Technical Documentation

POWER-ANALYZER

EMM-5

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Document history

Date	Name	Revision	Change
05.04.04	CE	01	initial document release
07.06.04	CE	02	features of new software revision (V1.02) added to manual, general updates
14.12.04	CE	03	features of new software (V1.05)
18.03.05	ATh	04	features of new software (V1.06)
08.12.05	ATh	05	features of new software (V1.07) connection diagrams added
28.02.06	ATh	06	features of new software (V1.8.2)

Contents

Important Information!

If the above sign appears besides a text passage in the manual the reader is strongly advised to read the corresponding information as it may be very important for usage of the EMM5.

It can contain safety advice or other information for the correct handling of the device.

If the information is disregarded, the device may be inoperable or even damaged!

1 Overview

The EMM5 power analyser has been designed to provide a great variety of information from the power distribution system it supervises. It contains a powerful measurement system which is able to provide high-precision values from 3-phase systems.

A big liquid crystal display with backlight provides a good visibility even in poor light conditions.

Four adaptive soft-keys provide easy, intuitive usage without the need to read the manual along all the time when using the device.

A basic set of standard values (currents, voltages and powers) is calculated from measured input data. These are then used to calculate further values such as power factors and others. A full list can be found in the “Measurement System” chapter. Nearly all calculated values are true RMS (TRMS) values, which means that they are correct even if the waveform is not a sine function.

A full range “Fast Fourier Transformation” is performed on the input data from all channels (3 voltage channels, 4 current channels). This provides information about the harmonic contents which distort the sine waveforms of currents and voltages.
A novelty in the device, which none of previous Beluk EMMs had, is the calculation of phase angles and cos-φ for the fundamentals of currents and voltages of one phase even if harmonics are present and distort the power readings. These values will be stable in disregard of changing harmonic contents.

The modular concept of the device enables us to develop a wide range of extension modules without the need for a re-design of the EMM5 main unit. Please ask for the actual available modules.

2 Measurement System

The EMM5 is designed to acquire all necessary data to provide full information in a 3-phase power distribution system. This requires the measurement of the three voltages L1/2/3 versus the N connector and the three currents in L1/L2/L3. Additionally, the current in N can be measured or, if desired, it can also be calculated from the data for I1/I2/I3 (but this will be less accurate due to calculation and rounding errors).

The EMM5 provides separate input terminals for device supply and measurement, so the measurement inputs are completely independent. Of course, measurement and supply may be connected to the same power grid.

For most values, minimum and maximum values are stored and available to the user.

2.1 Data collection

The waveforms of the signals (=voltage or current) on the 6 (7 with N-current) input channels are sampled by the data collection logic of the EMM5. This presents the software with enough information to calculate all the values.

The sampling of the input signal needs to be synchronized to the input signal, so the EMM5 needs at least one input signal for the voltage L1-N to be able to do calculations. If this voltage is too small or even disconnected, the device will not be able to do any measurements. This mechanism is also used to provide the frequency reading.

The data collection circuitry for the voltage channels uses the four terminals L1, L2, L3 and N which have to be connected in accordance to the connection diagram. As a minimum, the L1/L2/L3 terminals have to be connected while N can be left floating. In this case, N is artificially generated inside the device by three resistors. Connection of the N-terminal overrides these high-impedance resistor circuit. The voltages can be connected directly (with respect to the maximum rating) or via transformers. The voltage transformer factors can be set in the EMM5.

The three (four with N) current inputs use two terminals each. The two terminals for each current channel are labelled “K” and “L”. A current transformer can be connected to these terminals for measurement of currents, which exceed the maximum channel rating (see technical data and wiring diagram on backside of your device to be sure). If the currents remains below the maximum rating, direct connection is possible. The current inputs are internally interconnected only via high impedances, so the set-up and grounding of the current transformers is not influenced.

Always make sure, you don’t exceed the maximum ratings of voltage and current channels. The ratings and a connection diagram are available on the labels on the back side of the device.

Each input channel contains a high precision input filter with a 3dB-cutoff-frequency in the range of 2.5kHz - 3 kHz. This protects the system from being damaged by transients with high frequencies like voltage spikes and is mainly used to ensure synchronisation and measurement in presence of high frequency harmonics.

2.2 Measured values

The measurement system uses the information from the data collection system to calculate the values of the power grid.

The calculated values can be divided into several types:

Values, which are directly calculated from the raw input data:

- ULN : TRMS values for the voltages L1-N, L2-N, L3-N
- ULL : TRMS values for the voltages L1-L2, L2-L3, L3-L1
- I : TRMS values for the currents L1, L2, L3, (N)
- If : RMS values for the current fundamentals L1, L2, L3, (N)
- P : TRMS active power P for L1, L2, L3 and sum L1+L2+L3
- Q :TRMS reactive power Q for L1, L2, L3 and sum L1+L2+L3
- Harmonics in percent of fundamental wave (up to 63rd harmonic)
- phi : Angle between fundamental waves of current and voltage of a phase (L1, L2, L3)
- cp : cos-φ for fundamental waves of L1, L2, L3
- f : Frequency of voltage L1-N

From these, further calculations are possible:

- THD-U : THD for each voltage channel from the harmonics 1-63
- THD-I : THD for each current channel from the harmonics 1-63
- Pth / Ith : Exponentially damped values for currents and active powers which resemble the behaviour of thermic measurement
- S : TRMS Apparent powers S from P and Q of each phase and for power sums

- pf : Power factor as the absolute quotient P/S for each phase. This includes the influence of harmonics, because it is calculated from TRMS values P and S. If the harmonic-free information is needed, use the fundamental cp values!

Additional values by numeric integration:

For active powers P-L1, P-L2, P-L3 and P-sum, an energy accumulator is available, which separately counts the amount of energy for import and export direction (in kWh). The same counter is available for the reactive power readings Q-L1, Q-L2, Q-L3 and Q-sum. These are accumulated separately for inductive and capacitive reactive power.

Active power values are signed values! The signs have to be interpreted as follows: A positive sign shows power flow in one direction, a negative sign in the other. So, positive active power can be interpreted as active power import, the negative active power as active power export.[1]

Reactive power values are signed values! The signs are automatically interpreted as inductive or capacitive. The user of the EMM5 will always see a "ind" or "cap" mark with reactive values, so he never needs to worry about interpretation of signs with any reactive value.

[1] The precise definition is: If the current, measured on terminal K with respect to terminal L, is in phase with the corresponding voltage, the active power will be positive and defined as "energy import".

3 Alarm system

The unique Alarm-system of the EMM5 was designed to provide maximum flexibility as requested by many of our customers. It consists of 32 user-configurable alarms. Each of them continuously compares one of the measured values to an assigned limit and, if necessary, triggers the alarm. Each of the alarms provides the following features:

- Alarm source can be any measured value, with exclusion of work counters and single harmonics
- Configurable limit value for each alarm
- Trigger inversion (trigger alarm if “value>limit” or if “value<limit”)
- Alarm-specific turn-on-delay[2]
- Alarm-specific turn-off-delay[3]
- An alarm-specific set of output relays and the possibility to display an alarm message

[2] This provides a delay between the recognition of the alarm state and the activation of the alarm outputs (relays and display message).

[3] The function is similar to the turn-on-delay but it is used for insertion of a delay time between the alarm condition becoming false and the signal to all target relays to reset being sent.

This alarm system reaches its maximum flexibility by these features:

- **Multi-source alarm**

One single output relay, if available for alarms, can be triggered by any of the 32 alarms. More than one alarm can be used to trigger the same relay. In this case, only one of the alarms is sufficient to activate the relay (logical OR).

As each alarm first handles the necessary delay times before sending the activation signal to the relay, different delay times from all the alarms, which are sourcing a relay, are handled correctly!

- **Multi-target alarm**

One alarm can trigger a configurable set of relays. This includes the activation of more than one output relay.

4 User Interface

4.1 Introduction

The EMM5 user interface uses a combination of a graphical LCD display with automatic backlight and four multi-function softkeys. The action, a key performs, depends on the actual context and is given by small icons at the bottom of the display. This means a much more easy and intuitive usage of the device, even in complex situations.

4.2 The introduction screen

After the supply power is connected to the device, it will take a short time to power up and initialise itself. During this time, the display remains empty. After the power-up-procedures have been completed, an entry-screen is displayed. The keys on the left and the right (icon is a capital “M”) will proceed to main menu.

If, after waiting some seconds of set-up-time, the display does not show the introduction screen or is fully dark, it is possible that the display contrast is not set properly. Because the user would not able to navigate to the display contrast set-up menu in this case, an additional possibility to set the contrast is included in then introduction screen: press one of the two keys in the middle repeatedly to change contrast. If no change can be seen, try the other key. The value is automatically saved for the next start.

4.3 Main menu

The main menu is the central point of the devices menu navigation. It shows the following items:

- **measurement -** This submenu contains the measured values
- **auto-roll -** Measurement display with automatic switching to the next value
- **harmonics -** This sub-menu shows the single harmonics for the input channels (voltages L1-N, L2-N, L3-N and currents I-1, I-2, I-3, I-N)
- **work -** This sub-menu contains the work accumulators
- **setup -** The device setup can be found inside this menu
- **device info -** This submenu shows some information about the device

KEYS:

One can navigate through the menu entries by use of the "⇑ "and "⇓" keys. On the left side of the topmost item a tiny arrow shows which item is actually selected. By pressing ⇒, one can enter into the selected submenu. The left key is not used in the main menu.

Whenever a capital “M” is used as key symbol in any sub-menu, pressing the key will switch straight to this main menu.

4.4 Menu: “measurement”

This menu contains all measured values. The values are organised in several “pages”, which can be displayed on the LCD. Additionally, minimum and maximum values are available.

The navigation through the values is quite easy: You can use the "⇑" and "⇓" keys to select the different pages. Press one of the keys repeatedly to see all the values. If the last page is reached, the EMM5 continues with the first page (“roll-over function”).

Each value is displayed with its name (ULL, I,...), its origin (L1, L2, N,...) and the unit (V, A,...).

The EMM5 features an auto range-function: If a certain value gets too big, the display automatically switches the unit prefixes. For example: If the voltage exceeds 1000V, the display switches to 1.00 kV. If it would be greater than 1,000,000 Volt, the display would be 1.00 MV.

For most of the values, minima and maximal are stored. One can select between the display of

- The actual measured value (“val”)
- The minimum value (“min”)
- The maximum value (”max”)

By pressing the right button, the symbol of the button will change between “val”, “min” and “max”. The minimum and maximum values can be reset in the “setup”-menu. For some values the min/max function is disabled, only the “val” setting is available for them.

In the top right corner of the display, the status of all assembled output relays is shown. The relays are represented by numbers. A dark number on bright ground shows a deactivated relay, a bright number on dark ground shows an activated relay.

One can press the “M”-key to get back to the main menu at any time.

4.5 Menu: “auto-roll”

This menu contains all measured values. The values are organised in several “pages”, which can be displayed on the LCD. **This menu has a timer-controlled auto-roll mechanism.** Each approx. 10 seconds, the display is automatically switched to the next page.

Minimum and maximum values are *not* available in this “auto-roll”-display.

The navigation is easy: You can use the "⇑" and "⇓" keys to select the different pages. Press one of the keys repeatedly to see all the values. If the last page is reached, the EMM5 continues with the first page (“roll-over function”).

Each value is displayed with its name (ULL, I,...), its origin (L1, L2, N,...) and the unit (V, A,...).

The EMM5 features an auto range-function: If a certain value gets too big, the display automatically switches the unit prefixes. For example: If the voltage exceeds 1000V, the display switches to 1.00 kV. If it would be greater than 1,000,000 Volt, the display would be 1.00 MV.

In the top right corner of the display, the status of all assembled output relays is shown. The relays are represented by numbers. A dark number on bright ground shows an deactivated relay, a bright number on dark ground shows an activated relay.

One can press the “M”-key to get back to the main menu at any time.

4.6 Menu: “harmonics”

The EMM5 calculates harmonics for the seven input channels (U-L1, U-L2, U-L3, I-L1, I-L2, I-L3, I-N). This provides information about the distortions by harmonics. Harmonics are displayed from fundamental (1st harmonic) up to the 62nd harmonic. Both, even and odd harmonics are shown in the “harmonics”-submenu.

The harmonics are displayed in two columns: odd harmonics on the left side, even harmonics on the right. Each harmonic is shown as a percentage value of the fundamental harmonic. The numbers before the harmonic value give the order of the harmonic. The fundamental (order 01) is always 100.0%.

KEYS:

- Left key (“M”) switches back to main menu
- “⇓” - key scrolls the list of harmonics down to the harmonics of higher order
- “⇑” - key scrolls the list back to the top (lower harmonics)
- Right key (“⇔”) switches between the seven data sources (4 currents and 3 voltages)

If the harmonic display quotes “not available”, the current or voltage, which sources the harmonic calculation is below a certain limit or even not present. This makes the FFT calculation of the harmonics very inaccurate or impossible.

The contents of the harmonic menu occupy a great amount of memory (7channels * 63 values) in the device, so no minimum / maximum values are stored for the harmonics.

Single harmonics, as displayed in this menu, cannot be the source of alarms. Harmonic alarms should use the THD as source, which contains information of all harmonics of one source in one single value.

4.7 Menu: “work”

This submenu contains the work accumulators. The work accumulators count certain amounts of electrical energy and display the counter values in units of Wh or varh.

The work counters are programmed to integrate the powers for L1, L2, L3 and power sum in a separate accumulator each. They are further divided:

- Active work is accumulated separately for import and export energy flow direction.
- Reactive work is accumulated separately for inductive and capacitive reactive power.

This gives a total of 16 counters:

source	WP		WQ	
	Import	Export	Inductive	Capacitive
L1	WP-L1-imp	WP-L1-exp	WQ-L1-ind	WQ-L1-cap
L2	WP-L2-imp	WP-L2-exp	WQ-L2-ind	WQ-L2-cap
L3	WP-L3-imp	WP-L3-exp	WQ-L3-ind	WQ-L3-cap
Sum (L1+L2+L3)	WP-sum-imp	WP-sum-exp	WQ-sum-ind	WQ-sum-cap

The display can show one of four different pages, which are: WP-Import, WP-Export, WQ-Inductive, WQ-Capacitive. Each page contains four work counters for “L1”, “L2”, “L3”, and “sum” for the possible sources.

KEYS:

- Left key (“M”) switches back to main menu
- Keys two and three are unused
- Right key (“⇔”) switches between the four different work accumulator pages

It is important to mention, that, even if the lowest counter is labelled "sum", it must not show the sum of the above counters for L1, L2 and L3. This merely indicates that this work counter accumulates the power sum (P-sum and Q-sum), which is calculated as arithmetic sum of the powers of the three phases. Because the powers of the phases can be of different nature (imp. /exp. or índ. /cap.), which are mathematically represented by positive and negative values, the powers can even add up to zero. This would result in the sum-power-accumulator not running at all even if the single-phase accumulators are counting!

4.8 Menu: “setup”

The “setup”-menu contains all settings, which can be performed by the user of the EMM5 to adjust it to certain ambient circumstances. Because there are many possible settings, the “setup”-menu divides into more sub-menus to provide easy and logical access to all the set-up possibilities.

The available sub-menus are:

- **parameter:** This menu provides the possibility to set certain system parameters like transformer ratios and others.
- **alarm:** This sub-menu contains the settings for the 32 alarms.
- **reset settings:** This item resets the settings to safe default values. *All settings, which have been changed manually are lost. (The display contrast is not influenced by a parameter reset)*
- **reset min/max:** This item resets the min/max values. *All min/max values are lost!*
- **reset work:** This item resets the work counters to 0. *All old work accumulator values are lost!*

KEYS:

Select a sub-menu with the arrow-keys („⇓” and “⇑„) and enter it by pressing the “⇒” - key. When prompted for confirmation (“reset xxxx” entries) just press “yes” for confirmation of the action.

The left key (“M”) switches back to the main menu.

PASSWORD:

To enter the “setup”-Menu, a password is needed. This password is “2402”.

4.8.1 Input of numerical values

Inside the “setup”-menu and its submenus, the user will at certain points encounter the problem to enter numerical values. Whenever the EMM5 prompts for the input of a value, the routine will be the same:

A preset-value will be displayed with the first (highest) digit underlined by a “_”. This digit can now be changed by use of the keys which are labelled with “+” and “-“ signs. If no change can be encountered while pressing one of these buttons, the value may be at its minimum or maximum, so just try the other key or change to the next, smaller digit by use of the “⇒” key. After changing, the next digit will be also underlined and can now be changed just like the first one. To store the value, proceed to the least significant digit on the right side. Press the “⇒” key once more, and the new value will be saved and used.

At any time, one can go back to the last menu without changing the value by pressing the “⇐” key.

4.8.2 Submenu: “setup-parameter”

Select one of the submenu entries with the arrow-keys (“⇓” and “⇑”) and activate it by pressing the “⇒” key. The “⇐” key will switch back to the “setup”-menu.

The “setup-parameter” submenu allows the changing of the following parameters:

- **“vt ratio“:** This sets up the device to work with a voltage measurement transformer. Enter the transformer ratio here. If no transformer is used and the EMM5 is directly connected for voltage measurement, enter factor 1 here. This is the default value for this setting. The range is 1-4000.
- **“ct ratio“:** This sets up the device to work with a current measurement transformer. Enter the transformer ratio here. If no transformer is used and the EMM5 is directly connected for current measurement, enter factor 1 here. The range is 1-10000.

  This setting only applies to current channels L1, L2, and L3.
- **“ct-N ratio“:** This sets up the device to work with a current measurement transformer for the N current . Enter the transformer ratio here. If no transformer is used and the EMM5 is directly connected for N current measurement, enter factor 1 here. The range is 1-10000.

  This setting only applies to current channel N.

- **“thermic tau”:** This sets the damping time constant for the Ith and Pth values. The time constant is given in seconds (default value is 300 seconds / 5 min). The entered value is the time constant of the exponential damping function[4].
- **“calc/meas IN“:** Here, the measurement method of the I-N current can be selected: It can be calculated from the L1, L2 and L3 currents when no current measurement for N is connected to the device. This is less accurate due to calculation and rounding errors. If set to “measure IN”, the N current is measured on its own input terminals. Use the “⇔” key to change setting and return to the parent menu with the “⇐” key.
- **“display contrast“:** Here, the display contrast can be adjusted by repeated use of the “+” and “-” keys. The value is stored, so it will be used automatically with the next device start. One can return to the parent menu with the “⇐” key**.**

[4] To be more precise, the value is calculated as follows: value(t)=value(t=0)*(1-exp(-t/tau)), where tau is the time constant.

4.8.3 Submenu: “alarm”

This submenu contains all settings, which have to be performed in order to use the EMM5 alarm system. The menu contains a set of different settings, between which the user can select with the “⇓” key. The little arrow on the left border of the display shows the selected item. One can leave the alarm settings menu by pressing the “⇐” key.

- **ALARM:** Move the “>” to this line and use “+” and “-“ to select one of the 32 alarms. Each alarm compares one source value to a limit and, if the trigger condition is met, activates the outputs.
- **SOURCE:** Use the “+” and “-“ keys to select the appropriate source for the alarm. This is the value which is compared to the limit by the alarm system.
- **TRIGGER:** Use the “⇔” key to select the condition under which the alarm is considered to be active. Possible values are “val>limit” (alarm if selected source value is bigger than limit) and “val<limit” (alarm if selected source value is smaller than limit). For the source values which are of reactive nature (reactive power, cp) the display shows “+ind” or “+cap” for the trigger setting. This has to be interpreted as “more inductive than limit” or “more capacitive than limit”.
- **LIMIT:** The limit value can be set here. Press the “⇒” key to enter a value.
- **T-ON / T-OFF:** Use these items to enter delay times for activation and deactivation of alarm relays in a range of 0-600 seconds in steps of 10 ms.
- **OUTPUT:** Here you can choose to which of the 8 relays an activation signal will be sent once the alarm is active and the on-delay time is over. The alarm message display can also be selected here. In the following sub-menu “+” and “-“ select the relay and the “⇔” key chooses, whether the relay will be activated on alarm or not. If desired, the EMM5 can display a message if the alarm is active. This can also be chosen here.

Some of the alarm settings may not get active until the alarms menu is leaved because at that time, a great part of the entered values is given to the alarm subsystem for execution. This is done to inhibit the alarm subsystem from executing weird intermediate settings while the user enters an new alarm setup.

4.9 Menu: “device info”

This menu simply shows some information about the EMM5 device. It may contain several pages, the “⇔” key switches between them. The most interesting information is available on the second page:

- SW: software version number
- HW: hardware revision number
- SN: serial number of the device
- FLAGS: options of the device

4.10 Alarm display

If any alarm is configured to display an alarm message, the following contents will be shown whenever the alarm is triggered. The display message has to be quitted manually.

An alarm message offers the following information:

- In the right top corner of the display, the status of all assembled relays is displayed. A dark number on bright ground shows a relay which is deactivated, the reverse display (bright number on dark ground) shows an activated relay. Relays, which are not assembled, will not be shown here.
- The message “ALARM #xx” in the centre of the display shows the number of the active alarm. The number appears instead of “xx” in this example.
- The actual value of the measurement which is the source of this alarm.

If more than one alarm message is active, one can switch between them by pressing key “+”.

The right key (“Enter”) can be used to confirm the alarm message. After confirmation, this alarm message will not reappear until the alarm has become inactive and active again. The confirmation disables only the alarm message. If any output relays are configured for the same alarm they are **not** influenced by the confirmation.

After confirmation the display shows the next active alarm or, if there are no more active alarms, resumes work at the same point where it left before the alarm occurred. Each alarm message has to be confirmed separately.

The alarm message is displayed after the on-delay time for the alarm. If the alarm condition becomes false again, the alarm message is deactivated after expiration of the off-delay time. In this context, it works exactly as one of the relays.

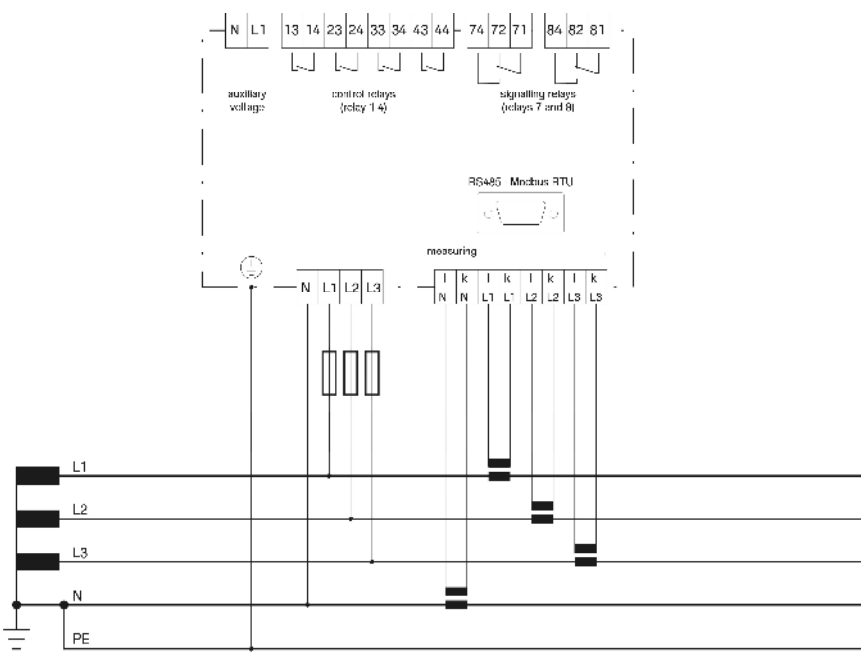
To enhance visibility and to make recognition of the alarm easier, the backlight of the display is toggled between full brightness and reduced brightness, which resembles a blinking signal light.

5 Technical Data

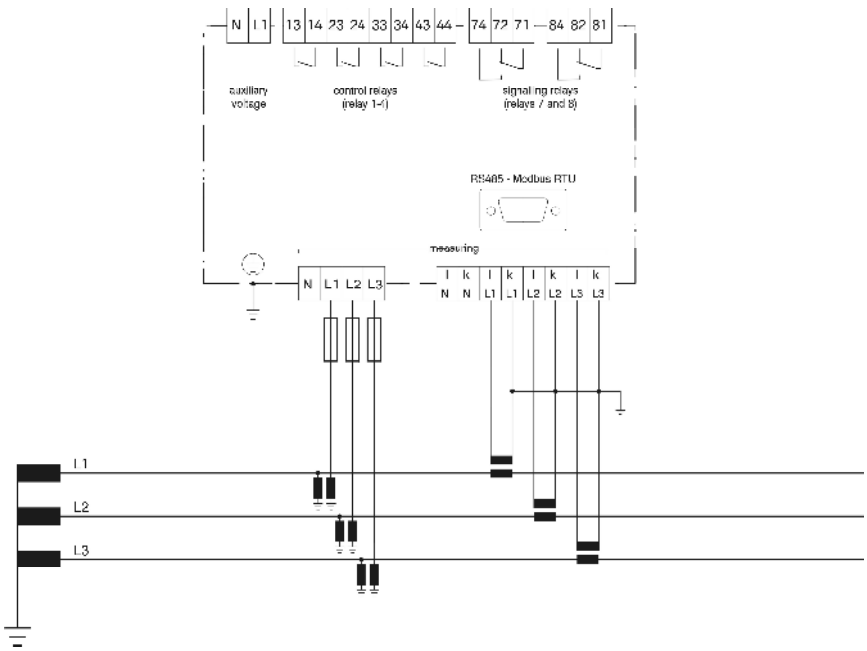
5.1 Connection diagrams

The EMM5 can be used in power systems with or without the neutral conductor. Below measurements in systems with L1/L2/L3 and N (PEN) are called four-wire measurement. Measurements in systems without N are called three-wire measurement.

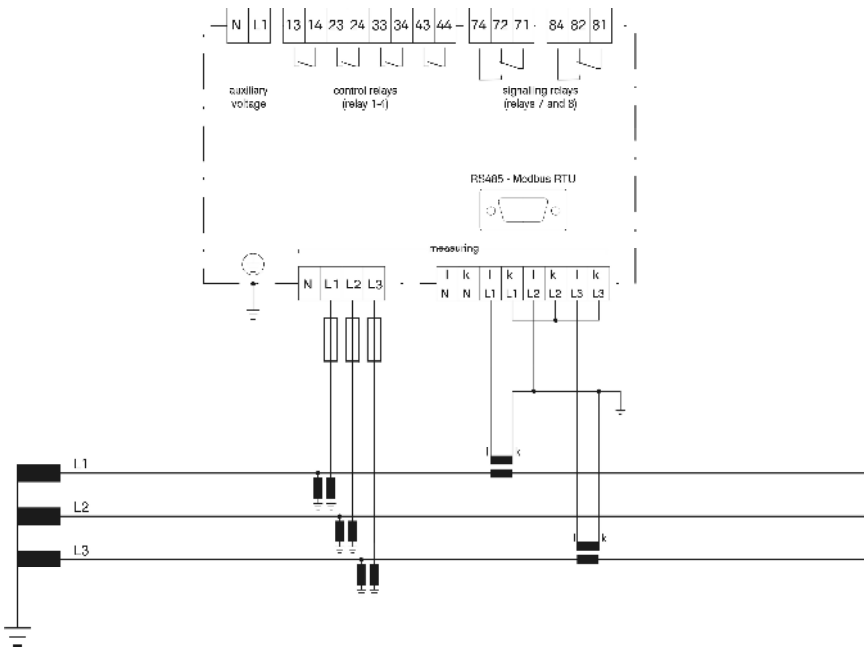
5.1.1 Three-phase measurement with neutral conductor and four current transformers (four-wire measurement)



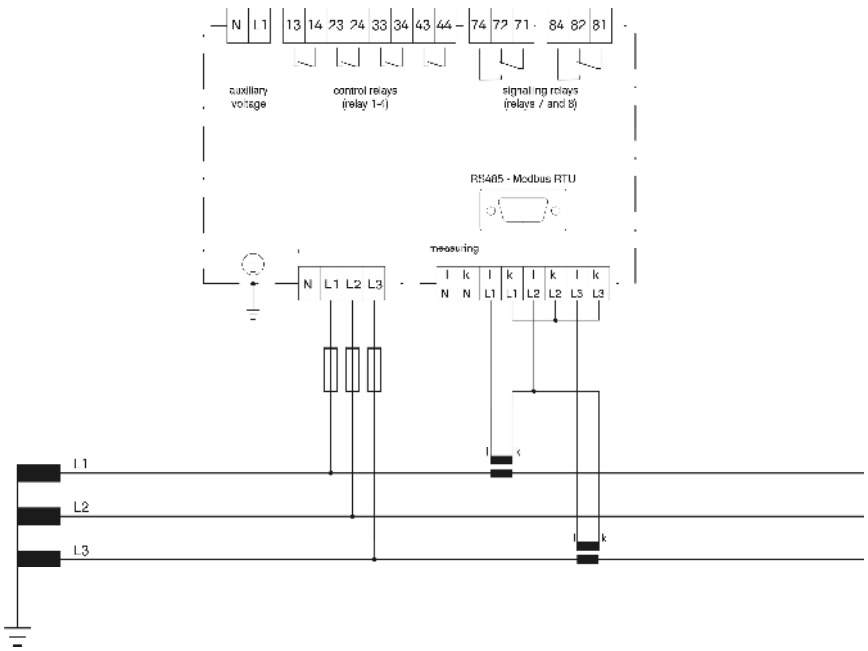
5.1.2 Three-phase measurement without neutral conductor with three current- and three voltage transformers (three-wire measurement)



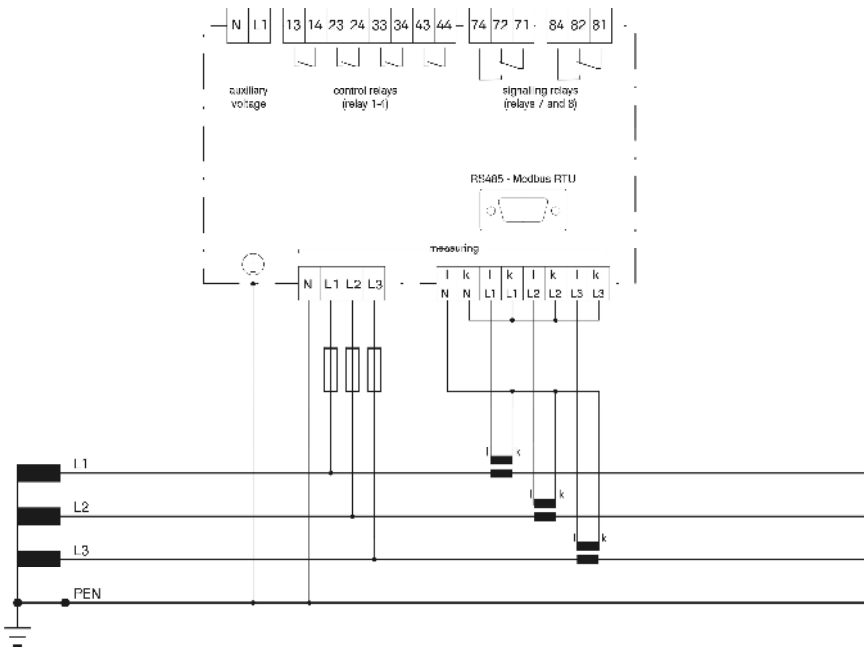
5.1.3 Three-phase measurement with two current- and three voltage transformers (three-wire measurement)



5.1.4 Three-phase measurement with two current transformers (three-wire measurement)



5.1.5 Three-phase measurement with three current transformers and measured neutral conductor current (four-wire measurement)



5.2 Absolute Maximum ratings

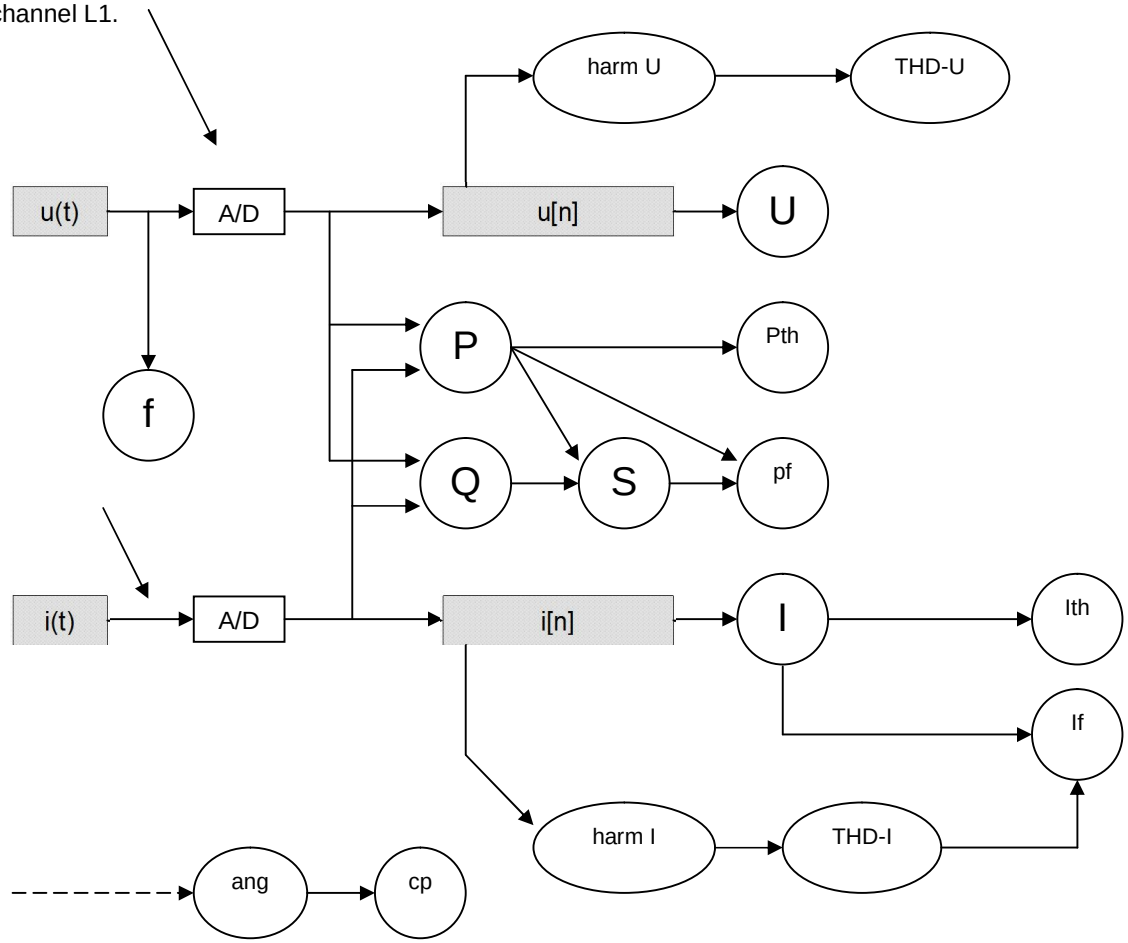
This section gives the absolute maximum ratings. Make sure these values are not exceeded or irreversible damage may be done to the device!

Value	Min	Max	Unit	Comment
Supply voltage	-	253 (AC) 130(DC)	V	-
Voltage measurement channel	-	318(550)	V	Lx-N (Lx-Ly).
Current measurement channel	-	5(50)	A	continuous (1 sec)
Relay 1-6 current	-	5	A	-
Relay 1-6 voltage	-	250	V	-
Relay 7/8 current	-	3 (AC) 3 (DC)	A	-
Relay 7/8 voltage	-	250 (AC) 30 (DC)	V	-
Ambient temperature (device active)	0	+70	°C	-
Ambient temperature (storage)	-20	+85	°C	Allow the device to reach normal temperature level before turning on by applying supply voltage!
Humidity		95%	-	Non-condensating!

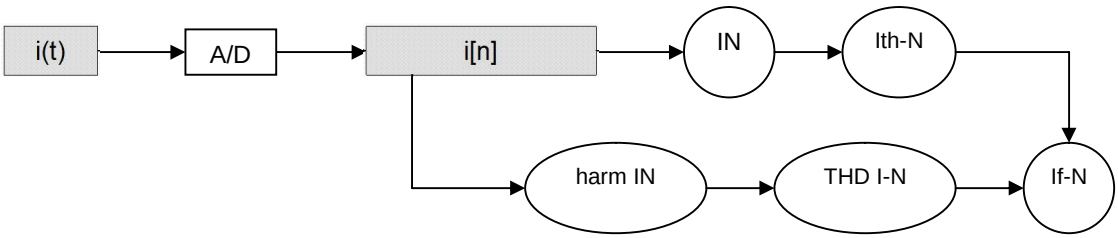
6 Diagrams

6.1 Data flow / Calculation of values

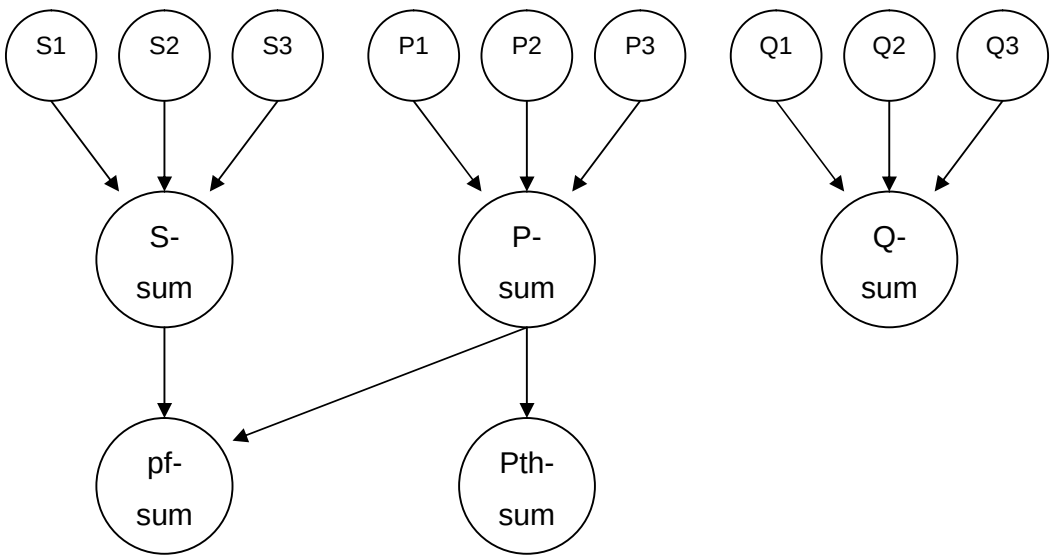
The following diagram shows the data flow **for one phase**. The calculation of the frequency f is only true for channel L1.



The following diagram shows the data flow for neutral current I-N:



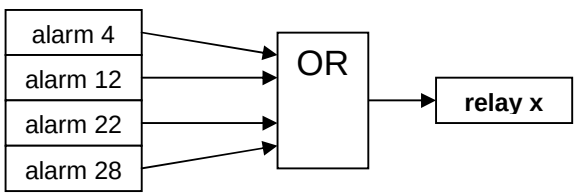
The following diagram shows the data flow for the sum-values:



6.2 Relays

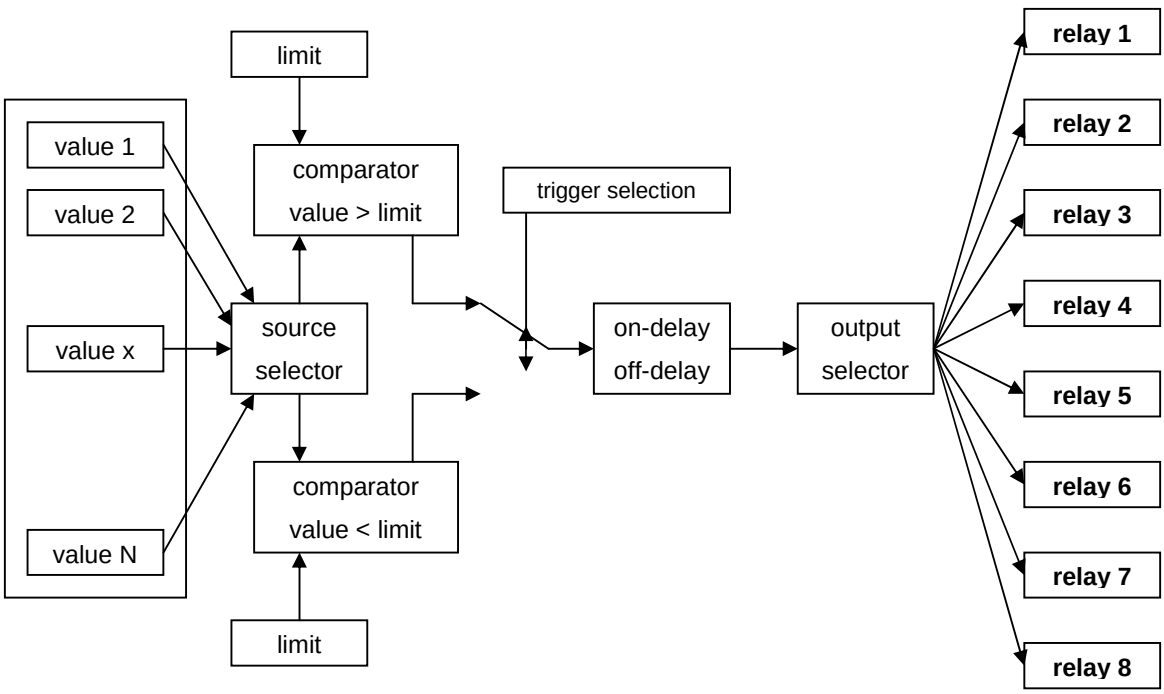
This diagram shows the set-up for the relays. Only relay number 1 is drawn, all other relays work similar.

In this diagram, four alarms (4,12,22,28) are drawn as an example. There may be up to 32 alarms sourcing one relay.



6.3 Alarms

This drawing shows the set-up for one single alarm. All of the 32 alarms work similar.



7 Sample alarm settings

7.1 Import / Export signalling by two relays

This sample alarm setting is used to signal the total energy flow direction to an external device by use of two alarm relays. The following specifications have to be met:

- Relay 1 signals energy import, relay 2 signals energy export. The relays may not be closed at the same time; a delay of up to 1 second at switchover point is suitable.
- The measurement needs to have a “dead area” around P=0. In the range [20W export; 20W import] none of the relays should be closed to prevent spurious switching at zero.

To accomplish these needs, the following set-up can be used:

- Define the following alarm: ALARM=01, SOURCE=P-sum, TRIGGER=val>limit; LIMIT=+20.00W, T-ON=01,000sec, T-OFF=00,500sec, OUTPUT=1
- Define the following alarm: ALARM=02, SOURCE=P-sum, TRIGGER=val<limit; LIMIT=-20.00W, T-ON=01,000sec, T-OFF=00,500sec, OUTPUT=2

This will have the following effects:

- Relay 1 will close if P-sum > +20W, relay 2 will close when P-sum < -20W. This setting contains the dead zone of ±20W.
- The on-delay of 1sec and off-delay of 0.5 sec for both relays prohibits them from being closed at the same time. After change of sign, the old (to be switched off) relay will wait for 0,5 seconds before turning off, while the new (to be turned on) relay will wait 1 second until it closes. Because both delay times start at the same moment, the new relay will close 0,5 sec after the old relay opened.
- The delay set-up provides some security against spurious relay switches, because every change in power flow direction has to persist for at least 0,5sec and has to exceed +/- 20W to cause a relay to close.