



ClimaCheck

Operating Manual

Energy and Power Meter ClimaCheck EP Pro

2016-02-04



Table of Contents

1	Overview ClimaCheck Energy – Power Meter	4
1.1	ClimaCheck EP Pro II - portable	4
1.2	ClimaCheck EP Pro I - portable.....	4
1.3	ClimaCheck EP Pro F - fixed installation	4
1.4	ClimaCheck EP Pro ST - fixed installation.....	4
2	ClimaCheck Energy/Power meters.....	5
3	Power measurement	6
4	Electric wiring - Connecting the ClimaCheck EP Pro	8
4.1	Connection of current measuring equipment	8
4.2	Current transformers	9
4.2.1	Measuring small currents	9
4.3	Voltage measurements.....	9
5	Wiring diagrams	10
5.1	ClimaCheck EP Pro II (Portable Unit).....	10
5.2	ClimaCheck EP Pro FI - 230V fixed installation (generic).....	11
5.3	ClimaCheck EP Pro FII - 24V fixed installation (generic)	12
5.4	ClimaCheck EP Pro ST - fixed installation (generic)	13
6	Useful accessories.....	14
6.1	International colour codes	14
7	RS485 Modbus communication	15
8	Installation of Current Transformers.....	16
8.1	EP Pro F with CTs	16
8.2	Calculation of burden for EP Pro in current measurement circuit	16
9	System configurations	20
9.1	Different voltage systems	20
9.2	Motor configurations	21
9.3	Measure on systems with inverter	21
9.4	Differential protection	21
10	Accuracy of measurements	22
11	ClimaCheck EP Pro configuration.....	23
11.1	ClimaCheck EP Pro I/II fixed and portable	23
11.1.1	Display	23
11.1.2	Configuration of electric system	24
11.1.3	Configuration of Current (CT) ratio	25
11.1.4	Configuration of voltage (VT) ratio	25
11.1.5	Using more than one Power Meter EP Pro I/II with ClimaCheck PA Pro	25
11.1.6	Resetting energy count.....	26
11.2	ClimaCheck EP Pro ST	26

¹http://modbus.org/docs/Modbus_over_serial_line_V1_02.pdf

11.2.1	Display	26
11.2.2	Configuration of electric system	27
11.2.3	Configuration of voltage (VT) ratio	27
11.2.4	Configuration of EP Pro as a second power meter	27
11.2.5	Resetting energy count	27
12	Troubleshooting	28
12.1	Screen on EP Pro does not light up	28
12.2	Display on EP Pro shows data but no data is read	28
12.3	Error in measurements - Power does not correspond to expected	31

1 Overview ClimaCheck Energy – Power Meter

ClimaCheck EP Pro is an energy power meter that will register all relevant electrical properties to analyse active power, current, voltage power factor and energy consumed by a refrigeration, air-conditioning or heat pump system. It can be used for all electrical systems from 1 phase with neutral to 3 phases with or without neutral. It is a vital part to the ClimaCheck Performance Analyser systems.

Data is collected from the ClimaCheck EP Pro through Modbus/RS485, a bus protocol that allows communication over relatively long distances and also wireless communication modems can be used if required. Please consult Modbus communication manuals or contact ClimaCheck for further advice on special applications.

The Modbus address is set to 1 as default, if several meters are used the address must be changed as described in manual.

1.1 ClimaCheck EP Pro II - portable

The ClimaCheck EP Pro II – part no. 100 417 (250VAC) or 100 427 (300 VAC) – is based on the Din rail mounted power meter, ClimaCheck EP Pro FII (part no. 100 514), powered by 24 VDC; either through the serial communication cable for the portable system (ClimaCheck PA Pro II), or through a separate 24 VDC power supply. If many units and long cables are used, it can be advisable to use an independent power 24 VDC supply to avoid overload of power supply to PA Pro. ClimaCheck PA Pro F has a separate 24VDC supply to the power meter.

1.2 ClimaCheck EP Pro I - portable

The first model of the EP Pro was the EP Pro I (100 415), a 230V powered meter. The portable version is self-powered over measured phase L1 and Neutral (N) or by a separate mains cable when no Neutral is available.

1.3 ClimaCheck EP Pro F - fixed installation

The permanently installed ClimaCheck PA Pro F uses the Din rail version of the power meter. EP Pro FI (part no. 100 512) is self-powered over measured phase L1 and Neutral (N), while EP Pro FII (part no 100 514) has a 24V power supply

1.4 ClimaCheck EP Pro ST - fixed installation

The EP Pro ST (Split Transformers) is a Din rail power meter, available only for fixed installations. It is available in three different versions and, in contrast to the other EP Pro's, it is sold in a package including current transformers (split-core type) for up to 90A (100 520), 150A (100 524) or 250A (100 528).

2 ClimaCheck Energy/Power meters



Picture of 250 V version of ClimaCheck EP Pro II. The alternative configuration is 300 V version for use in systems with line to neutral up to 300 V and Line to line 520 V.

RS-485 – PA Pro	Serial cable connection to the PA Pro. Also supplies 24 V DC.
RS-485 – EP Pro	Serial cable connection for daisy chaining additional EP Pro II units.
24 V DC	Optional 24 V DC power supply input. Only required when operated independently or when many EP Pro II units are connected. Will also supply units further out in the chain.
1A Fuse	Holder for 20x5 mm fuse of type T 1 A L, 250 V.
L1 – L3 (current)	2 mm sockets for connection of current clamp. Read section 5.3
L1 – L3 (voltage)	4 mm sockets for voltage probes. Read section 5.3
N	4 mm socket for neutral voltage probe. Read section 5.3
250 V version 100 mA Fuses	Holders for 20x5 mm fuses of type T 100 mA L, 250 V.
300 V version 375 mA Fuses	Holders for 4.7x14.48 mm fuses of type 375 mA or 500 mA, 350 V.

3 Power measurement

Experience shows that the biggest challenge for ClimaCheck users is to apply power measurements correctly. We recommend utmost care when applying sensors as it can often be difficult to follow cables in confined spaces. Always compare measured currents and power with rating plate's nominal data at start of measurements.



Warning - Working with electricity is potentially dangerous and should only be conducted by people with appropriate competencies and in accordance with local regulations.

- **The voltage measurement inputs of the EP Pro has an over voltage transient protection of CAT III. They may be connected to equipment of CAT III or lower as specified by IEC 61010. The table below contains a summary of the definitions for each category:**

CAT IV	Origin of installation, utility level and any outside cable run.
CAT III	Distribution wiring, including mains bus, feeders and branch circuits as well as permanently installed loads.
CAT II	Receptacle outlet circuit and plug-in loads.
CAT I	Protected electronic circuits.

Power measurement on refrigeration systems presents many possibilities for mistakes and inaccuracies, but proper care and observance of the following points will ensure that correct results are obtained.

Efficiency and COP values do not depend on the power measurement, so for system diagnostic purposes and system optimisation the precision of the input power is less important than pressures and temperatures. Where verification of capacity and power input is required, it is essential that the correct equipment is used and that it is applied correctly. The following procedures are recommended in these cases.

The ClimaCheck specified accuracy for power and capacity is dependent on:

- **Use of suitable equipment.** Current transformers (CTs) and clamps are available with different ranges and accuracies. They are often primarily designed for measurement of current where the influence of phase shift is not of primary interest. However, when the output is integrated with the voltage in a meter to obtain active power, experience shows that current clamps are less reliable at low currents (less than 20% of the range). A wide range of current clamps and power meters have been tested by ClimaCheck. The products supplied by us have been found to be the most reliable models available, with low errors from phase shift and current when used correctly.
- **Use of the equipment within appropriate range.** Manufacturers of power and current measuring equipment normally rate equipment errors as a percent of full scale (FS). Due to an increase in error they do not normally rate for accuracy below 10-20% of the range when there is phase shift. The lowest identified range of suitable clamp-on current transformers with high accuracy on current and phase shift is 100 A. **Below 20 % (20A for 100A clamps) there will be an increasing risk of deviation of accuracy from the manufacturer's stated percent FS error.**

Adjustment of current clamp or transformer ratio is described in section 11.1.3.

Follow the steps below to assure proper power and energy readings:

- It is important to only measure the power to the compressor. Make sure the measurement is done after the point where circulation pumps and fans are connected.
- Make sure that the voltage and current for each phase corresponds with the markings on the measuring equipment and that the arrow on the current clamps is pointing in the direction of the current.
- Make sure that the current clamps are completely closed and that the contact areas are clean.
- Check that the connections are correct by reading the voltage, current and power on the display of the power meter. If you find a problem remove the clamps and attach L1 followed by a control and then repeat the process for L2 and L3.

When the EP Pro II is connected to a powered up PA Pro it is not necessary to connect it to a separate power supply. The unit will be powered over the serial cable. A separate power supply is only necessary when using the EP Pro II on its own. In advanced applications with several power meters or very long serial cables it may be necessary to connect a second power supply to ensure sufficient power.

4 Electric wiring - Connecting the ClimaCheck EP Pro

The physical connection of measuring equipment should always be handled with the utmost care and all necessary safety precautions shall be completed.

Several aspects should be taken into consideration when installing the fixed installation EP Pro F and current transformers. Only trained professionals should make the installation and make the decision on appropriate cable sizes, fuses etc.

4.1 Connection of current measuring equipment

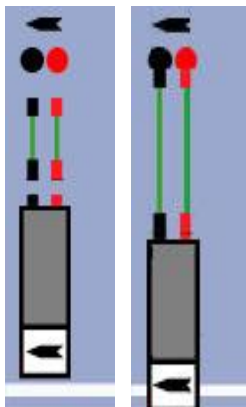
NOTES for Active Power Measurement

Correct mounting of current transformers and voltage probes is important.

- **The direction of measured current and output current is marked on clamps and transformers and they must be correctly mounted (the 24 VDC powered version will reverse current if clamp/transformers are mounted with current in wrong direction).**
- **The arrows on the current transformers must point at the compressor.**
- **Strictly follow the colour markings on cables and connectors.**
- **Current and voltage must be paired (for L1, L2 and L3). Phase order is shown in display.**

If connected wrong, active power will be reported incorrectly (normally too low).

Always connect the cables to the instrument before attaching the current clamp to the power cable.

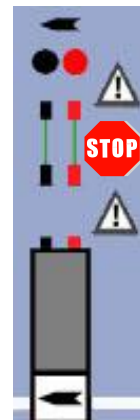


L1

Important

For EP Pro I and EP Pro II!

It is equally important not to detach the cables between clamp or transformer and the instrument while current is running through the measured cable. Detach the clamp or turn off the current before disconnecting any cables.



Correct sequence for connection is shown on the left side – Attach CT to instrument first then attach CT around live power. Never disconnect cables with CT on live power, as shown to the right.

When using current clamps - always connect the clamps to the instrument before attaching them to a live wire.

When using fixed transformers - always connect the transformers to the instrument before turning on the system.

If current is connected to a transformer without the connectors being attached, high voltages will be induced that can damage both personnel and equipment.

4.2 Current transformers

Basic guidance, including calculation of cable burden, is found in section 8. The EP Pro ST is however not affected in the same way, as it uses a different technology with calibrated split-core CT's (including cable), which are less sensitive to cable burden.

EP Pro I and EP Pro II, distributed by ClimaCheck, include cables and accessories which are designed for trouble free and safe connections, but the warnings in section 4.1 have to be observed.

There might also be cases where it is necessary to extend the cables by using more than one set, but then the cable burden must be taken into consideration in the same way as for the fixed installation EP Pro I /II.

4.2.1 Measuring small currents

Current clamps and transformers accuracy are typically rated in the range from 20% to 120% of the rated current.

ClimaCheck has not been able to locate clamp on type transformers with a rated range below 100 A with acceptable accuracy on phase shift at low currents (note that many suppliers state good accuracy on current reading whereas phase shift accuracy can deviate significantly).

In many cases, the increased deviation is small (a few %) and of limited importance, as COP/EER is not affected by errors in power for standard ClimaCheck calculations.

When high accuracy of capacity is required, i.e. for validation of performance versus specification, it is recommended that fixed CTs are used instead of clamp on type. When accuracy of power input is critical at the lower end (e.g. for currents of less than 20A) the following approach is recommended.

Accuracy at low currents can be improved by the following methods:

- A. **Below 10 A** the compressor power can be run directly through the meter eliminating the transformer error totally.
- B. **Above 10 A** the preferred method is to use high accuracy fixed transformers with suitable range. Select transformers with a full scale (FS) of the transformers as close to maximum current as possible. ClimaCheck offers a full range of CTs with high accuracy including currents below 20A.
- C. **The error can be reduced** by making several turns of the lead around the clamp/transformer, and then adjust the current ratio accordingly in the meter. E.g. if 5 turns is used on a 100:1 A clamp the effective ratio will be 20 instead of 100.

4.3 Voltage measurements

Incorrect connection of voltage between phase and neutral can damage the equipment.

Voltage measurements are not sensitive to cable resistance as no currents occur but permanent installations must be done in accordance to local regulations.

5 Wiring diagrams

For permanently installed EP Pro F, please refer to drawing specific for each plant, although generic schematics are found in sections 5.2 and 5.3.

5.1 ClimaCheck EP Pro II (Portable Unit)

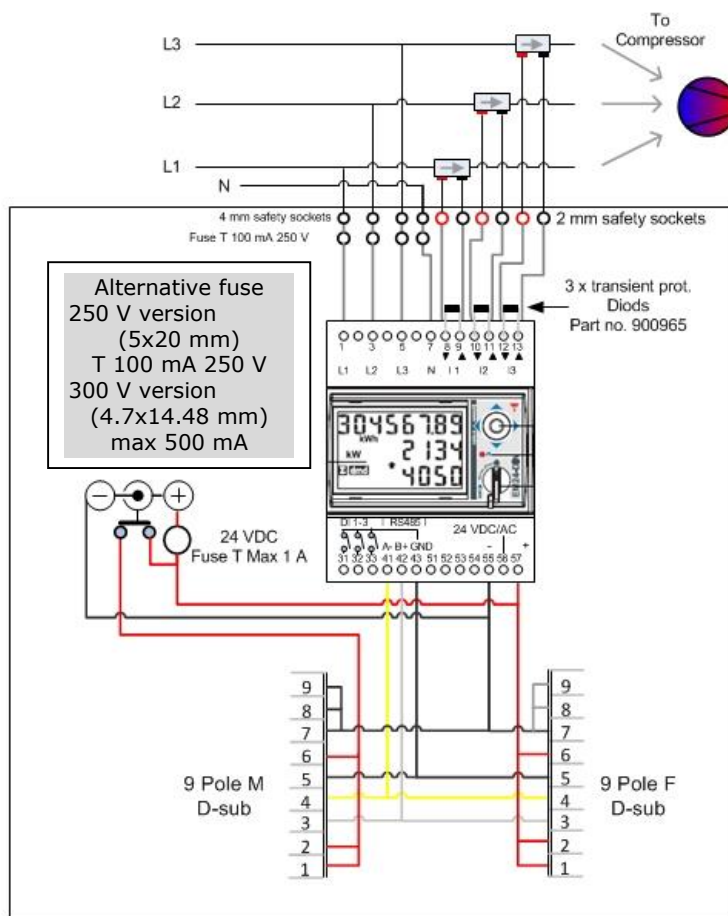
Note that external cables are available in standard colour for each market.



Only intended for use by competent staff - Read Operating manual Warning!

Never apply current transformers on leads to be measured before they are connected with cables to the EP Pro instrument.

Instrument will be damaged and dangerous voltage can be generated.



 **ClimaCheck**

Electrical drawing
ClimaCheck EP_Pro II
2011-10-12

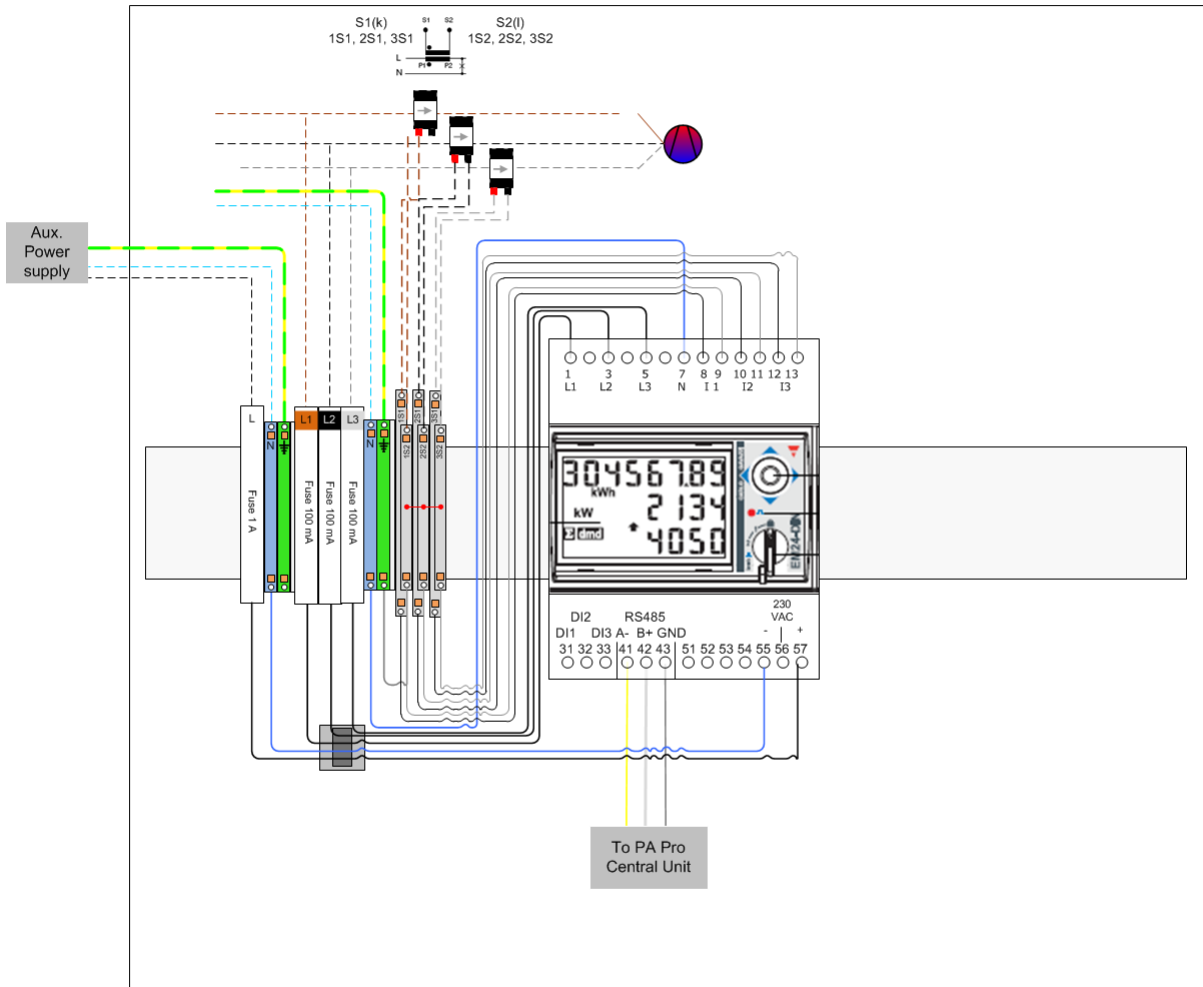
5.2 ClimaCheck EP Pro FI - 230V fixed installation (generic)



Warning!

Never apply current transformers on leads where there is a current before they are connected with cables to the EP Pro instrument (or shortcircuited).

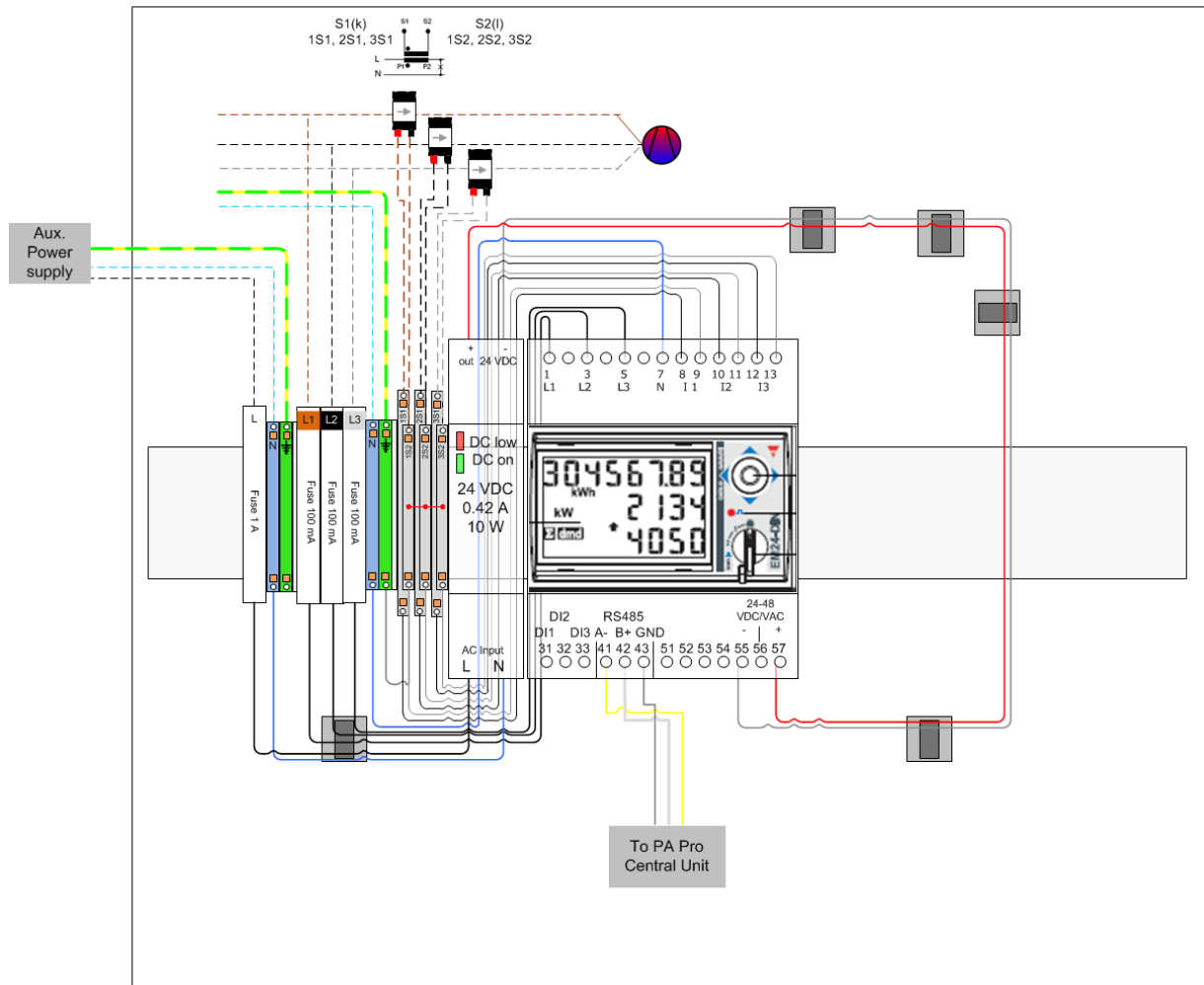
Instrument will be damaged and dangerous voltage can be generated.



ClimaCheck
 Performance Analyser
 PA Pro, EP_Pro 230V
 2012-08-27

5.3 ClimaCheck EP Pro FII - 24V fixed installation (generic)

Warning!
 Never apply current transformers on leads where there is a current before they are connected with cables to the EP Pro instrument (or shortcircuited).
 Instrument will be damaged and dangerous voltage can be generated.



ClimaCheck
 Performance Analyser
 PA Pro, EP_Pro 24V
 2012-08-27

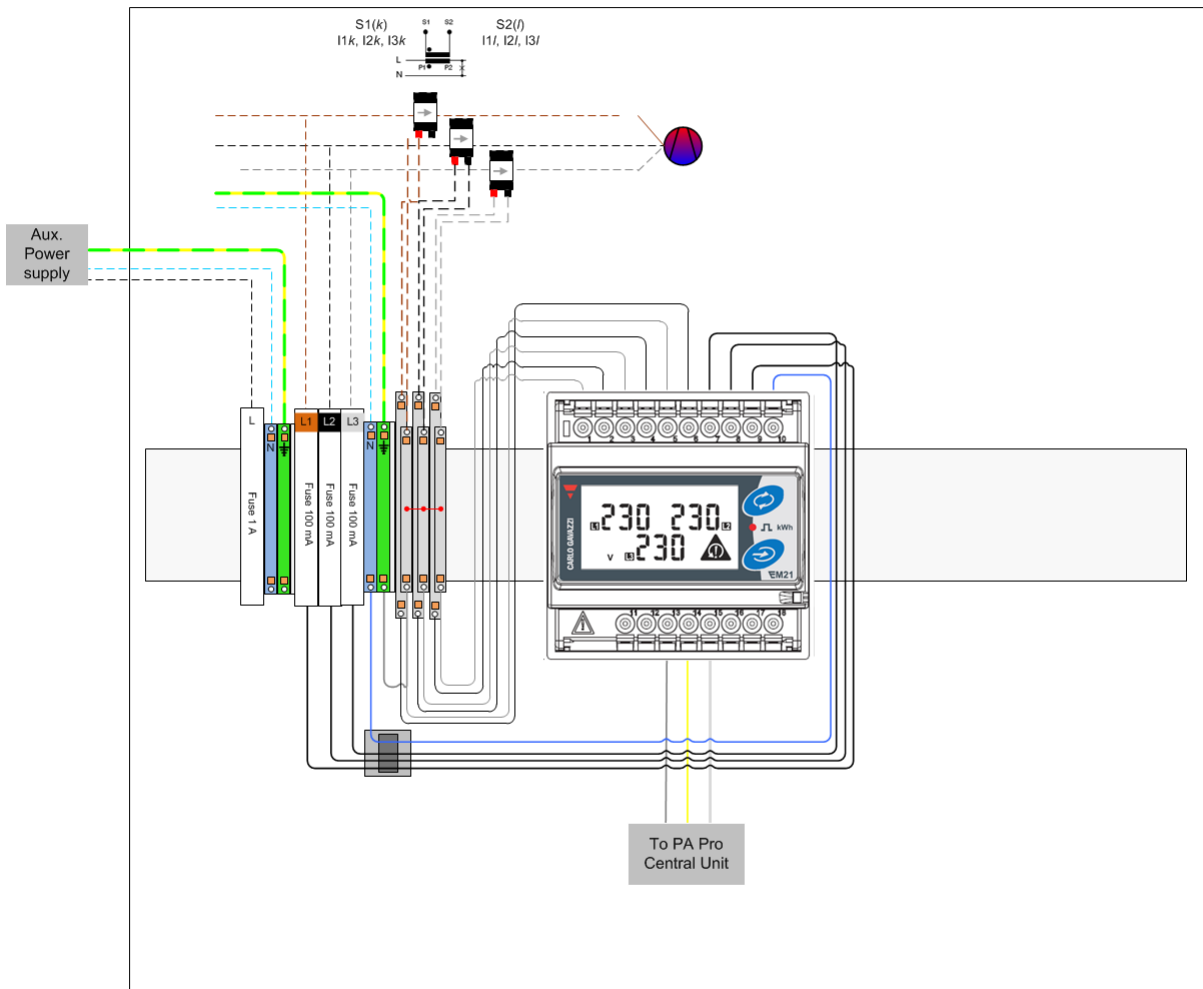
5.4 ClimaCheck EP Pro ST - fixed installation (generic)



Warning!

Never apply current transformers on leads where there is a current before they are connected with cables to the EP Pro instrument (or shortcircuited).

Instrument will be damaged and dangerous voltage can be generated.



ClimaCheck
 Performance Analyser
 PA Pro, EP_Pro EM21 230V
 2012-08-27

6 Useful accessories

ClimaCheck offers a full range of accessories for power measurements.



Magnetic probes, for easy connection of voltage available in international colour codes



Large 3 range current clamp 250/500/1000:5 A
Also other ranges available on request



Full range of fixed and split core transformers for all currents

ClimaCheck offers a range of cables for extensions including wireless cable extenders when serial cable between PA Pro central unit and meter is not practical.

6.1 International colour codes

ClimaCheck supplies colours as requested

Standard/common	L1	L2	L3	N	Ground	
EU	Brown	Black	Grey	Blue	Green &	Yellow
US 1	Black	Red	Blue	White or Grey	Green	
US 2 (delta)	Brown	Orange	Yellow	White or Grey	Green	
US 3 (star/Y)	Brown	Violet	Yellow	White or Grey	Green	
Canada	Red	Black	Blue	White	Green	
India/Pakistan	Red	Yellow	Blue	Black	Green	
China	Yellow	Green	Red	Light Blue	Green &	Yellow
Australia/New Zealand (Also use EU colours)	Red	White	Dark Blue	Black	Green &	Yellow

7 RS485 Modbus communication

The Modbus communication protocol allows a large quantity of devices to be connected on the same system. There are however some aspects that need to be taken in consideration in order to get a stable communication without any missed transfers.

The different Modbus devices (including the PA Pro) should normally be connected in series. It is however not necessary to set them up in the same order as they are addressed and the PA Pro could be connected anywhere in the chain and it is normally possible to make short branches out of the trunk line. The portable PA Pro is however designed in such way that it always is connected in the end of the chain as it only has one RS485 9-pin D-sub input. The portable EP Pro energy-power meter has both an input and an output which allows it to be connected anywhere in the series.

When using multiple Modbus devices or long cable lengths a need of "line termination" may arise. Line termination means that two 150 ohm resistors are connected parallel to the communicating line in both ends.

The EP Pro ST unit has line termination capabilities as default with the use of an extra terminal input (connecting input no. 15 and 16 together). See manufacturer's documentation for more information.

The RS485 connections allow communication over up to 1000 m of cable with AWG26 (or wider) gauge wires but when the cable length increases it is important to use cable termination.

For more information about the use of Modbus over serial line please see document [Modbus_over_serial_line_V1_02.pdf](#).

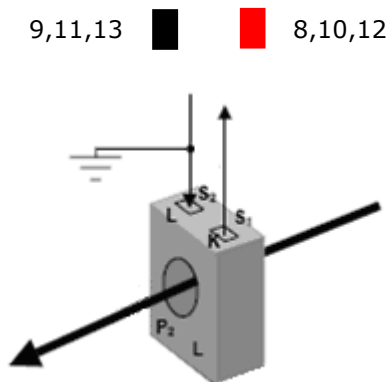
8 Installation of Current Transformers

8.1 EP Pro F with CTs

For details, always validate with instructions supplied with the actually used CTs that markings are in accordance with below as variations exist. Below tables are based on Carlo Gavazzi documentation.

Most fixed current transformers are labelled as shown below, one side P1-K and the other P2-L.

With current entering from P1 side as shown below the signal is from S1 through the instrument to S2.



The numbers shown above (9,11,13 and 8,10,12) correspond to the points of connection on ClimaCheck EP Pro F Power meter (EM24).

Voltage is connected to 31, 32, 33 for L1, L2 and L3. Neutral is connected to 41. (Systems without neutral can be measured with adapted settings and if necessary a separate supply voltage.)

The EP Pro Power Meter has to be configured with the current ratio of the transformers used. Please refer to section 11.1.3 for this operation.

Note that connection must be 100% correct for proper result. Always check voltage, currents, power factor and power for logical values versus expected load.

8.2 Calculation of burden for EP Pro in current measurement circuit

Always use as short cables as possible with large area to minimize resistance between meter and transformers. The used conductor area and length have a vital impact on the accuracy of the measurement as the equipment allows some burden in the connection, but if the specified burden is exceeded it will have a big effect on the result. The burden depends on the size of the current and cable resistance and can be calculated with the following formula:

The measured circuits total burden

$$VA = VA_L + VA_{I1} + VA_{I2} + \dots + VA_{In}$$

Where VA = total burden

VA_{I1} = Burden in instrument 1 to n

Burden for ClimaCheck EP Pro I/FI and II/FII 1/5(10)A < 0.3VA

In the measuring circuit the conductor burden VA_L must be included. See table below for some given sizes/length. Conversion to Feet is shown without decimals and AWG are approximated to nearest standard size.

Area (mm ² AW)	Conductor burden depending on length and secondary current (5A / 1A)										
	1 m	2 m	4 m	6 m	8 m	10 m	15 m	20 m	30 m	40 m	50 m
	3 feet	6 feet	13 feet	20 feet	26 feet	33 feet	49 feet	66 feet	99 feet	132 feet	164 feet
2 x 0,5 20 AWG	1,750 / 0,070	3,500 / 0,140	7,000 / 0,280	10,500 / 0,420	- / 0,560	- / 0,700	- / 1,050	- / 1,400	- / 2,100	- / 2,800	- / 3,500
2 x 0,75 18 AWG	1,167 / 0,047	2,333 / 0,093	4,667 / 0,187	7,000 / 0,280	9,333 / 0,373	- / 0,467	- / 0,700	- / 0,933	- / 1,400	- / 1,867	- / 2,333
2 x 1,0 17 AWG	0,875 / 0,035	1,750 / 0,070	3,500 / 0,140	5,250 / 0,210	7,000 / 0,280	8,750 / 0,350	- / 0,525	- / 0,700	- / 1,050	- / 1,400	- / 1,750
2 x 1,5 14 AWG	0,583 / 0,023	1,167 / 0,047	2,333 / 0,093	3,500 / 0,140	4,667 / 0,187	5,833 / 0,233	8,750 / 0,350	- / 0,467	- / 0,700	- / 0,933	- / 1,167
2 x 2,5 10 AWG	0,350 / 0,014	0,700 / 0,028	1,400 / 0,056	2,100 / 0,084	2,800 / 0,112	3,500 / 0,140	5,250 / 0,210	7,000 / 0,280	10,500 / 0,420	- / 0,560	- / 0,700
2 x 4,0 6 AWG	0,219 / 0,009	0,438 / 0,018	0,875 / 0,035	1,313 / 0,053	1,750 / 0,070	2,188 / 0,088	3,281 / 0,131	4,375 / 0,175	6,563 / 0,263	8,750 / 0,350	- / 0,438
2 x 6,0 3 AWG	0,146 / 0,006	0,292 / 0,012	0,583 / 0,023	0,875 / 0,035	1,167 / 0,047	1,458 / 0,058	2,188 / 0,088	2,917 / 0,117	4,375 / 0,175	5,833 / 0,233	7,292 / 0,292

Conductor burden can be calculated for any length and cable size with the following formula:

$$VA_L = \frac{0,0175x * 2D * I^2}{Cu}$$

Where

D = conductor length between meter and current transformer

I = secondary rated current

Cu = conductor area (mm)

Conversion table AWG to mm²

Source http://www.engineeringtoolbox.com/awg-wire-gauge-d_731.html

American Wire Gauge (AWG)	Diameter (inches)	Diameter (mm)	Cross Sectional Area (mm ²)
0000	0.46	11.68	107.16
000	0.4096	10.40	84.97
00	0.3648	9.27	67.40
0	0.3249	8.25	53.46
1	0.2893	7.35	42.39
2	0.2576	6.54	33.61
3	0.2294	5.83	26.65
4	0.2043	5.19	21.14
5	0.1819	4.62	16.76
6	0.162	4.11	13.29
7	0.1443	3.67	10.55
8	0.1285	3.26	8.36
9	0.1144	2.91	6.63
10	0.1019	2.59	5.26
11	0.0907	2.30	4.17
12	0.0808	2.05	3.31
13	0.072	1.83	2.63
14	0.0641	1.63	2.08
15	0.0571	1.45	1.65
16	0.0508	1.29	1.31
17	0.0453	1.15	1.04
18	0.0403	1.02	0.82
19	0.0359	0.91	0.65
20	0.032	0.81	0.52
21	0.0285	0.72	0.41
22	0.0254	0.65	0.33
23	0.0226	0.57	0.26

The specified burden for the standard ClimaCheck CT's can be found in the tables below:

Model CTD-1X from 50A to 100A			
Primary Current	Burden (VA)		
A	CL 0.5	CL 1	CL 3
50		1	1.25
60		1	1.25
70		1.5	1.75
75	1	1.25	1.75
80	1.25	1.5	2
100	1.5	1.75	2.25

Model CTD-1X from 120A to 300A			
Primary Current	Burden (VA)		
A	CL 0.5	CL 1	CL 3
120	1.75	2	2.5
125	2	2.25	2.75
150	2.25	2.5	3
160	2.5	2.75	3.25
200	3	3.25	3.75
250	4.5	4.75	5.25
300	5	5.5	6

Model CTD-2X from 40A to 125A			
Primary Current	Burden (VA)		
	A	CL 0.5	CL 3
40			1.25
50			1.5
60			2
70			2.5
75		1.75	2.5
80		2	2.75
100		2.5	3
120		2.75	3.75
125	2	2.75	3.75

Model CTD-2X from 150A to 600A			
Primary Current	Burden (VA)		
	A	CL 0.5	CL 3
150	3	4	5
160	3	4	5
200	4	5	6.5
250	5.5	7	8
300	7	8.5	9.5
400	12	13.5	14.5
500	14	15.5	16.5
600	17.5	19	20

Range Table

Model CTD-3X from 50A to 200A			
Primary Current	Burden (VA)		
	A	CL 0.5	CL 3
50			1.75
60			2
70			2.5
75			3
80			3
100		2	3.5
120		2.25	4
125		2.5	4.5
150	2.25	3	6
160	2.5	3.5	6.5
200	3	4.5	8.5

Model CTD-3X from 250A to 1200A			
Primary Current	Burden (VA)		
	A	CL 0.5	CL 3
250	3.5	6.5	10.5
300	7	10	13
400	9	14	17
500	14	18	21
600	17	21	24
700	22	26	29
750	24	28	31
800	25	29	32
1000	35	39	42
1200	40	44	47

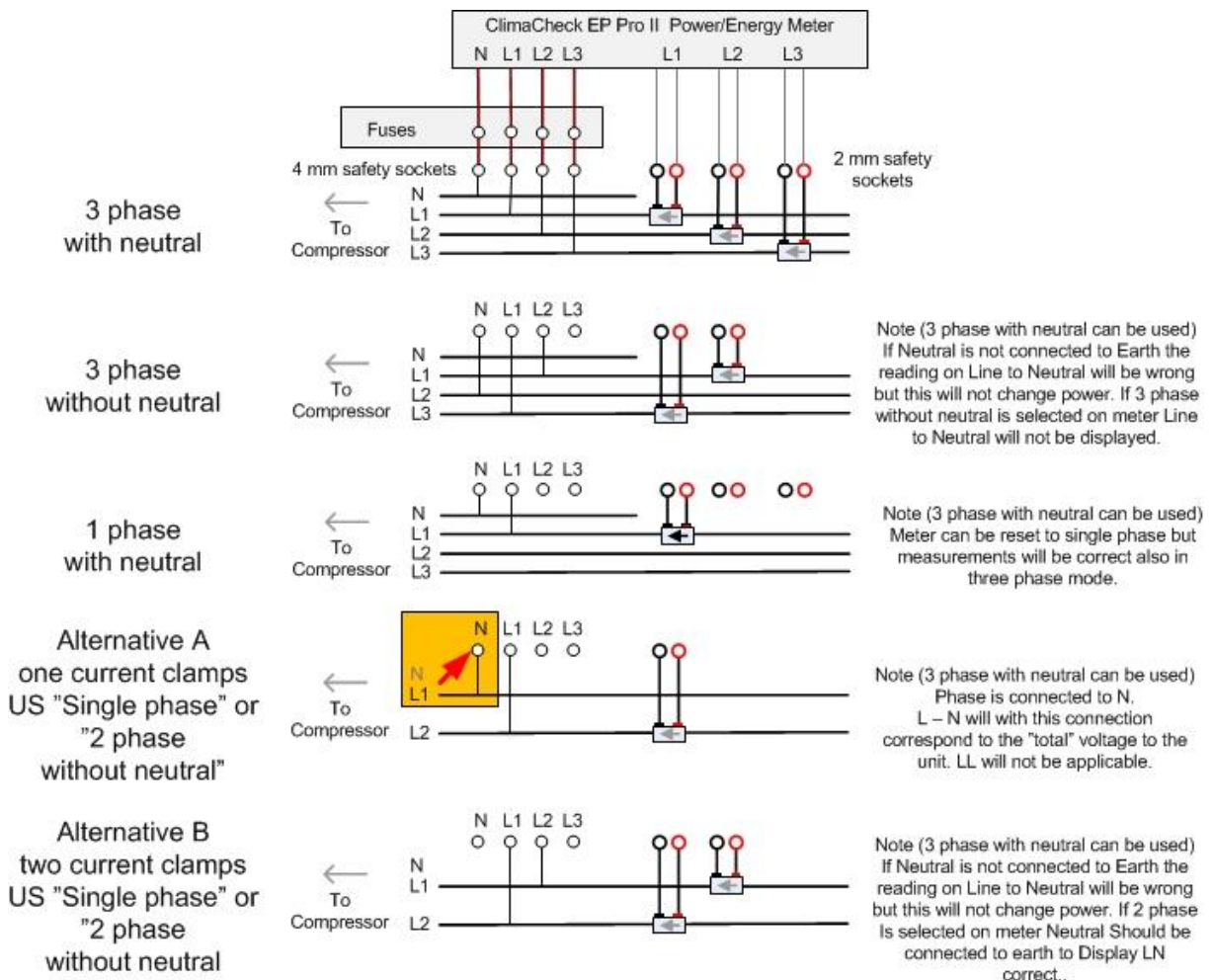
9 System configurations

9.1 Different voltage systems

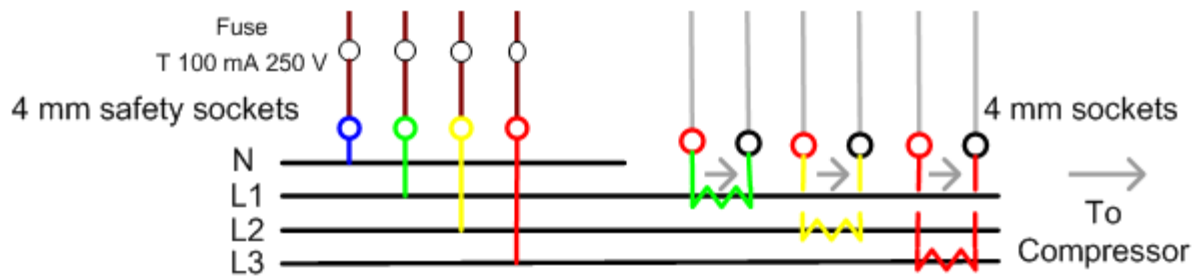
ClimaCheck EP Pro is based on a certified energy meter rated for voltage between V_{LN} : 160 V to 480V_{LN}, V_{LL} : 277 V to 830V_{LL} and can be configured to measure most types of systems. Due to availability of small fuses suitable to use in a portable meter the rating of the portable EP Pro I and EP Pro II are limited as marked on the casing.

For High voltage systems voltage transformer can be used or system connected to existing voltage transformers commonly in place for existing meters on large systems – in this case the voltage ratio should be programmed into the EP Pro. Refer to section 11.1.4.

One EP Pro can be used as three single phase meters as every phase is measured individually then the same voltage is connected to all voltage inputs and the parameter Power per phase is used.



For older ClimaCheck, EP Pro I, the below colouring system was used.



9.2 Motor configurations

Power measurements require good understanding of the electrical layout of the plant.

It is for example necessary to identify if a three phase motor is part winding or Y/D and connect accordingly.

Part Winding – This means that the motor has two separate windings and the total current to these should be measured. This can be done in several ways depending on the physical restrictions of cables and clamps.

- Preferred choice is to measure before the contactors where the total current runs through one lead. This can sometimes be physically impossible.
- One alternative is to put clamps around both L1 cables after the contactor or in the connection box on the compressor if this can be done. This is repeated for L2 and L3.
- It is possible to measure with 6 clamps i.e. 2 in parallel to the instrument per phase.
- If there is no way to connect around the total current an acceptable approximation can be achieved by measuring on one of the contactors (the one with largest power draw is preferred) and adjusting the CT-ratio in EP Pro (see 11.1.3) to compensate for this. The ratios are typically 50/50 or 60/40 and can be deduced by moving the clamp back and forth. Example: Using a 100/1A clamp when the distribution is 50/50 would require you to change to CT-ratio from 100 to 50.

9.3 Measure on systems with inverter

If inverters are used it is normally necessary to measure before inverter and use a loss factor of typically 3-6% to compensate for the heat loss. This factor is added under electrical motor losses in the Constant tab of the ClimaCheck software. Ensure that i.e. fans do not consume power from the same feed. If so an offset can be added in the input tab

9.4 Differential protection

Differential protection is used to improve the security of the installation and will cut the supply if any current is drawn outside the "protected loop". Normally this will not cause any issues as EP Pro II is using independent 24 VDC power supply and the voltage measurements do not result in any current draw over the meter. For EP Pro I and EP Pro FI, differential protection must be taken into account when connecting.

10 Accuracy of measurements

Accuracy of power and energy measurements are stated in the product data sheet for each product and the error from instrument as well as the transformers. Please refer to specification of each and add error from current transformer/clamp to that of instrument.

Current clamps and transformers accuracy are typically rated in the range from 20% to 120% of the rated current.

Current transducers and clamps are sensitive to cable resistance in leads to instrument - long leads should be avoided. It is preferred to use extensions between meter and PA Pro central unit rather than between current transformers and instrument.

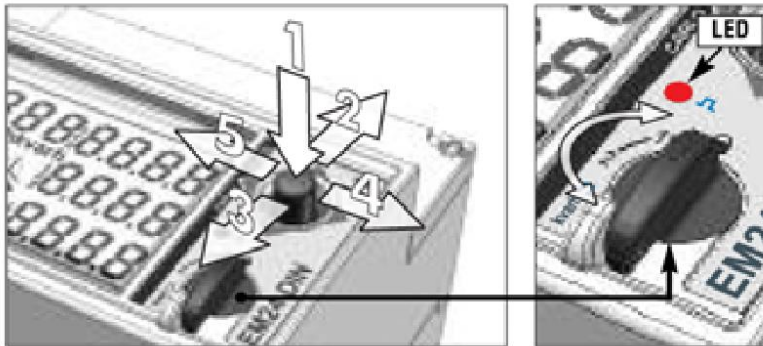
11 ClimaCheck EP Pro configuration

The EP Pro is normally set up according to the customer needed specification when purchased new. But when the EP Pro is to be used in a new application or if an existing ClimaCheck system is going to be expanded, there might arise a need of changing the setup. The parameters that may be changed are: current- and voltage transformer ratio, Modbus address measured electrical system etc.

When using more than one power meter EP Pro with a ClimaCheck PA Pro, both the EP Pro and the PA Pro need to be configured. In order to use the extra information collected from a second EP Pro in the ClimaCheck software, you need a special template that can be acquired from ClimaCheck or one of our distributors. Instructions for setting up the additional EP Pro is found under respective model in this chapter. Please see the PA Pro manual for instructions on how to set up the PA Pro.

11.1 ClimaCheck EP Pro I/II fixed and portable

There are two controls on the front side of the EP Pro unit, one joystick and one knob, with a number of possible setups as seen in the figure below.



Joystick functions shown to the left.

Dial to unlock for programming to the right.

11.1.1 Display

By pushing Joystick down you have the following sequence (marked on front of EP Pro Housing or on sticker with fixed installations).

v Total kWh (+) / W / W Max	Energy, power, and max power (see manufacturer manual for details to set interval for W max)
v Phase Seq /VLN/Hz	Phase sequence
v V L1-N / V L2-N / V L3-N	Phase to neutral voltage
v V L1-L2 / V L2-L3 / V L3-L1	Phase to phase voltage
v A L1 / A L2 / A L3	Current per phase
v W L1 / W L2 / W L3	Power per phase
v Pf L1 / Pf L2 / Pf L3	Power factor per phase
v Hours / W sys / PF sys	Hours since meter was commissioned /tot power /tot power factor

EP Pro I/FI (Older version) and 115-230 VAC versions.

- v Total kWh (+) / W / W Max
- v A L1 / A L2 / A L3
- v Hours / W sys / PF sys
- v Total kWh (-) / W dmd / W dmd max

The printed list on EP Pro detailing the information displayed by the unit is valid only for the default setting "Unbalanced 3-phase with zero". When using "Unbalanced 3-phase without zero" the following list should be referred to instead:

v Total kWh (+) / W / W Max	Energy, power, and max power (see manufacturer manual for details to set interval for W max)
v V L1-L2 / V L2-L3 / V L3-L1	Phase to phase voltage
v A L1 / A L2 / A L3	Current per phase
v Hours / W sys / PF sys	Hours since meter was commissioned /tot power /tot power factor

EP Pro II Default Display sequence (=application type G) on 24VDC ClimaCheck customised (in production since 2011).

By pushing joystick to the right, the following will be displayed:

Serial address (flashing text r.t indicate receive and transmit data) > VT ratio > CT ratio > mode (set voltage system)

When using other setting and position of dial the displayed information will change to adapt to settings. See full product manual for details and alternative configurations.

11.1.2 Configuration of electric system

For EP Pro to report correct values it must be configured for the electric configuration used. The device can handle the following varieties:

- Unbalanced 3-phase with zero (default)
- Unbalanced 3-phase without zero
- Balanced 3-phase
- 2-phase
- 1-phase

Change the electric configuration by doing the following:

1. Put the lower dial in position 1 to enable programming.
2. Push in the joystick for three seconds.
3. Enter the password by pushing up/down. Default setting is 0.
4. Push in to enter the password.
5. Push right three times to the menu section "SYS".
6. Push in to change the setting (PrG is displayed).
7. Push left/right to toggle between electric systems (for guidelines on connection see 4.1)
 - 3P.n = Unbalanced 3-phase with zero
 - 3P = Unbalanced 3-phase without zero
 - 3P.1 = Balanced 3-phase
 - 2P = 2-phase
 - 1P = 1-phase
8. Push in to save the setting (PrG disappears).
9. Push left four times to the menu section "End".
10. Push in to end the programming.
11. Put the knob back into position "locked".

11.1.3 Configuration of Current (CT) ratio

When delivered EP Pro is configured with a CT-ratio of 100 which is the correct setting for our standard current clamp 100:1A (400 100). When using other current clamps or transformers the CT-ratio needs to be reconfigured as explained below:

1. Put the knob in position 1 to enable programming.
2. Push in the joystick for three seconds.
3. Enter the password by pushing up/down. Default setting is 0.
4. Push in to enter the password.
5. Push right five times to the menu section "Ct rAtio".
6. Push in to change the setting (PrG is displayed).
7. Push right/left to toggle between different size ranges for the CT-ratio and up/down to set the exact value. A small "k" to the left of the value denotes a multiplier of 1000.
8. Push in to save the setting (PrG disappears).
9. Push left six times to the menu section "End".
10. Push in to end the programming.
11. Put the knob back into position "locked".

11.1.4 Configuration of voltage (VT) ratio

For high voltage system that cannot be measured directly voltage transformer should be used.

When these are used the VT ratio in the meter should be set in the same way as CT ratio is described above.

11.1.5 Using more than one Power Meter EP Pro I/II with ClimaCheck PA Pro

When using more than one power meter EP Pro with a ClimaCheck PA Pro, both the EP Pro and the PA Pro needs to be configured. In order to use the extra information collected from a second EP Pro in the ClimaCheck software you need a special template that can be acquired from ClimaCheck or one of our distributors.

Configuration of EP Pro I/ II as a second power meter

By default the EP Pro is configured as power meter 1 in the system (Adresss 1). To configure it as power meter 2 follow the instructions below:

- Put the knob in position 1 to enable programming.
- Push in the joystick for three seconds.
- Enter the password by pushing up/down. Default setting is 0.
- Push in to enter the password.
- Push left three times to the menu section "AddrESS".
- Push in to change the setting (PrG is displayed).
- Push up to change address to 2.
- Push in to save the setting. The display will show "bAudrAtE".
- Push up and then right twice to the menu section "End".
- Push in to end the programming.
- Put the knob back into position "locked".

To configure the PA Pro to communicate with additional EP Pro please see the PA Pro manual.

11.1.6 Resetting energy count

EP Pro records and reports measured energy. This value will continue to increase with each use of the meter. If you want to reset this value back to zero, follow the steps below:

- Put the knob in position 1 to enable programming.
- Push in the joystick for three seconds.
- Enter the password by pushing up/down. Default setting is 0.
- Push in to enter the password.
- Push left twice to the menu section "EnE trES".
- Push in to change the setting (PrG is displayed).
- Push up to change the value from "no" to YES".
- Push in to confirm the reset (PrG disappears).
- Push right once to the menu section "End".
- Push in to end the programming.
- Put the knob back into position "locked".

11.2ClimaCheck EP Pro ST



There are only two buttons on the front. One loop-button (1) and one enter-button (2). There is also a power indicator LED (3)

The loop-button is used to toggle the displayed page/values and to increase/decrease while in setup. The enter button is used to enter the setup (by holding it down), to alternate between increase/decrease and to confirm input.

Enter the setup interface by doing the following:

1. Hold down the enter-button for approx. 3 sec. until PASS? 0 is shown in display.
2. Hold down the enter button to confirm password 0 (default value) or make short clicks on the loop-button to increase value and then confirm password if default has been changed (the enter-button is used to switch the input to decrease by one short click).
3. Page through the setup with the loop-button. If a setting is to be changed, hold down the enter-button and make the configuration.
4. Exit the setup by going to the last page displaying END. Hold down the enter-button.

11.2.1 Display

By pressing the loop button the following sequence of values are shown:

v Total kWh (+) / W /	Energy and power
v Total kVAh / VAh	Reactive energy and power
v PF sys / Hz	Tot. power factor and frequency
v Pf L1 / Pf L2 / Pf L3	Power factor per phase
v A L1 / A L2 / A L3	Current per phase
v V L1-L2 / V L2-L3 / V L3-L1	Phase to phase voltage
v V L1-N / V L2-N / V L3-N	Phase to neutral voltage

11.2.2 Configuration of electric system

For EP Pro 21 to report correct values it must be configured for the electric configuration used. The device can handle the following varieties:

- Unbalanced 3-phase with zero (default)
- Unbalanced 3-phase without zero
- Balanced 3-phase
- 2-phase
- 1-phase

Change the electric configuration by doing the following:

1. Enter the setup according to previous description found under "**The setup interface is accessed and used as follows**"
2. Go to the page displaying SyS.
3. Press one time on the enter-button to set the loop-button into increase mode.
4. Press the loop-button to change the electrical configuration.
5. Finish the setup by holding down the enter-button and peruse to the END page. Hold down the enter-button to exit.

11.2.3 Configuration of voltage (VT) ratio

For high voltage system that cannot be measured directly voltage transformer should be used.

Enter the setup as previously described and make the change according to these instructions:

1. Go to page "Ut rAt". Press the enter-button.
2. Use the loop-button to change the ration.
3. Finish the setup by holding down the enter-button and peruse to the END page. Hold down the enter-button to exit.

11.2.4 Configuration of EP Pro as a second power meter

By default the EP Pro is configured as power meter 1 in the system (Address 1). To configure it as power meter 2; enter the setup as previously described and make the change according to these instructions:

1. Go to page "Add".
2. Press one time on enter.
3. Use the loop-button to increase value.
4. Finish the setup by holding down the enter-button and peruse to the END page. Hold down the enter-button to exit.

To configure the PA Pro to communicate with additional EP Pro please see the PA Pro manual.

11.2.5 Resetting energy count

EP Pro records and reports measured energy. This value will continue to increase with each use of the meter. If you want to reset this value back to zero, enter the setup interface as previously described and make the following change:

1. Go to page "EnE rES".
2. Press one time on enter.
3. Use the loop-button to change the input to yes.
4. Finish the setup by holding down the enter-button and peruse to the END page. Hold down the enter-button to exit.

12 Troubleshooting

In case of troubles with EP Pro device, please refer to the suggested actions describe in this chapter or contact ClimaCheck Sweden or ClimaCheck reseller for support.

12.1 Screen on EP Pro does not light up

1. Check power supply with multimeter (voltage meter) should be 24 VDC (24-48 VDC).
EP Pro can be supplied from:
 - PA Pro through serial communication cable (fused in PA Pro)
 - With separate 24VDC power supply (fused in EP Pro)
2. Check fuse if power supply is OK.
3. If supply and fuses are OK open EP Pro without any leads except 24 VDC supply connected. Check with multimeter on input terminals on instrument if 24 VDC is supplied. If there is power but screen remains off meter is defect please contact ClimaCheck Sweden.

12.2 Display on EP Pro shows data but no data is read

1. Check LED on RS485 communication on PA Pro
 - a. RD (receive data) and TD (transmit data) should flash
If only TD flashes on PA Pro while PA Pro show Status OK and EP Pro has a lit up display check serial cable and that address in PA Pro correspond with EP Pro address (default is 1).
2. If LED TD and RD flashes (with several units on Modbus check status on each). EP Pro will flash "r.t." in the view that show Address "X" only if a PA Pro is requesting data form this address on a correct cable.
 - A. Check cable. If r.t. is not flashing on one or more units (standard for portable unit is a "straight" 9 pole D-sub serial cable)
 - B. Check that the wiring is done according to instructions.
 - C. Check address of EP Pro in the PA Pro by logging in with your web browser (see PA Pro manual if you are not familiar with this procedure). Refer to section 11.1.5

Settings > Advanced > External units

Name	Type	Com. error count limit	Main parameter
1 EP_Pro1	EP_Pro EM24/EM2	5	Address = 1
2 EP_Pro2	EP_Pro EM24/EM2	5	Address = 2
3 EP_Pro3	-	-	-
4 EP_Pro4	-	-	-
5 EP_Pro 5	-	-	-
6 Device 6	-	-	-
7 Device 7	-	-	-
8 Device 8	-	-	-
9 Device 9	-	-	-
10 EP_Pro10	EP_Pro EM24/EM2	10	Address = 10
11 Device 11	-	-	-
12 Device 12	-	-	-
13 Device 13	-	-	-
14 Device 14	-	-	-
15 Device 15	-	-	-
16 Modbus_A	-	-	-
17 Modbus_B	-	-	-
18 Modbus_C	-	-	-
19 Device 19	-	-	-
20 Device 1617	RTD04	10	Sensor type T1 = 4
21 RTD04_2	-	-	-
22 Device 22	-	-	-
23 Device 23	-	-	-
24 Device 24	-	-	-

EP Pro should have address given in list above and and Baud rate 9600. Follow instruction in Chapter 11.1.5 for for reprogramming if necessary.

D. Enter the EP Pro by clicking on it and check settings.

Here are the standard settings put to to read all values except power per phase every 10 seconds. Current and voltage ratio are not read.

3. Check channel values under External units in PA Pro if RD and DT flash on EP Pro and r.t. in display of EP Pro but no or wrong data is displayed in ClimaCheck software or PA Pro

Settings > Advanced > External units > view values

If correct data is received here but not transferred correctly to Software or PA Pro memory next step is to check channel connections.

Settings > Advanced > External units > connections

Below the result for a system with EP Pro 1 is active whereas EP Pro 2 is not connected.

Each measured value from the EP Pro is here connected to channels that can be stored in the PA Pro and read by the software or sent to the Internet server of ClimaCheck on-line. The colour and status indication show status.

Performance Analyser PA Pro		PA Pro II på kontor Config 2011-12-14		0 alarms 2012-08-08 21:42:25		ClimaCheck	
View		External devices					
Settings		Setup		View values		WMSHare export	
Sensors & Actuators		Email				Connections	
Alarms							
Time control							
Overview							
Communication							
System							
Advanced							
Channels							
Parameters							
Curves							
Databases							
Summaries							
Graphical programming							
Script							
Weekday catalog							
Database email							
Database UDP							
Operator panel menus							
External units							
Manual override							
ClimaCheck							

Channel	Direction	Device	Value	Status	Last update
1 EP_Comp_EP_Pro1	In	EP_Pro1	Power sum	OK	2012-08-08 21:41:14
2 pF_Comp_EP_Pro1	In	EP_Pro1	Power factor	OK	2012-08-08 21:41:14
3 Energy_EP_Pro1	In	EP_Pro1	Energy total	OK	2012-08-08 21:41:14
4 EP_Comp_L1_EP_Pro1	In	EP_Pro1	Power L1	OK	2012-08-08 21:41:14
5 EP_Comp_L2_EP_Pro1	In	EP_Pro1	Power L2	OK	2012-08-08 21:41:16
6 EP_Comp_L3_EP_Pro1	In	EP_Pro1	Power L3	OK	2012-08-08 21:41:16
7 EA_Comp_L1_EP_Pro1	In	EP_Pro1	Current L1	OK	2012-08-08 21:41:16
8 EA_Comp_L2_EP_Pro1	In	EP_Pro1	Current L2	OK	2012-08-08 21:41:16
9 EA_Comp_L3_EP_Pro1	In	EP_Pro1	Current L3	OK	2012-08-08 21:41:16
10 EV_Comp_L1_EP_Pro1	In	EP_Pro1	Voltage L1	OK	2012-08-08 21:41:16
11 EV_Comp_L2_EP_Pro1	In	EP_Pro1	Voltage L2	OK	2012-08-08 21:41:16
12 EV_Comp_L3_EP_Pro1	In	EP_Pro1	Voltage L3	OK	2012-08-08 21:41:16
13 -	-	-	-	-	-
14 -	-	-	-	-	-
15 RTD04_T1	In	Device 1632	Temp T1	Error	2000-01-01 00:00:00
16 RTD04_T2	In	Device 1632	Temp T2	Error	2000-01-01 00:00:00
17 RTD04_T3	In	Device 1632	Temp T3	Error	2000-01-01 00:00:00
18 RTD04_T4	In	Device 1632	Temp T4	Error	2000-01-01 00:00:00
19 -	-	-	-	-	-
20 EP_Comp2_EP_Pro2	In	EP_Pro2	Power sum	Error	2000-01-01 00:00:00
21 pF_Comp2_EP_Pro2	In	EP_Pro2	Power factor	Error	2000-01-01 00:00:00
22 Energy_Comp2_EP_Pro2	In	EP_Pro2	Energy total	Error	2000-01-01 00:00:00
23 EV_Comp2_L1_EP_Pro2	In	EP_Pro2	Voltage L1	Error	2000-01-01 00:00:00
24 EV_Comp2_L2_EP_Pro2	In	EP_Pro2	Voltage L2	Error	2000-01-01 00:00:00
25 EV_Comp2_L3_EP_Pro2	In	EP_Pro2	Voltage L3	Error	2000-01-01 00:00:00
26 EA_Comp2_L1_EP_Pro2	In	EP_Pro2	Current L1	Error	2000-01-01 00:00:00
27 EA_Comp2_L2_EP_Pro2	In	EP_Pro2	Current L2	Error	2000-01-01 00:00:00
28 EA_Comp2_L3_EP_Pro2	In	EP_Pro2	Current L3	Error	2000-01-01 00:00:00
29 -	-	-	-	-	-
30 RTD04_2_T1	In	Device 21	Value 1	Invalid	2000-01-01 00:00:00
31 RTD04_2_T2	In	Device 21	Value 2	Invalid	2000-01-01 00:00:00

If the expected parameters are in the list shown in 3 above but not in connected variables please refer to PA Pro manual on how to connect External Units values to Channels in PA Pro and how to activate these channels.

4. Check that box for short term Databases in channel list is ticked.

Settings > Advanced > Channels

Performance Analyser PA Pro		PA Pro II på kontor Config 2011-12-14		0 alarms 2012-08-08 22:01:20		ClimaCheck	
View		Channels					
Settings						Tools	
Sensors & Actuators						Changes:	
Alarms						Channel <input checked="" type="checkbox"/>	
						Database <input checked="" type="checkbox"/>	
						Short <input checked="" type="checkbox"/>	
						Save	
						Update interval 2 s 5 s 10 s	
						For advanced edit click on the channel when the pointer becomes a hand.	
						Erased channels has a checkbox next to the E. To erase the channel check the box.	
Alarms						Short <input checked="" type="checkbox"/>	
Time control						Hour <input checked="" type="checkbox"/>	
Overview						Day <input checked="" type="checkbox"/>	
Communication							
System							
Advanced							
Channels							
Parameters							
Curves							
Databases							
Summaries							
Graphical programming							
Script							
Weekday catalog							
Database email							
Database UDP							
Operator panel menus							
External units							
Manual override							
ClimaCheck							

Nr	Name	Value	Unit	Dec.	Short	Hour	Day
1	T1_TT_RComp_out		153.5°C	1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Source: Temperature (1)		Math function: Polynomial		E: --	
		Source: Digital in counter (1)				E: --	
29	Counter_digital_in_2		10	0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Source: Digital in counter (2)				E: --	
30	Counter_digital_in_3		10	0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Source: Digital in counter (3)				E: --	
31	Counter_digital_in_4		10	0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Source: Digital in counter (4)				E: --	
32	EP_Comp_EP_Pro1		0.00 kW	2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		---				E: --	
33	pF_Comp_EP_Pro1		1.00	2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		---				E: --	
34	Energy_EP_Pro1		0.3 kWh	1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		---				E: --	
35	EP_Comp_L1_EP_Pro1		0.00 kW	2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		---				E: --	
36	EP_Comp_L2_EP_Pro1		0.00 kW	2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		---				E: --	
37	EP_Comp_L3_EP_Pro1		0.00 kW	2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		---				E: --	
38	EA_Comp_L1_EP_Pro1		0.00 A	2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		---				E: --	
39	EA_Comp_L2_EP_Pro1		0.00 A	2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		---				E: --	
40	EA_Comp_L3_EP_Pro1		0.00 A	2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		---				E: --	

5. Correct data in channel list in PA Pro and channels are ticked but ClimaCheck software do not display data.

Check that variables are connected in Data source in software. Values of each variable can be seen in datasource.

12.3 Error in measurements - Power does not correspond to expected

Always compare measured currents and power with rating plates and/or nominal data at start of measurements.

Experience show that the biggest challenge for ClimaCheck users are to apply power measurements correctly. We recommend outmost care when applying sensors as it can often be difficult to follow cables in confined housings. When using EP Pro with currents below 20% of range of clamp/transformer please read Section 4.2.1.

1. For EP Pro check that correct CT ratio is set

“Small” standard clamps (400 100)

100 :1 A have ratio 100

“Large” standard clamps with 3 ranges (400 112)

250:5 A range has ratio 50

500:5 A range has ratio 100

1000:5 A range has ratio 200

2. Check in display

- a. **Phase sequence**

- b. **Total power and power per phase**

- c. **Current**

If current is unbalanced, check that clamps are fully closed. If wrong level, check ratio and that complete compressor and only compressor current is measured. Typically current per phase is not allowed to vary so that any phase deviate more than 10% from average for a three phase motor.

- d. **Voltage**

Note that in EP Pro portable and fixed there are fuses for each phase and neutral;

Use multimeter to check voltage at terminal/contact. If voltage is supplied at terminals/contact but not registered in meter, check fuse resistance for EP Pro.

Typically voltage per phase is not allowed to vary so that any phase deviate more than 10% from average.

- e. **Power per phase**

If the power is uneven check the above points about current and voltage. If any power is negative but voltage and current are correctly matched, the CT is turned in the wrong direction or wires between CT and meters crossed (EP Pro with 24 V supply will in default setting reverse current if direction is wrong).

- f. **Power factor per phase and total**

At full load, power factor is 0.75-0.95 for three phase motors – higher for large/high efficiency motors but it can decrease significantly at low/part load. In permanent installation it is common that voltage supply to one or several power meters are taken from one place with a fused auxiliary supply and it can be a challenge to follow cables to the point where CTs are applied, frequently a significant distance between voltage.

Error in power factor is typically caused by

- i. **Mismatching voltage and current or direction of current.**

To validate the match, if possible, measure with a multimeter in Voltage position. Put one probe at the terminal in the direct vicinity of the CT and the other to the corresponding voltage input at the power meter. This

voltage should be 0 V whereas if the probe is moved to another phase on the meter it should show the full line to line voltage.

ii. **Interference on phase shift/Power factor by influence on CT wiring from power line**

Phase shift/Power factor values are sensitive to interference caused by power lines. Good practice for wiring of sensor leads should always be respected to avoid problems e.g. sensor cables should be separated from power cables and not run parallel to power cables without proper separators/shielding.

If power factor is inconsistent, wiring should be inspected and separation/shielding introduced if cables can be affected by magnetic fields from power cables.

Sensor cables can cross power lines at right angle but should not be run in parallel and never in bundles with power cables.

iii. **Resistance in CT cables**

Wire resistance that cause larger "burden" than allowed for a CT will affect the phase shift/power factor. Always respect wire length and size as specified in CT manual to avoid to decrease accuracy. Typically the phase shift increase=power factor decrease with a burden above the allowed.

3. Power factor for inverters are typically close to 1
If the power factor is wrong or uneven, the phase order or the match between voltage and current are normally not correct.
4. Check settings of voltage system and that connection is done accordingly.
5. Check if part winding or double cables are used and not correctly measured
See Section 9.2 on part winding and how to measure these.
6. Ensure that only compressor power is measured (pumps/fans should not be included in compressor power). If compressor cannot be measured separately, make an offset for accessories in software.
7. If inverters are used, it is normally necessary to measure before inverter and use a loss factor of typically 3-6% to compensate for the heat loss (inverter manufacturer can often give loss factor for their specific units).