integrated measurement & control

Power Quality Recorder

imc POLARES

Operating instruction

Version 2.4, 02.08.2011

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1 imc POLARES

Note

Please observe the instructions and warnings for your safety in the later chapter "Safety and other notifications 16".

Note

This instruction manual contains important information on the *imc POLARES*.
It comes standard with the product package. The statements made in this instruction manual are to considered more binding than any conflicting statements.

Version 2.4

Release 02.08.2011

2 imc Customer Support - Hotline

Germany:

imc Meßsysteme GmbH
Phone: ☎ 030 / 46 70 90 - 26
Fax: 🗐 030 / 4 63 15 76
WWW: www.imc-berlin.com
e-mail: hotline@imc-berlin.de

For our international partners see www.imc-berlin.com and click to ***International Distributors***

When requesting telephone consultation, please be prepared to state the serial numbers for your device and for your software's data carrier, and have this manual present. Thanks!

3 Preface

3.1 Disclaimer of Liability

We have checked the contents of this document and every effort has been made to ensure that the descriptions of both hardware and software are as accurate as possible. However, since deviations cannot be ruled out entirely, we do not accept liability for complete conformity or for any errors or omissions.

The information in this manual is checked periodically, and necessary corrections will be included in future editions. We are grateful for any improvements that you care to suggest.

Subject to technical alterations.

3.2 Copyright

4 Guidelines

4.1 Certificates and Quality Management

imc holds DIN-EN-ISO-9001 certification since May 1995.

You can download an English version of the CE Certification on our Webpage: http://www.imc-berlin.de/qualitaetssicherung. Current certificates and information about the imc quality system can be found on the Webpage: http://www.imc-berlin.com in section Customer Support.

For further information, please contact our hotline 6.

4.2 imc Guarantee

Subject to imc Meßsysteme GmbH's general terms and conditions.

4.3 ElektroG, RoHS, WEEE

The company imc Meßsysteme GmbH is registered under the following number:

WEEE Reg.- # DE 43368136

Brand: imcDevices

Category 9: Monitoring and control instruments exclusively for commercial use

Valid as of 24.11.2005

Our products fall under Category 9, "Monitoring and control instruments exclusively for commercial use" and are thus at this time exempted from the RoHS guidelines 2002/95/EG.

The law (ElektroG) governing electrical and electronic equipment was announced on March 23, 2005 in the German Federal Law Gazette. This law implements two European guidelines in German jurisdiction. The guideline 2002/95/EG serves "to impose restrictions on the use of hazardous materials in electrical and electronic devices". In English-speaking countries, it is abbreviated as "RoHS" ("Restriction of Hazardous Substances").

The second guideline, 2002/96/EG "on waste electrical and electronics equipment" institutes mandatory acceptance of returned used equipment and for its recycling; it is commonly referred to as WEEE guidelines ("Waste on Electric and Electronic Equipment").

The foundation "Elektro-Altgeräte Register" in Germany is the "Manufacturers' clearing house" in terms of the law on electric and electronic equipment ("ElektroG"). This foundation has been appointed to execute the mandatory regulations.

4.4 CE-Certification

Conformity Declaration

imc
integrated measurement & control

imc Meßsysteme GmbH
Voltastraße 5, D-13355 Berlin,

hereby declares that our product

imc POLARES

in all its model varieties

conforms to the following applicable standards: [1],[2]

EC Low Voltage Directive 2006/ 95/EEC*
(implemented in Germany as the 1st regulation of the Device And Product Safety Law GPSG)

EMC Directive 2004/108/EEC
(implemented in Germany as the EMC-Law EMVG)

The system was designed, constructed and tested in accordance with the regulations delineated in

Safety Regulations for electric measurement, open and closed-loop control and laboratory devices DIN EN 61 010-1:2002

and was subjected to a thorough routine test before shipment and left the production facility in perfect condition[3].

imc Meßsysteme GmbH
integrated measurement & control
Voltastraße 5
13355 Berlin
Telefon (030) 46 70 90-0

Berlin, 2008-JAN-04
Place and date of issue

Dipl. Ing. Josef Schwan
Production Department Head

Dipl. Ing. Michael Scheibner-Aden
Quality Assurance Manager

[1] *This conformity declaration pertains fundamentally only to the system as delivered by imc. The user is solely responsible for alterations and expansions as well as for ensuring the altered system's compliance with the applicable EC-directives.*

[2] ***Harmonized standards:***
DIN EN 61326:2004 (product standard): conforms to requirements for electromagnetic immunity measurements of equipment intended for industrial use (as per EN 61326/ table A1) and for Radio Interference Intensity Class A (EN 61326 table 3).
DIN EN 61000-4-2:2001, -4-3:2003, -4-4:2002, -4-5:2001, -4-6:2001 DIN EN 55011:2003

DIN EN 61010-1:2002

[3] ***Quality management:*** *imc holds DIN-EN-ISO-9001 certification since May 1995. imc's conformity to the world-wide accepted standard DIN EN 9001:2000 is attested to by the Certificate issued July, 2006 by the accredited TÜV CERT certification body of TÜV Anlagentechnik GmbH. imc's certificate registration number is 01 10085152.*

QS_POLARES_CE_2008_1_E.doc

Conformity Declaration

imc
integrated measurement & control

imc Meßsysteme GmbH
Voltastraße 5, D-13355 Berlin,

hereby declares that our product

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conforms to the following applicable standards: [1],[2]

EC Low Voltage Directive 2006/ 95/EEC*
(implemented in Germany as the 1st regulation of the Device And Product Safety Law GPSG)

EMC Directive 2004/108/EEC
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Safety Regulations for electric measurement, open and closed-loop control and laboratory devices DIN EN 61 010-1:2002

and was subjected to a thorough routine test before shipment and left the production facility in perfect condition[3].

Berlin, 2009-JUL-27
Place and date of issue

i.A. B. Schaefer

Dipl. Ing. (FH) Bertram Schaefer
Development Department

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Dipl. Ing. Michael Scheibner-Aden
Quality Assurance Manager

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[1] *This conformity declaration pertains fundamentally only to the system as delivered by imc. The user is solely responsible for alterations and expansions as well as for ensuring the altered system's compliance with the applicable EC-directives.*

[2] ***Harmonized standards**:*
DIN EN 61326:2006 (product standard): conforms to requirements for electromagnetic immunity measurements of equipment intended for industrial use (as per EN 61326/ table 1 and table A1) and for Radio Interference Intensity Class A (EN 61326 chapter 7.2 and CISPR 11).
DIN EN 61000-4-2:2001-12, -4-3:2003-11, -4-4:2005-07, -4-5:2001-12, -4-6:2001-12, DIN EN 55011:2003-08
DIN EN 61010-1:2002-08 incl. DIN EN 61010-1:2002-11 correction 1 + DIN EN 61010-1:2004-01 correction 2

[3] ***Quality management**: imc holds DIN-EN-ISO-9001 certification since May 1995. imc's conformity to the world-wide accepted standard DIN EN 9001:2008 is attested to by the Certificate issued Juni, 2009 by the accredited TÜV Rheinland CERT GmbH. imc's certificate registration number is 01 10085152.*

4.5 Product improvement

Dear Reader!

We at **imc** hope that you find this manual helpful and easy to use. To help us in further improving this documentation, we would appreciate hearing any comments or suggestions you may have.

In particular, feel free to give us feedback regarding the following:

- Terminology or concepts which are poorly explained
- Concepts which should be explained in more depth
- Grammar or spelling errors
- Printing errors

Please send your comments to the following address:

imc Mess-Systeme GmbH
Customer Service Department
Voltastrasse 5
D - 13355 Berlin

Telephone: 0049 - 30 - 467 090 - 26
Telefax: 0049 - 30 - 463 15 76
e-mail: hotline@imc-berlin.de

4.6 Important notes

4.6.1 Remarks Concerning EMC

imc POLARES satisfies the EMC requirements for unrestricted use in industrial settings.

Any additional devices connected to *imc POLARES* must satisfy the EMC requirements as specified by the responsible authority (within Europe[2]) in Germany the BNetzA - "Bundesnetzagentur" (formerly BMPT-Vfg. No. 1046/84 or No. 243/91) or EC Guidelines 2004/108/EEC. All products which satisfy these requirements must be appropriately marked by the manufacturer or display the CE certification marking.

Products not satisfying these requirements may only be used with special approval of the regulating body in the country where operated.

All signal lines connected to *imc POLARES* must be shielded and the shielding must be grounded.

Note

The EMC tests were carried out using shielded and grounded input and output cables with the exception of the power cord. Observe this condition when designing your experiment to ensure high interference immunity and low jamming.

Reference

See also *General Notes* \ *Precautions for operation* \ *Grounding, shielding* \ *Shielding*

[2] *If you are located outside Europe, please refer the appropriate EMC standards used in the country of operation.*

4.6.2 FCC-Note

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules (CFR 15.105)[3]. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment on and off, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio or television technician for help.

Modifications

The FCC requires the user to be notified that any changes or modifications made to this device that are not expressly approved by **imc** may void the user's authority to operate this equipment.

[3]*FCC - United States Federal Communications Commission*

4.6.3 Cables

Connections to this device must be made with shielded cables with metallic RFI/EMI connector hoods to maintain compliance with FCC Rules and Regulations.

4.6.4 Other Provisions

Industrial Safety

We certify that *imc POLARES* in all product configuration options corresponding to this documentation conforms to the directives in the accident prevention regulations in "Electric Installations and Industrial Equipment" (BGV-A3 of the Index of Accident Prevention Regulations of the Professional Guilds in Germany).

This certification has the sole purpose of releasing imc from the obligation to have the electrical equipment tested prior to first use (§ 5 Sec. 1, 4 of BGV-A3). This does not affect guarantee and liability regulations of the civil code.

** formely VBG-4, refer http://www.bgfe.de*

5 General notes

These operating instructions contain necessary information for the proper use of the devices descried. The instructions are targeted at technically qualified personnel possessing special training or relevant skills in the area of automation technology.

Such knowledge, as well as proper implementation of the safety guidelines and warnings presented in the instructions are the conditions for danger-free installation and commissioning as well as for safe operation and correct maintenance of the devices described. Only qualified personnel (see chapter 4) possess the necessary skills to be able to correctly interpret and apply the generally valid statements in this document to specific cases.

These instructions are standard included with the product package. Nevertheless, it can not possibly foresee and reflect all possible details pertaining to every version of the devices described or cover every possible situation involving setup, operation, or maintenance of the devices.

If you desire further information, or if special problems arise which are not adequately covered in this manual, you can order the manual named in chapter 1.

Additionally, you can obtain further information from our customer support 6.

We also point out that the contents of this instruction manual is not part of any former or existing agreement, commitment or legal relationship nor are intended to change any. Any obligations on the part of imc result exclusively from the applicable sales contract, which also states the sole valid guarantee agreement. The guarantee contract is unaffected by the contents of this document.

5.1 After Unpacking...

Please check the device for mechanical damage and/ or loose parts after unpacking it. The supplier must be notified immediately of any transportation damage! Do not operate a damaged device!

Check that the accessories as listed in Chapter Technical specification 98 have been delivered.

5.2 Guarantee

Each device is subjected to a 24-hour "burn-in" before leaving imc. This procedure is capable of recognizing almost all cases of early failure. This does not, however, guarantee that a component will not fail after longer operation. Therefore, all imc devices are guaranteed to function properly for ***one year***. The condition for this guarantee is that no alterations or modifications have been made to the device by the customer.

An unauthorized change at the device cancels the guarantee.

6 Safety and other notifications

This instruction manual does not contain a complete collection of all safety procedures needed for operating the devices, since special operational conditions can make additional steps necessary.

However, these instructions do contain information which you must observe for your own safety and in order to avoid damage to property. This information is sometimes highlighted by a warning triangle and appear as shown below, to reflect the degree of danger:

Danger

indicates that death, severe personal injury or substantial property damage can result if proper precautions are not taken.

Warning

indicates that death, severe personal injury or substantial property damage can result if proper precautions are not taken.

Caution

indicates that minor personal injury or property damage can result if proper precautions are not taken. This particularly applies to damage on or in the device itself and consequential damage thereof.

Attention

indicates that property damage can result if proper precautions are not taken.

Note

indicates information about the device or respective part of these operating instructions which is essential to highlight.

7 Qualified personnel

Qualified personnel

Commissioning and operation of the equipment (module, device) described in this manual may only be performed by qualified personnel. Qualified personnel, in the context of the safety information contained in this manual, are persons authorized to commission, start-up, ground and label devices, systems and circuits according to all applicable safety standards.

Use for the intended purpose

The equipment (device, module) may only be used for the applications specified in the catalog and the technical manual, and only in connection with OEM devices and components recommended and approved by imc.

The prerequisites for trouble-free, reliable operation of the product include proper transport, proper storage, proper installation and assembly, as well as proper operation and maintenance.

When operating electrical equipment, certain parts of this equipment are subject to dangerous voltage levels. Therefore, improper handling can result in serious injury or equipment damage:

- ❑ The equipment must be grounded at the PG terminal before making any connections whatsoever.
- ❑ Dangerous voltages may occur in all circuit components connected to the inputs or power supply.
- ❑ Dangerous voltages due to capacitor memory may still exist in the equipment even after it has been disconnected from the power supply or input circuits.
- ❑ Equipment with current transformer circuits must never be operated in any state where the current transformer circuits are open-circuited.
- ❑ The operating limits specified in the manual and in the operating instructions must not be exceeded at any time (including inspection and commissioning).

The parameter value limits stated in the instructions may not be exceeded; this also applies to inspection and commissioning situations.

8 Application

imc POLARES is a **IEC 61000-4-30 Ed. 2 class A** measurement device for integral measurement of power quality. It encompasses all important quantities for the assessment of electrical supply networks at once. The user software serves the purposes of rigging the device, taking measurements with online monitoring and composing a report of the quality analysis.

imc POLARES enables you to measure on up to 4 differently configured leads with a resolution extending **up to the 50th harmonic**.

You can devise a variety of trigger mechanisms for **long-term monitoring** of events to freely configured **short-term measurements** with 4 available input channels having sampling rates of up to 50 kHz for the monitoring of any voltage or current events.

Along with the conventional trigger mechanisms which respond to the signal exceeding limit values which can be set, it is also possible to set **triggering** conditions representing the signal deviating significantly from the expected **curve shape**. Thus, as an example, any sudden signal deviations occurring during long-term monitoring which are due to **harmonics** or brief **voltage fluctuations (spikes)** can be captured even if the magnitude of the deviation is much smaller than the nominal value itself.

The **long-term monitoring** technique of measurements returns results with the following attributes: independent of the option of triggered measurement mentioned previously, all relevant measurement data are recorded. *imc POLARES* provides you with the ability to decide after the measurement what limits you wish to set for which quantity, and thus what to consider in the evaluation of results. The incoming data are converted online by the signal processor to useful information for the user. The data volume is reduced to the minimum necessary. This avoids the danger of losing record of relevant events which lie inside the boundaries.

Wherever Complete Recording isn't possible, the European **standard EN50160** forms the basis for proceeding. This standard stipulates minimum requirements for inspection of power quality, in terms of the scope and the precision of measurements taken. By collaborating with German power suppliers on its development, *imc POLARES* benefits from large amounts of practical know-how which enables the scope of its functionality to go far beyond EN50160.

By using multiple *imc POLARES* units with an external real-time clock (**GPS**, **DCF 77**, **NTP** or **IRIG-B**), measured data from different sources can be **synchronously** correlated. And with the help of the database module, it is possible to search through the data for any events or limit overstepping, and then display and compare them. It is also possible to synchronize multiple *imc POLARES* units even without a external clock, and to plot their respective data jointly in correct chronological relationship.

imc POLARES main field of application is stationary **network monitoring** with subsequent evaluation. But short-term measurements are also fully supported, in which highly fluctuating disturbance phenomena must be observed. For this purpose, the data can be displayed online on the connected PC.

And if the device is intended for stationary operation for longer periods (such as many months), a special data storage mode makes it possible for the **measurement results** to be generated on a **daily or even a monthly** basis for later retrieval at the user's convenience.

In the examples below, the values assume the European low voltage grid frequency of 50Hz, and a phase-to-neutral voltage of 230 Volt; for measurements of a 60 Hz grid or other voltages, the quantities must be converted/adapted accordingly.

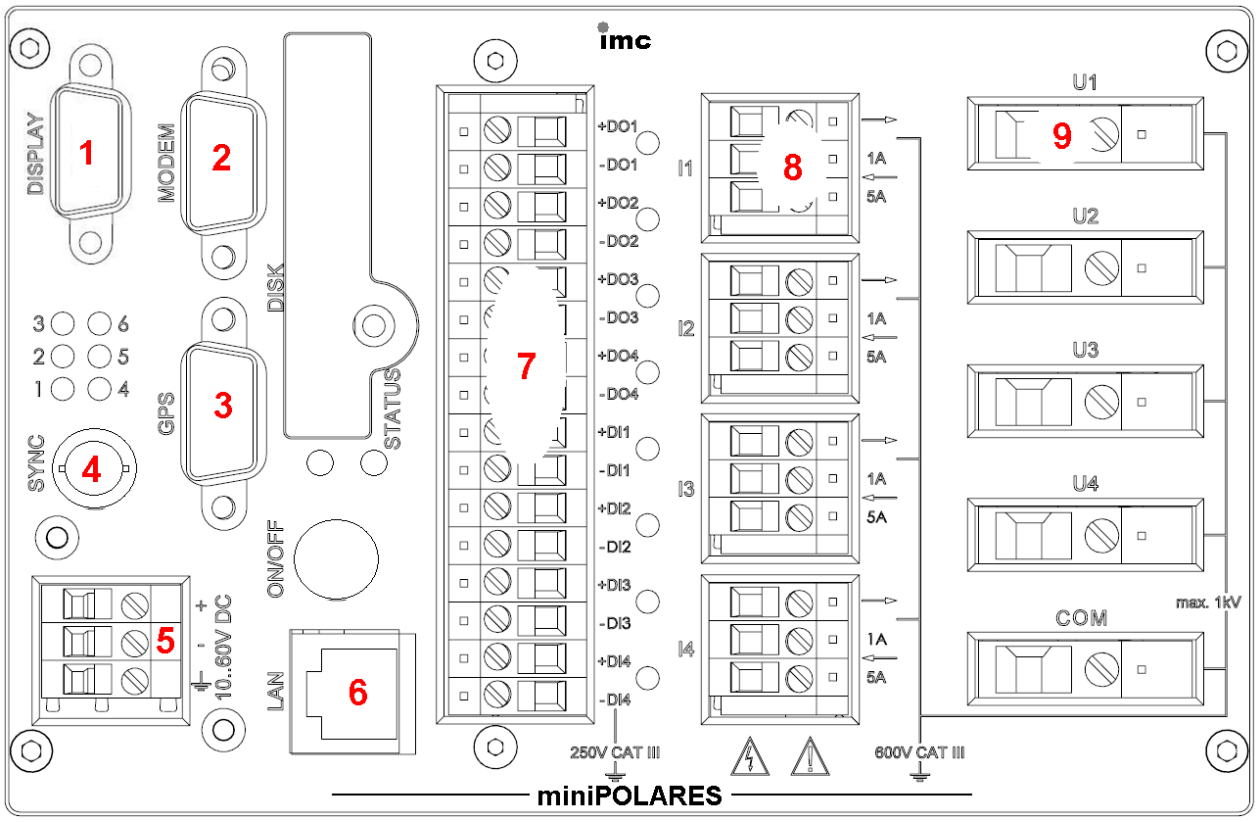
9 System architecture

9.1 imc miniPOLARES

imc POLARES device is optimized for stationary operation installed on a top hat rail in a switching cabinet.

With its 4 voltage and 4 current inputs, the device can handle all measurement tasks for a **3-phase-network** including the neutral point. Alternatively, *imc POLARES* with **8 voltage inputs** without current measurement is available, see order data. The sampling frequency ensures proper measurement of up to the **50th harmonic**.

For connectors, technical data see also *Technical specs and terminal configuration* 85.



miniPolares

Interconnections:

1. Display	DSUB-9 terminal (male)	6. LAN:	RJ45 terminal
2. Modem:	DSUB-9 terminal (male)	7. Binary inputs/outputs:	terminal for cables with up to 2.5 mm² cross section
3. GPS:	DSUB-9 terminal (male)	8. Current inputs:	terminal for cables with up to 2.5 mm² cross section
4. SYNC:	BNC-terminal	9. Voltage inputs:	terminal for cables with up to 2.5 mm² cross section
5. Supply:	terminal for cables with up to 2.5 mm² cross section		

imc POLARES is a multi-function measurement device for all physical quantities designed for standards-compliant evaluation of the quality of electrical supply networks, **specially designed to be installed in a switching cabinet**.

Construction

- Compact, robust aluminum housing with plastic front panel
- Top-hat rail installation set on the device's rear panel
- Slot for CF-card storage medium

Interconnections

- Voltage inputs: 4, isolated, via 0.5 .. 6mm² screw terminals *
- Current inputs: 4, isolated, via 0.2 .. 2.5mm² screw terminals *
- LAN-terminal: via Ethernet TCP/IP 10/100 MBit via RJ 45 socket
- GPS: terminal for external GPS mouse via DSUB-9 socket
- Synchronization: terminal for synchronization of multiple devices, via BNC
- Modem: terminal for optional external modems, via DSUB-9 socket

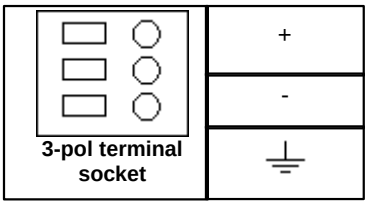
As interfaces, **TCP/IP** and an external modem are available.

As storage media, a Compact Flash card with a capacity of **16 GB** is available at this time.

There are both DC and AC versions of the power supply for *miniPOLARES*.

9.1.1 Supply for DC-variant (10 V to 60 VDC)

The supply for the DC variant of *miniPOLARES* is connected via a 3-pin terminal socket. The permitted supply voltage range is 10 V to 60V DC.



The following notes on *imc miniPOLARES* DC-power supply must be observed:

- The **supply line** must be a low-resistance cable with adequate cross-section. Any extra filters connected in the supply circuit may not have series inductivities above 1mH. Otherwise, an additional parallel capacitor is needed.
- The terminal is protected against misconnection.
- If the power supply is provided by the source to be measured, the measurement ends automatically if there is a longer power outage. *miniPOLARES* can be configured to resume measurement independently upon return of power.
- The device is **grounded** via the top-hat mounting. This grounding has no safety function, but is required in order to ensure the measurement accuracy and the electromagnetic compatibility (EMC). If the minus pole of the voltage supply source is connected to ground voltage, then grounding is ensured in this way. The included desktop supply unit is designed in this way.

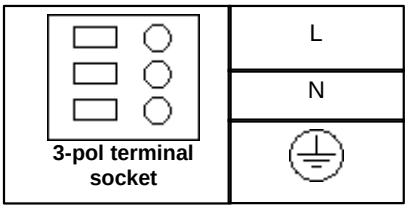
Note

Once imc *miniPOLARES* is grounded, the supply sources are no longer isolated but referenced to ground voltage.

9.1.2 Supply for AC/DC-variant (110 V to 230 VAC/DC)

The supply voltage for the AC/DC variant is routed through a 3-pin terminal socket. Wiring of this terminal has to be performed by expert personnel.

The permitted supply voltage range is 110 V to 250 V DC or 110 V to 240 V AC at either 50 Hz or 60 Hz. If the device is supplied from the source to be measured, then measurement stops automatically during longer power outages and restarts independently upon resumption of power.



For the AC-power supply of *imc miniPOLARES*, note the following:

- The grounding is relevant with respect to the safety for the device. Also the grounding ensures the measurement precision and the necessary electromagnetic compatibility (EMC).
- The input lead must have low impedance and sufficient cross-section area.

9.1.3 Main Switch

ON/OFF

1. **Switch ON:** For both ON and OFF, press the main switch.
2. **Switch OFF:** For shutting the machine off, there is a delay before the device is actually off, since all procedures running must be ended properly.

9.2 imc POLARES

imc POLARES is a **mobile** multi-function measurement device for all physical quantities designed for standards-compliant evaluation of the quality of electrical supply networks.

Construction

- Compact, robust plastic housing 260 x 85 x 300 (W x H x D in mm)
- Weight: 2.3 kg without power supply unit
- 3" LCD - display, B/W
- 2 slots for storage media or WLAN cards:
- 1 slot for PCMCIA - Flash card or WLAN card (WLAN card optional)
- 1 slot for CompactFlash card (CompactFlash card optional)

Interconnections

- 4 voltage inputs, isolated, connected via 4mm safety jacks, in accordance with IEC 1010, Cat. III.
- 4 current transducer inputs, isolated, via COMBICON DFK feed-through plugs, current transducer not included, see option
- Separate 4 mm protection ground terminal socket
- PC-connection via Ethernet TCP/IP 10/100 MBit via RJ 45.
- DSUB terminal for external DCF or GPS radio clock.
- BNC terminal for synchronization of multiple devices.
- prepared RJ 11 terminal for optional modems

As interfaces, **TCP/IP** and optionally an internal modem or WLAN via PCMCIA connector are available.

The available storage medium is a PCMCIA hard drive or optionally, Compact Flash cards can be used. Intelligent memory management and effective data reduction enable storage of up to 130 weeks' (2,5 years) worth of data, in compliance with EN50160.

9.2.1 DC-Supply

imc POLARES is powered by a DC-supply voltage which supplied via a 2-pole LEMO-plug (type designation: FGG.1B.302.CLAD).

The permissible supply voltage range is 10 V to 32 V (DC). Such voltages are provided by the standard included table-top power adapter. If the adapter is powered by the power source which is to be measured, then in case of voltage outages, the measurement is automatically interrupted and resumes by itself when the power is restored.

Observe the following general guidelines for powering imc POLARES:

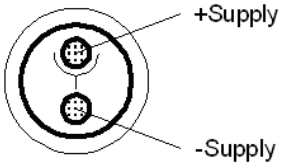
- **Grounding** of the device must be ensured. If the power supply unit comes with a grounding line, it would be possible to ground the system "by force", by making a connection from this line to the plug enclosure (and thus to the device ground). The table-top power supply unit is designed to meet this purpose. This manner of proceeding may not be desirable if you wish to avoid transient currents along the grounding line. In this case the ground-connection must be made to the device directly. For this purpose, a (yellow/green) banana jack ("CHASSIS") is provided.

Note

- Once *imc POLARES* is grounded, the power sources are no longer isolated but at ground potential.
- The standard included table top power adapter supplies 24 V DC at a max. power consumption of 130 W. The AC voltage on the input side is 110 V to 240 V 50/60 Hz.
- Note that the table-top power adapter is designed for **operating temperatures** of 0°C-40°C. This also applies if your measurement device is equipped for the extended temperature range!
- The **feed line** must have low resistance, and the cable must have an adequate cross-section. Any interference-suppressing filters which may be inserted into the line must not have any series inductor greater than 1mH. Otherwise an additional parallel-capacitor is needed.

Pin configuration:

LEMO-connector
FGG.1B.302.CLAD
(interior view of soldering contacts)



9.2.2 Main switch

1.Switch on: To activate the device, its main switch must be moved to the **"ON"**-position. A successful booting of the device is indicated by the display.

If no experiment is open, the display simply reads *"imc POLARES"* and the device's name. In other cases, the display content depends on the configuration or experiment.

2. Switch off: To deactivate the device, the main switch must be moved to the **"OFF"**-position. The device doesn't stop immediately. It first checks whether any measurements are running, stops these, and saves their data to the internal hard drive. Then, the device shuts off independently. This process lasts for a maximum of about 10 s. If no measurement is running at the time, the deactivation process is correspondingly quick.

9.3 UPS

An optional module for ***uninterruptible power supply*** (UPS) is available. This unit makes it possible to continue through a short-term outage of the mains power supply. It is especially useful in mobile settings (on board vehicles) in order to handle the drop in voltage from the vehicle battery which occurs at ignition.

The use of backup power from the battery is indicated by the control lamp "PWR" changing from green to yellow and the buzzer sounding.

The buffering of the power supply is provided by a built-in lead/gel storage battery (accumulator), which is recharged during normal operation by the external power supply.

The UPS provides backup in case of power outage and also monitors its duration. If the power outage is continuous and if it exceeds the device's buffer duration (standard: 1sec.), the device deactivates itself. This is done in the same way as in the case of manual deactivation, i.e., any running measurements and pertinent files are closed, which can cause a delay of up to approx. 10 s.

If the power outage isn't continuous but only temporary as in the case of a vehicle being started, the buffer duration monitoring always jumps back to the beginning.

Thus, a typical application of this configuration is in vehicles, where the power supply is coupled to the ignition. A buffer is thus provided against short-term interruptions. And on the other hand, deep discharge of the buffer battery is avoided in cases where the measurement system is not deactivated when the vehicle is turned off.

9.3.1 Buffering time constant and maximum buffer duration

The ***buffer time constant*** is a permanently configurable device parameter which can be selected as a order option. It sets the maximum duration of a ***continuous*** power outage after which the device turns itself off.

The ***maximum buffer duration*** is the maximum (total) time, determined by the battery capacity, which the device can run on backup. This refers to cases where the self-deactivation is not triggered; e.g., in case of repeated short-term power-interruptions. The maximum buffer duration depends on the battery's current charge, on the ambient temperature and on the battery's age. The device automatically deactivates itself just in time to avoid deep discharge of the battery.

Note

The buffer time constant can be changed using the operating software imcDevices. See imcDevices manual *Chapter 3: Operation > User Interface > Device - menu >Properties...*: Entry *UPS*

9.3.2 Charging power

The charging power depends on the device type, its hardware configuration, and the amount and type of rechargeable batteries installed. For this reason, there are a variety of combinations with charging power between 2,4 W and 16 W.

9.3.3 Take-over threshold

The voltage threshold at which the storage battery takes over the power supply from the external source is approx. ***9,75 V***. The take-over procedure is subjected to an hysteresis to prevent oscillating take-over. This would be caused by the external supply's impedance. This inevitable impedance lets the external supply rise again, right after take-over to internal buffering. Hysteresis in the take-over threshold will prevent oscillations due to this effect. If, during supply from of the buffering battery, the external supply voltage rises as high as ***10,9 V*** , the external voltage takes over again from the buffering battery.

If you check these thresholds, note that when the supply voltage is overlaid with a high frequency interference or ripple-voltage, the minima are of key importance. In fact, the overlying interference could be caused by feedback from the device itself!

☞ **Note**

- The voltage specification refers to the device terminals. Please consider the voltage drop of the supply line, when determining the voltage supply.
- **During activation the supply voltage must be above the upper take-over threshold** (≥11 V).

9.4 Potential difference with synchronized devices

☞ **Note**

When using multiple devices connected via the ***Sync terminal*** for synchronization purposes, ensure that all devices are the same voltage level. Any potential differences among devices may have to be evened out using an additional line having adequate cross section.
Alternatively it is possible to isolate the devices by using the module **ISOSYNC**, see also chapter Synchronization in the imcDevices manual.

9.5 Rechargeable accumulators and batteries

Replacement of the battery can only be performed by the manufacturer in the framework of a system revision (maintenance) (recommended for every 3-7 years depending on field of application).

9.5.1 Lead-gel accumulators

Devices which come with the optional ***UPS-Function*** contain maintenance-free lead-gel accumulators. ***Charging*** these internal backup batteries is accomplished automatically when the ***activated device*** receives a supply voltage. Due to the inevitable leakage of charge we recommend that the device be activated at least every 3 months to prevent the batteries from dying.

In case the UPS is used a lot (many discharge and recharge cycles), the life time depends on how much (deep) it has been discharged (is the UPS buffering only for a short time or is the UPS discharged completely every time?). The manufacturer specifies 200 cycles @100% discharging and 1200 cycles @ 30% and 25°C ambient temperature. (that should be true in general for all Pb accus.)

Note	**imc recommend maintenance every 2-3 years.**

Note	Do not throw the lead-gel accumulators in the household garbage.

9.6 Fuses

When selecting the breaker, both the switching capability and the suitability for AC as well as DC voltage must be taken into account!

Specifications for the breakers installed are provided here 85.

9.7 Modularity

For reasons of safety, the user should **not** modify devices having high-voltage modules by replacing the modules. Such modules may only be handled by imc Customer Support personnel!

10 Assembly, Commissioning, Parameterization

10.1 General Notes

Warning

When this device is in operation some of its parts will inevitably be at dangerous voltage levels. Failure to comply with the operating instructions may lead to serious injury or property damage.

Therefore, be sure to observe all warning messages.

Warning

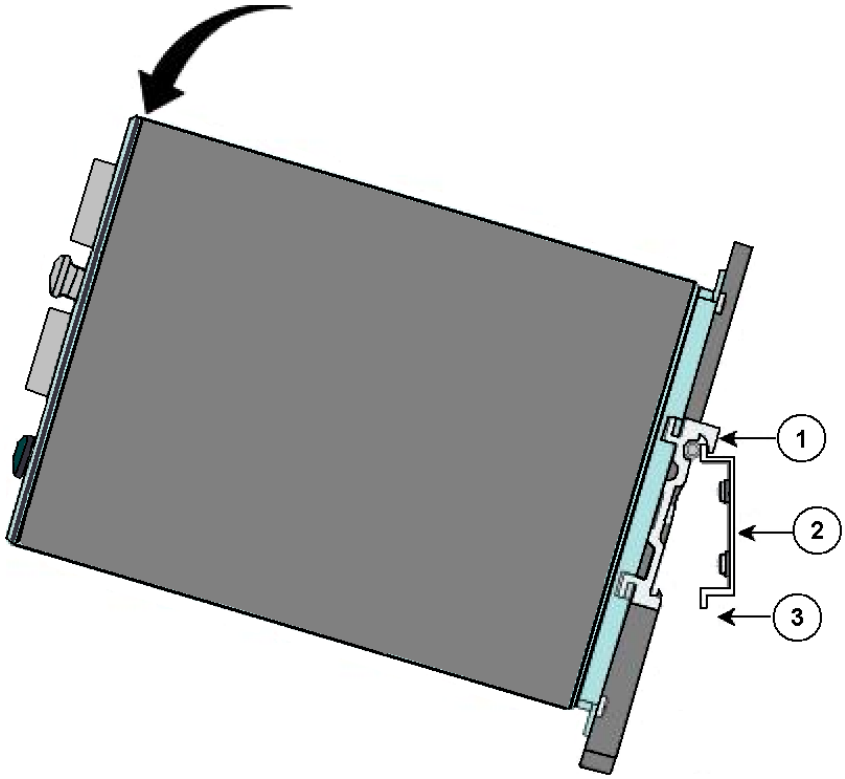
imc POLARES is a plug-in system designed for installation on a top-hat rail in a switching cabinet. After installing the device and connecting its terminals, the switching cabinet in all events be closed. This is the only way to provide adequate protection against inappropriate contact with parts under voltage.

- ❑ The installation site must be free from shock and vibration. The range of ambient temperature permitted for operation is limited (see Technical data 84).
- ❑ Operation at temperatures beyond the permitted working temperature range can lead to incorrect measurements and even failure of the device.
- ❑ The connection terminals are designed for cable diameters of up to 2,5 mm².
- ❑ The device may not be exposed to water condensation during operation. It must be positioned so that it is not in direct sunlight or exposed to strong fluctuations of temperature.

10.2 Assembly

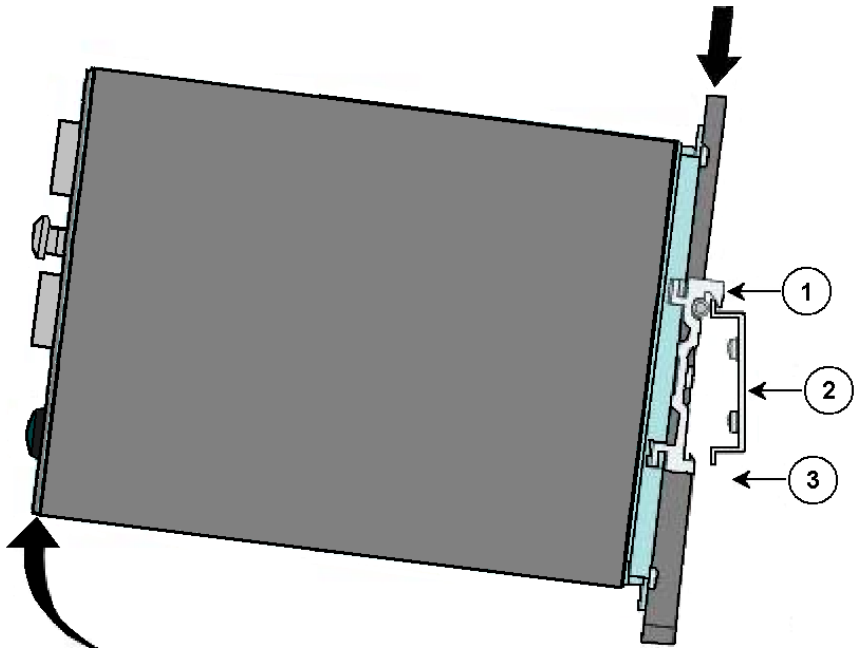
miniPOLARES is prepared for mounting on a top-hat rail according to EN 60750.

Mounting



1. Place the *miniPOLARES* with its rail clip on to the top-hat rail (2) from above at the desired position (1).
2. Push the device gently downwards until clasp (3) catches.

Disassembly



3. Push the device downwards on the side of the rail until the clasp(3) is loose.
4. While in this position, tip the device forwards.

10.3 Electrical connections

Warning

The following procedures may never be performed in the presence of dangerous voltage levels (voltage breaker) and only by personnel possessing relevant qualifications and familiar with the safety and caution regulations.

Note

In electrical installation it is necessary to observe and comply with national and international regulations governing high voltage systems.

- ❑ Prior to commissioning the device, check that all connections have been made correctly.
- ❑ The grounding terminal must be connected with the protection ground of the control cabinet. For a DC-device mounted on a top-hat rail, the grounding of the top-hat rail is also sufficient.
- ❑ The current outputs of any current transformers connected in-line must be short-circuited before you can disconnect the current leads to the device.
- ❑ The user is responsible for checking the polarity and the phase assignment of the transducers.
- ❑ Before commissioning the device, it should have at least two hours to rest in the location where it is to be operated in order to acclimatize to the prevailing temperature and to avoid condensation of humidity.

10.4 Commissioning

Subsequent to the last chapter in which an overview of the system was presented, this chapter describes the commissioning process. This chapter presents a description of the entire installation process in its correct sequence of steps.

You need not connect any measurement leads before starting. For starters, connect the power and interface cables.

10.4.1 Before starting

Condensation may form on the circuit boards when the device is moved from a cold environment to a warm one. In these situations, always wait until the device warms up to room temperature and is completely **dry** before turning it on. The acclimatization period should take about 2 hours.

Before taking measurements, we recommend that you give the device a ***warming-up phase*** of at least 30 min.

imc POLARES is technically approved for ambient temperatures of -10°C to 55°C. Make sure that the ventilation slits on the sides of the device housing are unobstructed in order to avoid internal heat accumulation.

The device conforms to Pollution Degree 2, which means that it's made to tolerate non-conducting contaminants and to withstand occasional conductivity due to condensation. The unit may not be operated in the presence of aggressive chemicals or danger of explosion.

10.4.2 Interface 10BASE-T, Twisted Pair, full duplex

There are two distinct ways of connecting the measurement device with a PC.

- If you connect the measurement directly with your PC, you must use a crossed network cable (crossed UTP-cable, category 5, RJ45-plug).
- If the measurement device is connected via a network hub or switch, or a patch field , us an uncrossed network cable (uncrossed UTP-cable, category 5, RJ45-plug). Contemporary network hubs are able to electronically switch over, so that it makes no difference whether you use a crossed or an uncrossed cable.

10.4.2.1 Ethernet protocol TCP/IP

This protocol requires you to proceed through a configuration phase before it is possible to access a device. This chapter presents step-by-step instructions for preparing your PC and *imc POLARES* unit for such operation. The necessary steps depend on the network environment in which your PC and measurement system are operated. Therefore the steps described are only a selection intended as an example based on the most common network configurations.

10.4.3 Installation of the POLARES operating software

Before it is possible to begin actual installation of the program, some general rules concerning installation of software should be followed:

1. ***Backup copy of the software*:** iIt is advisable to make backup copies of the original data carriers.
2. If possible, close all applications not needed for running Windows!
3. If any older version is already installed, first uninstall it. Then restart the PC, since various components are only completely uninstalled upon restarting the computer.
4. Note when updating from Version 1.x to Version 2.x: for trouble-free operation of the Autotransfer-mode, we strongly recommend obtaining all previous data and clearing the device hard drive! This avoids unnecessary data transfer and error messages due to missing information in older measurement data.

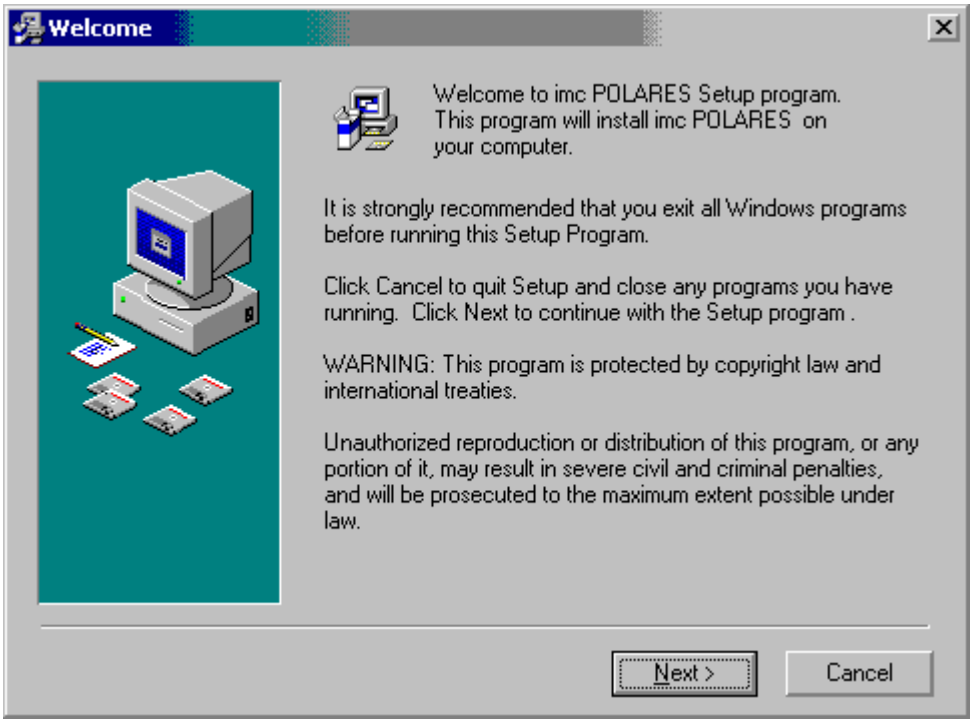
10.4.3.1 System requirements

The operating software *POLARES operating software* is conceived and has been tested for the following operating systems:

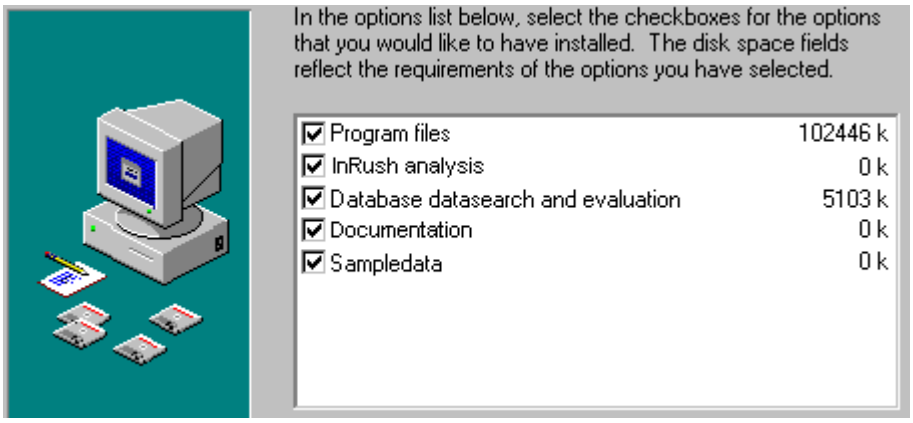
- Windows2000 and Windows XP (installation requires administrator rights)
- Windows Vista (installation requires administrator rights)
- Intel Pentium with 1 GHz or equivalent processor
- min. 1 GB main memory with Windows2000 and Windows XP
- min. 2 GB main memory with Windows Vista and Windows 7
- min. 400 MB free memory

10.4.3.2 Installation

Place the installation disk in the drive. If the installation does not start automatically, call the installation program **"setup.exe"**. Follow the instructions provided by the program interface.



Once the language has been selected, you can select which of the program components you wish to install:



For the database, you are provided with a password which must be entered here. The Inrush Measurement is enabled before the system delivered. Alternatively, it is enabled by a password in the software's Options dialog.

Next, you are prompted to specify the **folder** in which to install the program. The default target folder is **c:\imc\imc POLARES**.

The last prompt is for the **program group** under which you wish to be able to call the program from the Windows Start menu. Here you can choose freely.

Click ***<Next>*** on the last page to **start** the installation process.

Note

To use this application, you must have editing rights (unless you are an administrator).

10.4.4 Connect the device

Once the setup has been performed successfully, a shortcut to "*imc POLARES*" appears in the program group selected.

By now it is necessary to connect the interface cable and switch on the device. This is also true if you are running multiple devices from one PC. The device performs a **self-checkup** (of voltages, memory, etc.) when the unit is switched on.

In the section Connecting via LAN in four steps 33, you will learn the quickest way to connect the PC with the measurement device.

Note

Other options for making the connection are presented in the section "Special options for connecting the device" in the system manual for *imc POLARES*.

10.4.4.1 Connecting via LAN in four steps

The most common case is described below: the PC and the device are connected via cable or hub. The device's IP-address must be set in the PC's address space. Next, the device is connected with the PC. once it has been entered, the hardware configuration is known and measurement setups can be prepared without the device being connected.

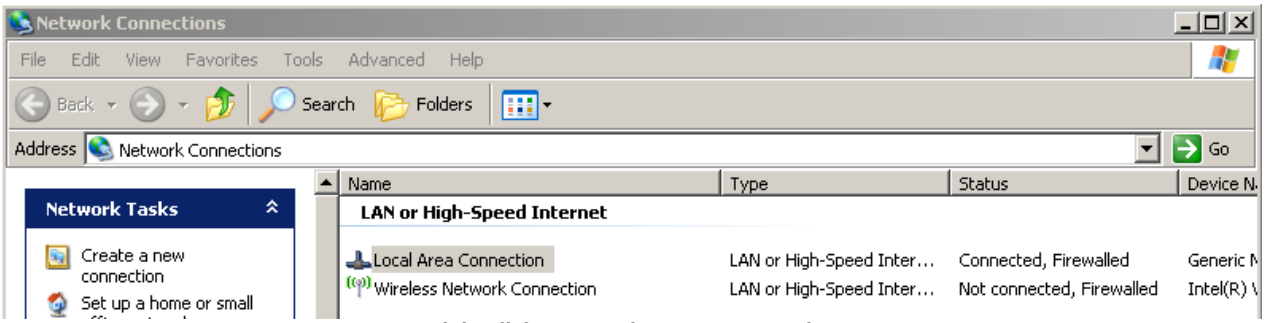
10.4.4.1.1 Step 1: Determining the PC's IP-address

Before starting configuration of your measurement device, you should find your PC's IP-address. To do this, open the Properties page under My Network Places by right-clicking the mouse over the desktop icon seen here:

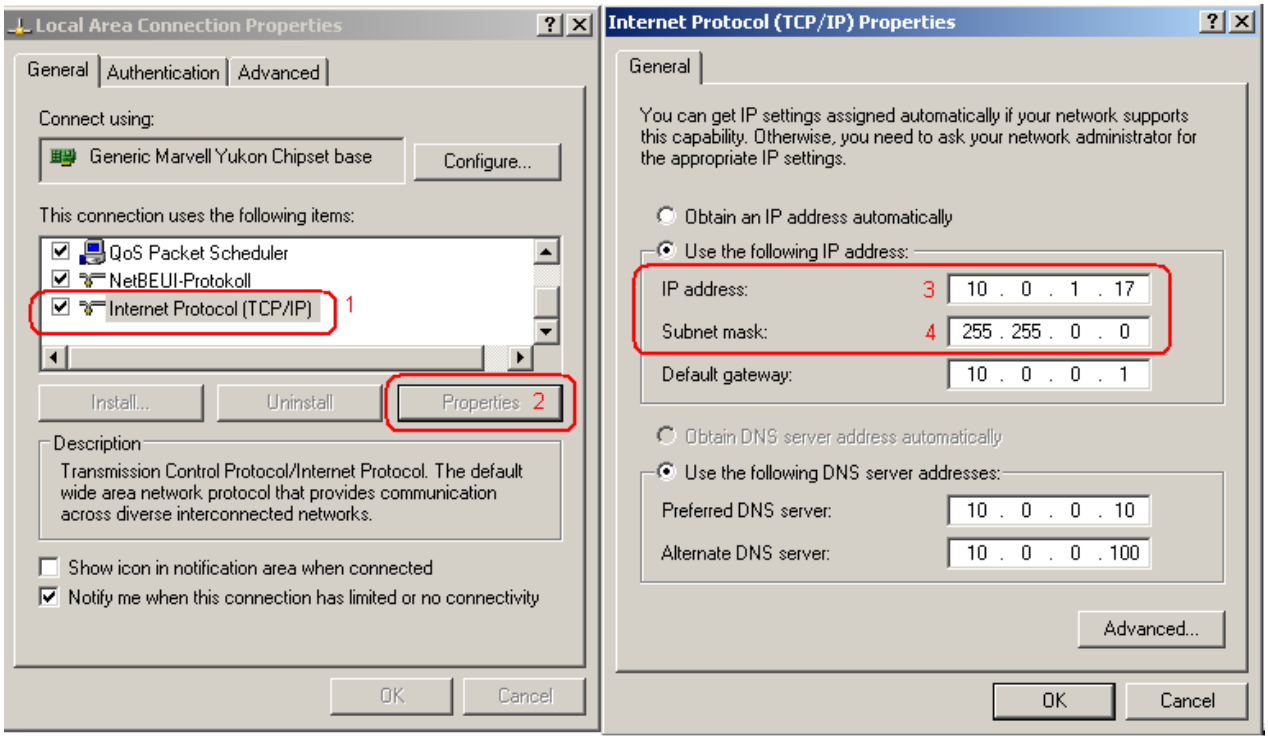
- Next, select the item Properties in the context menu. If the icon does not appear on your desktop, you can find it alternatively in the Windows Start menu or in the Control Panel.
- Then **right-click the mouse** over the entry for your LAN connection and then select the item *Properties* in the context menu once again.
- Highlight the TCP/IP Internet protocol in the list of components and then click on the button "Properties".
- Make note of the IP-address and your computer's subnet mask.

Note

The devices come with a default IP address and DHCP active. To avoid network conflicts, a unique IP address within the user network must be assigned. To do this, use the supplemental program IF-Config, which is described in the system manual.

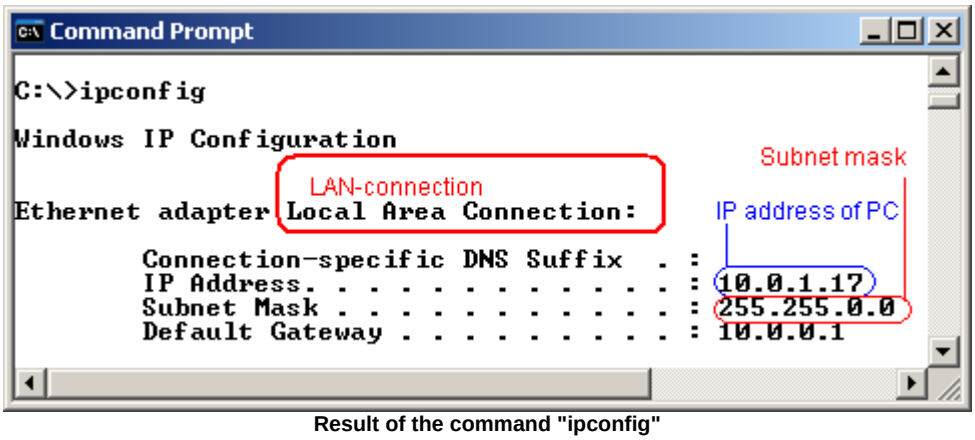


Right click to LAN, than open properties



Settings in Windows for TCP/IP

If no IP-address is entered in the Properties page for the TCP/IP-connection ("Obtain IP-address automatically"), you can determine the current IP-address using the Command Prompt. Note, however, that automatically obtained IP-addresses are only valid until the next time the operating system is started! Start the Command Prompt via the Windows Start menu by selecting *Programs : Accessories: Command Prompt* and then enter *Ipconfig or ipconfig /*all for more detailed information:



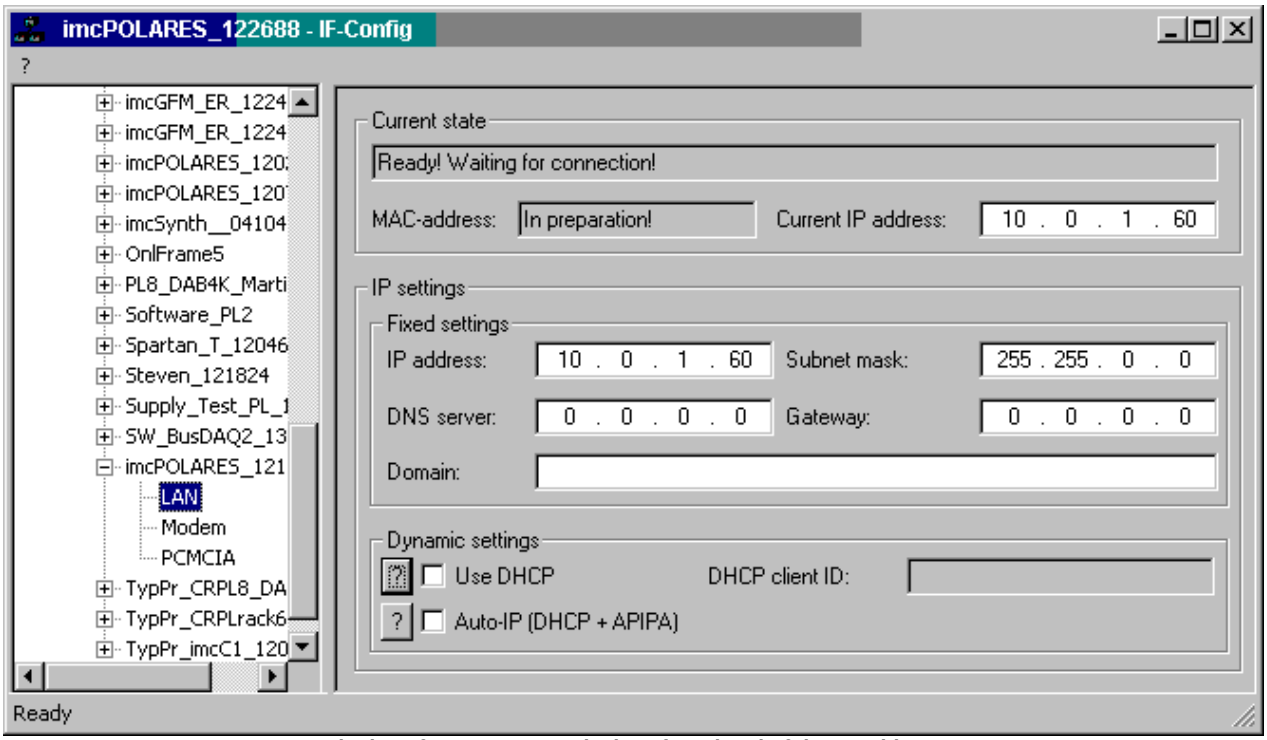
Result of the command "ipconfig"

10.4.4.1.2 Step 2: Connecting the measurement device

When you connect the *imc POLARES* device directly to your PC, you must used a "crossed" network cable (included in package, black color). If the measurement device is connected to the network via a network hub or switch, or a patch box, use an uncrossed network cable (red color, included). Present-day are able to switch electronically, so that it doesn't matter whether the cable is crossed or uncrossed.

10.4.4.1.3 Step 3: IP-configuration via IF-Config

Start IF-Config: *Start\Programs\imc POLARES\imc Devices IF-Config*. Click on the ⊞ symbol next to your PC's name in order to start an automatic device search. Then all available devices appear in the tree diagram under your PC. Double-click over the device and select the item *LAN*.



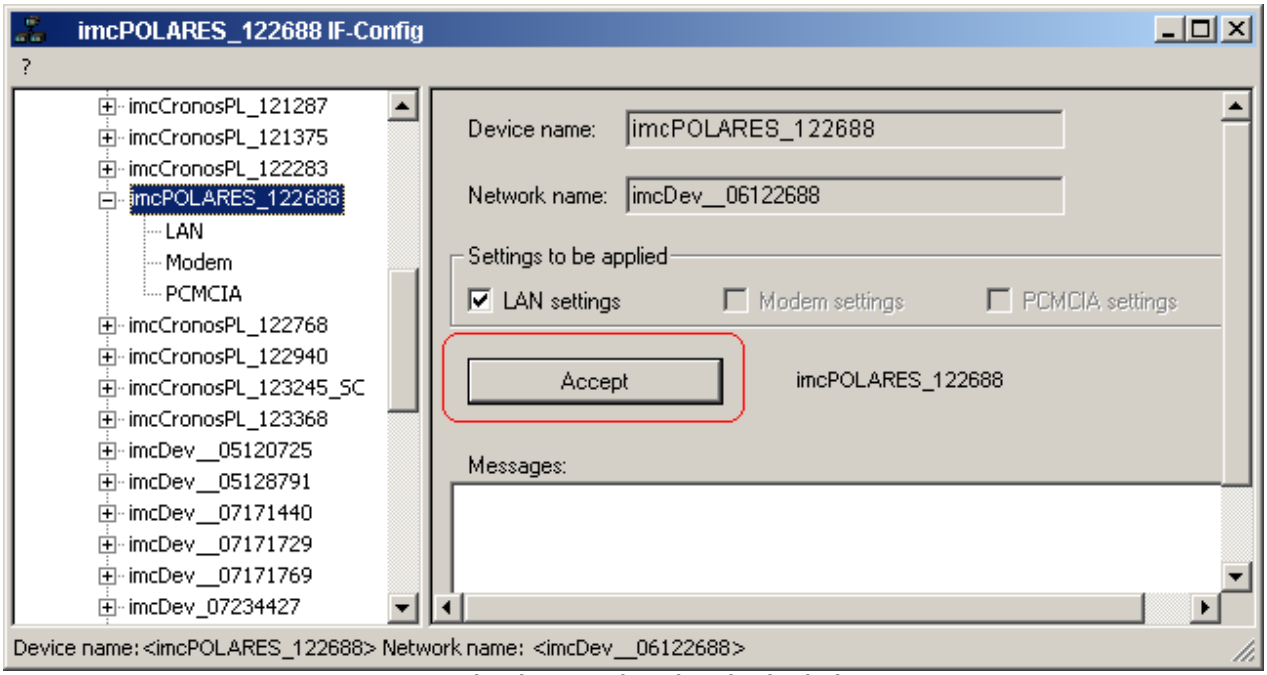
Display of measurement devices found and of the IP-address

If the option *Use DHCP* is checked, the IP-address is obtained automatically from the DHCP-server and there is no possibility of changing the settings. If there is a direct connection between the device and the PC with a crossed cable, you should deactivate the DHCP. Since no DHCP-server is supplying the necessary settings, the set values are used. These could lead to errors in the connection (different networks, same IP-addresses, etc.)

If you don't wish to use DHCP, you must set the IP-address manually. Make sure that the device's IP-address matches your PC's, in other words that in the network mask only the portion representing the device is different (see example). Analogously, you can also make modem.

Example for IP settings	PC	Device
IP-address	10. 0. 0. 34	10. 0. 0. 45
Network mask	255.255.255. 0	255.255.255. 0

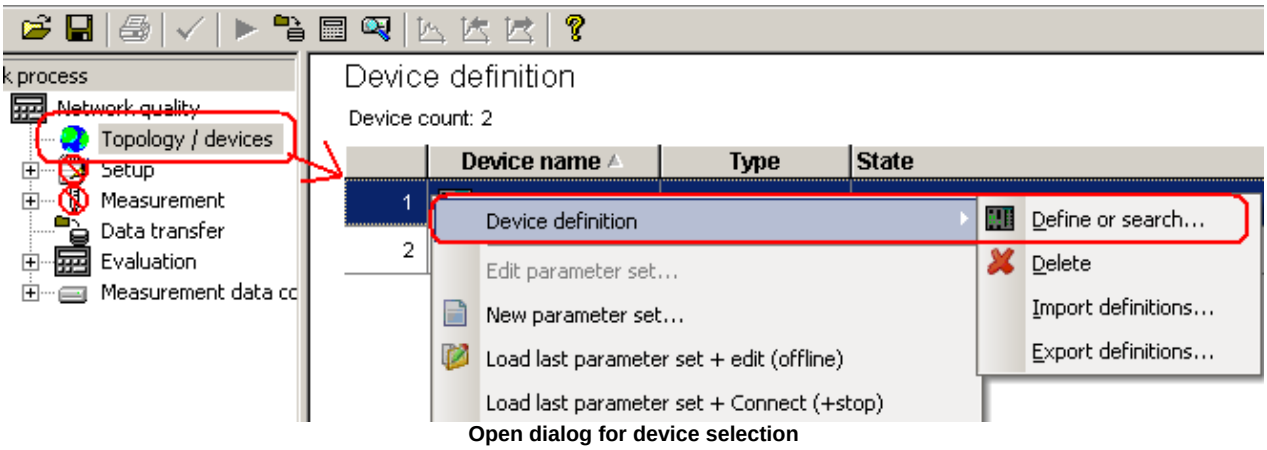
In order to apply the changes made, click in the tree diagram on the device name and then on the button *Accept*. Wait for the device to restart and then close the program IF-Config.



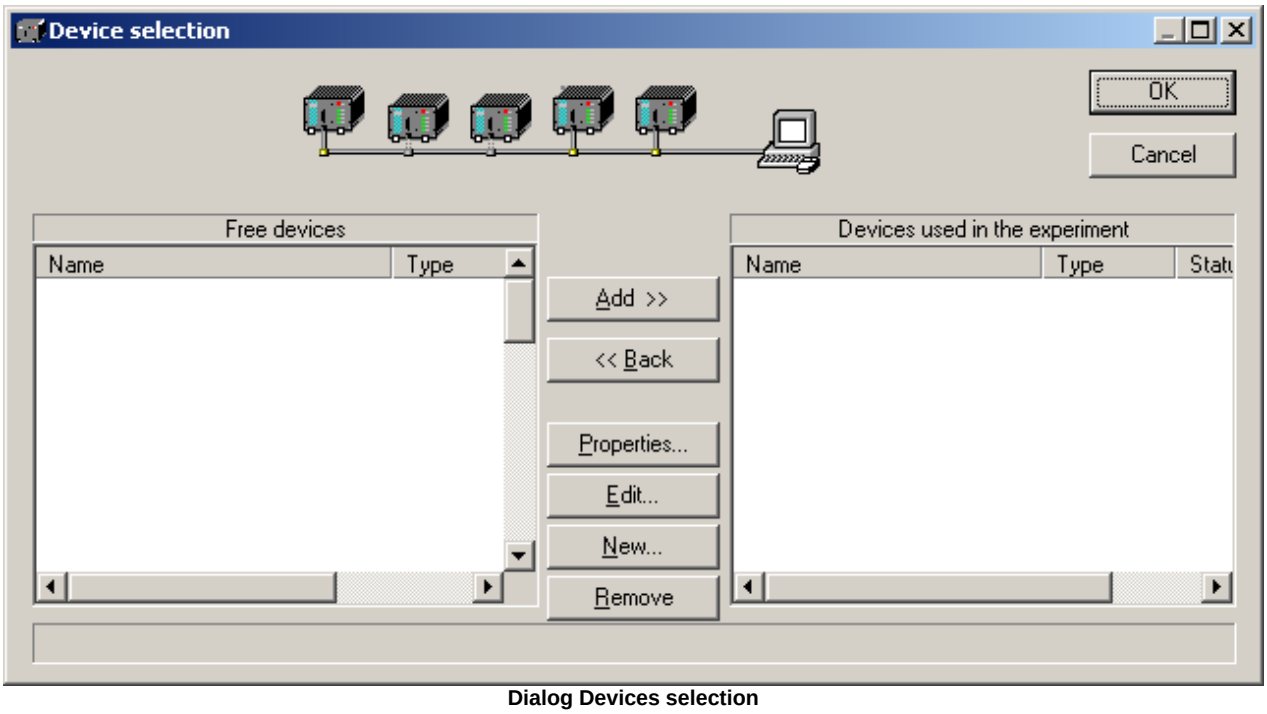
Accepting the network settings for the device

10.4.4.1.4 Step 4: Integrating a device into a project

Start the program *POLARES operating software*. If the device selection dialog does not appear automatically, right-click the mouse over the device definition area, as shown.

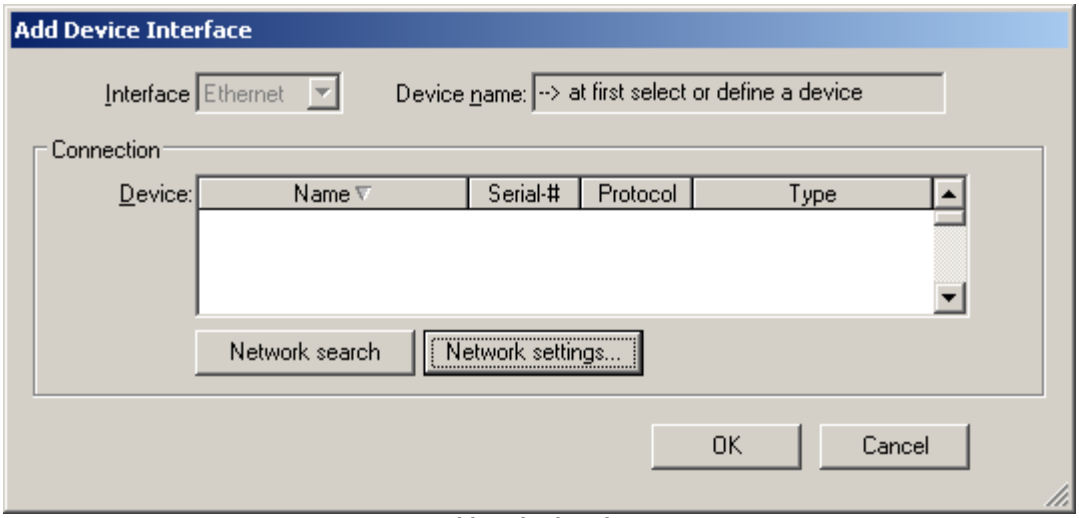


Open dialog for device selection



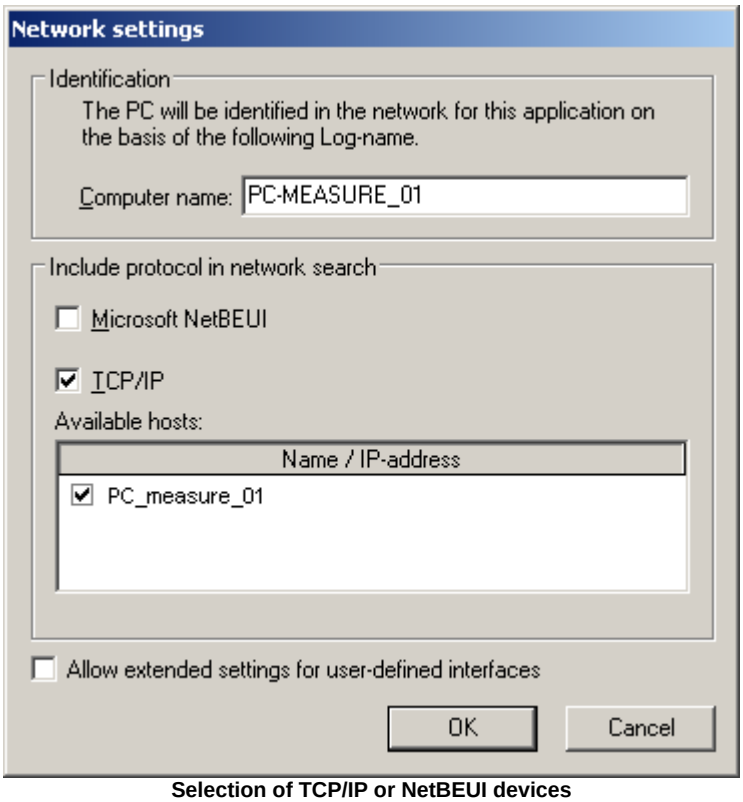
Dialog Devices selection

Click on *New.* The Add Device Interface dialog appears.



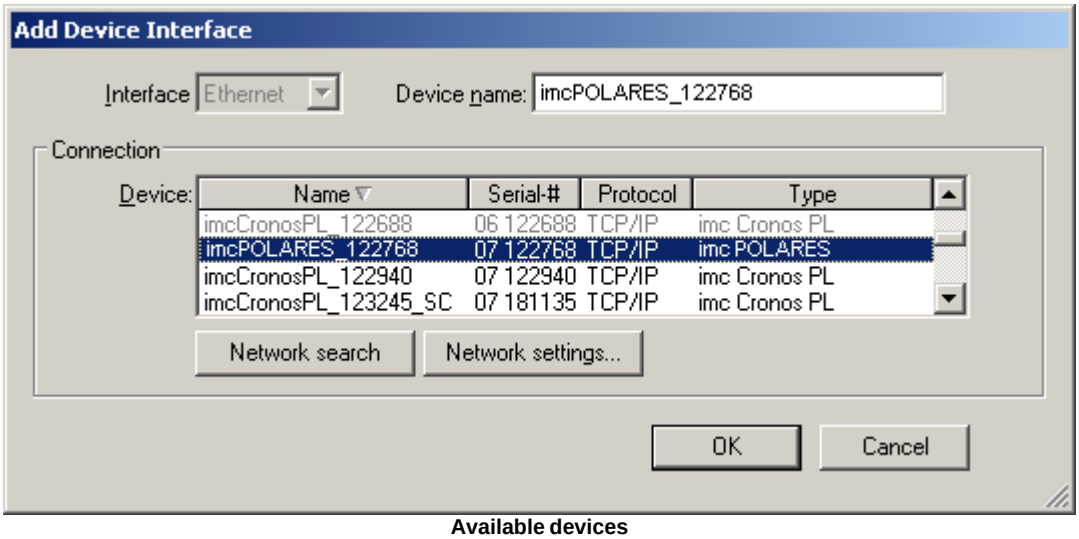
Add Device interface

If you have not yet added any device on this computer, then performing the network search automatically calls a dialog which can also be opened by the "Network settings" button.



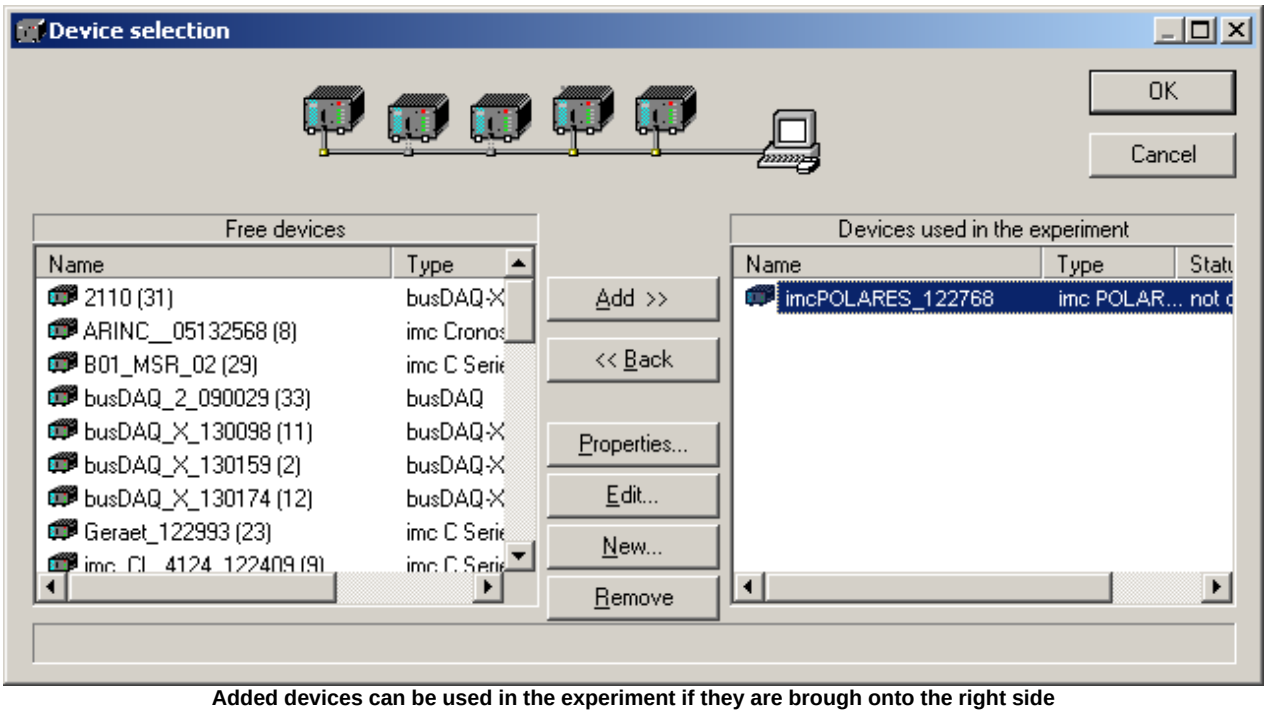
Selection of TCP/IP or NetBEUI devices

Activate the protocol which uses the measurement device and confirm your choice with OK. In the Add Device Interface dialog, a search is then performed for all devices in the PC's address space once you push the "Network search" button. Subsequently, the measurement devices appear in the list:



Available devices

Select your measurement device and confirm your selection with OK. The measurement device is then available for your measurements. In the Device selection window, the available devices not yet involved in any measurement task are listed on the left side. In order to use them for an measurement task, click on the button *Add*. In order to check a device's properties, highlight its entry and then click on the button *Properties*.



Added devices can be used in the experiment if they are brough onto the right side

Exit the device selection window with OK. Now, the device is known to the PC. You can now proceed to load a measurement configuration or to restart.

10.4.5 Firmware Update

Each software version includes the most current *imc POLARES* firmware. This makes it easy to update the system with new functions, for example. Depending on the particular device model, the following components are automatically loaded: Interface-Firmware (Ethernet, Modem, ...), Boot-program, amplifier firmware, firmware for the DSPs.

The firmware-update is only necessary if the *POLARES operating software* software was delivered as an update. If you received your *imc POLARES* device together with the software, no firmware-update is required.

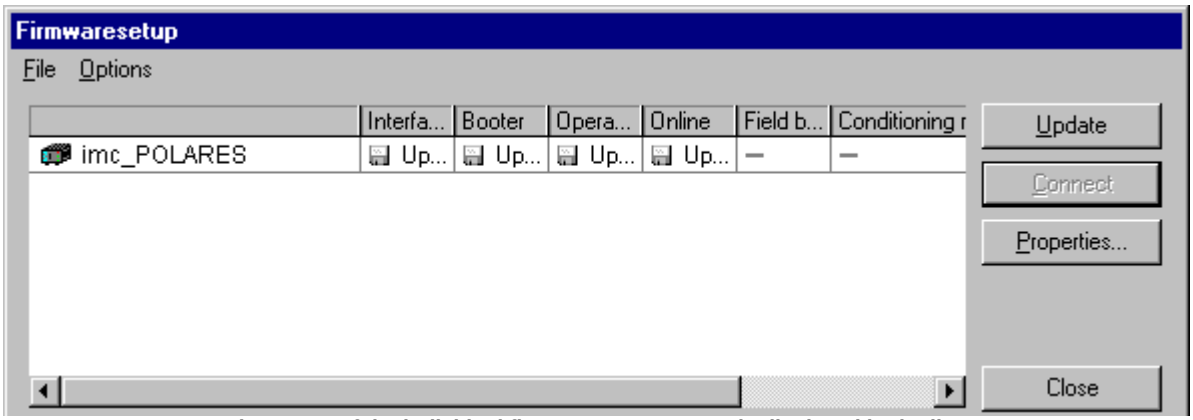
Once the program connects up with *imc POLARES*, the device's firmware is checked. If the software version doesn't match the device's firmware version, you are asked if you want to perform a firmware-update.

Note

As a matter of principle, we recommend updating to a higher version.

Downgrading to an older version can lead impairment of the device's functioning and to increased occurrence of errors.

The dialog for the firmware-update looks like this:



The status of the individual firmware components is displayed in the list.

Interface	Interface-Firmware (Ethernet)
Booter	Start-up program for the device upon switching-on
Operating system	Device operating system
Online	Online-functions and hard drive controller
Field bus	Field bus (optional, if your device is equipped with CAN or J1587)
Signal conditioners	Amplifiers

If no status indicators are displayed, no connection could be made to the corresponding device.

The following symbols for the individual firmware components appear in the list:

- not current
- ✓ firmware conforms to current standards
- error occurred during update procedure
- – this option is not available on the device

Select the device to be updated and then the softkey Update.

During the update, which can last up to several minutes, a progress indicator appears.

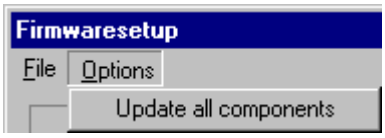
Do not switch off the device during the firmware-setup!

If an error message is posted during the firmware setup, leave the device on and contact the *imc*-Hotline. It may possible to continue the firmware-setup under the guidance of the Hotline using the following service program.

A message box will appear to notify you if and when the firmware-setup has been completed successfully.

The *File* menu offers a function for working with the log-book.

Each action during the firmware setup and errors (if occurring) are registered in a log book. This log book can be displayed with menu command *File* ⇒ *Show log book...*



The Options menu offers the option to Update all components. This makes it possible to earmark all the components of the selected device for an update. The function is only to be used in compliance with instructions from the *imc POLARES*-Hotline.

10.4.6 Continuing the configuration

Once the interface has been configured successfully, the program attempts to set up a connection with the device and to determine the device's hardware configuration. This process can last a few minutes.

Note

If the PC is unable to connect with the device, switch the device off for about 10 seconds. Then it should work without further problems.

10.4.7 Parameterization

Note

How to set the parameters is described in the *imc POLARES* system manual

10.4.7.1 Signal processing

A Digital Signal Processor (DSP) calculates most network quality attributes already while the measurement is in progress.

The results returned are not only simple aggregation values but also data-reduced ***curve plots*** and short ***segment*** of the waveform (instantaneous value). These data values are very small compared to the input data and contain the most important information for evaluating the network quality.

The **calculation procedures** used are FFT, digital filters and class counting systems.

The following table shows which supply voltage properties and other physical quantities can be measured using *imc POLARES*:

Supply network properties measured

Feature	Description
Slow fluctuations of RMS-values	Aggregation, maximum, minimum
Rapid fluctuation of RMS-values	Flicker as per IEC 61000-4-15, level fluctuations in terms of time and amplitude (voltage dips, -outages, surges)
Harmonics, interharmonics, THD, signal voltages	Mean values for all harmonics up to the 50th harmonic Mean values for definable frequencies of 10 Hz - 3 kHz
Asymmetry	Aggregation of positive-, negative- and zero-sequence systems
Form of oscillations, transients	Recording of instantaneous values at 10kHz upon release of trigger
Frequency	Aggregation
Signal voltage in the network	Aggregation, fluctuations, amplitude of the modulated signal
Power	Active power, apparent power, reactive power, power factor for all harmonics

11 Connections and Conditioning

11.1 Overview

Available inputs

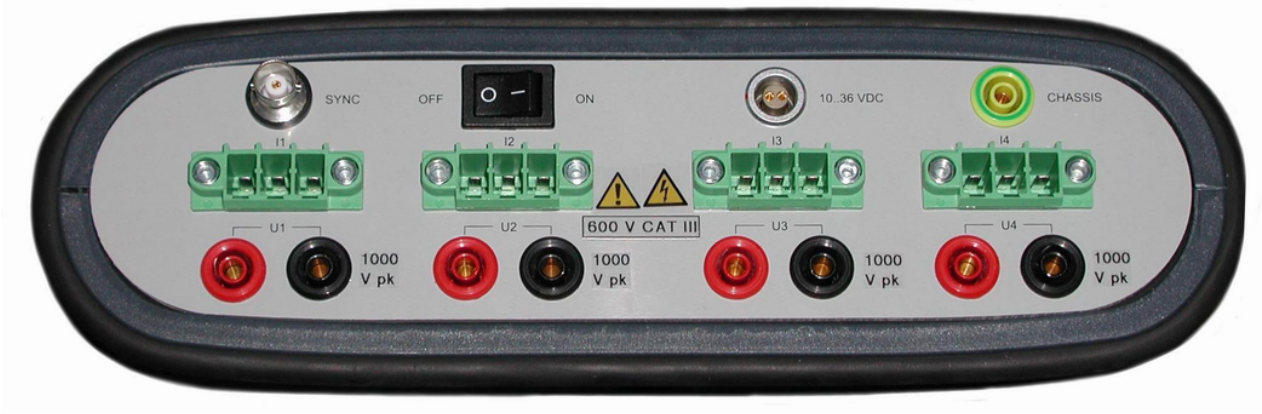
- High voltage
- Current

For the input ranges and other connection issues of *imc POLARES*, please see the chapter Technical Specifications and Pin Configuration 84.

11.1.1 Sampling rate

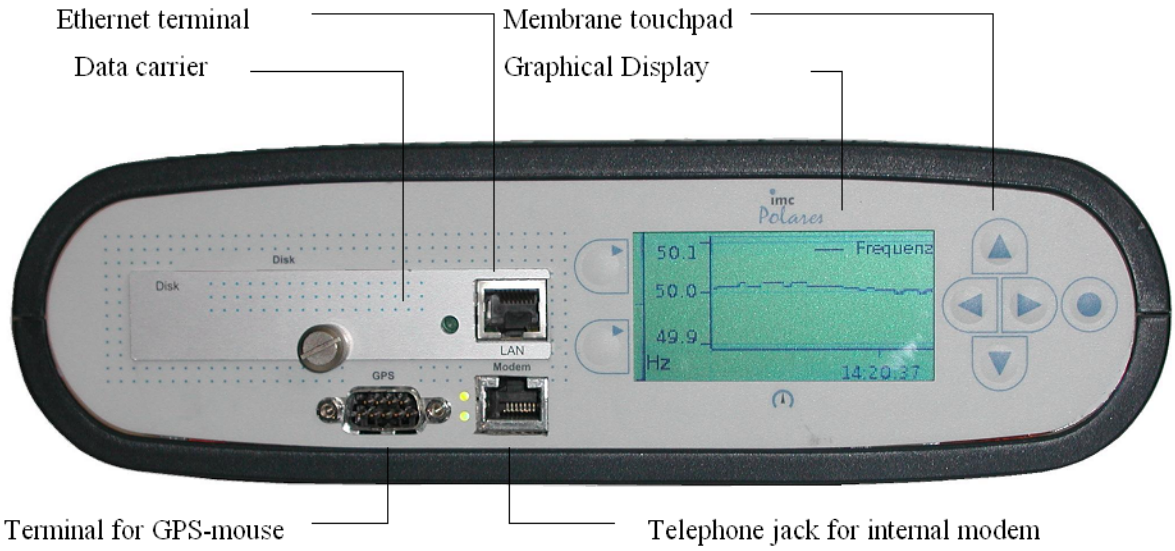
The input sampling rate is currently 10 kHz per channel. The process of resampling uses interpolation to generate a total number of samples for a data set which is a power of two and which is also a multiple of the fundamental network frequency. This enables quick and convenient processing using Fast Fourier Transformation, which exactly covers the fundamental frequency's spectral lines and provides sufficient resolution.

11.2 Interconnections imcPOLARES



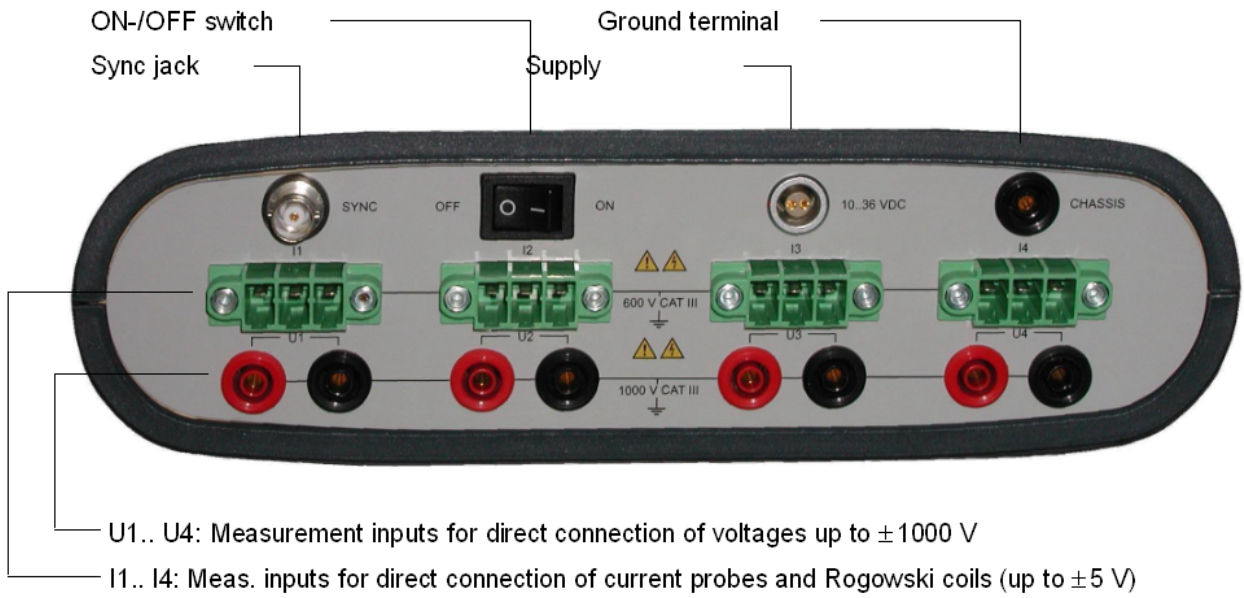
imc POLARES: connection panel for the signals

11.2.1 Front panel



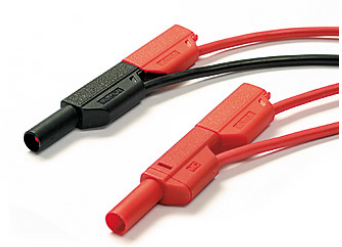
Designation	Terminal	Explanation
GPS	DSUB-9	Synchronization with satellite time (especially with decentralized measurements)
Modem	RJ45	Sending faxes, SMS or email on events
LAN	RJ45	Interface to the PC for configuration and data evaluation
Disk	PCMCIA CF-Card	Saving of experiments and measured data
Display/ membrane touch panel		Communication especially in standalone operation (without PC)

11.2.2 Rear panel



Designation	Terminal	Explanation
SYNC	BNC	Synchronization of multiple imc POLARES units using the Master device's system time. If the synchronized devices are at different voltage levels, an additional line of sufficient cross-section should be used for compensation purposes. Alternatively, it is possible to electrically isolate the connection via the ***ISOSYNC*** module.
OFF / ON		Activation/ deactivation of device. Neither action takes place ad hoc (measurements are configured, or ended with files closed)
10 V to 32 V_{DC}	LEMO FGG.1B.307. CLAD76	Supply of the device from DC-sources at ground voltage (negative pole)
CHASSIS	4 mm safety banana jack	Additional connection capability for ground potential with isolated supply sources
I1 .. I2	Phoenix-plug PC 4/3-G	Connection for current probes with signal levels up to ±5 V
U1 .. U4	4 mm safety banana jack	Connection for voltage measurement signals up to ±1000 V

11.2.3 Voltage



There are two safety banana jacks on the device backplane for connecting each of the conductor voltages to be measured, L1, L2, L3, and N. Each conductor's pair of one red and one black terminal is positioned side-by-side.

The maximum permitted **voltage over ground** depends on the measurement location. Please refer to Chapter T 84 to find the measurement category.

Only use plugs which are protected from contact from all sides!

Each input is specialized for a particular conductor voltage and is therefore not interchangeable. The exception is the input U4 which can be used for the measurement if any additional voltage unless it is required for monitoring the neutral conductor voltage (to ground). All inputs are isolated from each other.The voltage channels are each constructed with their own **isolated amplifier**. The allow direct measurement of voltages up to **± 1000 V** (as the measurement category increases, this value declines à see technical specs).The measurement signals are connected at **safety banana** jacks directly on the device.

The **analog bandwidth** provides the accurate measurement up to the 50th harmonic.

The inputs are DC-coupled and always have an input impedance in the MΩ-range. The differential behavior is achieved by means of the isolated construction.

Note

If possible, use symmetric connector cables which conduct the measurement and reference potentials separately for each conductor. Connect the leads for the reference potential, if required, only to the measurement object.

11.2.4 Currents

In *imc POLARES*, current measurement is performed contact-free using current transformers. For connection of the current transformers the housing's back panel has four mini DIN sockets. These are for connecting only current probes equipped with special plugs by **imc**. Make the connections according to the figure below.

imcPOLARES clamp current probe MN71

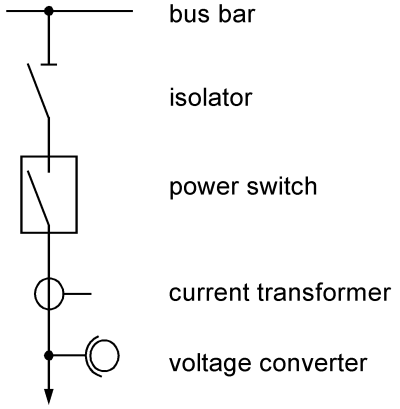
imcPOLARES transformer AmpFLEX A100

The current clamp probes provided by imc are adjusted in terms of their magnitude and phase response and cover input ranges from small currents all the way to mid-sized and high currents (see Chapter T 84). However, it's also possible to adapt other current probes to the measurement device. For current probes with **multiple input ranges**, the range must be set both by hand on the probe itself and in the measurement device's operating interface (see the chapter on setups). Please use the automatic connection recognition, because only in this way will all necessary correction values and computation methods be recognized.

Note

- If the current input range set in the measurement device's operating interface doesn't match the setting for the current probe, the current signal will be scaled incorrectly. However, this does **not** present any danger to the system's circuitry.
- Either use only current probes provided by **imc** or have your own current probes adapted by our Customer Service. Only then can correct functioning be ensured. Otherwise, any disturbances or damage sustained by the device will not be covered by the guarantee.

11.2.5 Using additional transducers



Up until they are digitized within the *imc POLARES* unit, the measured data is transmitted along a completely analog signal path. This path comprises not only the known and compensable elements including the current **clamp probes provided by imc**, but also all additional elements for adapting and transmitting the measured values.

The diagram shows an example of accessible measurement points within a switchgear – current transformer and voltage transformer. The properties of these transformers affect the uncertainty of the measurement results.

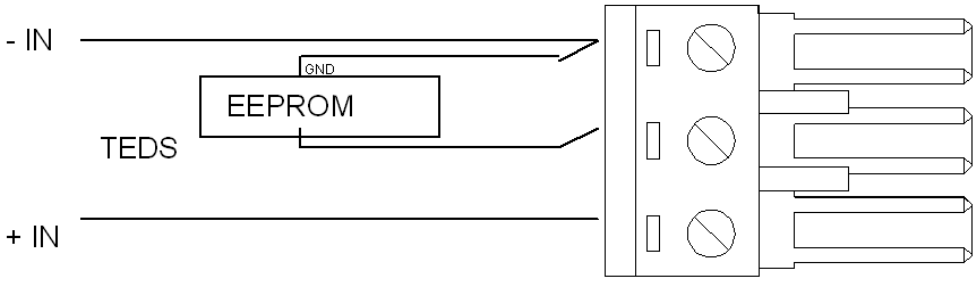
The rated measurement uncertainties of such transformers often only pertain to the technical frequencies, so that estimating the error with regard to upper harmonics is difficult.

Note

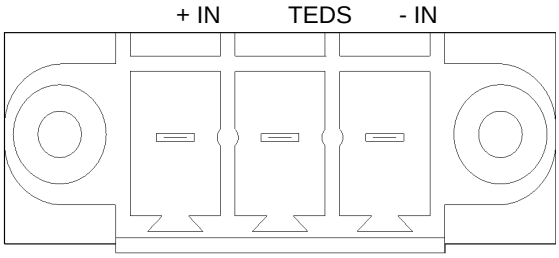
- The transducers' amplitude and phase errors influence the measurement results, especially with power measurements.

11.2.6 Pin configuration and cable wiring

Cable connection terminal (without housing) – Current probe channels



Typ PC 4/3-ST(F)-7.62)

Connection terminal (type DFK-PC 4)	Signal	Definition
	+IN	Signal-input
	-IN	Signal-input/ Reference potential L or (PE)N
	TEDS	**T**ransducer **E**lectronic **D**ata **S**heet Enables recognition of the current probe connected (optional)

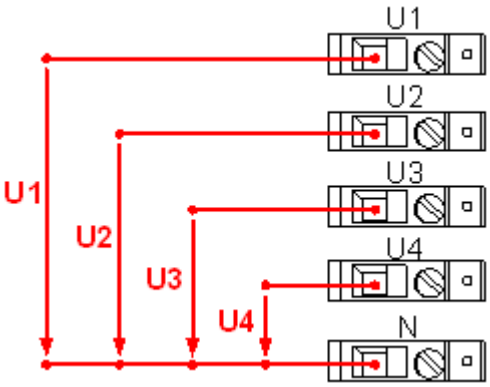
11.2.7 Notes on setting up a measurement

Protect measurement leads from unprotected leads, sharp edges, electromagnetic fields and other adverse conditions.

- **Voltage measurement leads:** The connection of the measurement lead to the measured object must be adapted to the maximum voltage applied. Check the wiring of the leads before measurement, in order to avoid accidental short circuiting. Special caution is necessary when using movable terminals. Check whether the mechanical connection is secure and what would happen if it accidentally gets loose. To increase safety, protect the leads at the measurement point. The fuse's breaking capacity must correspond to the expected fault current at the measurement point.
- **Current measurement leads:** The current probe must be connected in a mechanically secure manner. It should be positioned as orthogonally to the current conductor rail/lead as possible. This applies especially to current measurement instruments based on the Rogowski coil. The current probe terminals can be screwed onto the measurement device.
- **Measurement device:** *imc POLARES* must be positioned in such a way that it can't be accidentally disconnected.

11.3 Interconnections miniPOLARES

11.3.1 Voltage measurement inputs



Connection scheme for voltage measurement

imc POLARES has four inputs for voltage measurements.

The 4 channels are designated *U1* through *U*. For *U1* through *U4* there is a common ground reference *N*. Each channel's terminals are designed for connection of only one cable. This also applies to the *N* terminal!

For the appropriate cable cross-sections, please see the technical specs in the technical data 87.

There are different ways to connect the signals for measuring a three-phase system

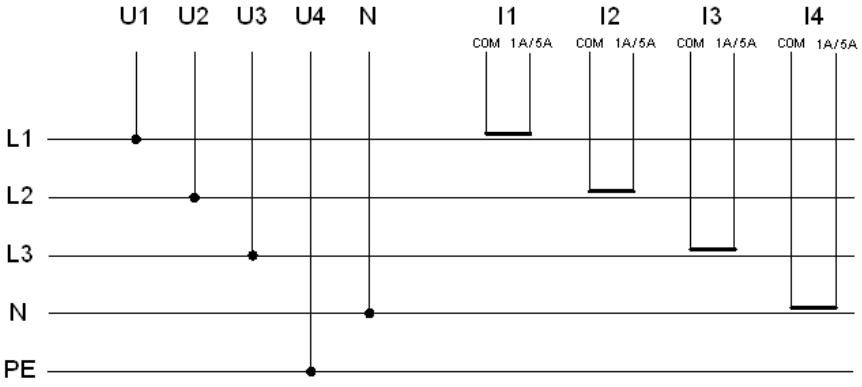
With the model *miniPOLARES -U8,* instead of the current inputs there are four more voltage inputs *U5* through *U8*. The second voltage group can be configured according to the connection types shown below, independently of the first voltage group.

Note

When hooking up the lines for the model *miniPOLARES -U8*, be aware that no measurement between the two voltage groups is possible.

11.3.1.1 Four-wire configuration (star circuit)

U1, U2, U3 lines 1,2,3, U4 – PE (protection ground) line
COM neutral
I1,I2,I3,I4 connected or unconnected (U4, I4 can be measured optionally

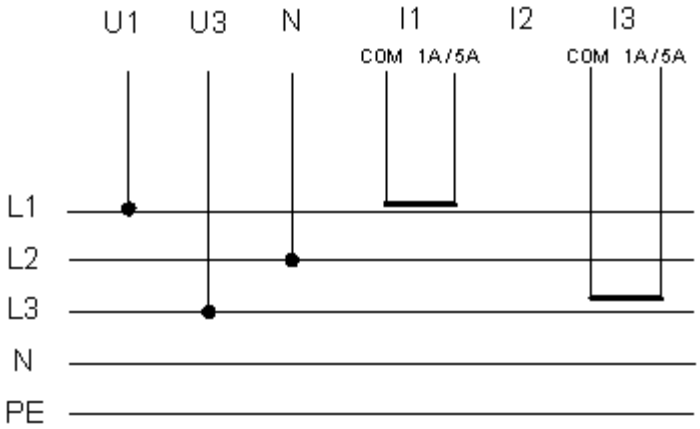


Four-Wire configuration

11.3.1.2 Three-wire configuration (delta connection)

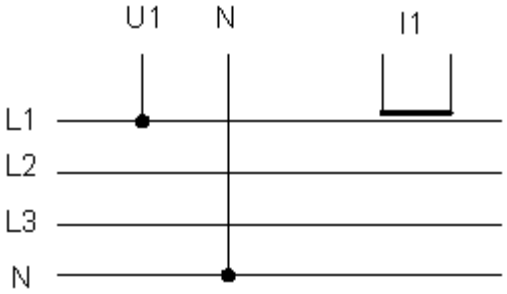
U1, U3 lines 1,3,
COM line 2
I1, I3 lines 1 and 3

I2 line 2 optionally possible



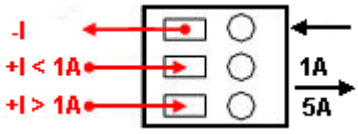
Three-wire configuration (delta connection)

11.3.1.3 Single-phase connection



Single-phase connection

11.3.2 Current measurement inputs



Current measurement connection scheme

imc POLARES has four current measurement inputs I1..I4.

In order to perform current measurements with the correct sign, the current conductors must be connected such that the current flows into either the 1A or 5A input ( ), depending on the maximum current magnitude, and flows out at the common output ( ).

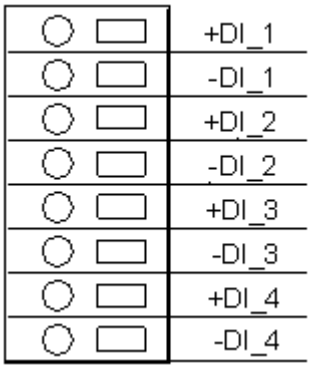
The technical data of the *current inputs of imc POLARES* 88.

Note

- Never use the connection for 1 A and 5 A at the same time!
- The connection terminals are designed for connection of only one cable.

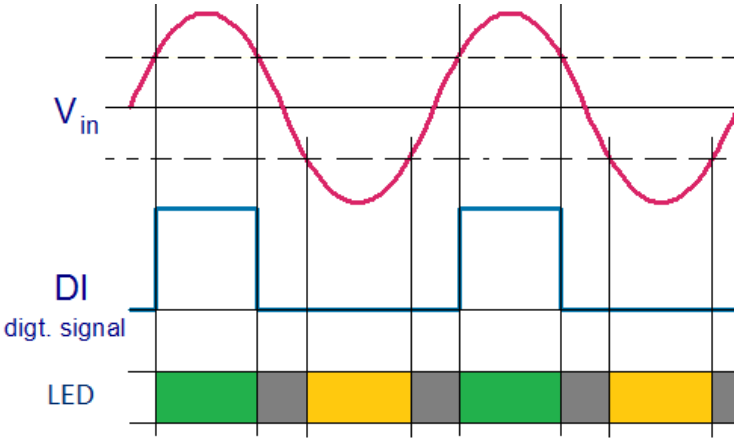
11.3.3 Digital inputs

imc POLARES has four digital inputs which are electrically isolated from the measurement system.



These mainly serve to process $230V_{eff}$ voltages, but it is also possible to monitor lower DC or AC voltages. The terminals are designed for connecting a cable.

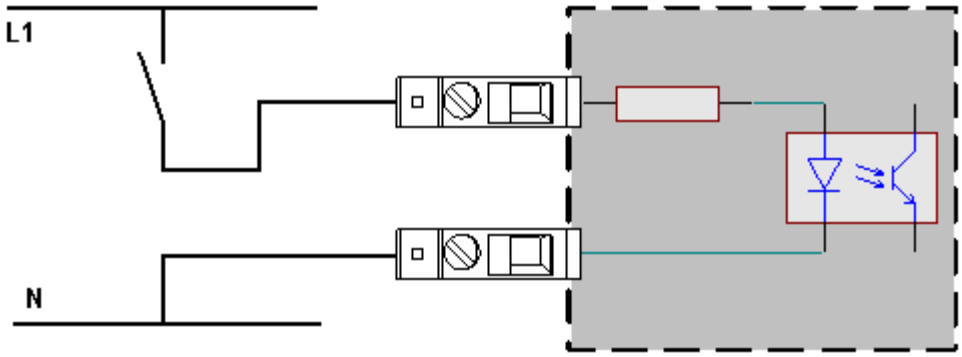
For appropriate cable cross-sections, please see the technical specs 89 for the digital inputs.



Level detection and LED

If the signal is above the switching threshold (typ. 16 V), the state of the input bit = 1 is displayed and the LED shines green.

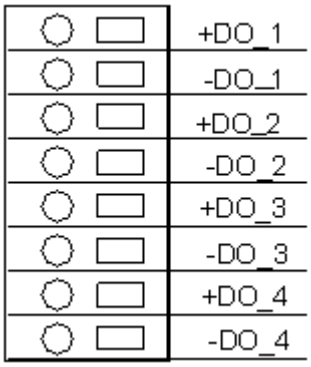
Below the switching threshold (typ. 16 V), the state is = 0 and the LED is off. Below –16 V the LED shines yellow.



Digital input connection scheme for a 230V voltage

11.3.4 Digital outputs

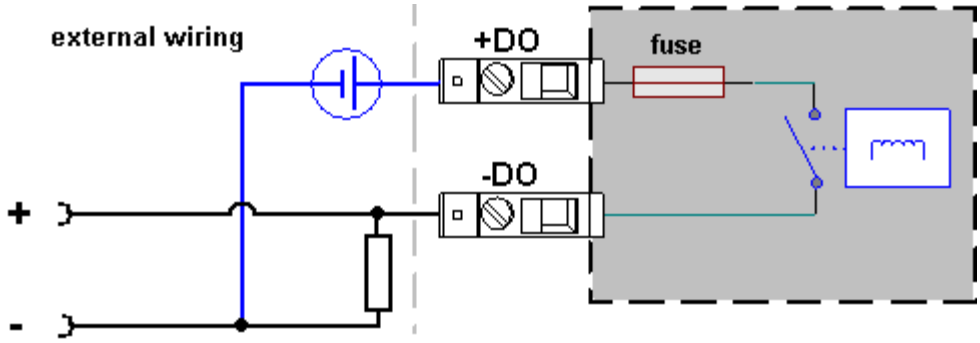
imc POLARES comes with four digital outputs, build as relays contacts.



The contacts are insulated from the measurement system.

If a digital output is set, the relay contact closes and the LED shines.

For the appropriate cable cross-sections, please see the technical specs for the digital outputs technical data. 90

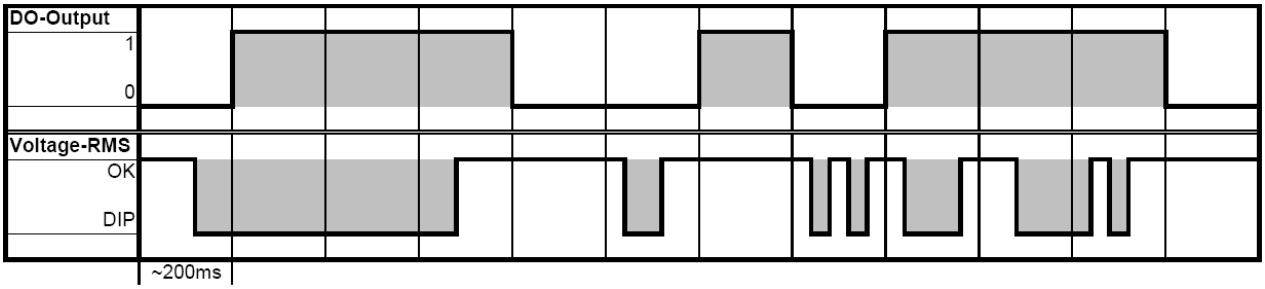


Example for a digital output with switched voltage and pull-down resistor

The measurement device offers no internal reference voltage. That has to be connected externally.

Note

- The standard 61000-4-30 requires processing over a span of 10 (for 50 Hz) or 12 periods (for 60 Hz). By this means, voltage events at this distance (200 ms) are also tested and signaled by the DO (digital output).
- If a brief voltage dip begins and ends within this processing period, the DO does transmit this, but after a delay. If the voltage dip begins in one cycle and ends in the next, the event is indicated by the DO. The signal output lasts at least 200 ms.
- In the worst case, the output by the DO is delayed by ca. 300ms. This delay depends on: the network frequency, the measurement channel and the demands on the measurement device.



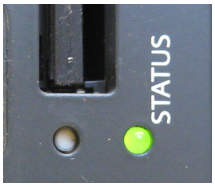
11.3.5 Miscellaneous terminals and controls

11.3.5.1 Double row of LEDs

imc POLARES has a two rows of 3 LEDs apiece. The flashing of these LEDs indicates which state is in effect. LEDs 3 and 4 are not affected at this time.

LED flashes	State
1	Measurement active
2	Trigger / event being recorded
3	no signal for synchronization
4	Frequency can not be measured
5	Free HD memory < 10MB (default value) or according to valid setting
6	System error

11.3.5.2 Status LED



The *STATUS* LED indicates the device's current operating status. Right after the device is activated, it flashes red a few times, then proceeds to flash green (during which the memory card is checked for any available measurement task to start) and finally goes off, which is indicative of normal operation..

11.3.5.3 LAN terminal

At the *LAN* terminal, *imc POLARES* is connected with the Ethernet and the PC. For connection via a local network, an uncrossed Ethernet cable must be used, and for direct connection of the measurement device to the PC, a crossed Ethernet cable is required.

11.3.5.4 GPS terminal

At the nine-pin GPS socket it is possible to connect a **GPS-receiver** of the type e.g. **Garmin GPS18LVC-5Hz**, **Meinberg GPS161AHSx** (item number: 25150)or **HOPF6875** (from firmware 7.0, order number 7XV5664-0CA00). This enables absolute synchronization to GPS time. If the GPS-receiver has reception, the measurement system synchronizes itself automatically. Find more information about setup and configurations in section Synchronisation 57.

NMEA sources are also supported. Therefore the clock must provide a 1s clock and the GPRMC string. For the RS232-interface parameter see here 98.

Pin configuration of the DSUB9 connector. 99

Note

- The max. cable length to the clock modules (HOPF or Meinberg) is 50 cm.
- The max. cable length to the Garmin GPS receiver is 9 m.

11.3.5.5 SYNC terminal

For synchronization of the *imc POLARES* units by DCF77 or IRIG-B, the device has a **BNC** socket labeled *SYNC*. Find more information about setup and configurations in section Synchronisation 57.

Note

Note that devices whose production date is earlier than June, 2010 were equipped with an SMB socket.

11.3.5.6 RS232 Connection for external modem

By means of this DSUB-9 terminal, an external modem (RS232) can be connected. For modem operation, the *imc POLARES* can be configured as a PPP-server, see also *System manual* of the software *POLARES operating software*.

Pin configuration of the modem terminal 99

11.3.5.7 Slot for CF-card

imc POLARES uses COMPACT FLASH (CF) cards exclusively as removable storage media. For legacy reasons, the CF card is sometimes displayed as "Removable storage(PCMCIA)".

CF-cards with volumes of up to 16 GB can be used at this time. When exchanging the CF-card, the device must be previously notified by pressing the button directly below the CF-card slot. When the Status-LED flashes, this indicates the device is ready for exchanging the CF-card. Then the CF-card can be exchanged.

Please note the information to the internal disk. 62

11.4 Synchronization

The simplest synchronization method for *imc POLARES devices is to use* NTP 58 via the Ethernet connection. If the devices are connected via the network interface, then if there is an NTP-Server this line can be used for synchronization.

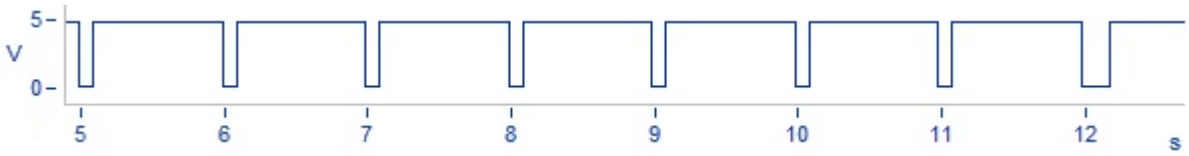
Further, on the terminal panel there is a **BNC** socket labeled *SYNC*. Depending on the configuration, an external synchronization signal (DCF77, GPS or IRIG-B) can be received or used to synchronize several devices with each other.

Technical specification of the synchronization. 97

11.4.1 Type of synchronization signal

11.4.1.1 DCF77

The DCF77 signal is applied via the **BNC** socket SYNC 56. *imc POLARES* processes a LOW active 5 V TTL signal e.g. 1 Hz pulse. As well, inverted signals are recognized and evaluated by the hardware.



DCF77 TTL signal with inverted logic (Low active)

Duration of synchronization: The complete time is encoded within one minute and begins at the start of the next minute.

For this reason the minimum duration for the synchronization process is at least one minute!

11.4.1.2 IRIG-B

This option is available for *miniPOLARES* only.

The IRIG-B signal is applied via the **BNC** socket SYNC 56. *imc POLARES* processes a 5 V TTL signal and supports IRIG-B002, B000, B001, B003.

For all models, the pulse rate is 100 pulses per second, DC Level Shift (DCLS), width coded, no carrier. The last digit indicates the correct information:

B00**0**	BCD, CF, SBS	BCD - Binary Coded Decimal, Code of the time (HH,MM,SS,DDD)
B00**1**	BCD, CF	SBS - Straight Binary Second of day, daily second (0....86400)
B00**2**	BCD	CF - Control Functions, depending on application
B00**3**	BCD, SBS	

Duration of synchronization: With a typical synchronization time of approx. 20s, the IRIG-B is the fastest model available.

11.4.1.3 GPS

The GPS receiver is connected at the 9-pin DSUB terminal "GPS 55". The supply is provided via *imc POLARES.* In this way, the GPS receiver finds its positions as soon as the device is activated.

Duration of synchronization process: The minimum duration for synchronization depends on the reception and on the last location of use. Upon first use, the receiver needs a few minutes until multiple satellites and its own position have been located. Upon the next start, the last position data are usd, and the satellites are found found more quickly.

With a direct line of sight to the sky, the receiver is typically synchronized within one minute.

11.4.1.4 NTP Network Time Protocol

This option is available for *miniPOLARES* only.

The Network Time Protocol (NTP) is a standard for synchronizing clocks in computer systems and uses the connectionless transport protocol UDP. It was specially developed to enable reliable timing via networks having variable package runtimes.

Precision: NTPv4 can keep a local system's time via the public Internet at a precision of 10 milliseconds; in local networks under ideal conditions, precision levels of 200 microseconds and even better are possible.

Duration of synchronization process: Synchronization on an NTP server is a lengthy process. At intervals of 64 seconds, *imc POLARES* exchanges a data package with the server. Initially, 4 x64s are needed to set the clock, after which the clock is synchronized at 64s intervals. It can take up to 3 h to reach precision in the range of 20ms. In order for the synchronization to begin upon activation, the measurement device must be set to use NTP by default.

imc POLARES supports up to two NTP servers. For **setting NTP**, the following parameters are needed:

- selection of the ***time zone***
- observance of the ***daylight saving's time*** transitions
- IP of the ***NTP server (1)***
- IP of the ***NTP server (2)***

Note

The synchronization between devices synchronized with NTP (see NTP time via LAN under Separate synchronization of all devices. 61) is within approx. 10ms in the best cases. However, it is not possible to determine it.

If the phasing between two voltages in different devices is to be compared, only the Master is to be synchronized to NTP. This synchronizes additional devices via DCF77, see NTP time via LAN in Master/Slave setup 60.

To reduce the time needed for synchronization, the standard synchronization signal should be defined with the device properties (see system manual section 4.1.2.2.2)

11.4.2 Master/Slave setup

In the setups described here, all devices are synchronized to each other via DCF77. The clock rate is provided by a master device synchronized to an external clock.

Note

- If the synchronized devices are at different voltage levels, they should be compensated by means of a lead having the appropriate cross-section. Alternatively, it is possible to isolate the different voltage levels from each other.
- If there is an outage of the Master, all devices continue to work according to their own internal clocks and drift apart in accordance with the precision stated in the technical data 97.
- If there is an outage of the external clock (GPS, IREG B or NTP), the Master continues according to its internal clock. However, the devices remain synchronized to each other.

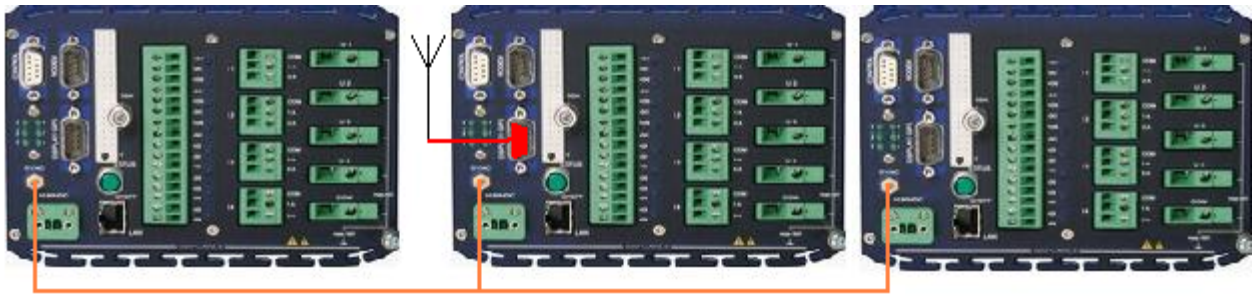
11.4.2.1 No external timer

No external timer: Devices are synchronized with each other, but not synchronized to absolute time by an external clock.

Example for synchronization with master and slave devices

11.4.2.2 GPS receiver as timer

GPS receiver as timer: Devices are synchronized with each other and synchronized to absolute GPS time.

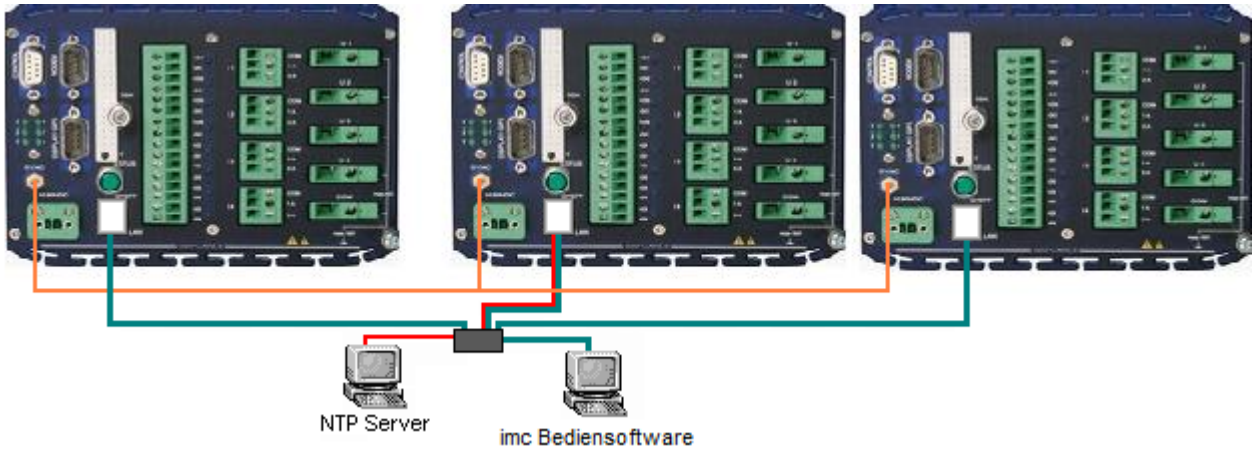


Master device synchronized by GPS and slave devices

11.4.2.3 NTP-time via LAN

This option is available for *miniPOLARES* only.

NTP-time via LAN: Devices are synchronized with each other and synchronized to absolute NTP time.



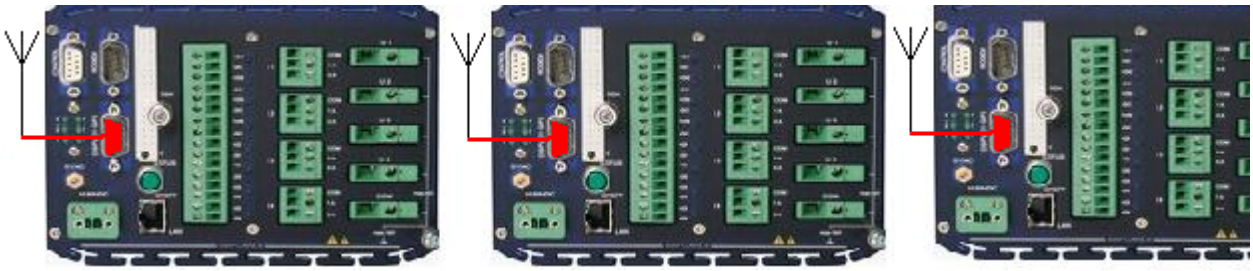
Master device synchronized by NTP and slave devices

11.4.3 Separate synchronization of all devices

If connection between devices via a Sync line is not possible, then each device can be synchronized separately to an external clock.

11.4.3.1 GPS-time

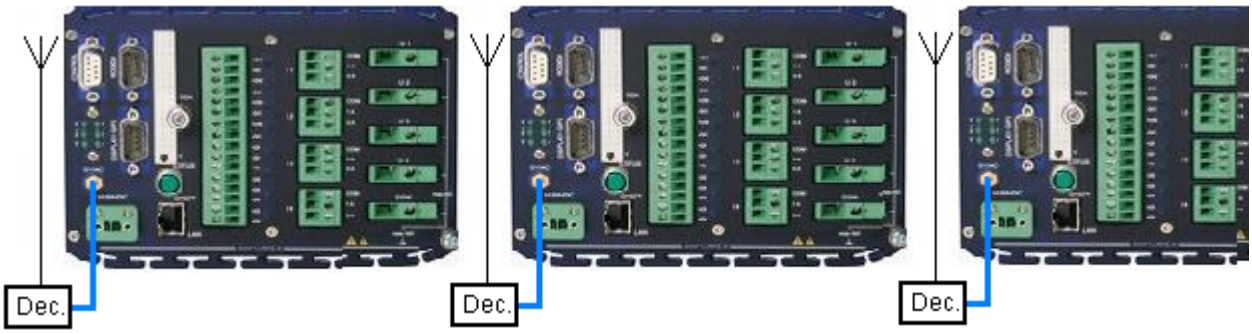
GPS time: Each device is synchronized to absolute GPS time and thus all devices are mutually synchronized.



Example for synchronization with GPS for stand alone devices

11.4.3.2 DCF77 time

DCF77 time: Each device is synchronized to absolute DCF77 time and thus all devices are mutually synchronized. The antenna signal must be converted to by a decoder to TTL level.

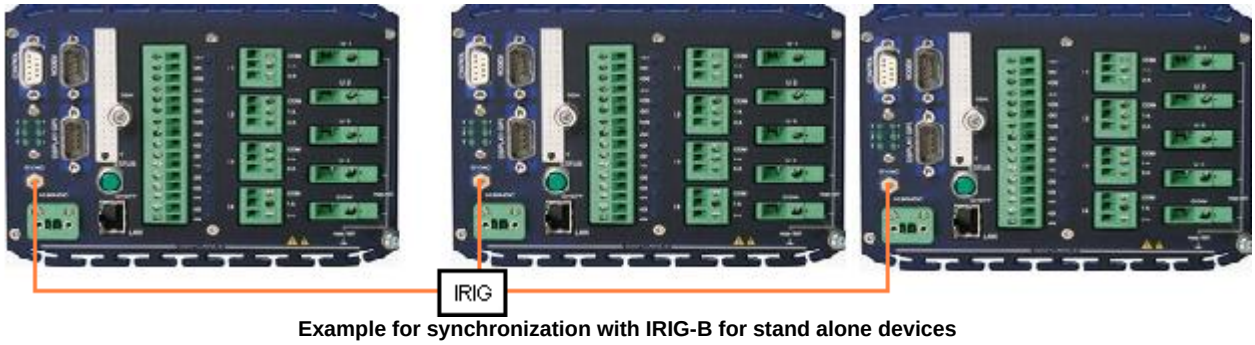


Example for synchronization with DCF77 for stand alone devices

11.4.3.3 IRIG-B time

This option is available for *miniPOLARES* only.

IRIG-B time: Each device is synchronized to absolute IRIG-B time and thus all devices are mutually synchronized

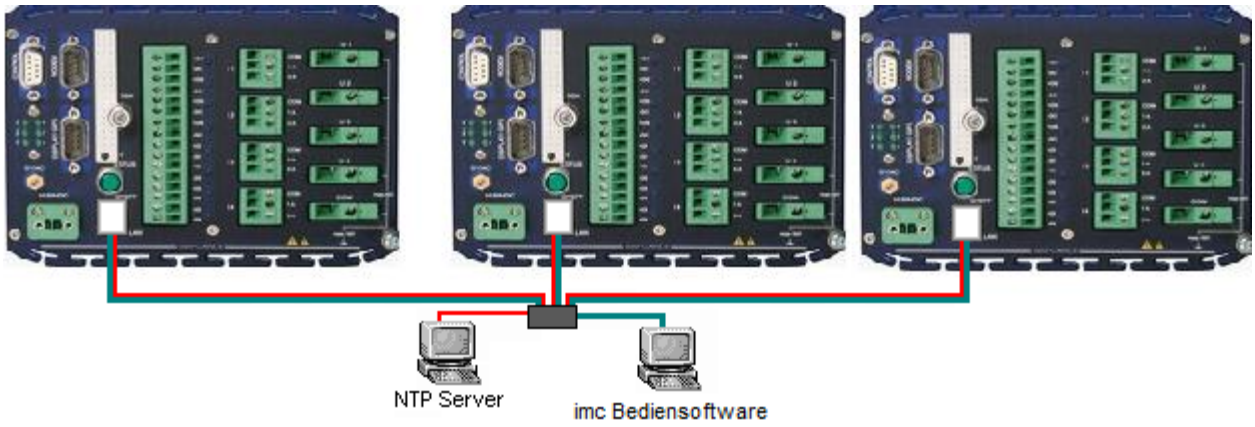


Example for synchronization with IRIG-B for stand alone devices

11.4.3.4 NTP time via LAN

This option is available for *miniPOLARES* only.

NTP time via LAN: Each device is synchronized to absolute NTP time. The mutual synchronization is limited, since NTP typically only achieves precision to a range of 10 ms to 20 ms.



Example for synchronization with NTP for stand alone devices

11.5 Hardware structure

11.5.1 Inputs (analog)

The system consists of two analog input boards, of which there are two basic models. One model can directly measure any voltages up to 1 kV_{rms} and the other can conveniently measure currents using clamp probes or Rogowski coils 48 with physical input ranges up to ± 5 V (for exact input range specs, see Chapter T for POLARES 93).

Each input signal has its own amplifier and separate analog-digital converter. The data are only consolidated after having been digitized. A signal processor, which is able to perform preliminary processing, serves as the link between the data bus and the board.

The AD- converters work with 16-bit resolution. The high-voltage inputs are connected to the internal circuitry by isolator amplifiers.

11.5.2 Digital in- and outputs

imc POLARES has four digital inputs 53 which are electrically isolated from the measurement system.

The four digital outputs 54 are build as relays contacts.

11.5.3 Data bus

The digitized measured data from the voltage and current sensors are carried to the central unit on the data bus. The data are retrieved cyclically.

11.5.4 Central unit

In the central unit, the measured data coming from the data bus are collected, processed and stored or transferred to the PC.

The central unit consists of signal processors (DSP) each entrusted with specific tasks, a data-RAM and a logic unit that regulates the data flow and the activity among the signal processors. A separate micro processor is not necessary for this purpose.

The individual DSP's have the following functions: trigger calculation, data capture, control of the device hard drive, online calculations with intermediate and final results.

11.5.5 Interface

The interface module receives the data from the central unit and passes them on to the network.

11.5.6 The internal disk

11.5.6.1 File system and formatting

Before using a storage medium, it must be partitioned and formatted to **Fat32**. When doing so, observe the following:

- At this time, there are no known limitations to the available storage medium volume.
- The maximum file size is 2 GB. In cases of larger data volumes per signal, use the interval storage.

Formatting of the storage media can be accomplished with the help of the menu item *Format* in the Windows Explorer (to do this, select the drive and click the right mouse button over it).

Under Windows 2000 / XP / Vista, the option *File system* "FAT32" or "FAT" (for "FAT16") can be selected. The file system "FAT16" must only be used for media having **less** than 32 MB.

11.5.6.2 Exchanging the removable drive

a) Retrieving data and exchanging the internal data carrier with the PC connected

- Once the data carrier has been exchanged, the measurement must be prepared and started over again.

b) Retrieving data via modem or network

- Select the device in the “Data transfer”-dialog.
- Run a search for measured data present.
- Transmit the measured data.
- Delete individual data sets or the entire disk.
- Data transfer can take place either during a running measurement or with the measurement stopped. It has no effect on the running measurement.

11.5.6.3 Notes on the use of the removable hard drive

ScanDisk

Check your µ-Disk(s) regularly for errors and correct these, if applicable, using ScanDisk under Windows or with a similar service program.

Removing from PC

The CF-Card data carrier may only be removed from the slot after it has been logged out from the system.

Failure to announce impending removal of the card may result in a crash of the operating system and the hard drive will thus be rendered unreadable. If this happens, Windows must be restarted.

Known problems and limitations

Please proceed as follows in case of problems with the Compact Flash-Cards:

- First, format the medium using a PC.
- If your PC has no CF-card slot, then it’s enough to erase the medium in the dialog “Data transfer”.
- Autostart configurations are stored on the CF-card, for which reason autostart is not possible without such a card!
- A storage medium with up to 32 MB used a the device hard disk may be formatted neither with Win95b’s 32-bit FAT, nor with WinNT/2000’s NTFS!
- If *imc POLARES* has an autostart configuration which uses the µ-Disk, an error will occur if this disk is missing upon activation. Switch the device off, insert a µ-Disk and re-activate the device.

Note

During a CF-card’s start-up phase, task switching on the processor must be disabled, regardless of what the disk type is. The duration of the disabling is approx. 2-3 s if a hard drive is inserted; for a Flashcard it’s about 50 ms.

12 Computations

For a list of all measurement channels see here 71. ***Bold and italic*** required for EN 50160

Parameter	Description	Remark
Voltage, current	RMS-values Curve plots (reduced RMS values)	Moving RMS value with each half-period over one period One data point at least per 24 h
Flicker	***short-term and long-term flicker*** momentary flicker value and maximum	optional
Frequency	50 Hz 60 Hz	40 Hz to 57,5 Hz 50 Hz to 69 Hz
Harmonics	***voltage***, current, power, cos phi up to the 50th,THD	For EN 50160: up to the 25th required
Interharmonics	up to 10 frequencies 10 Hz to 3000 Hz, resolution: 5 Hz	
Symmetry	zero-, positive-, negative phase sequence system	
Unbalance	negative/positive * 100 %	
Power	1-, 2-, 3-phase, overall system	active, reactive, apparent power power factor
Trigger	for voltage and current – RMS-trigger, curve shape trigger	amount of triggered recordings limited only by the memory card used
Voltage events	***overvoltage, dips,*** ***outages,*** ***rapid voltage fluctuations*** ***slow voltage fluctuations***	

Evaluations / Standards	
Voltage quality as per EN 50160	IEC 61000-4-30 Ed.2 class A compliant for the following: - Frequency - Magnitude of Supply Voltage - Flicker - Voltage Dips, Swells, Interruptions - Unbalance - Harmonics, Interharmonics - Mains Signaling - Time clock uncertainty - Flagging IEC 61000-4-15 IEC 61000-4-7 Power calculation as per DIN 40110-1 and –2
Data search and data comparison across multiple measurements	optional software module

IEC 61000-4-30 Ed.2 measurement accuracy and range

The accuracy and range specifications matches the IEC 61000-4-30 Ed.2 standard.

Parameter	Uncertainty	Measuring Range	Influence Quantity Range
Frequency	±10 mHz	40 Hz to 57,5 Hz 50 Hz to 69 Hz	40 Hz to 57,5 Hz 50 Hz to 69 Hz
Magnitude of supply	±0.1 %	10 % to 200 %	10% to 200 %
Flicker	±5 %	0.2 to 10 Pst	0 to 20 Pst
Dips and Swells	±0.2 %	-	-
Interruptions	-	-	-
Unbalance	±0.15 %	0.5 % to 5 %	0 % to 5 %
Voltage Harmonics	±5 % U_{harm} (U_{harm}>1 %)* ±0,05 % U_{nom} (U_{harm} <1 %)	-	-
Mains signalling voltage	±5 % U_{sgn} (U_{sgn}>3 %) ±0,15 % U_{nom} (1 %< U_{sgn} <3 %)	0 % to 9 %	0 % to 9 %

*U_{nom}= Operating voltage, U_{harm}= Amplitude of the harmonics (RMS values)

12.1 Basics

12.1.1 Preface

The first step will be to introduce basic ideas from the *imc POLARES* measurement philosophy which are the basis for using the device correctly. This knowledge is crucial, since already when you set up a measurement, it's necessary to know what settings influence your results, and which ones don't.

12.1.2 Measurement types

12.1.2.1 Connected channels and power measurement

Three modes for power measurement are available:

- 1 phase power measurement
- 2 phase power measurement
- 3 phase power measurement

12.1.2.2 Explanation of symbols

12.1.2.2.1 Device terminals

miniPOLARES

U1 = Voltage measurement input 1
(also channel designation in the display)

U2 = Voltage measurement input 2

U3 = Voltage measurement input 3

U4 = Voltage measurement input 4

I1 = Current measurement input 1
(also channel designation in the display)

I2 = Current measurement input 2

I3 = Current measurement input 3

I4 = Current measurement input 4

miniPOLARES -U8

U1 = Voltage measurement input 1
(also channel designation in the display)

U2 = Voltage measurement input 2

U3 = Voltage measurement input 3

U4 = Voltage measurement input 4

U5 = Voltage measurement input 5

U6 = Voltage measurement input 6

U7 = Voltage measurement input 7

U8 = Voltage measurement input 8

12.1.2.2.2 Designations of the voltages in the three-phase network

U_{L1} = Voltage of Line 1 to Ground

U_{L2} = Voltage of Line 2 to Ground

U_{L3} = Voltage of Line 3 to Ground

N = Neutral line potential

I_{L1} = Current in Line 1

I_{L2} = Current in Line 2

I_{L3} = Current in Line 3

I_N = Current in neutral line

12.1.2.2.3 Analysis

n = Line number 1...4

U_n = Voltage n, RMS-value
u_n = Voltage n, instantaneous value

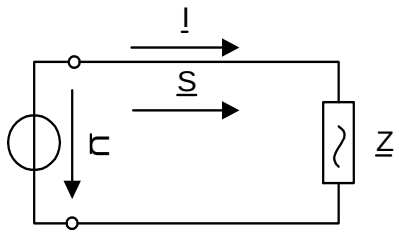
I_n = Current n, RMS-value
i_n = Current n, instantaneous value

S_n = Apparent power n from voltage n and current n
P_n = Active power n from voltage n and current n
Q_n = Reactive power n from voltage n and current n
LF_n = Power factor n

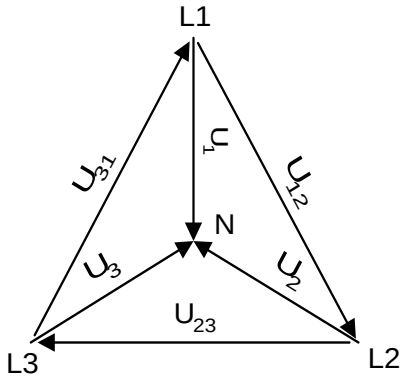
S_S = Total apparent power (system apparent power)
P_S = Total active power
Q_S = Total reactive power
LF_S = Total power factor

12.1.2.3 Circuiting and computation methods

The validity of the measurement results is defined by the consumer system (see adjacent image).



The correct rotation direction is assumed. The phasing is indicated by the complex representation of voltage (pointer diagram) in the adjacent figure.



Note

- If the rotation direction is reversed, a message is posted on the PC-monitor. *imc POLARES* interprets the reversed phasing as asymmetry.
- For analysis of a three-phase current system, the measurement terminals U1.. U3 and I1.. I3 are provided. The measurement terminals U4 and I4 are free extra inputs and can be used, for example, to monitor the N line.
- For 1-phase measurements, all measurement inputs U1.. U4 and I1.. I4 can be used, where U1 must always be used.
- With *miniPOLARES -U8,* U5 through U8 behave analogously to U1 through U4.

The selections for the configuration are presented in the description of the user interface in the system manual.

3-phase current	Terminal designation	Channels displayed	Power computation
4-wire system	**3xU, 3xI**		**3 phase power measurement**
	U_{L1} U_{L2} U_{L3} N	$U_1 = U_{L1}$ -N $U_2 = U_{L2}$-N $U_3 = U_{L3}$-N	for Lines n= 1,2,3 each $S_n = U_{nRMS} * I_{nRMS}$ $P_n = \frac{1}{T}\int_T (u_n \bullet i_n)dt$ $Q_n = \sqrt{S_n^2 - P_n^2}$ $LF_n = \frac{P_n}{S_n}$ P,Q,S,cos phi for each of 1st..50th harmonics
		$U_{12} = U_{L1} - U_{L2}$ $U_{23} = U_{L2} - U_{L3}$ $U_{31} = U_{L3} - U_{L1}$	
	I_{L1} I_{L2} I_{L3}	$I_1 = I_{L1}$ $I_2 = I_{L2}$ $I_3 = I_{L3}$	Total power $U_{eff} = \sqrt{U_1^2 + U_2^2 + U_3^2}$ $I_{eff} = \sqrt{I_1^2 + I_2^2 + I_3^2}$ $S_S = U_{eff} \bullet I_{eff}$ $P_S = P_1 + P_2 + P_3$ $Q_S = \sqrt{S_S^2 - P_S^2}$ $LF_S = \frac{P_S}{S_S}$

3-phase current	Terminal designation	Channels displayed	Power computation
3-wire system	**3xU, 2xI - ARON circuit**		**3 phase power measurement**
	U_{L1} U_{L3} N	$U_1 = U_{L1}$ U_2 = leer $U_3 = U_{L3}$ N= U_{L2}	
		$U_{12} = U_{L1}$ -N U_{23}= N-U_{L3} $U_{31} = U_{L3} - U_{L1}$	U_3 is computed
	I_{L1} I_{L3}	$I_1 = I_{L1}$ $I_2 = I_1 - I_3$ $I_3 = I_{L3}$	I_2 is computed

3-phase current	Terminal designation	Channels displayed	Power computation
			Total power of the systems: $I_{eff} = \sqrt{I_1^2 + I_2^2 + I_3^2}$ $S_S = \sqrt{\frac{1}{3}\left(U_{12}^2 + U_{13}^2 + U_{23}^2\right)} \bullet I_{eff}$ $P_S = \frac{1}{T}\int \left(u_{21} \bullet i_1 + u_{23} \bullet i_3\right) dt$ $Q_S = \sqrt{{S_S}^2 - {P_S}^2}$ $LF_S = \frac{P_S}{S_S}$

3-phase current	Terminal designation	Channels displayed	Power computation
3-wire system	**3xU, 2xI**		**3 phases U, 2 phases I**
	U_{L1}	$U_1 = U_{L1}$	Calculation as for ARON-circuit
		U_2 = leer	
	U_{L3}	$U_3 = U_{L3L}$	U_3 is computed
	N	N= U_{L2}	
		$U_{12} = U_{L1}$ -N	
		U_{23}= N-U_{L3}	
		U_{31}= U_{L3}-U_{L1}	
	I_{L1}	I_1=I_{L1}	
	I_{L2}	I_2=I_{L2}	
	I_{L3}	I_3=I_{L3}	

3-phase current	Terminal designation	Channels displayed	Power computation
Individual lines P-COM	**U, I**		**1 phase power measurement**
Measurement of up to 4 line pairs (U_{L1}-N)	U_{L1} N I_{L1}	$U_1 = U_{L1}$ -N $I_1=I_{L1}$	P,Q,S,LF for each of Lines 1,2,3,4 $S_n = U_n \bullet I_n$ $P_n = \frac{1}{T}\int_T (u_n \bullet i_n)dt$ $Q_n = \sqrt{S_n^{\,2} - P_n^{\,2}}$ $LF_n = \frac{P_n}{S_n}$
	U_{L2} N I_{L2}	$U_2= U_{L2}$-N $I_2=I_{L2}$	
	U_{L3} N I_{L3}	$U_3= U_{L3}$-N $I_3=I_{L3}$	
	U_{L4} N I_{L4}	$U_4= U_{L4}$-N $I_4=I_{L4}$	P,Q,S,cos phi for each of 1st..50th harmonics

12.1.2.4 Measurement channel overview

X = always present

Xi = present if current is measured

Xt = present of the associated trigger was activated

O = able to be switched on/ off (**O**ptional)

- = not present

Bold and italic entries are required for the EN 50160.

Measurement intervals: the interval written in bold print is to be used for compliance with the standard EN 50160.

For all channels, it's possible to calculate a histogram and the cumulative frequency subsequently.

Measurement channels	**Measurement intervals and comments**	**3-phase current 4-wire**	**3-phase current 3-wire**	**Single-line**
Voltage	3 s, 10 s, 1 min, 5 min, ***10* min**, 15 min, 30 min, 1 h, 2 h	X	X	X
Ux_rms_mean	Mean of the voltage RMS value	X	X	X
Ux_rms_min	Minima in the aggregation interval	O	O	O
Ux_rms_max	Maxima in the aggregation interval	O	O	O
Ux_rms_redu	Reduced time plot (maximum resolution: 1/2 cycle)	X	X	X
Ux_THD_mean	***THD (voltage total harmonic distortion)***			
Ux_harmn_mean	***Voltage harmonics***	X	X	X
with x=1..4; n=1..50		X	X	X
Ux_frz_mean with z=1..10	Arbitrary monitored fixed frequencies (e.g. interharmonics)	O	O	O
Current	3 s, 10 s, 1 min, 5 min, 10 min, 15 min, 30 min, 1 h, 2 h	O	O	O
Ix_rms_mean	Mean of the voltage RMS value	Xi	Xi	Xi
Ix_rms_min	Minima in the aggregation interval	O	O	O
Ix_rms_max	Maxima in the aggregation interval	O	O	O
Ix_rms_redu	Reduced time plot	Xi	Xi	Xi
Ix_THD_mean	THD (current total harmonic distortion)	Xi	-	Xi
Ix_harmn_mean with x=1..4; n=1..50	Current harmonics	Xi	-	Xi
Ix_frz_mean with z= 1..10	Arbitrary monitored fixed frequencies	O	O	O
Frequency	3 s, 10 s, 30 s, 1 min, 5 min, ***10 min***	X	X	X
Frequency	System frequency	X	X	X
Frequency_histogram	Histogram of frequency	X	X	X
Symmetry	3 s, 10 s, 1 min, 5 min, ***10 min***, 15 min, 30 min, 1 h, 2 h	X	X	-
Unbalance_rms		X	X	-
SymmetryZero_rms	Zero sequence system	X		-
SymmetryPositive_rms	Positive sequence system	X	X	-
SymmetryNegative_rms	Negative sequence system	X	X	-

Measurement channels	Measurement intervals and comments	3-phase current 4-wire	3-phase current 3-wire	Single-line
Flicker	3 s, 10 s, 1 min, 5 min, ***10 min***, 15 min, 30 min, 1 h, 2 h			
Ux_rms_pst	***Plt*** computed from 12 ***Pst***-values	X	X	X
Ux_rms_plt		X	X	X
Ux_rms_Pf5	Momentary flicker and maximum	X	X	X
Ux_rms_Pf5max with x=1..3		X	X	X
Power	3 s, 10 s, 1 min, 5 min, 10 min, 15 min, 30 min, 1 h, 2 h	O	O	O
P_P_mean	Active power for the overall system	Xi	Xi	-
P_Q_mean	Reactive power for the overall system	Xi	Xi	-
P_S_mean	Apparent power for the overall system	Xi	Xi	-
P_Lambda_mean	Power coefficient for the overall system	Xi	Xi	-
Px_P_mean	Active power for one channel	Xi	-	Xi
Px_Q_mean	Reactive power for one channel	Xi	-	Xi
Px_S_mean	Apparent power for one channel	Xi	-	Xi
Px_Lambda_mean	Power coefficient for one channel	Xi	-	Xi
Px_P_harmn_mean	Active power of the harmonics	Xi	-	Xi
Px_Q_harmn_mean	Reactive power of the harmonics	Xi	-	Xi
Px_S_harmn_mean	Apparent power of the harmonics	Xi	-	Xi
Px_Phase_harmn_mean with: x=1..4; n=1..50	Phase of the harmonics	Xi	-	Xi
P*x*_P_frz_mean	Active power of the monitored frequencies	O		O
P*x*_Q_frz_mean	Reactive power of the monitored frequencies	O		O
P*x*_S_frz_mean	Apparent power of the monitored frequencies	O		O
P*x*_Phase_frz_mean with: *x*=1..4; *z*=1..10	Phase of the monitored frequencies	O		O
Trigger	Measurement duration 200 ms to 90 s Resolution 100 µs	O	O	O
Ux_event	RMS-Trigger Curve shape trigger	Xt	Xt	Xt
Ix_event with: x=1..4		Xt	Xt	Xt
Signalfrequencytrigger (ripple control signal)	Mean values: 3 s, 10 s, 1 min, 5 min, ***10 min***, 15 min, 30 min, 1 h, 2 h	O	O	O
Ux_signal_mean	***Mean of the voltage***	Xt	Xt	Xt
Ux_signal_redu		Xt	Xt	Xt
Px_P_signal_mean	Mean of the active power	Xti	Xti	Xti
Px_Q_signal_mean	Mean of the reactive power	Xti	Xti	Xti
Px_S_signal_mean	Mean of the apparent power	Xti	Xti	Xti
Px_Phase_signal_mean with: x=1..3	Mean of the power coefficient	Xti	Xti	Xti

Channels during measurement (online monitoring)				
Voltage		X	X	X
Ux	100 µs (no aggregation, original signal)	X	X	X
Ux_rms	***RMS every 1/2 cycle***	X	X	X
Ux_FFT_	***Voltage harmonics (1st – 25th/50th)***	X	X	X
Phasing				
U1-U2		X	X	X
U1-U3		X	X	X
Ux-Ix with: x=1..3		Xi	Xi	Xi
Current	100µs	O	O	O
Ix	100 µs (no aggregation, original signal)	Xi	Xi	Xi
Ix_rms	RMS every 1/2 cycle	Xi	Xi	Xi
Ix_FFT_ with: x=1..3	Upper harmonics (1^{st} – 50^{th})	Xi	Xi	Xi
Px_P_harmonics_ with: x=1..3	Harmonic real power (1^{st} – 50^{th})	Xi	Xi	Xi

Overview display during measurement				
Ux	***RMS over one period***	X	X	X
THD ***U-harmonics (in % of fundamental frequency or V)*** ***with: x=1..3***	***of every 10(12) periods*** ***FFT over 10(12) periods***	X	X	X
Ix	RMS over on period	Xi	Xi	Xi
THD I- harmonics (in % of fundamental frequency or A) with: x=1..3	of every 10(12) periods FFT over 10(12) periods	Xi	Xi	Xi
Unsymmetry	***of every 10(12) periods***	X	X	-
Instantaneous flicker of Ux with: x=1..3	of every 10(12) periods	X	X	X
Power: Px,Qx,Sx, power factor For the overall system with: x=1..3		 Xi Xi	 - Xi	 Xi -
Additional information	free storage space in the measurement device number of recorded trigger events	X X	X X	X X

With the model *miniPOLARES -U8* the measurement channels U5 through U8 receive the suffix "_S2".

12.1.3 Data recording procedures

12.1.3.1 Overview

The following table pairs power network quality indicators with their respective data acquisition techniques.

Network quality and data

Attribute	Acquisition procedure		Resolution	Curve type
	acc. EN 50160	add. in imc POLARES		
Network frequency	mean value	histogram	10 s *	data-reduced, normal
Slow voltage variations	mean values		10 min	normal
Fast voltage variations		curve plots	$U_{rms1/2}$**	data-reduced
Events (voltage sags and outages)	tables of curve values		$U_{rms1/2}$	---
Harmonics voltage, interharmonics	mean values		10 min	normal
Voltage asymmetry	mean values		10 min	normal
Signal voltages	mean values	curve plots	10 /12 cycle, 10 min	data-reduced

* The values indicated are default values and can be changed.

** $U_{rms1/2}$: Value of the r.m.s. voltage measured over 1 cycle, commencing at a fundamental zero crossing, and refreshed each half cycle.

12.1.3.2 Mean values

Mean values can be used for **long-term analysis** of voltage, current and power. This includes upper harmonics and symmetry.

The interval duration for forming the mean value (the time resolution) is adjustable. According to EN 50160, the aggregation interval for most computations is **10 minutes**.

12.1.3.3 Curve plots

Curve plots describe the course of a quantity over time, usually the course of the **RMS-values** of voltages or currents with a resolution of 1/2 cycle.

Each data point in a curve plot consists of two values: the amplitude and the time (XY-waveform). This results in a reduction of data volume, since only one point must be saved if the original signal changes substantially.

The desired accuracy must be entered as a parameter. The default value has been set to conform to EN 50160 standards for network power quality.

Events (such as voltage dips and power outages) are extrapolated from the curve plots after measurement. For this reason, it is not yet necessary to set limit values when setting up measurement.

12.1.3.4 Triggers

Triggers serve in *imc POLARES* exclusively for **recording the instantaneous value**. Changes of the RMS-value as indications of events (such as voltage dips and power outages) are optimally captured in curve plots.

The length of a **trigger sequence** can theoretically be between at least 10 periods and at most until the storage medium is full. This includes any additional pretrigger, which has at least 0,1 s up to 30 s. In the world of measurement curves, triggers serve as a sort of **magnifying glass** for viewing data. This will is clearly seen when comparing curve plots with trigger sequences.

Note

Every signal recorded within such a trigger sequence at 100 µs resolution requires at least 14 kB of memory per channel. Frequent release of the trigger therefore limits the maximum duration of a long-term measurement. In order to ensure the duration of measurement, it is possible to set triggered recording to stop when available free memory falls below a certain amount; or it is possible to specify a maximum amount of memory for the trigger

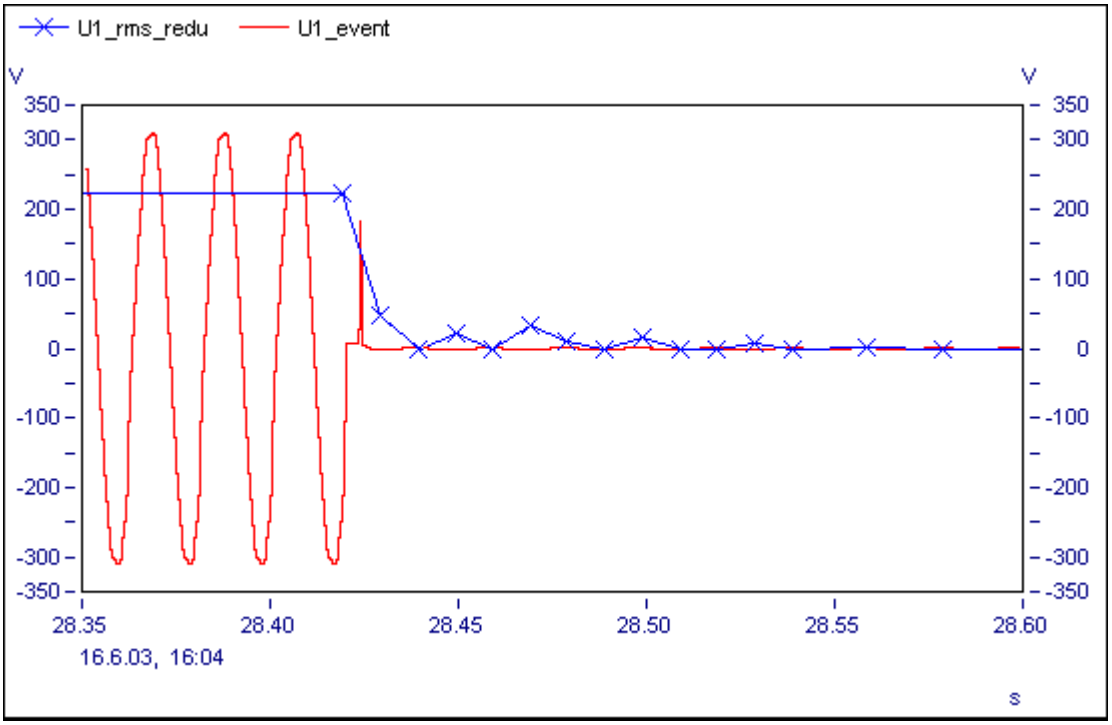
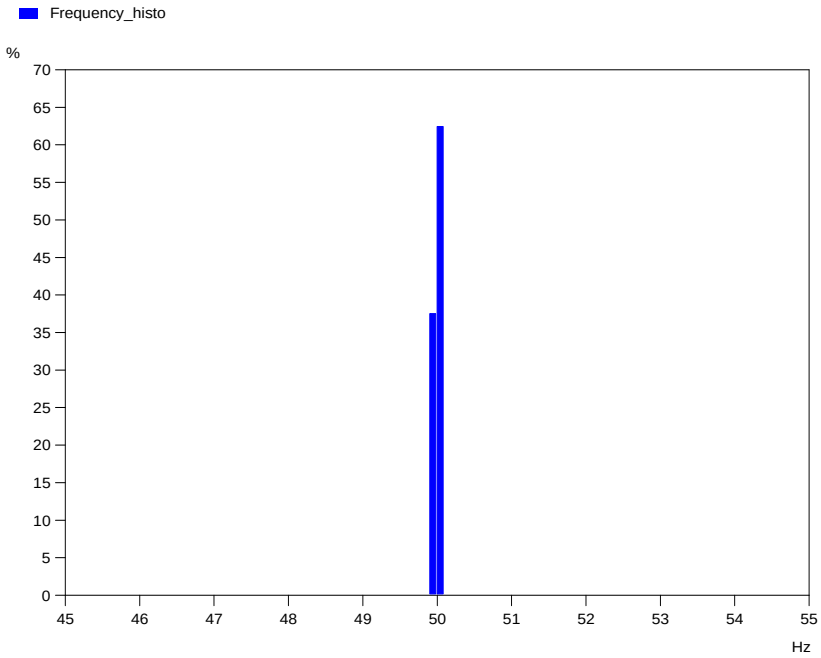


Fig 1-1 Curve plot and trigger

12.1.3.5 Histograms

For histograms, information on the absolute time is not relevant for the results. The information gained is on how long the signal remained within a particular range (classification).



Calculation of histograms is performed subsequently on the PC. It can be carried out for every channel which was sampled equidistantly (in contrast to XY-data of the reduced measurement channels).

12.1.4 Memory management

12.1.4.1 Aggregation interval

In normal cases, mean values are formed over **10 minute intervals**, which results in a very small data volume. 10-minute-values can even be kept for a week in the device's internal RAM.

In order to obtain more data on **how a quantity changes** (especially the upper harmonics), it is also possible to sample at intervals of whole seconds. It thus becomes possible to observe sudden jumps of an upper harmonic. Signal voltages even require a 3-second interval. However, such a measurement cannot be sustained for a long time due to the huge amounts of data which accumulate.

Data volume (per voltage channel) in Bytes for different combinations of aggregation interval and measurement time

Bold and italic entries are required for the EN 50160.

Interval	Measurement time		
	1 h	**1 day**	**1 week**
10 min	*13 k*	*50 k*	*300 k*
5 min	14 k	90 k	600 k
10 s	107 k	25 M	16 M
3 s	330 k	8 M	53 M

A voltage channel includes:

- mean value
- max., min. value in the aggregation interval
- mean value of harmonics
- flicker
- data reduced curve plot

Since the data volume also depends on the amount of disturbance, the actual memory requirements can deviate from the values indicated above.

The data volume expected is displayed as per the settings in the memory management dialog *Memory management* (see System manual).

For an EN50160 measurement over 3 voltage channels (including frequency and symmetry measurement) and an aggregation interval of 10 min, about 1,2 MByte of data accumulate per week.

12.1.5 Data

As various as are the properties which can characterize the quality of electric energy supply networks are also the data which *imc POLARES* returns. Analysis by *POLARES operating software* software provides you with up to **600 different curves** subsequent to a measurement. For this reason it makes sense to invest some effort in systematization in order to find your way through such a maze of curves.

12.1.5.1 Time resolution

Many network quality attributes (e.g. transients) require very detailed display, while for others (e.g. slow changes), aggregation over 10 minutes are adequate. In total, four different resolution levels can result, depending on the calculation technique used. ***Bold and italic*** entries are required for the EN 50160.

Time resolution of data

Resolution	Significance	Examples
10 min	Values over the selected ***aggregation interval*** (default = 10 Min)	***mean values, flicker***
10 s	Values over the selected ***aggregation interval*** f (default = 10 s)	***Frequency***
rms1/2	Value of the ***r.m.s. voltage*** measured over 1 cycle, commencing at a fundamental zero crossing, and refreshed each half cycle.	***data-reduced RMS-values***
100 µs	Input samples and derived quantities without data reduction	recording of instantaneous value (curve shape)

12.1.5.2 Curve types

Curves with high time resolution require large amounts of memory. For this reason, curve segments whose information content is large are given preference over relatively unimportant segments (trigger, data reduction). This produces special **curve types**. Additionally, complex numbers are used because they can conveniently record power values.

Curve type	Function	Examples
equidistant (normal)	curves with constant X-difference between consecutive data points	mean values, max – min values, flicker, histograms
reduced (XY)	curve plots with two values per point: amplitude and time	RMS-values (event recognition)
triggered (events)	curves consisting of multiple sequences	recording of instantaneous values (curve shape)
complex (RI, MP)	curves with Real and Imaginary parts (or magnitude and phase)	power (active, reactive power)

12.1.5.3 Curve names

The curve names are selected to reflect their origin and subsequent processing. They consist of a series of tags which describe the course of calculations performed on them. Each tag is linked to the next by an underline. This is illustrated in the example below:

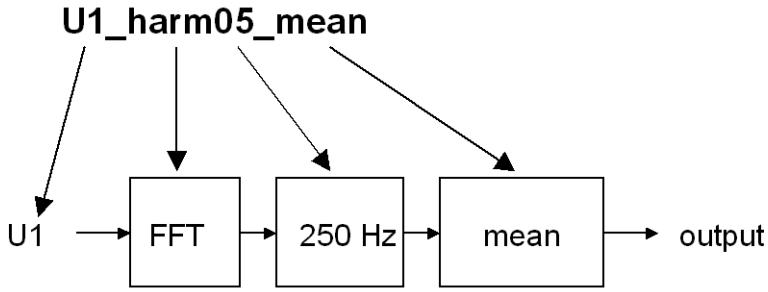


Fig 1-3 Designation of a channel for the 5th harmonic

The figure shows the channel designation for an upper harmonic. The input signal is the conductor voltage on the first conductor **U1**. This is decomposed into its spectral lines by means of an FFT. Only the values of the 5th **harmonic** (250 Hz) are used to derive the **mean value** later on.

Bold and italic entries are required for the EN 50160.

Tag	Definition
_***fft***	***spectrum with Fast Fourier Transformation***
_signal	signal frequency (FFT)
_***rms***	***effective value***
_min, _max, _***mean***	minimum, maximum, ***mean value***
_***harm00*** _***harm05***	***upper harmonics, 0th to*** 50th***(25th) order*** ***spectrum components determined by FFT***
fr01..fr10	freely selectable frequency (interharmonic) 1...10
_redu	curve plot (data reduction)
U_, I_	***voltage,*** current
P; _P	power (generally); active power
_S	apparent power
_Q	reactive power
_Phase	phase angle
_Lambda	power coefficient
_event	high-resolution, triggered recording of original signal
_***pst, _plt***	***short-term flicker, long-term flicker***
_pf5	flicker momentary value
Symmetry_Zero	symmetric zero sequence system
Symmetry_Positive	symmetric positive sequence system
Symmetry_Negative	symmetric negative sequence system
unbalance	***asymmetry (negative/positive*100)***
_Histogramm	frequency distribution

12.1.6 Event overview - Which value limit affects what

	Text-Notification	DO-output	Message (SMS, Email)	Data recording	LED
Value limits for event messages					
Voltage events	x	x	x	-	-
THD	x	-	-	-	-
Asymmetry	x	x	-	-	-
Frequency	x	-	-	-	-
Available memory	x	x	x	-	x
Value limits for triggering					
Voltage	x	x	-	x	x
Current	x	x	-	x	x
Frequency	x	x	-	x	x
Signal frequency	x	-	-	x	x
Digital input					
DI 1..4	x	-	-	x	x
Miscellaneous					
System error	-	x	-	-	x
Device active	-	-	-	-	x
Network trigger	-	x	-	x	x
Time synchronization	x	-	-	-	x
Frequency measurable	x	-	-	-	x

13 Troubleshooting

Only qualified technicians[1] are allowed to make repairs on the device! Unauthorized opening or incorrect repair of the device may greatly endanger the user (electric shock, fire hazard). Devices which have been altered or tampered with no longer comply with their license and may not be used. In case of accident (e.g. damage to housing, terminals, modules or power supply, or exposure to liquids or foreign substances), turn the device off immediately, unplug the power cord and inform the Customer Service. As a matter of principle, the user is not permitted to install or remove modules.

[1]Authorized/ qualified personnel refers to persons familiar with the setup, installation, commissioning, and operation of the product and who hold certification for their respective skills.

13.1 If imc POLARES can't be activated

- Check the power supply and the fuses (below the power switch).
- After deactivating the device, wait at least 10 seconds before switching it on again.
- Switch the system off and disconnect all lines except the power supply. Then try again to switch the unit on.

13.2 Error message when starting operating software

Check the connection between *imc POLARES* and your PC – chapter 2. Have you specified the correct connection type (Ethernet, TCP/IP, PPP)? Observe the specifications on the type plaque.

After reactivating *imc POLARES*, select in the dialog "Start/Stop network analysis" the command *disconnect* and subsequently the command *connect*.

The hardware parameters are only imported after an initial connection to the device.

13.3 Device not found or measurement data is not displayed

Error message 103 – Check the *imc POLARES* <=> PC connection and the power supply.

If your device isn't found in a *Network search*, read the notes in Getting started 30.

13.4 Error messages when saving to the internal Disk

For problems with Compact Flash cards, proceed as follows:

1. Format the medium using a PC.
2. Run the service program SCANDISK on the CF-card. *Scandisk* can be called from the Windows Explorer => Right-click the mouse on the drive => Properties => Tools.

13.5 Error description

To help locate defects when sending a unit back for repairs, please enclose a description of the error(s) encountered and, if applicable, a graph of expected versus incorrectly returned signal courses, as well as the following information for our Customer Service:

- The device's serial number
- The file *POLARES.log* from the *POLARES* folder under ..\output\service\...
- The files dev00x.umi (in the *POLARES* folder)
- e-mail to the Customer Support: *?*-Menu ⇒ *Info on POLARES.*

13.6 Resetting the device

If you are unable to set up a connection with the measurement device even though the device is activated and no other user is connected with it (and the correct TCP/IP or modem settings were also verified), the device can be reset and restarted using the menu item ***Extras \ Measurement device \ Reboot*** on the start page. This action will stop any running measurement or active data transfer! Afterwards you must re-connect to the device. Since this function ends any processes running on the device, it can only be used on the conditions described above!

14 Storage and Transporting

14.1 Transporting

When transporting the *imc POLARES* unit, always use the original packaging or appropriate packaging which protects the device against knocks and jolts. Above all, never let the unit fall. If transport damages occur, please be sure to contact the customer service. Damage arising from transporting is not covered in the manufacturer's guarantee.

Possible damage due to condensation can be limited by wrapping the device in plastic sheeting. For more on this topic, see the notes under Before starting 30.

14.2 Storage

Store the device in dry, clean locations. The storage temperature range for the device and associated components is -40 °C through 90 °C.

The relative humidity may not be high enough to cause formation of either condensation or frost.

We recommend a limited temperature range of +10 °C to +35 °C for storage purposes in order to avoid premature aging of the electrolyte capacitors.

Additionally, if the device is to be stored for longer periods, it is recommended to connect it once a year to a power supply for one or two days in order to prime its electrolyte capacitors. The same procedure should be applied prior to using the device after any long storage time.

15 Technical specs and terminal configuration

Operating conditions

Unless otherwise stated, the following conditions must be met for use of *imc POLARES*:

- use indoors
- altitude up to 2000 m NN
- operating temperature range of -10 °C through 55 °C without condensation
- maximum relative humidity: 80 % for temperatures up to 31 °C, decreasing linearly to 50 % relative humidity at 40 °C
- in case of power supply from the power grid, voltage fluctuations of no more than ±10 % from the nominal value (for other power supplies, the respective voltage fluctuation limitations apply)
- transient voltage surges conforming to overvoltage categories II and III. For power supply from the grid, the lowest and most common overvoltage category II is to be applied.
- Pollution degree 1 or 2 in accordance with IEC 60664

15.1 Technical data miniPOLARES

Parameter	typ.	min. / max.	Test conditions/ Remarks
General (at 25°C)			
Ambient conditions	The normal *ambient conditions* according to EN 61010-1 apply (see Operating conditions 84). These ambient conditions are can be broadened in accordance with the statements made in these technical specs		
Signal inputs	4 x current [I] 4 x voltage [U] 8 x voltage [U]		for miniPOLARES-DC and miniPOLARES-AC for miniPOLARES-8U-DC and miniPOLARES-8U-AC
Digital in/out	4 binary inputs 4 relays outputs		
Power supply rating voltage rating frequency rating power consumption	 10 V to 60 VDC (+10%) 100 V bis 240 VAC / 110 V to 250 VDC (±10%) 50 / 60 Hz < 20 VA < 12 W < 10 W		 for miniPOLARES-DC and miniPOLARES-8U-DC for miniPOLARES-AC and miniPOLARES-8U-AC for miniPOLARES-AC and miniPOLARES-8U-AC after switch-on (recharging the UPS) permanent operation
UPS capacitor	buffer time: ≤ 1 second		factory settings
EMC Interference resistance/ transient emissions	class A		according IEC/EN 61326-1
Protection degree		IP 20	according EN60529
Weight		ca. 1,9 kg	
Dimensions	166 mm x 105 mm x 126 mm		(W x H x D) without top-hat rail
Ambient temp. range	-10 °C to 55 °C		acc. to IEC 60688, no condensation
Storage temperature	-40 °C to 90 °C		acc. to IEC 60688, within < -15°C or > +55°C only for short time recommended
Fuses	1 A T, 1500 A @AC 250 V 1 A T, 1500 A @DC 300 V		e.g. type 179200 /SIBA or 0001.2504 SCHURTER
Interfaces	Ethernet, Modem		RJ45 (TCP/IP) DSUB9
Memory capacity	2 GB standard up to 16 GB possible		CF-Card
Timer (internal RTC) crystal-controlled real time clock external synchronization	± 1s/day GPS, DCF, IRIG-B, NTP or other miniPOLARES		battery backed GPS-input Sync-input

Parameter	Test conditions/ Remarks
Mechanical stress	
Vibrations, sinusoidal; stationary use	- IEC 60068-2-6: test Fc - IEC 60255-21-1 class 2
Vibrations, sinusoidal; transport	- IEC 60068-2-6: test Fc - IEC 60255-21-1 Klasse 1
Seismic stress, stationary use	- IEC 60068-3-3: test Fc - IEC 60255-21-3 class 1
Shock, half sine wave; stationary use	- IEC 60068-2-27: test Ea - IEC 60255-21-2 class 1
Shock, half sine wave; for resistance	- IEC 60068-2-27: test Ea - IEC 60255-21-2 class 1
Shock, half sine wave; continuous shock, transport	- IEC 60068-2-29: test Eb - IEC 60255-21-2 class 1
Drop test in transport packaging Fall of 0,5 m height	- IEC 60068-2-31 + /A1 - EN 60068-2-31 - DIN EN 60068-2-31 Device packaged ready to ship
Mechanical resistance to shock and impact	- IEC 61010-1, section 8.1 and 8.2 - IEC 60068-3-75 / 1997
Industrial atmosphere	
SO_2 H_2S	-IEC 60068-2-42 / DIN 40046 part 36 test -IEC 60068-2-43 / DIN 40046 part 37 test

15.1.1 Voltage inputs

4 channels for voltage measurement			
Parameter	**typ.**	**min. / max.**	**Test conditions / Remarks.**
input	4 8		for miniPOLARES-DC and miniPOLARES-AC for miniPOLARES-8U-DC and miniPOLARES-8U-AC single end, isolation for each group
terminal connections	screw terminal AWG 10-20 rigid line 0,5 mm² to 6 mm² flexible line 0,5 mm² to 4 mm²		American Wire Gauge
sampling rate per channel		10 kHz ≤ 50 kHz	network analysis with In Rush module
bandwidth		0 Hz to 4,1 kHz 0 Hz to 21 kHz	-3dB, network analysis -3dB, with In Rush module
electrical safety rating / measurement category degree of pollution		600 V / CAT III 2	according EN 61010-1 voltage inputs U1..U4 according IEC 60664
insulation test voltage		5,4 kV_{RMS}	50 Hz Sinus; 1 min
measurement ranges	1000 V_{RMS}		automatic range setting
overload limit	1000 V_{RMS}		
overload resistance		±1,5 kV 1,1 kV_{RMS}	DC or 50 Hz simus, permanent
input impedance	2,5 MΩ	±1%	differential
measurement insecurity drift	0,04 % ±10 ppm/K·ΔTa	≤0,1 % ±50 ppm/K·ΔTa	of ranges ΔTa=|Ta -25°C| ambient temperature Ta
isolation suppression		>110 dB >71 dB >47 dB	isolation voltage 1000V_{RMS} DC 50 Hz 1 kHz
channel crosstalk		<-110 dB <-85 dB <-60 dB	test voltage: 1000 V_{RMS} DC 50 Hz 1 kHz
strain voltage(RTI)	20 mV_{RMS}		bandwidth: 0,1Hz to 10 kHz

Description of the voltage inputs of miniPOLARES 50.

15.1.2 Current inputs

4 channels for current measurement			
Parameter	**typ.**	**min. / max.**	**Test conditions / Remarks.**
input	4		for miniPOLARES-DC and miniPOLARES-AC; differential, isolated
terminal connection	screw terminal 14 to 24 AWG 0,2 mm² to 2,5 mm²		(American Wire Gauge) for rigid or flexible line
sampling rate per channel		10 kHz ≤ 50 kHz	network analysis with In Rush module
bandwidth lower cutoff frequ. upper cutoff frequ.		 10 Hz 4,1 kHz 21 kHz	 -0,1 dB -3 dB, network analysis -3 dB, with In Rush module
electrical safety rating / measurement category pollution degree		 600 V / CAT III 2	 in accordance with EN 61010-1 current inputs I1…I4 in accordance with IEC 60664
measurement ranges	10 A, 5 A, 2,5 A, 1 A, 0,5 A		RMS values 5 A – connection 1 A – connection
overload limit		±145 %	of range
overload strength 5A terminal 1A terminal		 ≤ 20 A ≤ 100 A ≤ 10 A ≤ 100 A	 long-term 1 s long-term 1 s
input impedance 5A terminal 1A terminal		 ≤ 10 mΩ ≤ 20 mΩ	differential
measurement uncertainty	0,06 % ±8 ppm/K·ΔT_a	≤ 0,1 % ±60 ppm/K·ΔT_a	of input range ΔTa=|Ta –25°C| ambient temperature T_a
isolation suppression	 1,5 µA/V 50 µA/V		Isolation test voltage 500 V_{eff}· 50 Hz 1 kHz
channel cross talk	 -120 dB -100 dB		test current: 10 A_{eff}, 50 Hz 1 kHz
phase uncertainty		≤ 1 °	40 Hz to 2,5 kHz
noise signal	600 µA_{eff} 60 µA_{eff}		bandwidth: 0,1 kHz to 1 kHz range > 1 A range ≤ 1 A

Description of the current inputs of miniPOLARES 52.

15.1.3 Digital inputs

4 digital inputs			
Parameter	**typ.**	**min. / max.**	**Test conditions / Remarks.**
channels / bits	4		each isolated
terminal connections	screw terminal 14 to 24 AWG 0,2 mm² to 2,5mm²		American Wire Gauge for rigid or flexible line
sampling rate per channel	1 kHz		
insulation test voltage	3,6 kV_{RMS}		50 Hz, 10 sec between channels and chassis
electrical safety rating measurement category degree of pollution	250V / CAT III 2		 in accordance with EN 61010-1 in accordance with IEC 60664
max. input level ue		≤600 V	peak-to-peak or DC voltage
nom. input level ue	230 V_{RMS} / 350 V_{DC}		
switching level Us unipolar low unipolar high	 <16 V >16,8 V	 <14 V >18 V	Schmitt-Trigger-characteristics Hysteresis 0,04 V typ.
current input	280 µA	<500 µA	ue = -600 V to +600 V
circuit time low → high high → low	 70 µs 23 µs	 <180 µs <40 µs	

Description of the digital inputs of miniPOLARES 53.

15.1.4 Digital outputs

4 digital outputs			
Parameter	**typ.**	**min. / max.**	**Test conditions / Remarks.**
channel / bits	4		mechanical closer
terminal connection	screw terminal 14 to 24 AWG 0,2 mm² to 2,5mm²		American Wire Gauge for rigid and flexible lines
insulation test voltage	3,6 kV_{RMS}		50 Hz Sinus; 10 sec
electrical safety rating / measurement category degree of pollution	250 V / CAT III 2		 according EN 61010-1 according IEC 60664
switching time	5 ms	<8 ms	
max. switching power		<1000 VA	
switching voltage	>1 V_{DC}	<250 V_{RMS}	min. switching voltage at 1mA
max. switching current		<1 A <4 A	250 V~ cos φ=1.0 ... 0.4 250 V~ cos φ=1.0
contact impedance		<50 mΩ	

Description of the digital outputs of miniPOLARES 54.

15.2 Technical data imc POLARES

Parameter	typ.	min. / max.	Test conditions/ Remarks
ambient conditions	The *normal* ambient conditions according to EN 61010-1 apply (see “Operating conditions” in Chapter 0). These ambient conditions are can be broadened in accordance with the statements made in these technical specs		
power consumption	11 W	< 20 W	With fully charged UPS rechargeable battery
power supply		10 V to 36V_{DC}	external 110 V to 230 V_{AC} supply unit
UPS	buffer time: 1seconds per power outage		23°C, for fully charged UPS battery, extension possible
electrical safety rated voltage/ measurement category pollution degree		 600 V / CAT III 600 V / CAT III 2	in accordance with EN 61010-1 voltage inputs U1 .. U4 current probe inputs I1 .. I4 in accordance with 60664
Isolation strength		5,4 kV_{RMS}	permanent, 50 Hz, 1min test voltage
protection degree		IP 20	
weight	2,5 kg	< 2,6 kg	without power adapter
dimensions (WxHxD)	260 mm x 85 mm x 300 mm		without plug
ambient temp. range	-10°C to 55°C -20°C to 85°C (optional)		no condensation extended temp. range (with condensation as per IEC 60664 Pollution Degree 2)
storage temperature	-20°C to 85°C		
bandwidth	5 kHz 0 to 6,5 kHz 0 to 14 kHz		network analysis <±0,1 % -3 dB
interfaces	Ethernet, wireless LAN modem		TCP/IP
memory capacity	PCMCIA-Flashcard CompactFlash card		up to 16 GB up to 16 GB
accessories	signal-specific connection terminal, table-top power adapter incl. network line (operating temp range 5°C to 40°C)		

15.2.1 Voltage inputs

Parameter	typ.	min. / max.	Test conditions/ Remarks
4 channels for voltage measurement			
terminals	8 x 4 safety jacks, 4 mm		
input range	±1000V		crest value
bandwidth		5 kHz 14 kHz	-3 dB network analysis -3 dB with inrush module
sampling rate	10 kHz	 ≤50 kHz	per channel with network analysis per channel with inrush module
overvoltage protection		±1450V	differential, long-term
input impedance	2,0 MΩ	±1%	
input coupling	DC		isolated
gain uncertainty drift	0,02 % ±5 ppm/K*ΔT_a	≤0,05 % ±15 ppm/K*ΔT_a	 ΔTa=|Ta -25°C| ambient temperature Ta
offset drift	0,02 % ±5 ppm/K*ΔTa	≤0,05 % ±15 ppm/K*ΔT_a	 ΔTa=|Ta -25°C| ambient temperature Ta
isolation suppression		 > 130 dB >70 dB >44 dB	Isolation voltage: 500Vrms. DC 50Hz 1kHz
phase uncertainty		0 Hz bis 2,5 kHz	<±1°
input noise suppression		<60 mV	

The description of the voltage inputs of imc POLARES 47.

15.2.2 Current inputs

Parameter	typ.	min. / max.	Test conditions/ Remarks
4 channels for current measurement with current probes			
terminals	4 x 3-pin Phoenix plugs (PC 4/3-G)		matching plug: PC-4/3-ST(F)-7,62
input range	±5V depending on the current probe used		Converters, e.g.: MN71 0.01 - 12A~ AmpFLEX A100 5 - 2000A~
bandwidth		5 kHz 14 kHz	-3 dB with network analysis -3 dB with inrush module
sampling rate	10 kHz	≤ 50 kHz	per channel with network analysis per channel with inrush module
overvoltage protection		±100V	long-term
input impedance	500 kΩ	± 1%	isolated
gain uncertainty drift	0,05 % ±3 ppm/K·ΔT_a	≤ 0,1 % ±15 ppm/K·ΔT_a	ΔT_a=|T_a -25°C| ambient temperature Ta
offset drift	0,02 % ±3ppm/K·ΔT_a	≤ 0,05 % ±15 ppm/K·ΔT_a	ΔT_a=|T_a -25°C| ambient temperature Ta
isolation suppression		>130 dB >105 dB > 80 dB	Isolation voltage: 500 Vrms. DC 50 Hz 1 kHz
phase uncertainty		0 Hz bis 2,5 kHz	<±1°
input noise voltage noise suppression	75 µV	> 86 dB	Bandwidth: 100Hz

[2] for input voltages >3 V the impedance is 83 kΩ.

The description of the current inputs of imcPOLARES 48.

15.2.2.1 Current measurement with MN71 current probe

Parameter	Value (typ. / min.max.)		Remarks
input range	10 A, 5 A bis 2,5 A		RMS-values, crest factor <1,5
overload protection		≤200 A	long-term t, f ≤ 1 kHz, crest factor <1,5
measurement uncertainty	0,3 %	≤ 0,7 % ±1 mA	50 Hz, sinus
measurement bandwidth	40 Hz to 6,5 kHz		<±0,5 %
phase uncertainty	40 Hz to 2,5 kHz		< ±1°

15.2.2.2 Current measurement with AmpFlex A100 (2kA)

Parameter	Value (typ. / min.max.)		Remarks
input range	2000 A		RMS-values, crest factor <1.5
overload protection		≤3000 A	long-term t, f≤1 kHz, crest factor <1.5
measurement uncertainty	0,2 %	≤ 0,6 % ±1 A	50 Hz, sine
measurement bandwidth	40 Hz to 6,5 kHz		< ±0.6%
phase uncertainty	40 Hz to 2,5 kHz		< ±1°

15.2.3 Computations

Computations		
voltage, current	RMS-values Curve plots (reduced RMS values)	Moving RMS value with each half-period over one period One data point at least per 23:30 h
flicker	short-term and long-term flicker momentary flicker value and maximum	optional
frequency	50 Hz 60 Hz	40 Hz to 57,5 Hz 50 Hz to 69 Hz
harmonics	voltage, current, power, cos phi up to the 50th,THD	
interharmonics	up to 10 frequencies 10 Hz to 3000 Hz, resolution: 5 Hz	
symmetry	zero-, positive-, negative phase sequence system	
power	single- or multi-wire, overall system	active, reactive, apparent power power factor
trigger	for voltage and current – RMS-trigger, curve shape trigger signal frequency trigger (e.g. ripple control signals)	amount of triggered recordings limited only by the memory card used
voltage events	overvoltage, dips, outages, rapid voltage fluctuations slow voltage fluctuations	

Evaluations / Standards		
	Voltage quality as per EN 501606	IEC 61000-4-30, -15, -7 Power calculation as per DIN 40110-1 and –2
	Data search and data comparison across multiple measurements	optional software module

15.2.4 Internal modem

The following data on the modular modems pertain only to the properties supported by imc. Information on other properties of the modular modems are available upon request.

15.2.4.1 Analog modem

Supported protocols	**Data transfer** • V.92 / 56k max data speed **Fax Group 3** • Fax Class 2 • Fax Class 2.0/2.1
Accreditation	Global (50 countries)

15.2.4.2 Euro-ISDN Modem

Protocols supported	**Data transfer** • 64k max data **B-Channel protocol** • X.75 • PPP
Accreditation	Europe

15.2.4.3 Dual band 900/1800 GSM modem

Protocols supported	**Data transfer** • 14.4k GSM circuit switched data / 9.6k max data speed **Fax Group 3** • Fax Class 2
Accreditation	Europe

15.3 Synchronization and time base

Parameter	value typical	min. / max.	Remarks
time base per device without external synchronization			
balanced (default)		±10 ppm	at 25°C (accuracy of internal time base)
Drift	±20 ppm	±50 ppm	-40 °C to +85 °C operating temp.
Ageing		±10 ppm	at 25°C, 10 years

time base per device with external synchronization signal				
Parameter	**GPS**	**DCF77**	**IRIG-B*** **	**NTP*** **
Supported formats	NMEA / PPS*		B002 B000, B001, B003**	version 4 (downwards compatible)
Precision	±1 µs			<5 ms after ca. 12 h
Jitter (max.)	±8 µs			
Voltage level	TTL (PPS*) RS232 (NMEA)	5 V TTL level	5 V TTL level	---
Input resistance	1 kΩ (pull up)	20 kΩ (pull up)		---
Input connector	DSUB-9 connector "GPS" not isolated	BNC connector "SYNC" short circuit proof, not isolated		Ethernet
Shield potential input		system ground		---

*PPS (pulse per second): signal is necessary, **using BCD information only
*** Not available for devices with serial number less then 140000

Synchronization with DCF77 for several devices (Master/Slave)			
Max. cable length		200 m	SMB cable
Max. number of devices		20	slaves only
Common mode	0 V		theses device must have the same ground voltage level, otherwise signal quality problems (signal edges) may result.Remedy see ISOSYNC
Voltage level	5 V		
DCF input/output	connector "SYNC"		SMB
Shield potential, IRIG-input	system ground		

ISOSYNC with different potentials			
Isolation strength	1000 V		1 minute
Delay	5 µs		@ 25°C
Temperature range		-35°C to +80°C	

For description see here 57

15.4 RS232 interface for GPS

The following RS232 settings are required to use a clock module Meinberg GPS161AHSx or Hopf Receiver 6875-FW7.0: 7XV5664-0CA00. Garmin GPS receivers will be set to 38400 by *imc POLARES*.

8n1(8 bit, no parity, 1 stop bit), no flow control

Baudrate: Autobaud for 4800, 9600, 19200, 38400, 57600, 115200.

15.5 Calibration conditions

Calibration conditions		
Parameter	**typ.**	**Test conditions / Remarks.**
temperature	25 °C	±5 °C
humidity	40 %	±30 %
power supply	24 V	60 W power adapter
input signal	±1000 V_{DC} / sine 50 Hz 1 A_{RMS} / sine 50 Hz	voltage inputs current inputs

15.6 Notes on maintenance and servicing

No special maintenance efforts should be necessary.

In case of ***returns***, please send the device back with a note outlining the errors encountered. Please also include in the note a contact name and telephone number, in the interest of the fastest possible processing of the case.

In telephone inquiries you can aid us in being helpful by having the serial number of your device, the installations CD for the *imc POLARES* software and this manual handy. Thanks!

The ***type plaque*** on the housing states the device's serial number, nominal supply voltage and the device's nominal power consumption. On the options plaque next to it, the delivered software version and the installation of the In-Rush module (POL-IRM) for short-term measurements is noted.

15.7 Included accessories

- Manufacturer’s calibration certificate
- 2 GB CF-Card
- Manual Getting started printed
- Ethernet connection cable (2 m) 1 x STP, 1 x STPx (crossed)
- German and English system manualand operation manual as online help and PDF on CD

15.8 Pin configuration of the DSUB-9 plugs

15.8.1 Modem (external)

DSUB-PIN	Signal	Description	Use in device
1	**DCD**	**Data Carrier Detect**	**connected**
2	**RxD**	**Receive Data**	**connected**
3	**TxD**	**Transmit Data**	**connected**
4	**DTR**	**Data Terminal Ready**	**connected**
5	**GND**	**Ground**	**connected**
6	**DSR**	**Data Set Ready**	**connected**
7	**RTS**	**Ready To Send**	**connected**
8	**CTS**	**Clear To Send**	**connected**
9	**nc**	**reserved**	**unused**

15.8.2 GPS

With the following wiring, a Garmin GPS-mouse can be connected:

DSUB-9		GPS 18 LVC	GPS 18 - 5Hz
Pin	**Signal**	**Color**	**Color**
1	Vin	Red	Red
2	RxD1*	White	White
3	TxD1	Green	Green
4	-	-	-
5	GND, PowerOff	2x Black	2x Black
6	-	-	-
7	PPS (1Hz clock)	Yellow	Yellow
8	-	-	-
9	-	-	-

*Pin configuration at measurement device. At the GPS-mouse Rx and Tx are interchanged.

15.8.3 Clock modules for imc POLARES

With the following wiring, a clock module (HOPF or Meinberg) can be connected to the GPS plug:

Signal	imc POLARES	Meinberg GPS161AHSx	HOPF 6875
	GPS DSUB-9 socket	**DSUB-9 plug**	**DSUB-9 socket**
(Vin)	1	**do not connect**	**do not connect**
Rx/Tx	**2 (Rx)**	**2 (Tx)**	**6 (Tx)**
Tx/Rx	**3 (Tx)**	**3 (Rx)**	**8 (Rx)**
-	4	**-**	**-**
GND	**5**	**5**	**5**
-	6	**-**	**-**
PPS (TTL 1 Hz clock)	**7**	**7**	**4**
-	8	**-**	**-**
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