+I2

φ	90.0	°
I1	5.0	A
I2	22.7	A

Voltage – Current

Measuring inputs I1+U2

- 1] Press SELECT button to activate the correct inputs.



φ	0.0	°
I1	5.0	A
U2	230.2	V
F2	49.99	Hz

Measuring inputs U1+I2

- 1] Press SELECT button to activate the correct inputs.



φ	180.0	°
U1	228.1	V
F1	50.01	Hz
I2	3.5	A

7 Calibration

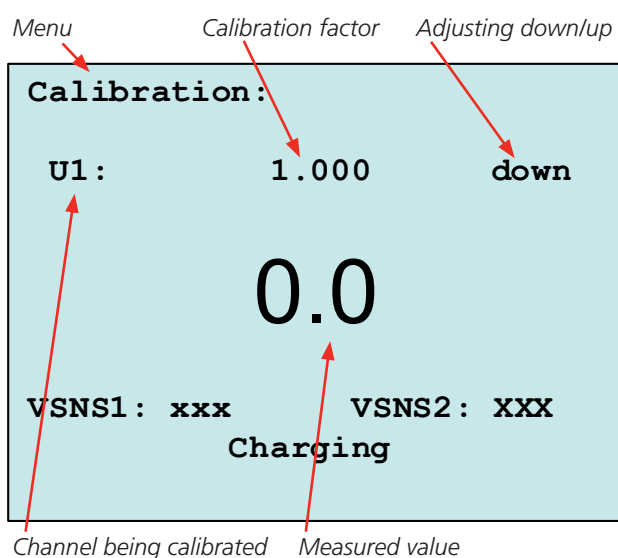
7.1 Standard calibration

Equipment needed

- Accurate DMM, e.g. bench multi meter e.g. Agilent 34401A or Fluke 8845
- Synthesized voltage and current source
 - Preferred 0-500 V AC, 0-25 A AC
 - Acceptable 0-300 V AC, 0-15 A AC

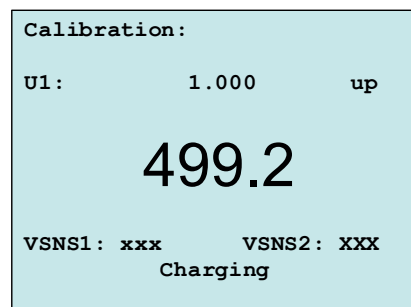
Calibration procedure

- 1] Press ON.
- 2] When LED's go on, press and hold ON + SELECT during the entire startup process (about 5 seconds)
The calibration menu will be shown, see figure below.



Voltage

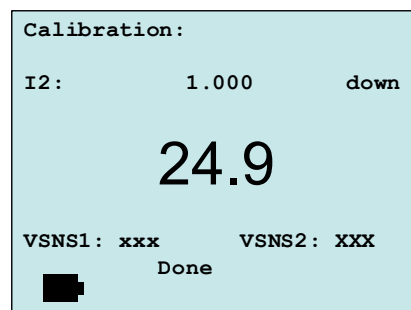
- 1] Connect the voltage source to U1.
- 2] Set voltage to 500.0 V, measure with DMM.
- 3] Adjust the voltage in the display to 500.0 V.



- 4] Press SELECT to adjust "down" or press and hold SELECT for a few seconds to change to "up".
- 5] Then press SELECT to increase the voltage reading.
- 6] Press ON to toggle between U1 and U2.
- 7] Repeat the same process for U2.

Current

- 1] Press ON once for I2.
- 2] Connect the current source to I2 and set current to 25.0 A



- 3] Press SELECT to adjust "down" or press and hold SELECT for a few seconds to change to "up".
- 4] Then press SELECT to increase the current reading.
- 5] Press ON to toggle between I1 and I2
- 6] To save calibration data, press ON for 3 seconds
- 7] The instrument will now make an automatic startup.

7.2 Check procedure after calibration

Voltage

- 1] Connect U1 to the voltage source
- 2] Set voltage to 500.0 V and 50.00 Hz
- 3] Compare instrument reading with DMM reading (max deviation 0.5 V).
- 4] Set voltage to 50.0 V and compare (max deviation 0.2 V)
- 5] Repeat the procedure with U2

Note *The frequency cannot be adjusted but max allowed deviation is 0.05 Hz*

Current

- 1] Connect I1 to the current source
- 2] Set current to 25.0 A
- 3] Compare instrument reading with DMM reading (max deviation 0.1 A).
- 4] Set voltage to 5.0 A and compare (max deviation 0.1 A)
- 5] Repeat the procedure with I2

Phase angle

- 1] Connect U1 and U2 to AC source (e.g. 230V). If same polarity, phase angle should be 0.0°. When switching polarity on U2, phase angle should now be 180.0°. Max deviation allowed is:
 $\pm 0.5^\circ$ from 50 – 500 V
 $\pm 1.0^\circ$ from 10 – 50 V
 $\pm 2.0^\circ$ from 5 – 10 V

7.3 Timer

The timer functionality cannot be calibrated, only tested if within specifications. As the timer is using the same internal clock as the frequency measurement, it is suggested that the timer will show the correct time as long as the frequency measurement is within specifications.

- 1] To check the timer; use another timer with an accuracy better than 0.02% +/- one digit.

8

Specifications

8.1 SPECIFICATIONS

PAM420

Specifications are valid at nominal input voltage and an ambient temperature of +25°C, (77°F). Specifications are subject to change without notice.

Environment

Application field The instrument is intended for use in high-voltage substations and industrial environments.

Temperature

Operating -10°C to +50°C (14°F to +122°F)
Storage & transport -40°C to +70°C (-40°F to +158°F)

Humidity

5% – 95% RH, non-condensing

Altitude

< 2000 m above sea level

CE-marking

LVD 2014/35/EU

EMC 2014/30/EU

RoHS 2011/65/EU

General

Measurement category CAT III 500 V
 CAT IV 300 V

Enclosure class IP21

Power supply Rechargeable batteries

Mains adapter 100–240 V AC, 50/60 Hz

Adapter output voltage 9 V DC

Output connector Ø 5.08 mm with Ø 2.54 centre pin (+)

Power consumption 10 W (max)

Dimensions

Instrument 260 x 140 x 55 mm (except handle)
 (10.2" x 5.5" x 2.2")

Transport case 390 x 300 x 140 mm
 (15.4" x 11.8" x 5.5")

Weight

1.2 kg (2.6 lbs)
 3.5 kg (7.7 lbs)
 with accessories and transport case

Test lead set, with 4 mm stackable safety plugs Black 2 x 2 m (6.6 ft), 2.5 mm²
 Red 2 x 2 m (6.6 ft), 2.5 mm²

Display Alpha numerical LC display with backlighter

Measurement section

Current – Inputs I1 and I2

Measurement category CAT III 500 V
 CAT IV 300 V

Input range 0 – 25 A AC

Inaccuracy 0.5% of reading

Resolution 0.1 A

Protection Built-in 25 A fuse

Voltage – Inputs U1 and U2

Measurement category CAT III 500 V
 CAT IV 300 V

Input range 0 – 500 V AC true RMS

Inaccuracy 0.15 % of reading + 0.03% of range
 (± 0.15 V)

Resolution 0.1 V

Phase angle

0.1°

Range

0 – 359.9° (2–500 V and 0.15–25 A)

Type of phase angle measurement

Current-current, voltage-voltage and current-voltage

Waveform

Sinusoidal

Resolution

Inaccuracy1

±0.5° at >10% of voltage/current range
 ±1° at 2–10% of voltage/current range
 ±2° at 1–2% of voltage/current range

Frequency

Note: Frequency component in voltage component only

Range 15 – 75 Hz

Inaccuracy 0.1%

Resolution 0.01 Hz

Timer

Measurement category CAT II 250 V

Range 0–999.999 s

Resolution 1 ms

Inaccuracy ±0.02% + 2 digits of displayed value

Max input voltage 250 V AC/DC

Input debouncing filter 1 ms

Voltage mode

Parameter	Min	Max	Unit
Trig AC	9	250	V AC
Trig DC	11	250	V DC

Contact mode

Parameter	Min	Max	Unit
Closed contact detection	0	1	kΩ
Open contact detection	4	-	kΩ

Internal battery

Coin cell battery, only replaceable by accredited service centre

¹When main adapter is connected the inaccuracy can increase to 1.2°



Local Sales office

Visit: www.megger.com

Manufacturing sites

Megger Limited
Archcliffe Road
Dover
Kent
CT17 9EN
ENGLAND

T. +44 (0)1 304 502101

F. +44 (0)1 304 207342

Megger GmbH
Weststraße 59
52074 Aachen
T. +49 (0) 241 91380 500
E. info@megger.de

Megger USA - Valley Forge
Valley Forge Corporate Center
2621 Van Buren Avenue
Norristown
Pennsylvania, 19403
USA

T. +1 610 676 8500

F. +1 610 676 8610

Megger USA - Dallas
4545 West Davis Street
Dallas TX 75237
USA

T. 800 723 2861 (USA only)

T. +1 214 333 3201

F. +1 214 331 7399

E. USsales@megger.com

Megger AB
Rinkebyvägen 19, Box 724,
SE-182 17 DANDERYD
SWEDEN

T. +46 08 510 195 00

E. seinfo@megger.com

Megger USA - Fort Collins
4812 McMurry Avenue
Suite 100
Fort Collins CO 80525
USA

T. +1 970 282 1200

This instrument is manufactured in SWEDEN.

The company reserves the right to change the specification or design without prior notice.

Megger is a registered trademark

© Megger Limited 2023

www.megger.com