Mains Monitoring Instrument EMA 1101 / EMA 1101-DP

Operating Instructions

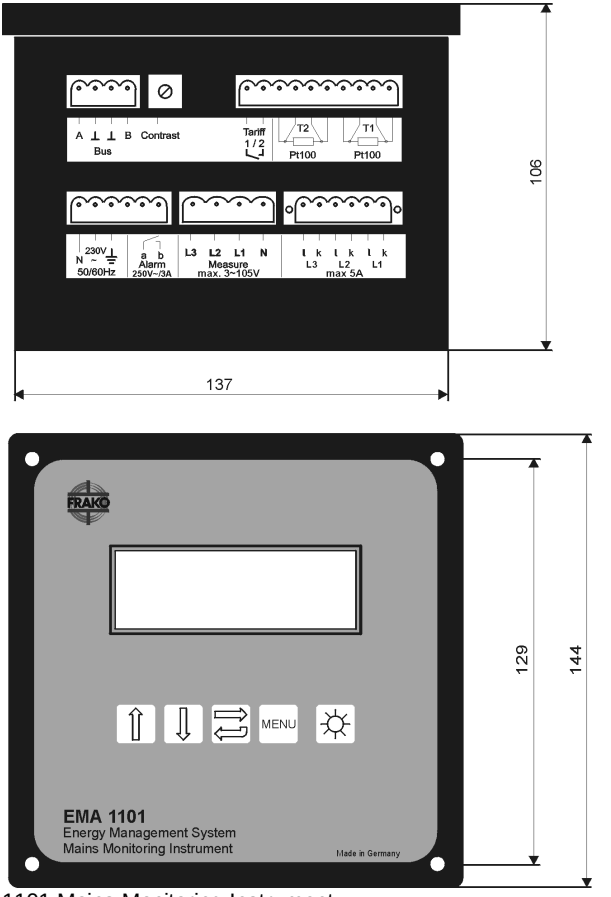


Figure 1: EMA 1101 Mains Monitoring Instrument

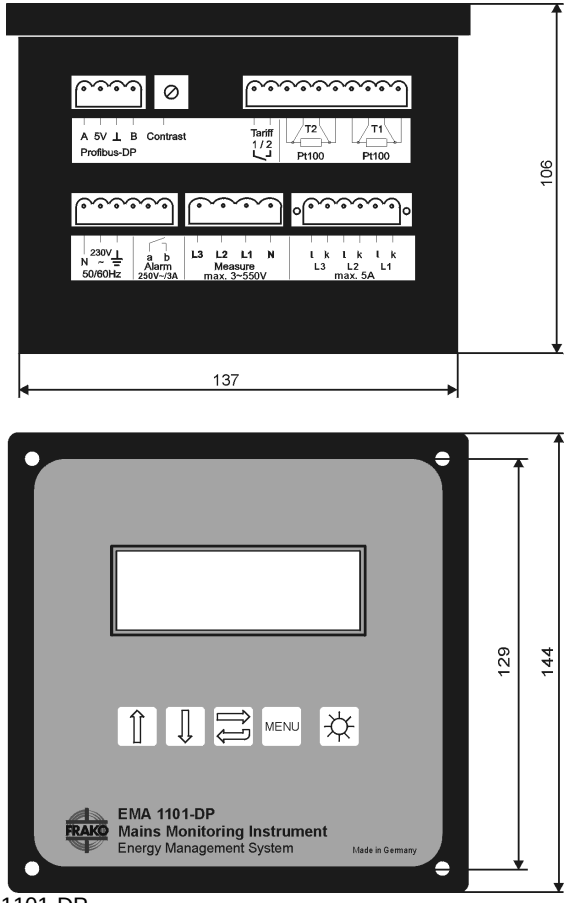


Figure 2: EMA 1101-DP

Contents

Page

Page

List of figures

Safety instructions

!!! Important, read before commissioning !!!

- The user must ensure that all operators are familiar with these operating instructions and follow them at all times.
- The operating instructions must be read carefully before the instrument is mounted, installed and commissioned.
- All actions taken must follow the operating instructions.
- Installation and commissioning may only be carried out by appropriately qualified personnel with due regard to all rules and regulations.
- The instrument is at mains voltage and must not be opened.
- If the instrument is visibly damaged, it must not be installed, wired up or commissioned.
- If the instrument does not work after commissioning, it must again be isolated from the mains.
- Any further laws, standards, guidelines, etc. relevant to this product must be complied with.

EG-Konformitätserklärung

Declaration of Conformity

Dokument-Nr.: EG-EMA 1101-101A / 09.2002

Wir/*We* **FRAKO Kondensatoren- und Anlagenbau GmbH**
Tscheulinstraße 21 a
79331 Teningen
GERMANY

erklären in alleiniger Verantwortung, daß das Produkt
declare under our sole responsibility that the product

Produktbezeichnung: *name of product*	Netzanalysegerät EMA 1101 *Mains Monitoring Device EMA 1101*	
Typenreihe: *family*	**alle Ausf.**	ab Fert.-Nr. 1000 *from Ser. No.*

auf das sich diese Erklärung bezieht, mit der/den folgenden Norm(en) oder normativen Dokument(en) übereinstimmt:
to which this declaration relates is in conformity with the following standard(s) or other normative document(s):

1.	EN 50 081-1	01.92	EMV, Fachgrundnorm Störaussendung Wohnbereich
	EN 50 081-2	08.93	EMV, Fachgrundnorm Störaussendung Industriebereich
	EN 50 082-1	03.93	EMV, Fachgrundnorm Störfestigkeit Wohnbereich
	EN 50 082-2	01.93	EMV, Fachgrundnorm Störfestigkeit Industriebereich

gemäß der Bestimmungen der Richtlinien
following the provisions of Directive

89/336/EWG	Elektromagnetische Verträglichkeit / Electromagnetic Compatibility Directive
92/31/EWG	Änderung der Richtlinie 89/336/EWG / Modification of 89/336/EEC
93/68/EWG	Änderung der Richtlinien 89/336/EWG / Modification of 89/336/EEC

2.	EN 61 010-1	1993	Sicherheitsbestimmungen für elektrische Meß-, Steuer-, Regel- und Laborgeräte

gemäß der Bestimmungen der Richtlinien
following the provisions of Directive

73/23/EWG	Niederspannungsrichtlinie / Low Voltage Directive

Teningen, den 20.09.2002

P. Herbst / H.-G. Mall

Diese Erklärung bescheinigt die Übereinstimmung mit den genannten Richtlinien, beinhaltet jedoch keine Zusicherung von Eigenschaften. Die Sicherheitshinweise der mitgelieferten Produktdokumentation sind zu beachten.
This declaration certifiy the conformity according the mentioned directives, without any assurence of features. Please note the safety instructions of the attached product documentation.

1. Quick start

Note:
The functions described here refer to both the EMA 1101 and the EMA 1101-DP.

The instrument is set in the factory so that it can be commissioned immediately when installed. In most cases only the current transformer ratio has to be entered. If a voltage transformer is used, its ratio also has to be entered.

Commissioning is as follows:

a) The *EMA* must be connected as shown in Figures 3 – 6 , depending on application.

b) Switch on mains power:
After about 4 seconds, the main menu appears in the display window.

```
  Mains Analysis
Power     U-/Idf
UΔ-/Irms  Harmon.
Phase     υ/Max/Min
```

If this main menu does not appear after power is switched on, press the **[Menu]** key several times until the above display appears.

c) Hold down the **[Menu]** key for about 5 seconds until the set-up menu appears in the display window.

```
      Setup
Transformer Ratios
Bus Address
Set Alarm Values
```

d) The "transformer" row is already flashing. Confirm by pressing **[↵]**. The following appears in the display window:

```
Transformer Ratios

Ip/Is =    1.
Up/Us =    1.00
```

The row with the current transformer ratio flashes.

e) When the **[↵]** key is pressed again, a cursor bar appears underneath the first digit of the transformer ratio. Use the **[⇩]** or **[⇧]** key to change the first digit of the transformer ratio. Once the correct numeral is set, press the **[↵]** key to select the next digit and change this as described above.

f) After setting the last digit, the **[↵]** key is pressed to store the new transformer ratio in a non-volatile memory.

g) Now press the **[Menu]** key twice. The main menu reappears and the *EMA* is ready for operation.

2. Description

The *EMA* has the function of measuring, analysing and monitoring the relevant parameters of the electrical power supply system, as well as the temporary storage and transmission of the measurement data.

In addition, the *EMA* mains monitoring instrument can also measure two temperatures (only at full version), can be connected to a tariff change-over switch and can give an alarm via a contact when set values are exceeded.

The ***EMA 1101*** has been designed as part of the FRAKO energy management system and realises its full potential when installed as part of that system. It can be connected to the **FRAKO Power Bus®** (only at full version) by means of the built-in bus connection.

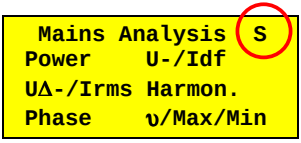
All current data and alarms of the ***EMA 1101-DP*** can be read via its Profibus interface. The **Profibus-DP** interface allows transmission rates between 9.6 kBaud and 12 MBaud.

2.1 Functions

2.1.1 Device version

The ***EMA 1101*** mains monitoring instrument is availaby as a basic version (**-S)** and a full version. The ***EMA 1101-DP*** is only as full version available.

The basic version (**–S**) is shown at the main menu.



The basic version (**–S**) has the following reductions:

- no bus- or serial connection possible
- no temperature measurement
- no harmonics
- no distortion factor of current

The basic version (**–S**) can be enlarged by an update-key for the full version any time.

2.1.2 Parameters

The EMA mains monitoring instrument measures and indicates the following parameters.

(The designation that actually appears in the display concerned is shown in brackets in each case.):

Peak values are registered for parameters marked with "♣". For underlined parameters an alarm limit can be set.

Total power (Power)

- Apparent power in kVA or MVA
- Active power in kW or MW
- Reactive power in kvar or Mvar

♣ Power factor
♣ Asymmetry in phase load in %
- Frequency in Hz.

Voltages and currents (UΔ/Irms)
♣ Voltages phase / phase in V or kV
♣ Phase currents in A
♣ Current in neutral conductor in A

Phase parameters (Phase)
- Apparent power in kVA or MVA
- Active power in kW or MW
- Power factor
- Voltage phase/neutral in V or kV

Distortion factor for each phase (U/I_{df})
♣ Distortion factor of voltage in %
♣ Distortion factor of current in % (full version only)

Harmonics (Harmon.) for each phase (full version only)
- Voltage of the fundamental frequency (e.g. 50 Hz or 60 Hz) in V or kV,
♣ Proportion of the 3rd, 5th, 7th, 9th, 11th, 13th, 15th, 17th and 19th harmonics in the effective value of voltage in %

Active and reactive energies (Work)
- Active energy demand in kWh for tariff 1 and tariff 2
- Reactive energy demand in kvarh for tariff 1 and tariff 2
- Regenerated active energy in kWh (alternative to tariff change-over).

Temperature (ϑ/Max/Min)
(full version only)
♣ Temperature 1
♣ Temperature 2

2.1.3 Peak value memory

The parameters marked with "♣" are averaged for about 8 seconds. If a mean value exceeds a maximum that has already been stored, the new value is written to the peak value memory. With power factor (PF) and the voltages, the minimum is also recorded the same fashion.

2.1.4 Alarms

Limits (alarm set points) can be set for those parameters that are underlined. An alarm is triggered if the parameter

measured exceeds these limits for about 20 seconds. With power factor (PF), the delay is about 1 minute. During the alarm condition, the alarm contact closes, the cause of the alarm is shown in the display and the display backlight flashes.

Alarms can be confirmed at the keyboard. The alarm contact remains closed as long as the value is out of bounds

(Further information in section 6.6, page 26)

2.1.5 Active and reactive energies

The active and reactive energies are calculated from the measured active and reactive powers and are totalised in the electronic counters.
The recovered active energy can also be measured if wished. In this case tariff change-over is not possible.

2.1.6 Tariff change-over

A volt-free contact for changing the tariff can be connected to the terminals for tariff change-over. Depending on the state of the contact, the meters for the measurement of active and reactive energy are switched over to a second counter. If the regenerated active energy is counted, (setting in setup menu) the external tariff change-over is deactivated.

2.1.7 Bus connection

All current data, can be read at the FRAKO Power Bus® (full version only) or the Profibus-DP.
Peak values can be reset with the FRAKO Power Bus® in the case of the ***EMA 1101*** .

If the connection to the bus central unit is disrupted, the mains monitoring device remains fully functional.
Starting the bus is described in section 5.3 on page 20.

3. Installation

3.1 Mounting

Important:
Before mounting and maintenance the instrument must be disconnected from the mains.

The *EMA* is inserted from the front into a cut-out in a control panel with the standard dimensions 138 x 138 mm, and is secured with the preassembled clamping screws supplied with the instrument.

To achieve IP54 ingress protection, the gasket supplied with the instrument must be fitted before installation in the panel.

3.1.1 Power supply

Important:
The power supply must be protected externally with a 2A fuse.

The permissible power supply voltage is noted on the instrument.

The power supply must correspond with the permissible power supply voltage (e.g. 120V or 230V).

The mains frequency must lie between 45 Hz and 62 Hz.

3.1.2 Voltage measurement (Measure)

Important:

The permissible phase/phase – measurable voltage is displayed on the instrument. This may not be exceeded.

The external conductors of the measured voltage must be externally protected with a 2A fuse.

The *EMA* employed must have the appropriate measurable voltage for the existing mains voltage. (e.g. 550V or 105V). The measured voltage connection (measure) also varies according to the type of mains.

Figure 3 shows the measurement in a 4 conductor power supply system. It must be observed that the instrument employed is suitable for the existing mains voltage.

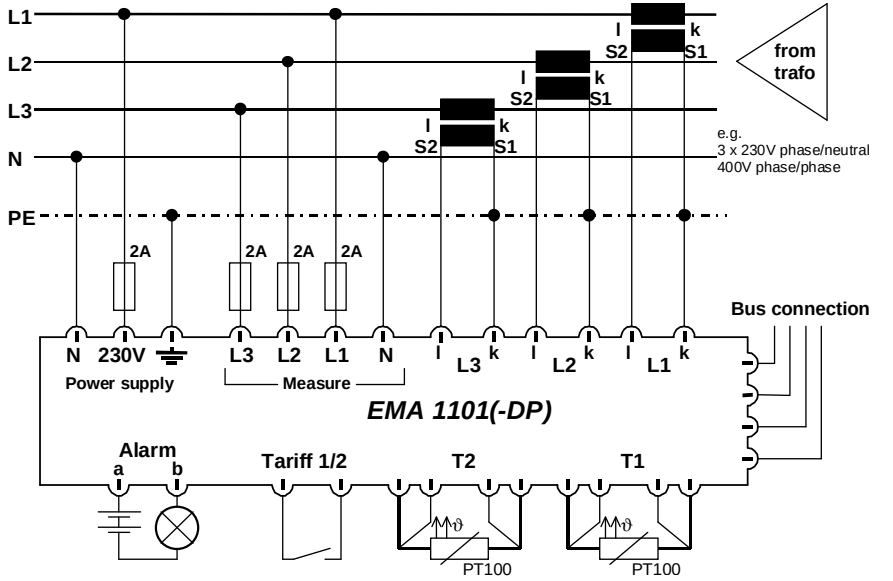


Figure 3: Direct connection

The measured voltage may drop below the limits shown on the instrument label by up to 50%.

Direct measurement in a 3 conductor power system is shown in Figure 4. The unused N conductor terminal must be connected to the earth terminal of the instrument.

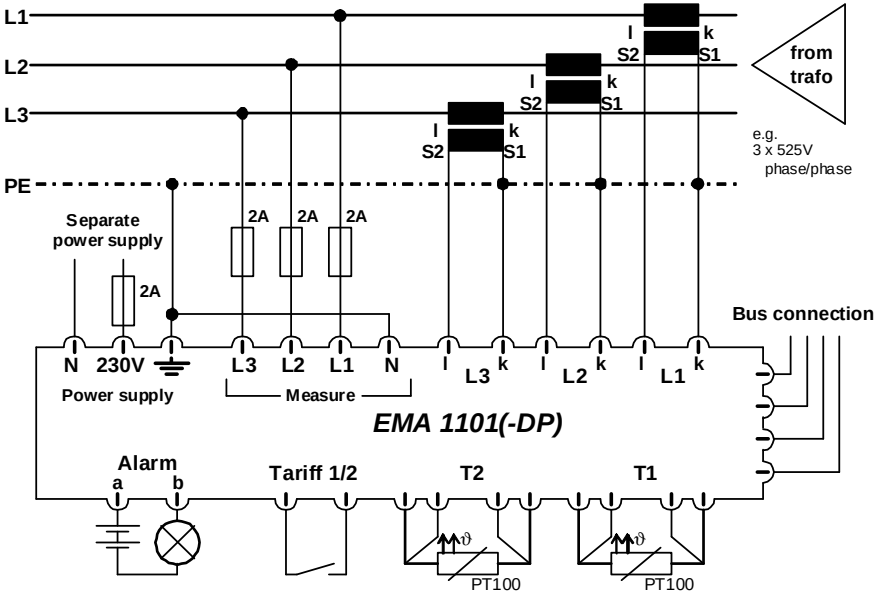


Figure 4: Connection without neutral

Connection to a medium voltage transformer is shown in Figure 5. Here the N terminal of the measured voltage is also connected to the to the earth terminal.

The connection for the current transformer connection shown below must be chosen if the current measurement is carried out with an Aron measuring circuit.
(See also section 3.1.3 page 15)

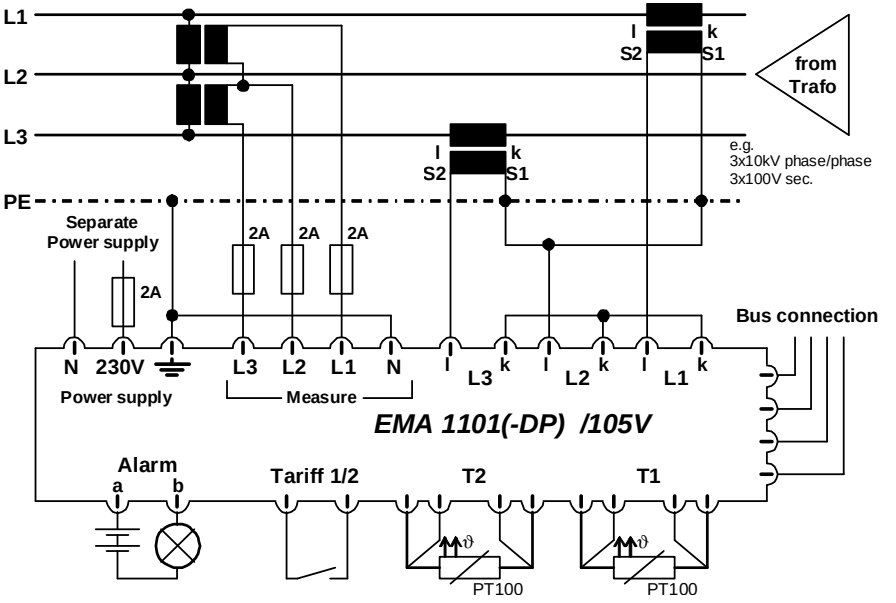


Figure 5: Medium voltage connection

Additional voltage transformers may be connected in series in the case of deviating mains voltages.

Figure 6 shows an example of this with a 690V power system. The transformer is connected before the measured voltage input.

Note:
If the instrument is used for measuring a single-phase supply, the unoccupied terminals for phase voltage measurement must be connected with the N terminal.

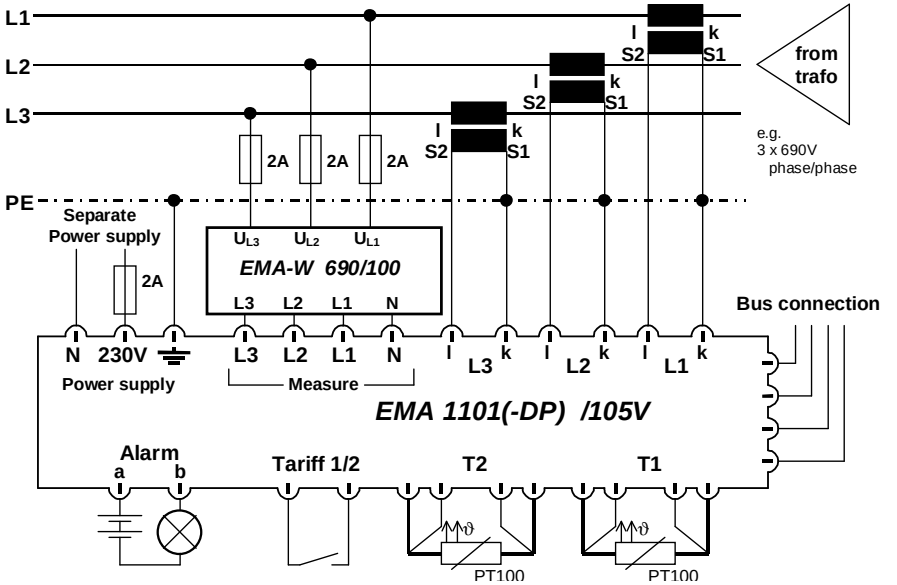


Figure 6: With transformer

3.1.3 Current transformer

The current in the three phases is measured by means of external current transformers. The current transformer channels are volt-free. Examples of connection are shown in Figures 3 – 6.

Care must be taken that the voltage and current measurement connections for the three phases are connected in the correct order. External current transformers of Class 0.5 or 1 should be used. The conducting leads must have a cross section of minimum 2.5 mm².

Additionally the installation direction and the polarity of the current transformer must be observed, otherwise the active power is measured as regenerated power and inductive power as capacitive power.

Important:

The maximum current in the current transformer path may not exceed 6 A.

The lower limit of the current input is 6 mA. Currents lower than 6 mA are not registered.

Important:

The current transformer must be earthed in power systems with a voltage over 1kV.

3.1.4 Tariff change-over

An external volt-free contact for tariff change-over can be connected to the **Tariff 1/2** terminal. When closed *EMA* registers according to tariff 2.

Note:

It is not possible to connect the terminals of two or more instruments in parallel.

3.1.5 Alarm contact

The contact **Alarm** is an internal volt-free contact. If the measured values exceed or fall below the alarm limits set in the *EMA*, the contact closes.
The contact also closes if the instrument power supply is interrupted.

Important:

The alarm contact is designed for a maximum of 250 V AC and a maximum of 3 A.

3.1.6 Temperature probes

The terminals **T1** and **T2** are provided for connecting two Pt100 external probes. (full version only)
These can be connected in a two-wire configuration, in which case the jumpers fitted in the factory must remain in place.

In the case of connection in a 4-wire configuration, the jumpers fitted in the factory must be removed.
If temperature probes are not employed the jumpers must remain in place.
(full and basic version)

3.1.7 Bus connection

The *EMA* instrument is delivered in two versions.

FRAKO Power Bus®:
The ***EMA 1101*** is configured for connection to the FRAKO Power Bus®.

It can also be connected to an RS 232 interface with an *"RS232 adapter"* (accessory). The PC software *"EMA-SW"* (accessory) can be used as a user interface. (full version only)

The two poles of the 2-wire bus are connected to terminals A and B (note polarity). The shielding is connected to one of the " ⊥" terminals.

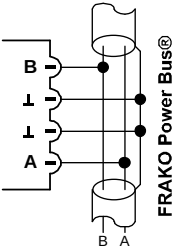


Figure 7: FRAKO Power Bus®

Terminal "A" is therefore connected to all terminals "A" of the other devices connected to the bus. Terminal "B" is connected to all other terminals "B". Terminal "⊥" is connected to all other terminals "⊥". (Do not cross the wires!!)

The bus structure must be linear. All instruments must be looped in the string or connected to it with a wiring. (up to 2 m). Other bus structures can be realised with a repeater (accessory EMB 1101).

The overall length of the bus should not exceed 1200m. A repeater (accessory EMB 1101) must be employed to bridge greater distances.

Recommended cables
Characteristic impedance 100-120Ω;
Ø ≥ 0,3mm²; twisted and shielded;

Types:
- IBM Twinax 105 Ω
- Lapp Unitronic® Bus CAN 1x2x0,34 /
- Helukabel CAN BUS 1x2x0,34

Note:
A mixture of different cable types must always be avoided.
Never connect the shielding ("⊥") to the earth terminal of EMA 1101.

Terminal resistors must be employed at the beginning and end of a string.

A 120 Ohm resistor must be connected between the terminals "A" and "B".

A 1 kOhm resistor must be connected between "A" and "⊥" in bus systems with less than 4 devices. The resistors must be suitable for 250mW power.

Profibus-DP:
The ***EMA 1101-DP*** is suitable for connection to the Profibus.

Connection is as shown in the illustration below. Both poles of the two wire bus are connected to terminals "A" and "B" (note polarity). The shielding is connected to terminal "⊥".

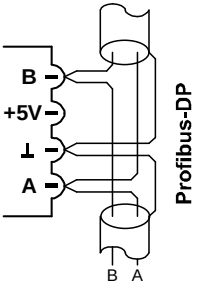


Figure 8: Profibus-DP

The wires "A" and "B" may be identified as shown below:
A ..... RxD/TxD-N ....Data line-Minus ....-
B ..... RxD/TxD-P ....Data line-Plus.....+

Terminal "A" is therefore connected to all terminals "A" of the other devices connected to the bus. Terminal "B" is connected to all other terminals "B". Terminal "⊥" is connected to all other terminals "⊥". (Do not cross the wires!!)

Terminal "+5V" may not be passed on via the bus system.

Note:
A mixture of different cable types must always be avoided.
The shield ("⊥") may only be earthed at one point in the bus system.

An external bus termination must be connected if the ***EMA 1101-DP*** is the first or last instrument on the Profibus-DP.

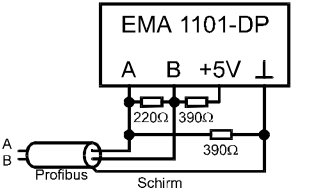


Figure 9: Profibus bus termination

The supported transmission rates and the permissible bus lengths are shown below:

kbit/s :	9,6	19,2	45,45
Length:	1200m	1200m	1200m

kbit/s :	93,75	187,5	500
Length:	1200m	1000m	400m

Mbit/s :	1,5	3	6	12
Length:	200m	100m	100m	100m

4. Commissioning

4.1 Before commissioning

Important:

Care must be taken that the terminals of *EMA 1101* cannot be touched any more. This can be ensured by a closed door or a cover.

The instrument may not be connected to mains before above condition is met.

4.2 Control of functions

Subsequent to connecting to mains the display is illuminated and the main menu or a window with starting values is displayed.

Attention:

If the *EMA* does not function as described above, isolate the instrument from mains immediately and check for correct installation.

Faulty connections in the measurement circuit are quickly identified by checking the display readings of active and reactive power.

In case of unrealistic values of active or reactive power (e.g. negative power during consumption of energy or extremely low power factor) the connection must be checked.

Important:

Always disconnect the instrument from the mains voltage before carrying out wiring or mounting activities.

In purely stand-alone operation (when the instrument is not connected to a bus system) only the transformation ratio must be entered.
(see chapter 5.2, page 20)

4.3 Entering the bus address

Every device connected to a bus system must have a unique bus address. The bus address can be set in the *EMA* under the menu item ”bus address” in instrument set-up.

(see chapter 5.3, page 20)

5. Basic Settings

In order for the instrument to measure correctly, several parameters must be adjusted to suit individual conditions. These include:

- transformer ratios
- bus address
- alarm set points

In order to change these parameters, it is first necessary to revert to the main menu. This can always be done by pressing the **[MENU]** key several times, regardless of which submenu is currently displayed.

```
 Mains Analysis
Power    U-/Idf
UΔ-/Irms Harmon.
Phase    υ/Max/Min
```

If the **[MENU]** key is then held down for about 5 seconds, the **"Setup"**-menu appears. The above-mentioned parameters can now be changed from this menu.

```
      Setup
Transformer Ratios
Bus Address
Set Alarm Values
```

5.1 Programming

The following example shows how the numerical values in the basic settings can be changed. The functions of the individual keys remain the same regardless of which parameter is being set.

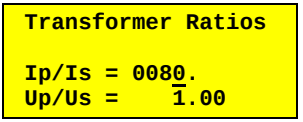
Example:
A current transformer with a "400 A / 5 A" rating is to be used.
The transformer ratio to be entered is therefore 80.
In the **"Setup"**-menu use the **[⇓]** or **[⇑]** keys to mark the menu item "**transformer ratio**" (this row then flashes) and confirm by pressing the **[↵]** key.
The following submenu then appears:

```
Transformer Ratios

Ip/Is =    1.
Up/Us =    1.00
```

Use the **[⇓]** or **[⇑]** key to mark the menu item "**Ip/Is =**" and confirm by pressing the **[↵]** key. A cursor bar can then be seen underneath the first digit of the current transformer ratio.

```
Transformer Ratios

Ip/Is = 0001.
Up/Us =    1.00
```

The **[⇓]** or **[⇑]** can now be used to change the first digit of the current transformer ratio. As this is not necessary, however, the **[↵]** key is pressed twice to move the cursor bar to the next digit but one. The **[⇓]** key is then pressed twice, producing the digit 8 at this point. The **[↵]** key is pressed again to move the cursor bar to the last digit. Here the **[⇓]** or **[⇑]** key can be used to produce a zero at this position:

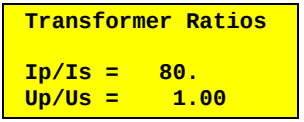


The procedure is completed by pressing the **[↵]** key one last time which saves the new current transformer ratio in a non-volatile memory.
This input mode can be terminated at any time by pressing the **[MENU]** key.

The "**Ip/Is**" row flashes and the voltage transformer ratio can be selected by pressing the **[⇓]** key.

To return again to the "basic settings" menu, press the **[MENU]** key. Press this key again to end the basic setting mode and to return to the "main menu".

5.2 Transformer ratios

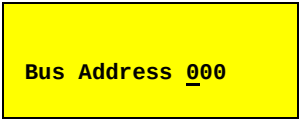


In order to calculate and indicate correct measurement readings, the *EMA* needs information on the current and voltage transformers that are installed.

The transformer ratio of the installed **current transformer** must be entered in the row "Ip/Is =". If a three-phase system is being monitored, three transformers with the same ratio must be used. Current transformers of Class 0.5 or 1 should be used.

If a **voltage transformer** is used, its ratio also has to be entered.

5.3 Bus address



If the instrument is operated on a bus system, it must be assigned its own bus address. This individual address must not be assigned to any other instrument within the bus system. The number allocated may be between 9 and 124.

For complex systems, we recommend the FRAKO Power Bus®, the address setting by means of the "System-SW" program. Its software is included in the scope of supply of the Bus Central Unit EMIS 1500.

It offers the advantage that all addresses that have been assigned appear in an overview, thus helping to prevent the same address being allocated twice.

5.4 Set alarm values

When this menu item is selected, the *EMA* alarm set points can be changed. Data entry takes place in four dialogue boxes which appear one after the other by pressing the **[MENU]** key. The individual set points are selected within the dialogue box with the **[⇓]** or **[⇑]** keys.

```
     Set Alarms
In9999.A  2 Tariffs
I 9999.A  PF  0.01
Asym 99% P-LF 9999kW
```

- **In** (neutral current**)**
  The upper limit for the rms neutral current.

- **I** (rms current**)**
  The upper limit for the rms apparent current. All three phases are monitored.

- **Asymmetry and P-LF**
  The upper limit for the rms apparent current. All three phases are monitored.

$$Asymmetry = (1 - \frac{I_{min}}{I_{max}}) * 100\%$$

  Where I_{min} is the rms apparent current of the phase with the lowest load and I_{max} is the current of the phase with the highest load.

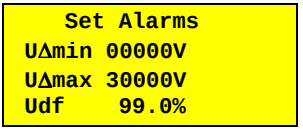
  Note:
  The alarm is triggered only if <u>all</u> following points apply:
  - ⇒ The set point is less then 99%.
  - ⇒ The asymmetry is higher then the set point.
  - ⇒ The active power is higher than the set value in P-LF

  If the alarm set point is 99%, the alarm is disabled.

- **2 Tariffs / regeneration**
  Under the setting " 2 Tariffs " the active and reactive energies are counted on two separate meters corresponding to the external tariff change-over contact.
  Under the setting "regenerat." the active, reactive and regenerated active energy are registered seperately by the *EMA*. Here the condition of the external tariff change-over contact is of no importance.

- **PF and P-LF**
  An alarm is triggered after about 1 minute in the case of an inductive fall short of the power factor (PF) and an active power that is greater than the set value in P-PF.
  The set lower limit for the active power(P-PF) is intended to suppress the PF alarm during periods of low load.

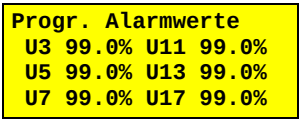
- **UΔmin and UΔmax**



  These are the limits for the three phase-to-phase voltages in a three-phase system. An alarm is triggered when a measured voltage is outside the set limits.
  The upper settable voltage limit is 32765V.

- **Udf**
  This parameter is for monitoring the voltage distortion factor. The measurement readings needed for this are determined from the phase-to-neutral voltages of the individual phases.

- **U3, U5, U7, U11, U13, U17**



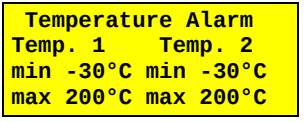
full version only

  The alarm set points for the proportion of mains harmonics in the rms value of the voltage. The alarm set points are applied to all three phases.

  Compatibility levels as per IEC 1000-2-2:

U3: 5,0 %	U7: 5,0 %	U13: 3 %
U5: 6,0 %	U11: 3,5 %	U17: 2 %

- **Temperature 1 / 2 max / min**



full version only

  If external temperature probes (Pt100) are connected, a temperature set point can be programmed for each channel independently. The EMA then gives an alarm signal if the measured temperature exceeds or falls below the set limits.

  Note:
  The temperature measuring range lies between -25℃ and +150℃.
  (see section 7.2, page 29)

6. Operation

6.1 Display and key functions

The instrument has a display window with 4 rows each of 20 characters. The contrast can be adjusted using a potentiometer on the underside of the instrument.

Important:

The Contrast may only be changed in voltage free condition.

The following 5 keys are available for operating purposes:

- **[⇑] and [⇓]:**
Individual menu items are selected with the arrow keys. The item selected flashes.
- **[↵]** Enter-key:
Pressing the Enter key causes the dialogue box corresponding to the flashing menu item to be displayed, or a further submenu.
- **[MENU]** Return-key:
This key is pressed to return to the menu, one level above.
- **[☼]** Backlight:
This key switches the display backlight on or off. During an alarm condition this key can be used to stop the display flashing.
If the alarm remains present, however, the backlight automatically starts flashing three minutes after the last manipulation.

6.2 Main menu

```
  Mains Analysis
Power    U-/Idf
UΔ-/Irms Harmon.
Phase    υ/Max/Min
```

After the instrument power supply has been switched on, the *EMA* first displays its version and serial number for several seconds:

e.g. “EMA V 1.35 SN 002315“

Following this, the most recently displayed dialogue box reappears in the display window. By pressing the **[MENU]** key several times, the main menu can again be displayed at any time. From the main menu, all the functions of the *EMA* can be accessed.

6.3 Display window

The individual windows with values that can be displayed are illustrated in the overview in Figure 10 und Figure 11
The various windows contain values grouped together by context. The current readings are continually updated in the window displayed.
If the current display is overwritten by an alarm message, the old window can be recovered by pressing any key (apart from the backlight key).

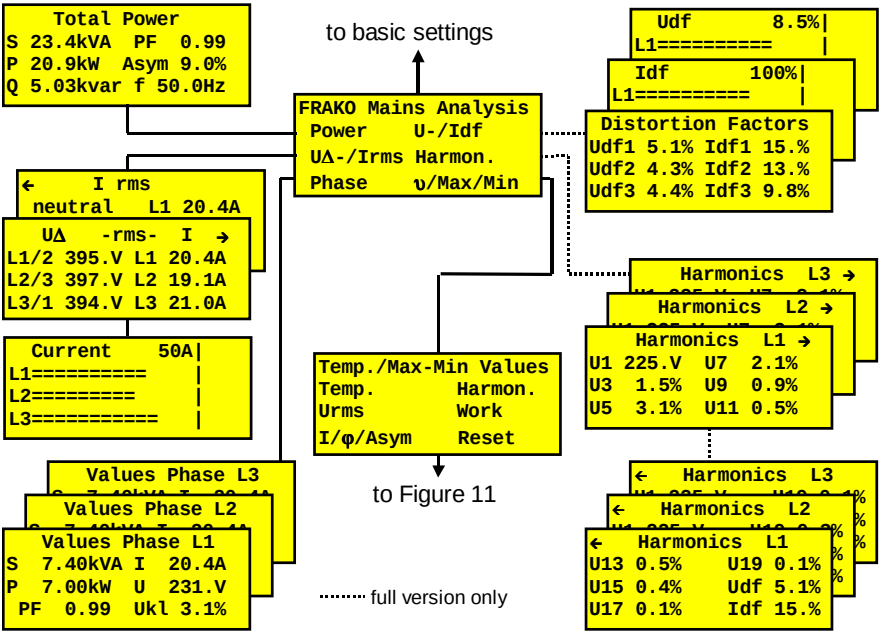


Figure 10: Main menu

To display a submenu:

- Select the menu item with the **[⇓]** or **[⇑]** key and confirm by pressing **[↵]**
- Change between menu items from L1 to L3: **[⇓]** or **[⇑]**
- Change between Display U1 - U11 and Display U13. - U19, Udf and Idf: **[↵]**
- Submenus under "Temp/peak values" see Figure 11 .

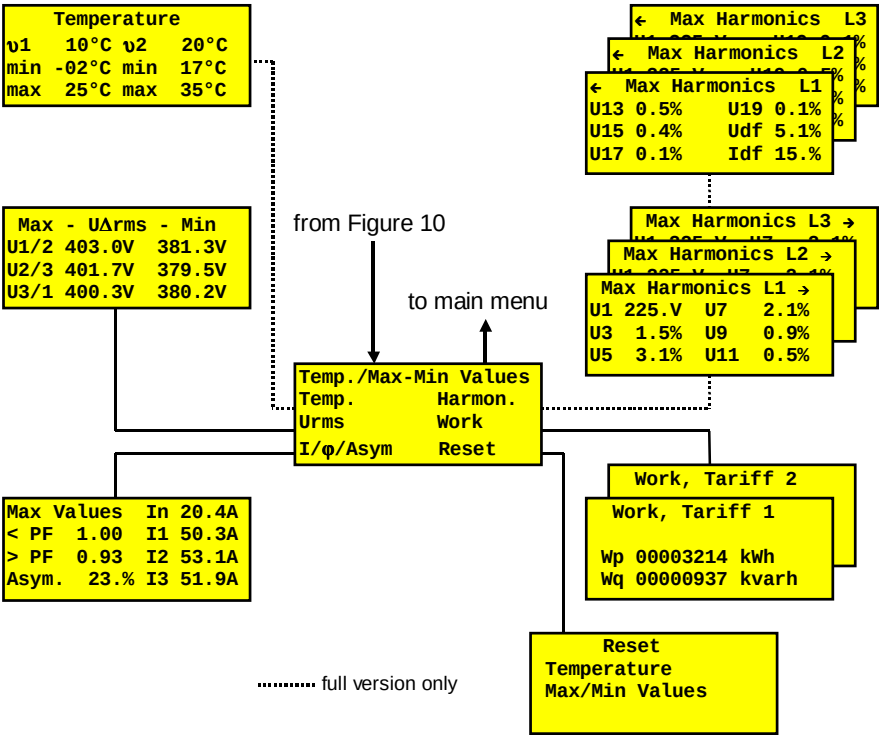


Figure 11: Sub menu

Here the minimum and maximum measurement readings and current counter readings can be viewed. Sub menu selection:

- Select the menu item with **[⇓]** or **[⇑]** key and confirm by pressing **[↵]**.
- In the "Reset" submenu, the min./max. values are reset: Select the group of values: with **[⇓]** or **[⇑]** key and press **[↵]** to select.

6.4 Display the values

The measurement readings and the max. and min. values are arranged in a clear menu structure and can comfortably be called up. (see Figure 10 und Figure 11)
The formulas of the measured values are specified in section 7.1.

Bar line display:
The measurement readings 'voltage distortion factor' and 'current distortion factor' (full version only) as well as the current rms can be displayed as a bar diagram. The scaling is given either by the appropriate alarm value or amounts to 100%.

Energy meter:
The energy meter can be configured to function either as two-tariff energy meter (active and reactive energy) or as one-tariff energy meter for active, reactive and regenerated active energy.
(see section 5.4)
in the case of a two-tariff energy meter the current tariff condition is indicated in the right upper corner of the energy meter display.

The work counters wrap around with a count of 999.999.999 on the count 0.

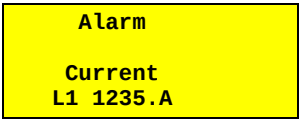
6.5 Reset function

Stored values can be reset in the menu item "Reset". Using the **[⇩]** or **[⇧]** key, a group of stored values can be selected. They are then reset by pressing the **[↵]** key. The **[MENU]** key is then pressed to exit from the reset submenu. The following groups of stored values can be reset:

- The recorded max. and min. values of both temperature channels.
- The memories for the max. and min. measurement readings.

6.6 Alarm messages

The *EMA* triggers an alarm if the mean value of a measurement reading (averaged over a period of 8 seconds) is outside the alarm set points without interruption for about 20 seconds. The alarm contact closes, the display backlight flashes and the cause of the alarm is indicated in the display, e.g.



The value displayed corresponds to the current measurement reading.
This message disappears when any function key is pressed. If other alarm messages are present then those will be displayed.

The flashing of the backlighting can be stopped by pressing the **[☼]** key.
If the alarm is still present, the backlight automatically recommences flashing three minutes after the last manipulation.
Alarms that have already been acknowledged but are still present can be displayed by pressing the **[⇑]** and **[⇓]** keys simultaneously.
The alarm contact remains closed during the alarm condition. This contact also closes when there is no instrument power supply to the *EMA*.
When all measured values are again within their set limits, the *EMA* alarm contact opens automatically and the flashing backlight and the message in the display window automatically disappear.

6.7 Energy regeneration

If the direction of the active power in the current transformer is reversed (regenerated energy), this condition is indicated by a minus sign in front of the indicated active power.

6.8 Reactive power

If the reactive power is leading, a minus sign is indicated before the values of reactive power and power factor (PF).
The reactive energy meter recognizes only the inductive reactive energy. During

capacitive reactive power no counting takes place.

7. Technical Data

7.1 Measurement readings

There are n discrete measurements (*Umeas*, *Imeas*) made of each input signal over the duration of two cycles. These are then registered and evaluated.
The scan time for such a measurement cycle is about 800 ms.

- **Fundamental voltage ($U_{fun.}$)**
  The voltage of the fundamental wave (50/60Hz).
- **Voltage rms**
  $$U_{rms} = \sqrt{\frac{1}{n}\sum_{k=1}^{n} Umess_k^2}$$
- **Voltage harmonics**
  $$Hx = \frac{Harmonic\ voltage}{U_{rms}} * 100\%$$
- **Voltage distortion factor**
  $$U_{df} = \sqrt{1 - \frac{U_{fun.}^{\ 2}}{U_{rms}^{\ 2}}} * 100\%$$
- **Current rms**
  $$I_{rms} = \sqrt{\frac{1}{n}\sum_{k=1}^{n} Imeas_k^2}$$
- **Current distortion factor**
  $$I_{df} = \sqrt{1 - \frac{I_{fun.}^{\ 2}}{I_{rms}^{\ 2}}} * 100\%$$
- **Apparent power**
  $$S = I_{rms} * U_{rms}$$
- **Active power**
  $$P = \frac{1}{n}\sum_{k=1}^{n} Umeas_k * Imeas_k$$
- **Active power of Fundamental wave**
  P_{fun} = the active power of the fundamental wave (50/60Hz).
  This value is not indicated, only serving as a basis for calculating other parameters.
- **Reactive power Q**
  Q_{fun} = reactive power of the fundamental wave (50/60 Hz)
- **Power factor of the fundamental wave**
  $$PF\ (\cos\varphi) = \sqrt{\frac{P_{fun}^{\ 2}}{P_{fun}^{\ 2} + Q_{fun}^{\ 2}}}$$
- **Total powers**
  $$P_{total} = P1 + P2 + P3$$
  $$S_{total} = S1 + S2 + S3$$
  $$Q_{total\ fun} = Q1_{fun} + Q2_{fun} + Q3_{fun}$$
- **Overall power factor**
  $$PF_{total\ fun} = \sqrt{\frac{P_{total\ fun}^{\ 2}}{P_{total\ fun}^{\ 2} + Q_{total\ fun}^{\ 2}}}$$
- **Asymmetry**
  $$Asym = (1 - \frac{I_{\min}}{I_{\max}}) * 100\%$$

7.2 Measurement accuracy

All data relate to the use of .../5 A transformers. The tolerance of the current transformer used is not taken into account.

Voltages: 45-62 Hz	250-550 V~, ±1 % of full scale reading
Currents:	0 ... 9999 A~, depending on the current transformer, ±1 % of full scale reading,
Neutral conductor current:	0 ... 9999 A~, depending on the current transformer, ±2 % of full scale reading,
Active, reactive and apparent power:	10 W ... 2000 MW, ±2 % of full scale reading, negative active power indicates a regeneration mode
Power factor (cos φ):	0,01 leading ... 1 ... 0,00 lagging (Tolerance : see active and reactive power)
Active and reactive energy:	max. 77800 MWh / Mvarh, ±2 % of counter reading
Distortion factor: (in U and I)	0...100 % of effective value, tolerance: ±0.5 % of full scale reading
Asymmetry (unbalanced load):	0...100 %, ±1 % of full scale reading
Harmonics:	3rd,5th, 7th,9th, 11th,13th, 15th,17th and 19th in %, related to U_{rms} Tolerance ±0.5 % of full scale
Temp. via external Pt100:	-25°...150°C, ± 2°C

7.3 Additional functions

Alarm: Voltages, current, power factor, asymmetry, harmonics, temperatures via display window and volt-free contact, max. 3 A

7.4 General specifications

Power supply:

- **Mains voltage:** 230VAC ±10 %
- **Frequency:** 48 / 62 Hz
- **Power consumption:** max. 7VA
- ♣ **Fusing:** external mit 2A specified

Measurement inputs:

- **Voltage path:** 3x 250 to 550VAC (phase to phase) or
  3x 50 to 105VAC (phase to phase)
  -Power consumption: max. 1,0 VA per phase
  -:Fusing external with 2A specified
- **Current path:** 3x X/5 A (minimal ct current >6mA)
  - Power consumption: max. 1,8 VA per current transformer

Outputs:

- **1 Alarm contact:** 250VAC /max. 3A (Volt free closer)

Interfaces (EMA 1101,operation mode optional):

- **1 FRAKO Power Bus®:** For connection to the FRAKO Energy Management System according to EN 50170 (P-NET)
  - Transmission rate.: 76,8 kbit/s
- **1 RS232- interface:** Via RS232-Adapter (Optional) for direct connection to PC
  - Transmission rate.: 19,2 kbit/s

Interface (EMA 1101-DP):

- **1 Profibus-DP:** According to EN 50170 standardised field bus. RS485
  - Transmission rate.: Up to 12 Mbit/s

Operating conditions:

- **Ambient temperature:** -10℃ to +50℃

Additional functions:

- **Operating elements:** Membrane keypad with 5 keys
- **Display elements:** Illuminated LC-Display (4 lines each of 20 characters)
- **Connections:** Pluggable via multiple socket-outlet
  (delivered with instrument)

Construction data:

- **Dimensions:**
  - Front panel: 144 x 144 mm (DIN 43700)
  - Front panel cut-out: 138 x 138 mm (DIN 43700)
  - Mounting depth: 105 mm
- **Ingress protection:** Built in enclosure, front IP54
  Terminals IP20 degree of polution 3,
  according to VDE 470 / EN60529
- **Design:** According to VDE 0411 / EN61010
  According to EN 50081-1 und EN 50082-2
- **Enclosure:** Flame-resistant according to UL94-V0
- **Mounting:** With screwdriver at the front cover
- **Orientation:** As desired
- **Weight:** approx. 1,3 kg
- **Accessories:** protection kit for protection class II / IP 54
  ..... *item no. 20-50014*
  Software “EMA-SW” ..... *item no. 20-10311*
  update full verion ..... *item no. 20-30013*
  RS232-Adapter (PC) ..... *item no. 20-10310*
  RS232-Adapter (Modem) ..... *item no. 20-10309*

7.5 Profibus-DP

A floppy disk with the GSD file for the *EMA 1101-DP* is delivered with the instrument. Please use this to configure the bus system.
The measurable values of the *EMA 1101-DP* are in various modules. The modules can be linked together as required with the configuration. The modules can be ordered according to your requirements.
The modules are listed below:

No	Module name	Description	Order (L= LongInt, I=Integer)	length	Value range
1	3x active power	active power (rms) of the three phases in W	P1(L), P2(L), P3(L)	12 Byte	1000 == 1kW
2	3x reactive power	Fundamental wave component of the reactive power of the three phases in var	Qfun.1(L), Qfun.2(L), Qfun.3(L)	12 Byte	1000 == 1kvar
3	3x apparent power	Apparent power of the three phases in VA	S1(L), S2(L), S3(L)	12 Byte	1000 == 1kVA
4	3x power factor	Fundamental wave power factor of the three phases	PF 1(I), PF 2(I), PF 3(I)	6 Byte	990 ==ind0,99 -990 ==cap0,99
5	P,Q,S,Asym,PF, Freq	Total active, reactive, and apparent power. Asymmetry (%),overall PF and Freq.	P total(L), Qfun. total(L), S total(L), Asymmetry(I), PF total(I), Freq.(I),	18 Byte	5000 == 50Hz Asym 10 == 1%
6	3x U_{rms} phase/neutral	values of the voltages phase/neutral in V	Urms1(L), Urms2(L), Urms3(L)	12 Byte	10 == 1V
7	3x I_{rms}, Ineutral	values of the currents in the phases and the current in neutral conductor in mA	Irms1(L), Irms2(L), Irms3(L), Irms/neutral(L)	16 Byte	1000 == 1A
8	3x U_{rms} phase/phase	values of the voltages phase/phase in V	Urms1/2(L), Urms2/3(L), Urms3/1(L)	12 Byte	10 == 1V
9	3x U_{fun} phase/neutral	Fundamental wave voltage phase/neutral in V	Ufun.1(L), Ufun.2(L), Ufun.3(L)	12 Byte	10 == 1V
10	3x Idf, 3x Udf	Distortion factors of current and voltage in %	Idf1(I),Udf1(I), Idf2(I),Udf2(I), Idf3(I),Udf3(I)	12 Byte	10 == 1%
11	3x H03, H05, H07	The components of the 3rd., 5th. and 7th. harmonics of three phases in %	H03*1*(I), H03*2*(I), H033(I), H05*1*(I), H05*2*(I), H053(I), H07*1*(I) ,H07*2*(I), H073(I),	18 Byte	10 == 1%
12	3x H09, H11, H13	The components of the 9th., 11th. and 13th. harmonics for three phases in %	H09*1*(I), H09*2*(I), H093(I), H11*1*(I), H11*2*(I), H113(I), H13*1*(I) ,H13*2*(I), H133(I),	18 Byte	10 == 1 %
13	3x H15, H17, H19	The components of the 15th., 17th. and 19th. harmonics for three phases in %	H15*1*(I), H15*2*(I), H153(I), H17*1*(I), H17*2*(I), H173(I), H19*1*(I) ,H19*2*(I), H193(I),	18 Byte	10 == 1%
14	2x active/reactive work	Active and reactive work for tariff 1 and tariff 2 or the regenerated work in kWh	Active work tariff 1(L), reactive work tariff 1(L), Active work tariff 2(or regenerated work) (L), reactive work tariff 2(L)	16 Byte	1 == 1kWh 1 == 1kvarh
15	2x temperature	Value of both voltage inputs in ℃	Tem p1(I), Temp2(I)	4 Byte	20 == 20℃
16	3x active power Int	RMS active power of the three phases in kW	P1(I), P2(I), P3(I)	6 Byte	1 == 1kW
17	3x reactive power Int	Fundamental wave component of the reactive power of the three phases in kvar (Integer)	Qfun.1(I), Qfun.2(I), Qfun.3(I)	6 Byte	1 == 1kvar
18	3x apparent power Integer	Apparent power of the three phases in kVA	S1(I), S2(I), S3(I)	6 Byte	1 == 1kVA
19	P,Q,S,Asym,PF, Freq Integer	Total active, reactive, and apparent power. Asymmetry (%),overall PF and Freq.	P total(I), Q fun. total(I), S total(I), Asymmetry(I), PF total(I), Frequency(I)	12 Byte	5000 == 50Hz Asym 10 == 1%
20	3x U_{rms} phase/n. Int	values of the voltages phase/neutral in V	Urms(I), Urms2(I), Urms3(I)	6 Byte	1 == 1V
21	3x I_{rms}, Ineutral Int	values of the currents in the phases and the current in neutral conductor in A	Irms1(I), Irms2(I), Irms3(I), IrmsN(I)	8 Byte	1 == 1A
22	3x U_{rms} phase/ph. Int	values of the voltages phase/phase in V	Urms1/2(I), Urms2/3(I), Urms3/1(I)	6 Byte	1 == 1V
23	Alarm patterns	Every bit of the 6 bytes is assigned to an alarm (see table 2)	Alarm pattern(6byte)	6 Byte	See table 2
28	Variable Module	See following description	Dependant on the chosen module	24 Byte	

Table 1: Profibus-DP modules

A byte was received from *EMA 1101-DP* in the variable module (module 28) and 24 bytes sent. The byte received must contain a module number between 1 and 23. The *EMA 1101-DP* sends the relevant module back in this case. The 24th byte in the returned data stream corresponds to the chosen module number. The module choice may be changed within the cyclic data exchange.

Bit position of the individual alarmflags					
1st Byte		**3rd Byte**		**5th Byte**	
Xooo oooo	$U_{1/2}$ max	Xooo oooo	$H05_1$ max	Xooo oooo	Free
oXoo oooo	$U_{2/3}$ max	oXoo oooo	$H05_2$ max	oXoo oooo	Free
ooXo oooo	$U_{3/1}$ max	ooXo oooo	$H05_3$ max	ooXo oooo	$H17_1$ max
oooX oooo	$I_{rms}1$ max	oooX oooo	$H07_1$ max	oooX oooo	$H17_2$ max
oooo Xooo	$I_{rms}2$ max	oooo Xooo	$H07_2$ max	oooo Xooo	$H17_3$ max
oooo oXoo	$I_{rms}3$ max	oooo oXoo	$H07_3$ max	oooo oXoo	Asymmetry max
oooo ooXo	In max	oooo ooXo	Free	oooo ooXo	PF min
oooo oooX	$U_{1/2}$ min	oooo oooX	Free	oooo oooX	Temperature 1 max
2nd Byte		**4th Byte**		**6th Byte**	
Xooo oooo	$U_{2/3}$ min	Xooo oooo	Free	Xooo oooo	Temperature 2 max
oXoo oooo	$U_{3/1}$ min	oXoo oooo	$H11_1$ max	oXoo oooo	Temperature 1 min
ooXo oooo	Udf 1 max	ooXo oooo	$H11_2$ max	ooXo oooo	Temperature 2 min
oooX oooo	Udf 2 max	oooX oooo	$H11_3$ max	oooX oooo	Frequency alarm
oooo Xooo	Udf 3 max	oooo Xooo	$H13_1$ max	oooo Xooo	Free
oooo oXoo	$H03_1$ max	oooo oXoo	$H13_2$ max	oooo oXoo	Free
oooo ooXo	$H03_2$ max	oooo ooXo	$H13_3$ max	oooo ooXo	Free
oooo oooX	$H03_3$ max	oooo oooX	Free	oooo oooX	Free

Table 2: Position of the Alarmflags

Measuring values are transmitted according to the sequence shown in Table 1. When transmitting integer or long integer values the byte with the highest value is transmitted first.
It has to be observed that the total number of the selected bytes does not exceed the capacity of the master. A maximum of 240 bytes can be selected.

Example of a Profi Bus configuration:
Supposing the active power, the power factor, the three phase currents and the current active energy meter are to be read from the *EMA 1101-DP*. During the configuration of the Profi Bus the modules number 5 (P, Q, S, Asym, PF, Freq), number 7 (3xIrms, Inull) and number 14 (2x active/reactive work) must be chosen for the *EMA 1101-DP*.
Subsequently the cyclic data exchange with the *EMA 1101-DP* can be started. *The EMA 1101-DP* now delivers 50 bytes per data exchange to the Profi Bus master. If the modules were configured in the order described above, the received bytes will have the following meaning:

Bytes 1 - 4	Total active power in W	Long Integer
Bytes 15 - 16	Total power factor	Integer
Bytes 19 - 22	rms current of phase 1 in mA	Long Integer
Bytes 23 - 26	rms current of phase 2 in mA	Long Integer
Bytes 27 - 30	rms current of phase 2 in mA	Long Integer
Bytes 35 - 38	active work for tariff 1 in KWh	Long Integer
Bytes 39 - 42	reactive work for tariff 1 in Kvarh	Long Integer
Bytes 43 - 46	active work for tariff 2 in KWh	Long Integer
Bytes 47 - 50	reactive work for tariff 2 in Kvarh	Long Integer

The individual data types are sent first with the byte with the highest value,
I.e. in the case of the total power.

1^{st} byte *256*256*256 +2^{nd} byte*256*256 +3^{rd} byte*256+ 4^{th} byte = Total power in W

8. Troubleshooting

Fault	Possible cause	Remedial action
No display whatsover on mains monitoring device	No operating power or the wrong voltage	Verify that the operating voltage is at the right level on the mains monitoring device
Mains monitoring device indicates no current/no power	Jumpers still fitted to current transformers	Remove current transformer jumpers
Mains monitoring device indicates unrealistic values of power factor and / or phase power	Voltage and current circuits not connected in correct phase sequence	Connect voltage and current circuits in correct phase sequence
Mains monitoring device indicates unrealistic values of voltage or current	Transformer ratio not entered correctly	Set the transformer ratios correctly in ”Basic Settings” (see section 5, page 19)
An alarm message appears continually in the display window	The alarm limits are set too closely	Acknowledge all alarm messages and then set new alarm limits in ”Basic Settings” (see section 5, page 19)
Mains monitoring device does not respond to bus	Bus address set incorrectly	Set bus address correctly (see section 5.3, page 20)
	Bus polarity incorrect	Connect bus correctly
Mains monitoring device indicates unrealistic values of temperature	No Pt100 RTD has been installed or is connected wrongly	Connect according to wiring diagram (see pages 15)

Notice:

Notice:

Mains Monitoring Instrument EMA 1101 / EMA 1101-DP

Sales Programme

Power capacitors for low and medium voltage
Power factor correction systems
Power factor correction systems with reactors
Modules for power factor correction systems
Active filters
Dynamic compensation of harmonics
Reactive power control relays
Maximum demand control systems
Mains monitoring instruments
Cost allocation
Energy management systems

FRAKO 55-02604 / 10/10 / 8540 / ab V1.35 / V1.70
Subject to technical alteration

Reliable energy solutions.

FRAKO Kondensatoren- und Anlagenbau GmbH
Tscheulinstr. 21a · D-79331 Teningen · Germany
Phone +49 7641/453-0 · Fax +49 7641 / 453-545
http://www.frako.de · E-Mail: info@frako.de

Quality is our Motto
Quality has a Name
We are certified for ISO 9001 and ISO 14001

REG.NR. 1410