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User Manual

pSens2

3 Phase Power meter & logger

PI021
Version 1.7

Revision History		
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1. Purpose

This document describes the user manual and the functional specifications of the pSens2 power meter. The pSens2 is identified by Project-ID PI021.

2. Intended Audience

The intended audience is generally anybody who wants to familiarize with and use the pSens2 power meter.

3. Glossary

VAC	Volts AC
mA	milli-Ampere, 1mA = 10^{-3}A
Arms	Ampere root-mean-square
Hz	Hertz, 1Hz = 1/second
MB	mega byte, 1MB = 10^{6} bytes
Wh	Watt-hour, 1Wh energy corresponds to 1 Watt during 1 hour = 3600J

4. Safety Regulations

4.1. Warning, caution and notes

Warnings, cautions and notes within this manual will be used as follows:

WARNING: Used to denote a danger to personnel of serious injury and/or death. The warning will be preceded by the caption WARNING and the detail of any warning will be in bold and uppercase.

CAUTION: Used to denote a possibility of damage to material or equipment but not a danger to personnel. The caution will be preceded by the caption CAUTION and the detail of any caution will be in bold and lowercase.

NOTE: used to draw attention to information that is extraneous to the immediate subject of the text. A note will be preceded by the caption NOTE and the detail will be in italics.

All warnings, cautions and notes will precede the relevant sections of the text.

4.2. General Safety Regulations

WARNING: THIS DEVICE IS NOT DESIGNED FOR AND THEREFORE NOT INTENDED FOR USE IN ANY ENVIRONMENT WHERE HUMAN LIFE DEPENDS DIRECTLY ON THE USE OF PROVEN RELIABILITY AND FAILSAFE TECHNIQUES AND COMPONENTS.

WARNING: THIS DEVICE MUST ONLY BE OPERATED IN ENVIRONMENTS LIMITED TO THE SPECIFIED TEMPERATURE AND HUMIDITY CONDITIONS.

WARNING: THIS DEVICE IS NOT PROTECTED AGAINST ANY CORROSION FROM ANY TOXICAL VAST PARTICLE, FLUID OR GAS.

WARNING: THIS DEVICE MUST NOT BE USED IN NUCLEAR PLANTS OR IN ANY EXPLOSIVE ENVIRONMENT.

CAUTION: The maximum input voltages must not be exceeded.

5. Instrument Description

The pSens2 is a compact and advanced mains analyzer. It measures voltage, current and power on 3 supply lines and the voltage on a neutral wire. Temperature and mains frequency are measured as well. For the currents, an external current sensor is required.
All measurements can be logged in an internal memory. The memory has a size of 16MB.

The pSens2 detects and logs mains events such as voltage interruptions, frequency deviations, harmonics, flicker, etc. For short events the waveform is stored.

The pSens2 has an Ethernet connection. The module takes its supply directly from the mains.

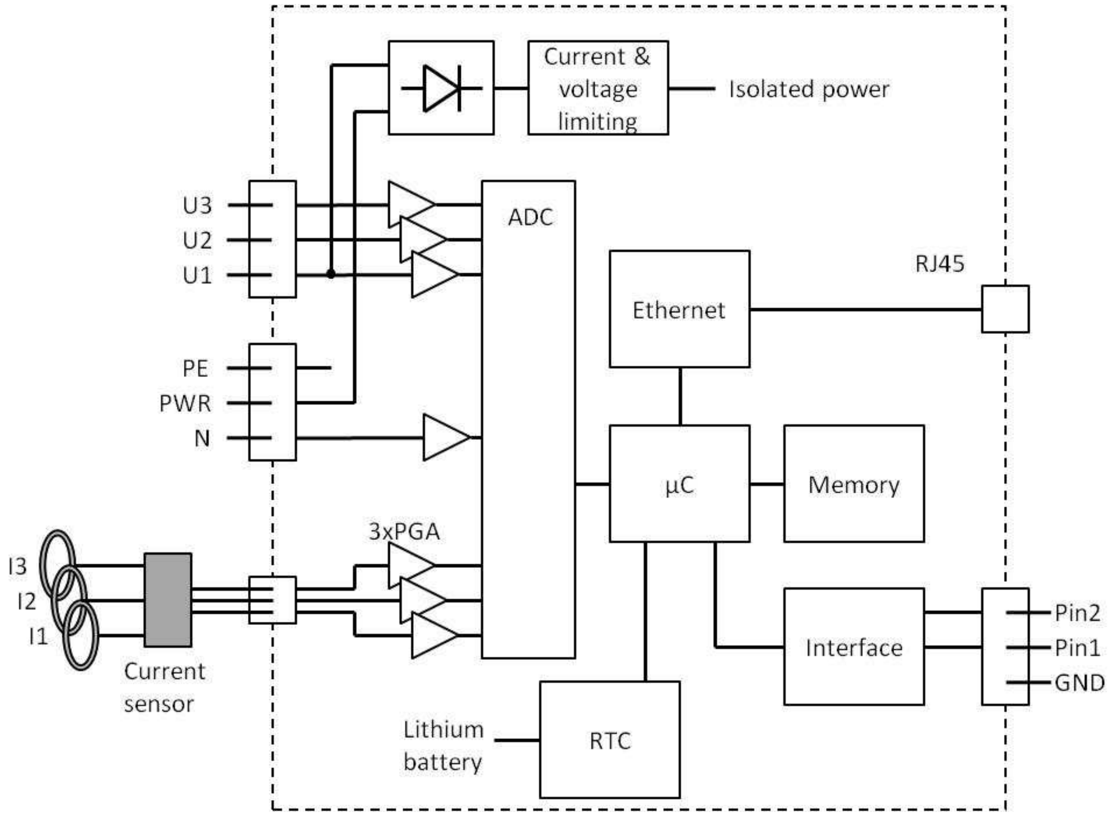


Figure 5-1 Schematic

The schematic above shows the main parts of the pSens2.

The pSens2 takes its power from the lines U1 and PWR. If either of those lines is not connected, the pSens2 will not operate. The power consumption is only 1.6W when Ethernet is not active and 2W when Ethernet is not active. The minimum required phase voltage to operate is 70 VAC (120 VAC line voltage).

The RTC has a lithium battery, garanteeing that the correct time is maintained when power is off.

The interface can be a double pulse output or an RS485 connection.

6. Logging

6.1. Sampling

The pSens2 samples the input voltages and currents at 32 samples/signal period. To do this, it tracks the frequency of the inputs and continuously updates its sampling rate accordingly.

At the same time, the pSens2 resamples the input voltages at 1kHz. These samples give a picture of the waveform. These waveforms are stored for several types of events.

Events are generated when a disturbance of the mains voltage is higher than the configurable limits.

6.2. Settings

The pSens2 has a 16MB memory to store logs and events.
It holds power logs per second for the last 2 days and per minute for the last 13 months.
It holds logs off all measurements per interval for the last 13 months and per day for the last 10 years.

No logging is performed if the time in the pSens2 is not valid, i.e. earlier than October 6^{th}, 2011 or later than December 31th, 2099.
This prevents correct logs from being overwritten by incorrect and unusable data.

The following settings control the logging.

All measures are AC except for these noted as DC.

6.2.1. Log Interval

Logs are stored after every interval. Average, minimum and maximum values are determined over the interval.
The interval is expressed in seconds and can be either 600s (10min) or 900s (15min).

6.2.2. Log variables

The pSens2 calculates a set of measurements during each log interval.

When the logs are read from the pSens2, the user can select which variables are printed. Selecting only the required parameters reduces the amount of data to be transferred.

Bit	Variables	Unit
0	L1 average rms voltage	Vrms
1	L1 minimum rms voltage L1 maximum rms voltage L1 average total harmonic voltage distortion	Vrms Vrms %
2	L2 average rms voltage	Vrms
3	L2 minimum rms voltage	Vrms

	L2 maximum rms voltage L2 average total harmonic voltage distortion	Vrms %
4	L3 average rms voltage	Vrms
5	L3 minimum rms voltage L3 maximum rms voltage L3 average total harmonic voltage distortion	Vrms Vrms %
6..7	*(reserved)*	
8	L1 average rms current	Arms
9	L1 minimum rms current L1 maximum rms current L1 average total harmonic current distortion	Arms Arms %
10	L2 average rms current	Arms
11	L2 minimum rms current L2 maximum rms current L2 average total harmonic current distortion	Arms Arms %
12	L3 average rms current	Arms
13	L3 minimum rms current L3 maximum rms current L3 average total harmonic current distortion	Arms Arms %
14..15	*(reserved)*	
16	L1 average active power L1 average reactive power	W VAr
17	L1 average positive active power L1 average negative active power L1 average power factor	W W -
18	L2 average active power L2 average reactive power	W VAr
19	L2 average positive active power L2 average negative active power L2 average power factor	W W -
20	L3 average active power L3 average reactive power	W VAr
21	L3 average positive active power L3 average negative active power L3 average power factor	W W -
22	*(reserved)*	
23	average total active power (sum of L1, L2 and L3) average total reactive power (sum of L1, L2 and L3)	W VAr
24	number of samples frequency temperature log code	- Hz °C -
25	Neutral average rms voltage	Vrms
26	Neutral minimum rms voltage Neutral maximum rms voltage	Vrms Vrms
27	*In1* *In2 (*)*	V/- V/-
28	*average total positive active power (sum of L1, L2 and L3)* *average total negative active power (sum of L1, L2 and L3)* *average total reactive power (sum of L1, L2 and L3)* *In1* *In2 (*)*	W W VAr V/- V/-

29..31	*(reserved)*	

(*) Volts for analog inputs, dimensionless for pulse inputs

Table 6-1 Log variables

All average values are calculated for the entire interval.
The same variables are logged for entire days. This allows for measurement data to be stored for up to 10 years.

NOTE: The power values for day logs are different than those for interval logs. They give the total energy for the day in Wh/VArh instead of the average power in W/VAr. This concerns bits 16 to 23.

Each log also contains a time stamp. This gives the beginning of the log interval.

With every log a code is stored that indicates errors.

Bit	Description
0	Internal supply dropped too low
1	Supply frequency could not be determined
2	Supply frequency deviates too much from nominal value
3	Current auto ranging failed due to excessive current
4	Log is continued after a reset
5	No external current sensor detected
6	Log is not complete; the data does not span an entire log interval. This can occur at startup or if the supply is removed for a while.
7	The log was found but it contains no data
8	The log was not found in memory

Table 6-2 Log code

6.2.3. Pulse Weight

The pulse weight setting is only used when the pSens2 interface is configured for pulse outputs.
The pulse weight determines the pulse rate of the pulse output. It is expressed in Wh/pulse.
The maximum pulse rate is 10Hz or 10 pulses/second.
When the pulse weight is set to zero, no pulses are sent.

6.3. Memory Erase

The logging memory can be erased either via the logging menu or via the command interface (commands 3A and 3B).
The memory is not erased automatically.

6.4. Time Change

The pSens2 clock can be trimmed accurately to run synchronously with a time server. This means that a change of the time value in the pSens2 will be required rarely.

Should such a change occur however, the logging ensures that no power is lost in the interval and day logs. This means that all consumed power that has been measured is included in the logs.
The logs for seconds en minutes are intended for graphical representation only. These logs can be overwritten when the time is changed, leading to a loss of measured power.
Depending on when the time change occurs and how large it is, the actual duration of a log interval can be almost double or almost zero.

The following sections describe how logging treats a time change.

6.4.1. Time is increased, the new value is still in the current interval

The actual duration of the interval will be less than a full log interval. It can be very short if the time changes from a value near the beginning of the interval to a value near the end.
The measured power consumption will therefore be smaller.

6.4.2. Time is increased, the new value is in a later interval

The previous interval is logged. Its actual duration will be shorter. The new interval will also have a shorter duration.

6.4.3. Time is decreased, the new value is still in the current interval

The actual duration of the interval will be longer than a full log interval. It can be almost double if the time changes from a value near the end of the interval to a value near the beginning.
The measured power consumption will therefore be higher.

6.4.4. Time is decreased, the new value is in a previous interval

The measured values will be included in the interval of the new time value. Its duration will therefore be longer.

7. Events

The pSens2 detects events on the supply. These are stored in the memory. For several events a 1s waveform of the line and neutral voltages is also stored. The waveform contains 1000 sample points. The memory holds up to 50 records for every event type.

The events are:
- Frequency variations
- Magnitude variations
- Rapid voltage changes
- Flicker severity
- Voltage dips
- Voltage interruptions
- Temporary overvoltage
- Transient overvoltage
- Voltage unbalance
- Harmonic voltage
- Current limit
- Frequency drift
- Vector surge
- Neutral overvoltage
- Power on/off
- Harmonic current
- Time Change

The limits for all events are set at calibrations. They can be changed from the default values given here.

Unless noted otherwise, an event log contains the start time, the duration and the event specific measurements.

7.1. Event description

7.1.1. Frequency variations

The average supply frequency is checked every 10 seconds. Deviations of more than 1% from the nominal frequency are detected. This is the slow frequency deviation event.

7.1.2. Magnitude variations

The average supply voltage is checked every 10 minutes. Deviations of more than 10% from the nominal supply voltage are detected. This is the slow voltage deviation event.

7.1.3. Rapid voltage changes

The 3 supply phases are checked. Sudden voltage changes of more than 5% of the nominal supply voltage are detected.

7.1.4. Flicker severity

The 3 supply phases are checked. The method used to calculate the flicker is an approximation of the standard method.

7.1.5. Voltage dips

The 3 supply phases are checked. Voltage drops below 90% of the nominal supply voltage and less than 1 minute in duration are detected.

A waveform is stored for this event.

7.1.6. Voltage interruptions

The 3 supply phases are checked. Voltage drops below 10% of the nominal supply voltage and less than 3 minutes in duration are detected.

A waveform is stored for this event.

7.1.7. Temporary overvoltage

The 3 supply phases are checked. Overvoltage above 110% of the nominal supply voltage and less than 3 minutes in duration are detected.

A waveform is stored for this event.

7.1.8. Transient overvoltage

The 3 supply phases are checked. Overvoltage above 150% of the nominal supply voltage and less than 1 minute in duration are detected.

A waveform is stored for this event.

7.1.9. Voltage unbalance

The 3 supply phases are checked. Unbalance above 2% is detected.

A waveform is stored for this event.

7.1.10. Harmonic voltage

The 3 supply phases are checked. Total harmonic distortions of a voltage above 8% are detected. Harmonics are detected up to the 15^{th} harmonic.

A waveform is stored for this event.

7.1.11. Current limit

The 3 supply phases are checked. Currents above maximum current range are detected.

A waveform is stored for this event.

7.1.12. Frequency drift

The supply frequency is checked. Sudden frequency changes of more than 1Hz of the nominal supply voltage are detected.

A waveform is stored for this event.

7.1.13. Vector jump

The 3 supply phases are checked. Jumps of the voltage angle of more than 30° are detected.

A waveform is stored for this event.

7.1.14. Neutral overvoltage

The neutral voltage is checked. A voltage above 10% of the nominal supply voltage is detected.

7.1.15. Power on/off

The last power on and off times are logged.

7.1.16. Harmonic current

The 3 supply phases are checked. Total harmonic distortions of a current above 2% are detected.

A waveform is stored for this event.

7.1.17. Time change

Changes to the internal clock time are logged.

7.2. Event settings

Each event has between 1 and 3 settings. These are shown in table 7-1.

Event	Setting 1	Setting 2	Setting 3
Frequency variations	period in seconds *default: 10s*	low limit in % of nominal freq. *default: 99%*	high limit in % of nominal freq. *default: 101%*
Magnitude variations	period in seconds *default: 600s*	low limit in % of nominal volt. *default: 90%*	high limit in % of nominal volt. *default: 110%*
Rapid voltage changes	limit in % of nominal volt. *default: 5%*	-	-
Flicker severity	period in seconds	limit dimensionless x10	-

	default: 60s	*default: 10*	
Voltage dips	limit in % of nominal volt. *default: 90%*	-	-
Voltage interruptions	limit in % of nominal volt. *default: 10%*	-	-
Temporary overvoltage	limit in % of nominal volt. *default: 110%*	-	-
Transient overvoltage	limit in % of nominal volt. *default: 150%*	-	-
Voltage unbalance	limit in % distortion *default: 2%*	-	-
Harmonic voltage	limit in % distortion *default: 8%*	-	-
Current limit	limit in Arms *default: 3000Arms*	-	-
Frequency drift	limit in mHz *default: 1000mHz*	-	-
Vector jump	limit in ° *default: 30°*	-	-
Neutral overvoltage	limit in % of nominal volt. *default: 10%*	-	-
Power on/off	-	-	-
Harmonic current	limit in % distortion *default: 100%*	-	-
Time change	-	-	-

Table 7-1 Event settings

7.3. Event log parameters

For each event up to 6 parameters are logged when the event occurs. These are shown in table 7-2. Unused parameters are 0.

Event	Parameter 1	Parameter 2	Parameter 3	Parameter 4	Parameter 5	Parameter 6
Frequency variations	measured frequency [mHz]	ratio of measured to nominal frequency [%]	0	0	0	0
Magnitude variations	measured voltage on line 1 [dVrms]	measured voltage on line 2 [dVrms]	measured voltage on line 3 [dVrms]	ratio of maximum measured voltage to nominal voltage[%]	0	0
Rapid voltage changes	voltage change on line 1 [dVrms]	voltage change on line 2 [dVrms]	voltage change on line 3 [dVrms]	0	0	0
Flicker severity	long-term flicker on line 1 [-/10]	long-term flicker on line 2 [-/10]	long-term flicker on line 3 [-/10]	0	0	0
Voltage dips	lowest ratio measured to nominal voltage for line 1 [%]	lowest ratio measured to nominal voltage for line 1 [%]	lowest ratio measured to nominal voltage for line 1 [%]	duration [ms]	0	0
Voltage interruptions	lowest voltage on line 1 [dVrms]	lowest voltage on line 2 [dVrms]	lowest voltage on line 3 [dVrms]	duration [ms]	0	0
Temporary overvoltage	highest ratio measured to nominal voltage for line 1 [%]	highest ratio measured to nominal voltage for line 1 [%]	highest ratio measured to nominal voltage for line 1 [%]	duration [ms]	0	0
Transient overvoltage	integral of overvoltage for line 1 [dVrms*s]	integral of overvoltage for line 2 [dVrms*s]	integral of overvoltage for line 3 [dVrms*s]	duration [ms]	0	0
Voltage unbalance	maximum unbalance for line 1 [%]	maximum unbalance for line 2 [%]	maximum unbalance for line 3 [%]	duration [ms]	0	0
Harmonic voltage	maximum total	maximum total	maximum total	duration [ms]	0	0

	distortion for line 1 [%]	distortion for line 2 [%]	distortion for line 3 [%]			
Current limit	integral of current above limit for line 1 [dArms*s]	integral of current above limit for line 2 [dArms*s]	integral of current above limit for line 3 [dArms*s]	duration [ms]	0	0
Frequency drift	frequency before change [mHz]	frequency after change [mHz]	0	0	0	0
Vector jump	vector jump for line 1 [°]	vector jump for line 2 [°]	vector jump for line 3 [°]	0	0	0
Neutral overvoltage	highest neutral voltage [dVrms]	duration [ms]	0	0	0	0
Power on/off	1=0n, 0=off	0	0	0	0	0
Harmonic current	maximum total distortion for line 1 [%]	maximum total distortion for line 2 [%]	maximum total distortion for line 3 [%]	duration [ms]	0	0
Time change	time difference [s]	0	0	0	0	0

Table 7-2 Event parameters

8. Ethernet connection

The Ethernet speed is optimized for 100Mb, but the pSens2 can be used with very old 10Mb hubs and with the 100/10Mb or 1Gb/100/10Mb switches (sometimes still hub named).

Each pSens2 has a MAC address 00-E0-82-CE-nn-nn where nn-nn is a unique HEX number. The serial number is A82CEnnnn, i.e. an 'A' followed by the last 4 bytes of the MAC address.

8.1. pSens2 in a network connection.

After a power up or reset or every minute the pSens2 tries to discover a DHCP server. Once he find the server, he registries for one day en gets the following information from the DHCP server:

- His private IP-address
- The network mask
- The router address
- The WINS server address
- The DNS server address
- The NTP server address
- The domain name
- The maximum registration time

These settings will override those in the pSens2.
In the next step, if there is a WINS server, the pSens2 registries his name and IP address at the WINS server. Normally your DNS server copies the WINS date.
After the maximum registration time or at least every day the pSens2 will redo the whole discover and registration procedure.

If you have access to the WINS server than you can see the used IP address and connect to the pSens2.
Normally we use the name or serial number "A82CEnnnn" of the pSens2. Your PC will ask the translation of this name to an IP-address to the WINS or DNS server. Or in absence of these servers the pSens2 respond to a WINS name resolution broadcast of your PC.
HTTP://A82CEnnnn is the URL to surf to the pSens2, do not type a WWW in this URL.

8.2. pSens2 in a point to point connection.

This paragraph describes how to connect to the pSens2 with a direct connection PC-pSens2. The pSens2 supports auto MDX, which means that you can use both, a standard Ethernet patch cable or a cross cable, the auto MDX function switches cable pairs if necessary.

1) Use the default ip-address = 169.254.1.1 to connect. This address can be changed in the settings:network http page, and the default value depend on the client. If it is impossible to connect, a last action could be a factory reset.
2) Connect to pSens2's serial number "A82CEnnnn". Name resolution is done by your PC with a WINS broadcast.
3) Temporally change of the IP address of your pSens2. This method can also be used in a network, and works only if your PC supports WINS broadcasts (Linux don't). The pSens2 recognizes a connection with a name formed by his serial number and the last 16 bits of the wanted IP address. See next paragraph.

8.3. Setting up an ip address for a client.

Using basic windows commands, users can set or verify clients IP addresses (=address of the module).
Take these steps to set the IP address for a new device:
1 - Make sure that your network has a Class B or C network.
    Type "ipconfig /all" and look to the subnet mask of your PC.
    This should be 255.255.0.0 or 255.255.255.0 or something in between.
    If not, use the windows environment to change the subnet mask.
    You need Administrator rights to do this.
2 - Check if the IP address is not already in use.
    The IP address supplied by the network manager must be checked first,
    Ping to this IP address
    Ping must return a time out, if you are not sure if the client already has this address, you can pull out the network connector from the client for this test.
    If you receive a reply from this IP address, this means a device in your network is
3 - Set the IP address of the client.
    Ping or connect to the next network address. The format of the free IP address is always AAA.BBB.CCC.DDD where
        AAA.BBB should be the same as the first 2 bytes of your PC's IP address.
        CCC.DDD is the client specific part
    Command: ping or connect to [SN]+[CCCDDD]
    [SN]: is the serial number "A82CEnnnn" of the client.
    [CCCDDD] = last 2 bytes of the clients IP address.
    000 < CCC < 255, 000 < DDD < 255 (do not use 000 or 255)

Examples:
    ping A82CEnnnn006009 (change the device IP address to AAA.BBB.6.9 and ping)
    ping A82CEnnnn239001 (change the device IP address to AAA.BBB.239.1 and ping)

NOT allowed:
    ping A82CEBFFC000000 (host)
    ping A82CEBFFC255255 (broadcast)
    ping A82CEBFFC900900 (> 255 is not allowed)
    ping A82CEBFFC45 (wrong format)
    ping A82CEBFFC00A00B (no numbers)

After setting up the address in the client you can also use:
    ping A82CEBFFC (ping to currently associated IP address)

Note1: The command "ping A82CEBFFC006009" is the same as "ping AAA.BBB.6.9"
Note2: The given IP address is placed in RAM (=volatile memory) of the pSens2.
    Change in the settings:network to change it permanently.
Note3: Windows can do the configuration once in an hour for the given IP-address,
    when there goes something wrong you should use another IP-address.

Some possible checks are:
    Type "arp -a" in the command prompt to display the ARP table.
    1. Look for the clients' full IP address. It is returned in brackets after pinging (red circle).
    2. Check in the ARP table which MAC address is associated with it.
    3. If the MAC address is not that of your device, you need to find another available IP address.

Possible advanced commands if you have administrator rights on your PC:

- ARP –a : display the ARP table

- ARP –d : delete the ARP table (Windows7 in user mode doesn't accept this command)

- nbtstat –c : show the network bios table (-c must be in lower case)
- nbtstat –R : reset the network bios table (-R must be in upper case) (Windows7 in user mode doesn't accept this command)

8.4. User menu on port 55555

When connected, the pSens2 user menu appears:

```
pSens2 main menu
====================
      Time      : 28/03/2012 11:43:03
      Serial nr : A82CEA402
      IPA       : 11.7.4.112
      Software  : App.:3.0.2.0  / Sys.:3.0.8.0 / Boot:3.0.1.0
      Hardware  : 1 / Interface : Pulse Output / Memory : 16 MB
      Sensor    : nr 1134016 , 3 x 17 cm coil

1 : Print last measurements
2 : Print 100ms waveform
L : Logging & settings menu
V : View logs, events, waveforms
@ : change IP address
```

Software : the 3 numbers give the application version, system version and boot loader version.

Sensor : the serial number and type of the connected sensor are shown.

Print last measurements shows the frequency, voltage amplitudes & angles and current amplitudes & angles.

Print 100ms waveform prints the phase and neutral voltages of the last 100ms, sampled at 1kHz, i.e. 1 sample/ms.

Logging & settings menu starts a separate menu where all the logging and event settings can be set.

View logs, events, waveforms starts a separate menu where all the logs can be viewed as well as the memory consumption.

To change the IP address, type @ followed by an IPA address, including the dots, e.g. @11.22.33.44

8.5. Command interface

The command interface can be accessed via the main menu. This section describes the commands that can be used in this interface.

Each command consists of a 2-digit number followed by a set of parameters, all separated by either spaces or tabs. The command is terminated by a carriage return.
The pSens2 returns the 2-digit number followed by a set of values, all separated by tabs. The result is terminated by a carriage return.
If the command or its parameters are incorrect, the pSens2 returns the 2-digit number followed by a tab and a question mark.

Most commands are protected by a 6-character password. Giving the correct password (command 12) enables all commands. The password has a time-out of 1 hour. After that time the password has to be given again or the commands are disabled. When the command interface is terminated, the password becomes invalid.

If no commands are given for 1 hour, the command interface is terminated.

The table below lists the possible commands. Commands indicated as "free" are not password protected.

Command	Description
12	Check password *(free)*
13	Give new password
14	Read software version *(free)*
15	Read serial number *(free)*
21	Read/write time
22	Read/write IP address
31	Read/write settings
32	Read/write log interval
33	Read/write pulse weight
34	Read actual measurements
35	Read total energy
36	Read event counters
37	Read/write event settings
3A	Erase memory
3B	Erase memory
3C	Set default event settings
3D	Reset total energy
3E	Read total negative energy
3F	Read/write IO settings
51	Read logs
52	Read logged events
53	Read logged waveforms
54	Read selected logs
55	Read selected logs for selected time
56	Read logged events for selected time
57	Read second logs
58	Read selected second logs for selected time

59	Read minute logs
5A	Read selected minute logs for selected time
5B	Read day logs
5C	Read selected day logs
5D	Read selected day logs for selected time
61	Read system log
62	Reset system log
63	Read log memory page
64	Read parameters
65	Read current sensor info
66	Read clock processor info

Table 8-1 Commands

8.5.1. Command 12 – Check password

Input : 12 p1g2f3
Output : 12 p1g2f3

The input has 1 parameter: the password (*p1g2f3* in this example).
The output contains the same parameter if the password is correct, otherwise it contains a question mark.

8.5.2. Command 13 – Give new password

Input : 13 newpas
Output : 13 newpas

The input has 1 parameter: the new password. Only 6-character strings are allowed.
The output has 1 parameter, this is the new password.

8.5.3. Command 14 – Read software version

Input : 14 ?
Output : 14 270

The input has 1 parameter: a question mark.
The output has 1 parameter, the software version in decimal format. 270 corresponds to 0x10E, i.e. version 0.0.1.14.

8.5.4. Command 15 – Read serial number

Input : 15 ?
Output : 15 40962

The input has 1 parameter: a question mark.
The output has 1 parameter, the serial number in decimal format. 40962 corresponds to 0xA002.

8.5.5. Command 21 – Read/write time

8.5.5.1. Read time

Input : 21 ?
Output : 21 091127 135154

The input has 1 parameter: a question mark.
The output has 2 parameters, the date and the time in the format YYMMDD hhmmss. The output 091127 135154 corresponds to November 27th, 2009 13h51:54.

8.5.5.2. Write time

Input : 21 091127 140000
Output : 21 091127 140000

The input has 2 parameters: the date and time in the format described above.
The output has 2 parameters, the date and the time.

8.5.6. Command 22 – Read/write IP address

8.5.6.1. Read IP address

Input : 22 ?
Output : 22 11.22.33.44

The input has 1 parameter: a question mark.
The output has 1 parameter: the IP address.

8.5.6.2. Write IP address

Input : 22 11.22.33.45
Output : 22 11.22.33.45

The input has 1 parameter: the IP address.
The output has 1 parameter: the IP address.

8.5.7. Command 31 – Read/write settings

8.5.7.1. Read settings

Input : 31 ?
Output : 31 2

The input has 1 parameter, a question mark.
The output has 1 parameter, the settings value. This is 32-bit value in decimal format. The meaning of the bits is shown in the table below. Value 0 corresponds to 50Hz 230/400V star net, circular buffer.

Bit	Description
0	**mains frequency** 0: 50Hz

	1: 60Hz
1..7	[]
8..11	**phase/line voltage:** 0000: 230/400V 0001: 200/350V 0010: 220/380V 0011: 240/420V 0100: 100/175V 0101: 110/190V 0110: 115/200V 0111: 120/210V 1000: 127/220V 1001: 400/690V 1010: 130/230V 1011..1111: *invalid*
12..15	**topology:** 0000: star (=three-phase with neutral) 0001: triangle (=three-phase without neutral) 0010: mono=single-phase 0011: double-phase 180° 0100..1111: *invalid*
16..31	[]

Table 8-2 Command 31 settings

The following examples show the settings for several net configurations. Note that the log mode bits (5..6) are not set here.

Settings (hex)	Setting (dec)	Net Configuration
0x00000000	0	50Hz, 230V phase voltage, star
0x00001000	4096	50Hz, 400V line voltage, triangle
0x00002000	8192	50Hz, 230V phase voltage, mono
0x00000900	2304	50Hz, 400V phase voltage, star
0x00001900	6400	50Hz, 690V line voltage, triangle
0x00002900	10496	50Hz, 400V phase voltage, mono

Table 8-3 Command 31 examples

8.5.7.2. Write settings

Input : 31 2
Output : 31 2

The input has 1 parameter, the settings value in decimal format.
The output has 1 parameter, the settings value.

8.5.8. Command 32 – Read/write log interval

8.5.8.1. Read log interval

Input : 32 ?
Output : 32 1500

The input has 1 parameter, a question mark.
The output has 1 parameter, the log interval in the format hhmmss. The output 1500 corresponds to 15 minutes.

8.5.8.2. Write log interval

Input : 32 1500
Output : 32 1500

The input has 1 parameter, the log interval. The only values that are allowed are 1000 and 1500.
The output has 1 parameter, the log interval.

8.5.9. Command 33 – Read/write pulse weight

8.5.9.1. Read pulse weight

Input : 33 ?
Output : 33 100

The input has 1 parameter, a question mark.
The output has 1 parameter, the pulse weight. This is the energy in Wh corresponding to 1 pulse at the pSens2 pulse output. When the pulse output is 100, the pSens2 sends a pulse for every 100Wh that is measured.

8.5.9.2. Write pulse weight

Input : 33 100
Output : 33 100

The input has 1 parameter, the pulse weight.
The output has 1 parameter, the pulse weight.

8.5.10. Command 34 – Read actual measurements

Input : 34 ?
Output : 34 …

The input has 1 parameter, a question mark.
The output has 27 parameters. These are the version number and the actual measurements. The order of the measurements and their units are shown in the table below.

1	Version number (decimal)
2	U1 in dVrms
3	U2 in dVrms
4	U3 in dVrms
5	U12 in dVrms
6	U23 in dVrms
7	U31 in dVrms
8	I1 in dArms
9	I2 in dArms
10	I3 in dArms

11	P1 in W
12	P2 in W
13	P3 in W
14	Q1 in W
15	Q2 in W
16	Q3 in W
17	PF1 *100
18	PF2 *100
19	PF3 *100
20	Distortion U1 in %
21	Distortion U2 in %
22	Distortion U3 in %
23	Distortion I1 in %
24	Distortion I2 in %
25	Distortion I3 in %
26	Temperature in °C
27	Frequency in mHz
28	In1
29	In2

Table 8-4 Command 34 output parameters

8.5.11. Command 35 – Read total energy

Input : 35 ?
Output : 35 31 22785736

The input has 1 parameter, a question mark.
The output has 2 parameters. The total energy is a 64-bit value and is expressed in Joule. The 64-bit value is sent as 2 decimal numbers, the first represents the highest 32 bits, the second the lowest 32 bits. The output 31 22785736 corresponds to $31*2^{32} + 22785736$, i.e. 133.1668 GJ.
Both numbers are signed, meaning that values from 2^{31} to 2^{32}-1 are shown as negative values.

8.5.12. Command 36 – Read event counters

Input : 36 ?
Output : 36 …

The input has 1 parameter, a question mark.
The output has 16 parameters. These are counters for the 16 events. Each counter is a 1-byte value. When the count reaches 255, the counter stops.

8.5.13. Command 37 – Read/write event settings

8.5.13.1. Read event settings

Input : 37 ?
Output : 37 …

The input has 1 parameter, a question mark.

The output has 17 lines, 1 for each event. Each line contains up to 5 parameters: the event number, the enable flag (0=disabled, <>0 is enabled) and between 1 and 3 settings. The number of settings depends on the event as discussed in section 7.2. After the last line a "z" is printed.

8.5.13.2. Write event settings

Input : 37 1 -1 600 98 102
Output : 37 1 -1 600 98 102

The input has 3 to 5 parameters, the event number, and the enable flag and between 1 and 3 event settings.
The output returns the settings for the event specified in the input.

8.5.14. Command 38 – Read/write log variable setting

8.5.14.1. Read log variable setting

Input : 38 ?
Output : 38 2

The input has 1 parameter, a question mark.
The output has 1 parameter, the log variable setting. This is a number from 1 to 3 (1=compact, 2=normal, 3=detailed).

8.5.14.2. Write log variable setting

Input : 38 3
Output : 38 3

The input has 1 parameter, the log variable setting. Only numbers from 1 to 3 are allowed.
The output has 1 parameter, the log variable setting.

8.5.15. Command 39 – Read/write log start time

8.5.15.1. Read log start time

Input : 39 ?
Output : 39 091127 135154

The input has 1 parameter, a question mark.
The output has 2 parameters, the date and the time in the format YYMMDD hhmmss. The output 091127 135154 corresponds to November 27th, 2009 13h51:54.

8.5.15.2. Write log start time

Input : 39 091127 140000
Output : 39 091127 140000

The input has 2 parameters: the date and time in the format described above.
The output has 2 parameters, the date and the time.

8.5.16. Command 3A – Memory erase

Input : 3A ?
Output : 3A …

The input has 1 parameter, a question mark.
The entire memory is erased in fast mode. The module detects which memory blocks have been written and erases only those blocks. The progress of the erase is printed. At the end a "z" is printed.

8.5.17. Command 3B – Memory erase

Input : 3B ?
Output : 3B …

The input has 1 parameter, a question mark.
The entire memory is erased. The progress of the erase is printed. At the end a "z" is printed.

8.5.18. Command 3C – Set default event settings

Input : 3C ?
Output : 3C …

The input has 1 parameter, a question mark.
The output contains the event settings for all events. At the end a "z" is printed.

8.5.19. Command 3D – Reset total energy

Input : 3D ?
Output : 3D 0 0

The input has 1 parameter, a question mark.
The output has 2 parameters that are zero. This is the new total energy.

8.5.20. Command 3E – Read total negative energy

Input : 3E ?
Output : 3E -1 22785736

The input has 1 parameter, a question mark.
The output has 2 parameters. The total negative energy is a 64-bit value and is expressed in Joule. The 64-bit value is sent as 2 decimal numbers, the first represents the highest 32 bits, the second the lowest 32 bits.
Both numbers are signed, meaning that values from 2^{31} to 2^{32}-1 are shown as negative values.

8.5.21. Command 3F – Read/write IO settings

8.5.21.1. Read IO settings

Input : 3F ?
Output : 3F 2

The input has 1 parameter, a question mark.
The output has 1 parameter, the settings value.

Value	Description
0	Pulse output
1	Active pulse input (minimum 5V)
2	Passive pulse input
3	Analog Input (0..24V)
>4	[]

Table 8-5 Command 3F settings

8.5.21.2. Write IO settings

Input : 3F 2
Output : 3F 2

The input has 1 parameter, the settings value in decimal format.
The output has 1 parameter, the settings value.

8.5.22. Command 51 – Read logs

Input : 51 YYMMDD
Output : 51 …

The input has 1 parameter, a date in YYMMDD format. This specifies the date for which the logs are read. By setting DD to 00, the logs for a month are read.
The output has a line for every log. The first line is a header. After the last line a "z" is printed.

8.5.23. Command 52 – Read events

Input : 52 YYMMDD
Output : 52 …

The input has 1 parameter, a date in YYMMDD format. This specifies the date for which the events are read. By setting DD to 00, the events for a month are read.
The output has a line for every event. The first line is a header. After the last line a "z" is printed.

8.5.24. Command 53 – Read waveform

Input : 53 n
Output : 53 …

The input has 1 parameter, a number specifying the waveform.
The output has the following format: the first line is a header, 1023 data lines, a line with "z" to indicate the end.

8.5.25. Command 54 – Read selected logs

Input : 54 YYMMDD mask

Output : 54 …

The input has 2 parameters, a date in YYMMDD format and a mask that selects which measurements are printed. The date specifies which the logs are read. By setting DD to 00, the logs for a month are read.
The output has a line for every log. The first line is a header. After the last line a "z" is printed.

The mask is a 32-bit value given in decimal format. The bits are described in table 6-1. Only the variables whose bit is 1 are printed. Variables whose bit is 0 are not printed.

Setting the mask to -1 (all bits 1) prints all the variables. This is equivalent to command 51.

8.5.26. Command 55 – Read selected logs for selected time

Input : 55 YYMMDD HHMMSS YYMMDD HHMMSS mask
Output : 55 …

The input has 5 parameters, a start time in YYMMDD HHMMSS format, an end time in YYMMDD HHMMSS format and a mask. The start time and end time specify which logs are read. The mask is used as described for command 54.
The output has a line for every log. The first line is a header. After the last line a "z" is printed.

8.5.27. Command 56 – Read events for selected time

Input : 56 YYMMDD HHMMSS YYMMDD HHMMSS
Output : 56 …

The input has 4 parameters, a start time in YYMMDD HHMMSS format and an end time in YYMMDD HHMMSS format. The start time and end time specify which events are read. The mask is used as described for command 54.
The output has a line for every log. The first line is a header. After the last line a "z" is printed.

8.5.28. Command 57 – Read second logs

Input : 57 YYMMDD
Output : 57 …

The input has 1 parameter, a date in YYMMDD format. This specifies the date for which the logs are read. By setting DD to 00, the logs for a month are read.
The output has a line for every log. The first line is a header. After the last line a "z" is printed.

8.5.29. Command 58 – Read second logs for selected time

Input : 58 YYMMDD HHMMSS YYMMDD HHMMSS
Output : 58 …

The input has 4 parameters, a start time in YYMMDD HHMMSS format and an end time in YYMMDD HHMMSS format. The start time and end time specify which logs are read.

The output has a line for every log. The first line is a header. After the last line a "z" is printed.

8.5.30. Command 59 – Read minute logs

Input : 59 YYMMDD
Output : 59 …

The input has 1 parameter, a date in YYMMDD format. This specifies the date for which the logs are read. By setting DD to 00, the logs for a month are read.
The output has a line for every log. The first line is a header. After the last line a "z" is printed.

8.5.31. Command 5A – Read minute logs for selected time

Input : 5A YYMMDD HHMMSS YYMMDD HHMMSS
Output : 5A …

The input has 4 parameters, a start time in YYMMDD HHMMSS format and an end time in YYMMDD HHMMSS format. The start time and end time specify which logs are read.
The output has a line for every log. The first line is a header. After the last line a "z" is printed.

8.5.32. Command 5B – Read day logs

Input : 5B YYMMDD
Output : 5B …

The input has 1 parameter, a date in YYMMDD format. This specifies the date for which the logs are read. By setting DD to 00, the logs for a month are read.
The output has a line for every log. The first line is a header. After the last line a "z" is printed.

8.5.33. Command 5C – Read selected day logs

Input : 5C YYMMDD mask
Output : 5C …

The input has 2 parameters, a date in YYMMDD format and a mask that selects which measurements are printed. The date specifies which the logs are read. By setting DD to 00, the logs for a month are read.
The output has a line for every log. The first line is a header. After the last line a "z" is printed.

The mask is a 32-bit value given in decimal format. The bits are described in table 6-1. Only the variables whose bit is 1 are printed. Variables whose bit is 0 are not printed.

Setting the mask to -1 (all bits 1) prints all the variables. This is equivalent to command 5B.

8.5.34. Command 5D – Read selected day logs for selected time

Input : 5D YYMMDD HHMMSS YYMMDD HHMMSS mask
Output : 5D …

The input has 5 parameters, a start time in YYMMDD HHMMSS format, an end time in YYMMDD HHMMSS format and a mask. The start time and end time specify which logs are read. The mask is used as described for command 5C.
The output has a line for every log. The first line is a header. After the last line a "z" is printed.

8.5.35. Command 61 – Read system log

Input : 61 ?
Output : 61 …

The input has 1 parameter, a question mark.
The output contains the system log. After the last line a "z" is printed.

NOTE: The system log contains operational information that is intended for diagnostic purposes by Idetron only.

8.5.36. Command 62 – Reset system log

Input : 62 ?
Output : 62 reset

The input has 1 parameter, a question mark.
The output contains a line "reset" that confirms the reset of the system log.

NOTE: The system log contains operational information that is intended for diagnostic purposes by Idetron only.

8.5.37. Command 63 – Read log memory page

Input : 63 1
Output : 63 …

The input has 1 parameter, the page number.
The output contains a memory dump of the selected page in the log memory. After the last line a "z" is printed.

NOTE: This command is intended for diagnostic purposes by Idetron only.

8.5.38. Command 64 – Read parameters

Input : 64 ?
Output : 64 …

The input has 1 parameter, a question mark.
The output contains a memory dump of the parameters. After the last line a "z" is printed.

NOTE: This command is intended for diagnostic purposes by Idetron only.

8.5.39. Command 65 – Read current sensor information

Input : 65 ?

Output : 65 -1 1139045 17

The input has 1 parameter, a question mark.
The output contains 3 parameters. The first value is a flag indicating if a current sensor was detected (-1=detected, 0=not detected). The second value is the sensor serial number. The third value is the sensor configuration number.

NOTE: This command is intended for diagnostic purposes by Idetron only.

8.5.40. Command 66 – Read clock processor information

Input : 66 ?
Output : 66 8

The input has 1 parameter, a question mark.
The output contains 1 parameter. This is the software version of the clock processor.

NOTE: This command is intended for diagnostic purposes by Idetron only.

8.6. Factory reset

A factory reset will reload all the default settings for the pSens2 that were programmed at fabrication time.
To initiate a factory reset, press the reset button for 10 seconds and then release it.
The Log LED will blink fast during these 10 seconds. The end of the 10 seconds is indicated by the Log LED blinking even faster.

Do not push longer than 20s, this is intended for special factory test. If you do this, than, no factory reset is done, while all communication and actions are blocked during 1 minute.

9. Installation

9.1. Overview

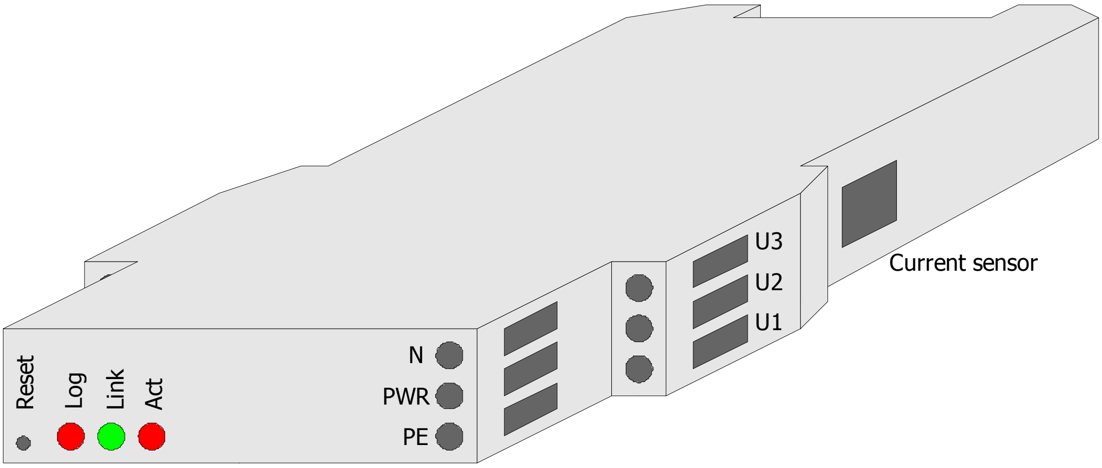


Figure 9-1 Front view

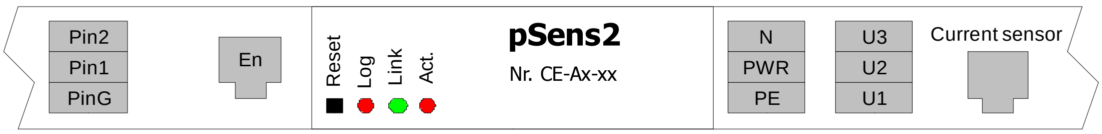


Figure 9-2 Expanded view

At the front, the pSens2 has a reset button and 3 LEDs: Log, Link, and Network Activity.

At the right side, the pSens2 has connections for:
- neutral, earth (PE), power
- phase voltages U1,U2,U3
- the current sensor

At the left side, the pSens2 has connections for:
- Ethernet
- 3 pins for the interface

	Description
Reset	The reset button can only be pressed with a small pin. A short press resets the pSens2. The reset button can also be used for a factory reset (see section 8.6).
Log	The log LED blinks every second to show activity. If the LED is premanently on, the pSens2 is not logging.
Link	The LED is on if the pSens2 is connected to a network.
Activity	The LED blinks when there is data transfer on the network.

Table 9-1 LEDs and reset button

The interface connector is located behind the Ethernet connector. The functionality of the pins is shown in the table below.

	PinG	**Pin1**	**Pin2**
IO	GND	IO1	IO2

Table 9-2 Interface connector pins

When the IO is set as pulse output IO1 is the pulse for positive power and IO2 is the pulse for negative power.

9.2. Connections

The next figure shows the connections for a supply net with 4 lines.

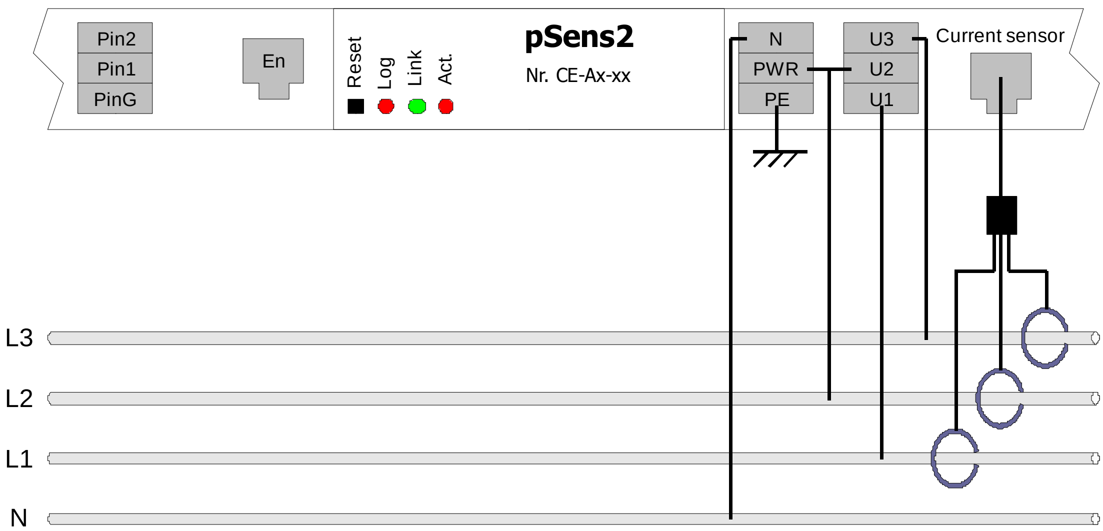
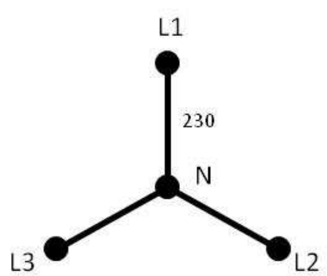
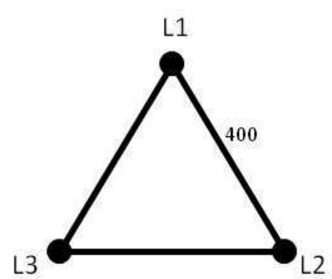


Figure 9-3 Installation

The power meter can be used with different distribution systems. The required connections for U1, U2, U3 and N are shown in the following table. Note the connection for the pSens2 power, which is taken from U1 and PWR.
The setting for the distribution system is accessible through the command interface (section 8.5.7) or through the Logging&Settings menu in the user menu (section 8.4).

Three-phase with neutral	**Three-phase without neutral**	**Single-phase**
		

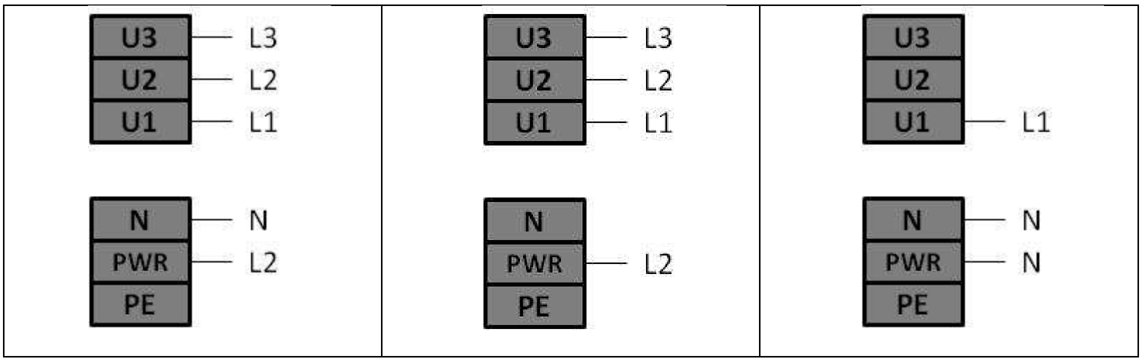


Table 9-3 Connections for different distribution systems

9.3. Coils

To install a current sensor, wrap the measurement coil round the single phase power cable. Click the free end (with box) into the clamp holder on the coil cable. The coil has to make a **closed** loop around the power cable.

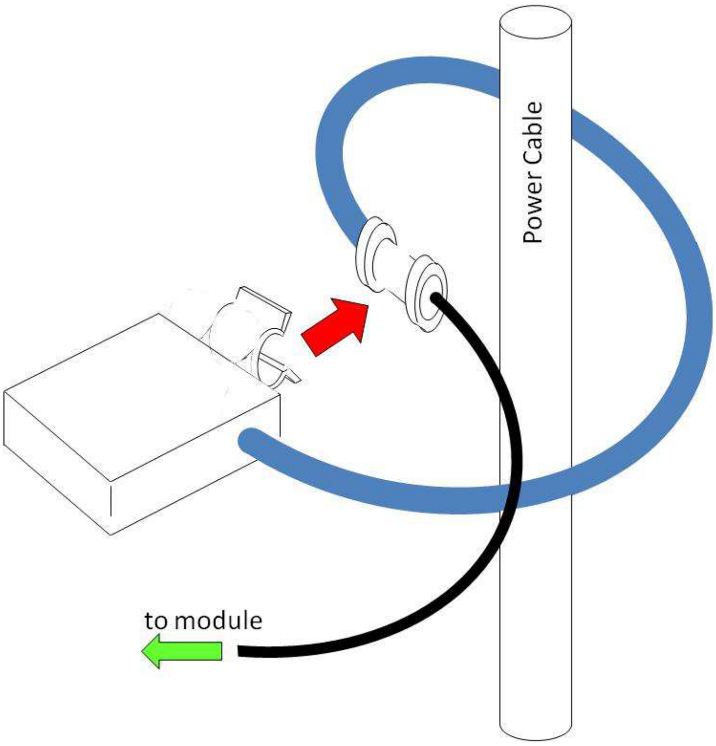


Figure 9-4 Correct coil connection

The following figure illustrates a faulty installation.

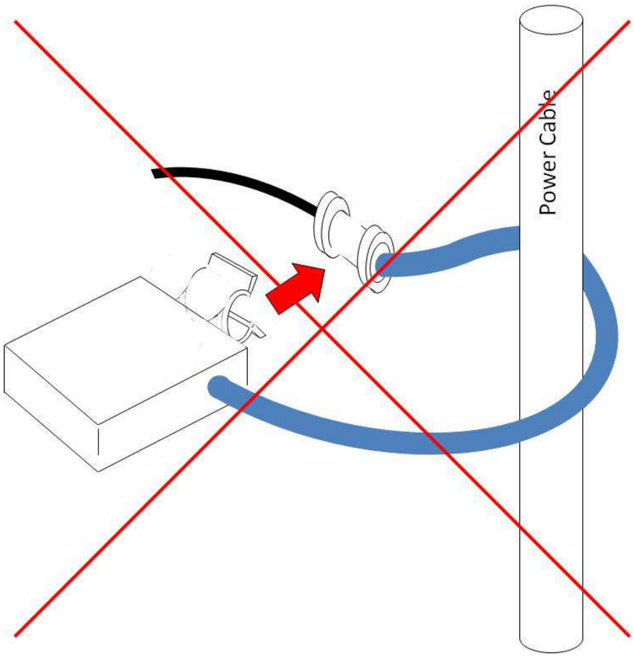


Figure 9-5 Incorrect coil connection

The sensor has to be properly aligned to the cable, as shown in the following figure.

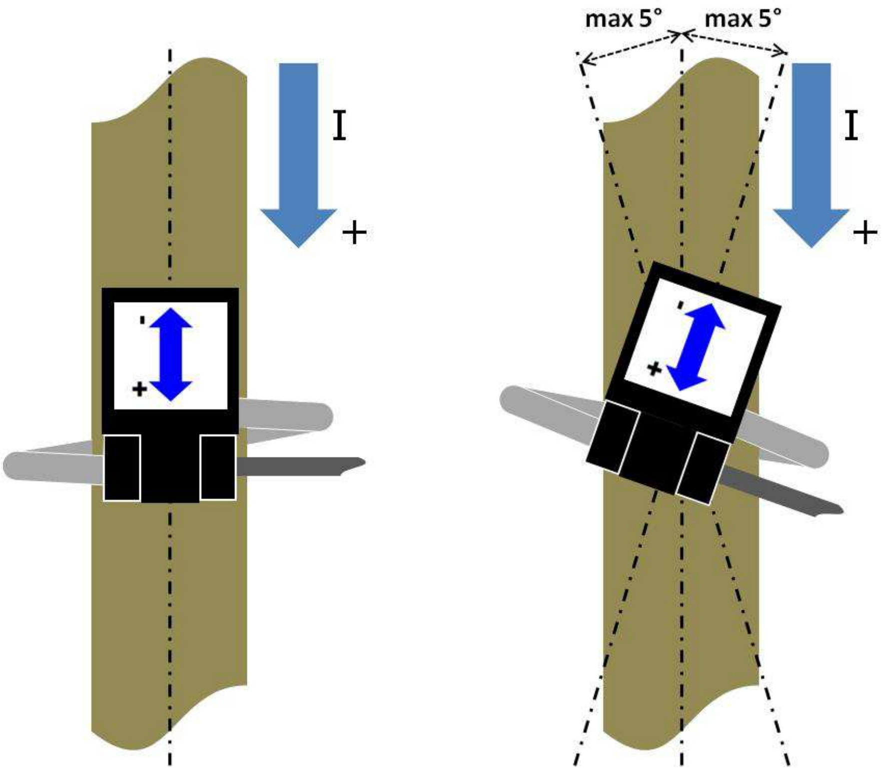


Figure 9-6 Correct coil alignment

9.4. Interface

This section shows the schematics for the different interface options.

9.4.1. Pulse output

The output pulse is a voltage that is about 16V when active and 0V when incative.
PinG is tied to GND.

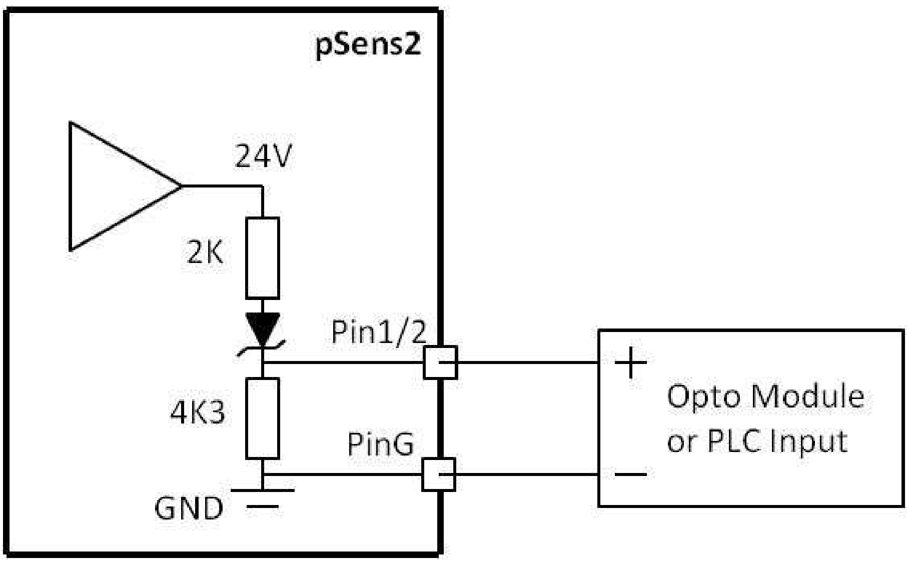


Figure 9-7 IO pulse output configuration

This output can either be used directly or a NPN power transistor can be used to drive a higher current. Possible transistors that can be used are: BD201, BD135, BD137, BD139, … Check the appropriate datasheet.

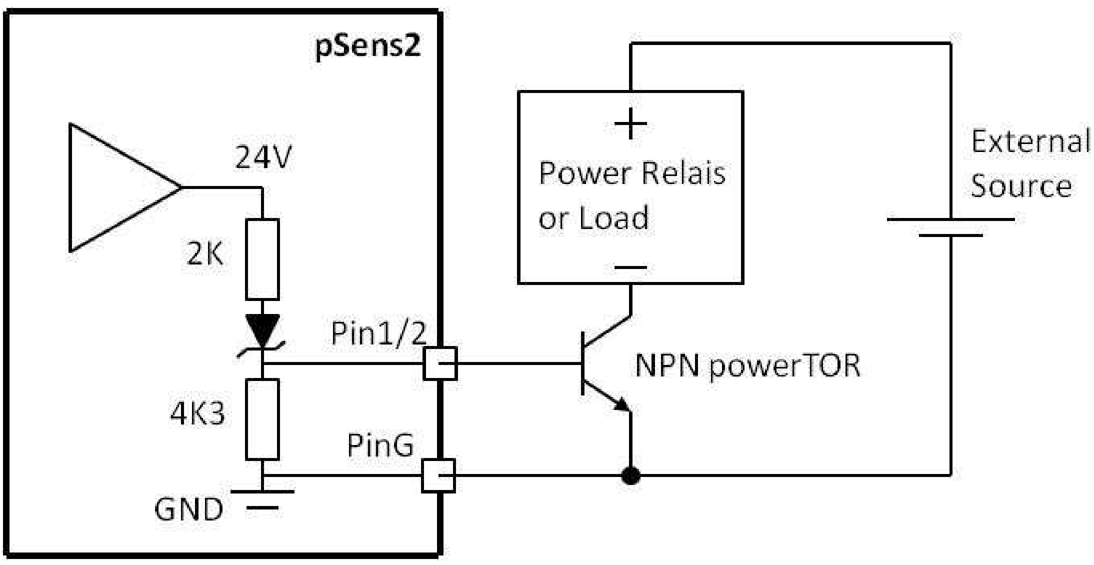


Figure 9-8 IO pulse output driving a NPN power transistor

9.4.2. Active pulse input

The active pulse input requires a voltage at Pin1/2.

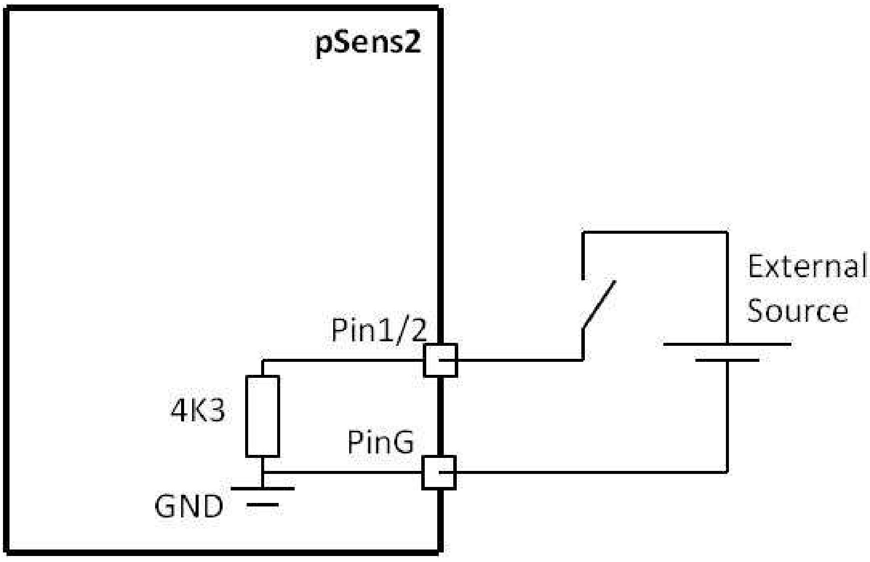


Figure 9-9 IO active pulse input configuration

Specification	Units	Value
Inactive level	V	<0.5
Active level	V	>5
Maximum input voltage	V	30

Table 9-4 IO active pulse input specification

9.4.3. Passive pulse input

The passive pulse input uses an internal 24V supply. To give a pulse, Pin1/2 has to be tied to ground.

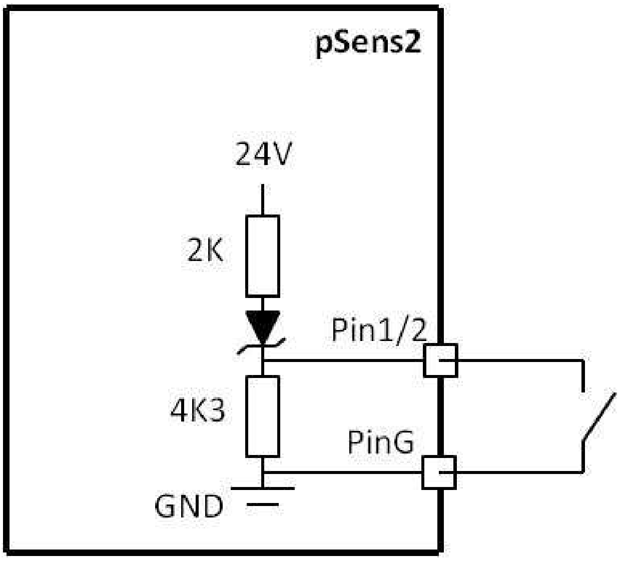


Figure 9-10 IO passive pulse input configuration

9.4.4. Analog input

The analog input acts as a resistance to GND.

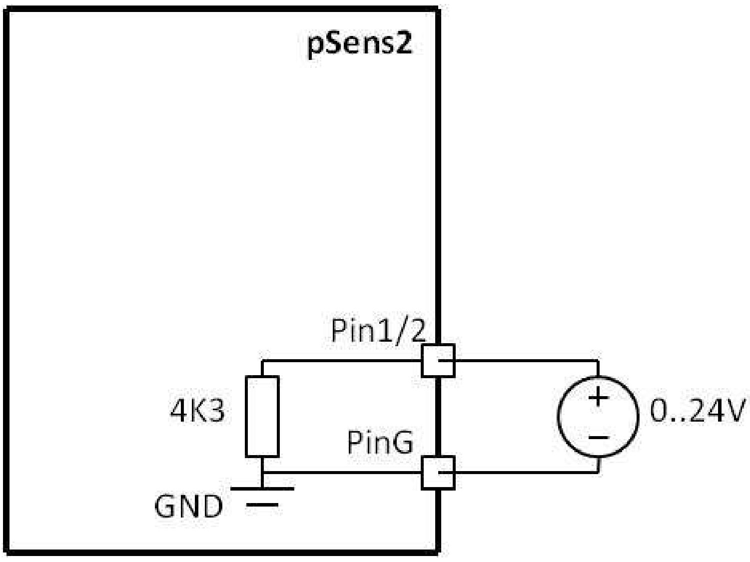


Figure 9-11 IO analog input configuration

To use the analog input as a current input, a parallel resistance can be used to convert a 4..20mA current to a 0..5V voltage or a 0..10V voltage.. This is shown in the schematic below.

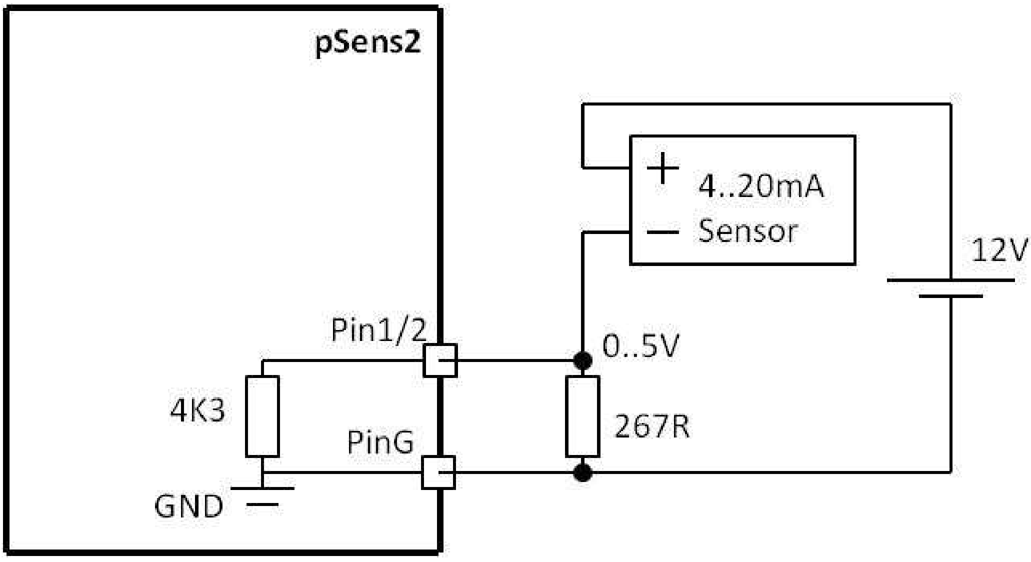


Figure 9-12 IO analog current input configuration for current - 1

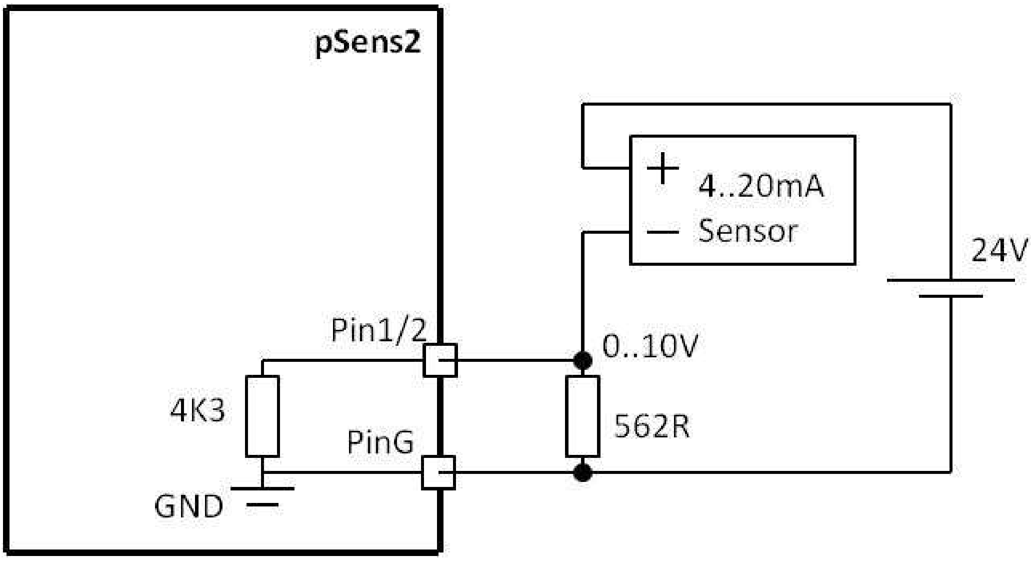


Figure 9-13 IO analog current input configuration for current - 2

Specification	Units	Value
Input voltage	V	0..24
Maximum input voltage	V	30

Table 9-5 IO analog input specification

10. Specifications

Specification	Units	Value
Minimum operating voltage *(1)*	VAC	70
Maximum current	mA	9
Power consumption	W	1.5 (no Ethernet) 2.0 (100Mbit Ethernet)

(1) The power is taken from lines U1 & PWR

Table 10-1 Power

Specification	Units	Value
Maximum allowed phase voltage	V	350 (continuous) 710 (peak for 20us)
Accuracy	%	±1

Table 10-2 Voltage inputs

Specification	Units	Value
Current range	Arms	3200 *(1)*
Resolution	Arms	0.1
Accuracy	%	±1

(2) At crest factor 2.5

Table 10-3 Current inputs

Specification	Units	Value
Maximum pulse rate	Hz	10

Table 10-4 Pulse output

Specification	Units	Value
Size	MB	16
Log Time – seconds	days	2
Log Time – minutes	months	13
Log Time – intervals	months	13 (10min interval) 20 (15min interval)
Log Time – days	years	10

Table 10-5 Memory

Specification	Units	Value
Housing W x H x D	mm	94 x 23 x 121
Coil Length	mm	170, 250, 350
Allowed Cable Diameter	mm	35, 65, 95
Coil Diameter	mm	7
Coil Bend Radius	mm	35
Output Cable	mm	3 m UL-LiYY, double insulation

Table 10-6 Mechanical

11. Reported problems

11.1. Direct connection without network

Problem: With a direct connection, PC – pSens2, it was impossible to establish a connection. See also paragraph 8.2.

A client performs the following actions:
-PC starts up with WLAN and pSens2 not connected.
-Once started, opens the browser and tries to connect to the pSens2. This did not work because there the pSens2 isn’t connected.
- connect pSens2 to PC
- Connection on name or 169.254.1.1 does not work
-Ping to 169.254.1.1 works.
- A power off/on cycle of the pSens2 does not change anything.
- After 1 a 2 minutes connection works on 169.254.1.1, and also on name.

Our reaction:
- Windows caches names and address translations for a while, sometimes you must be patient, or restart your PC.
- if your PC have got an IP address form the network and you disconnect him from the network to form a point to point connection to the pSens2, then he keeps this IP-address until you restart your computer (this is the same for the pSens2)
- A method that always works, is connect PC to pSens2, power on pSens2, and at least power up your PC. With this sequence, the PC caches don’t contain erroneous data.

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