

Fronius DATCOM Detail

US Operating Instructions
Data Communication



Dear Fronius Customer,

Introduction

Thank you for choosing Fronius - and congratulations on your new, high-quality, high-tech Fronius product. This introduction should provide you with general information about the equipment. Please read it carefully to learn about the many great features of your new Fronius product. This is the best way to get the most out of all the advantages that it has to offer.

Please also note the safety information and the safety precautions for the product installation location. Following all product instructions will ensure long-lasting quality and reliability. And these are the essential ingredients for outstanding results.



Safety Instructions

DANGER!



„**DANGER!**“ indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.



WARNING!



„**WARNING!**“ indicates a potentially hazardous situation which, if not avoided, will result in death or serious injury.

CAUTION!



„**CAUTION!**“ indicates a potentially harmful situation which, if not avoided, may result in minor and moderate injury or property damage.

NOTE



„**NOTE**“ indicates a situation which could adversely affect work results and may cause damage to equipment.

Important

„**Important**“ indicates practical tips and other useful information. It is not a signal word for a harmful or dangerous situation.

Please pay special attention when one of the above symbols appears in the manual.

General



This equipment has been manufactured using state-of-the-art technology and in accordance with general safety regulations. However, incorrect operation or misuse may endanger

- the life and well-being of the operator or third parties
- the equipment and other property of the owner/operator
- the efficient operation of the equipment

All persons involved with equipment startup, service and maintenance must

- be suitably qualified
- be familiar with electrical installations
- have completely read and followed these operating instructions

The operating instructions must be available at the equipment location at all times. In addition to the operating instructions, all applicable local rules and regulations regarding accident prevention and environmental protection must also be followed.

General (continued)

All safety instructions and warning signs on the equipment itself:

- must be maintained in legible condition
- must not be damaged
- must not be removed
- must not be covered or painted over

For information about where the safety instructions and warning signs are located on the equipment, please refer to the „General“ section of your equipment's operating instructions.

Any equipment malfunctions which might impair safety must be remedied immediately before the device is turned on.

Your safety is at stake.

Intended Use



The equipment may only be operated in compliance with its intended use.

Any other purpose does not constitute intended use. The manufacturer is not responsible for any damages resulting from unintended use.

Intended use also includes

- reading and compliance with all general information as well as safety information and warnings from the operating instructions
- compliance with all inspection and maintenance requirements
- installation as per operating instructions

Where appropriate, the following guidelines should also be applied:

- Utility company regulations regarding mains feed-in
- Information from solar module manufacturer

Ambient Conditions



Operation and/or storage of the device outside of the stipulated range does not constitute intended use. The manufacturer is not responsible for any damages resulting from unintended use.

Please refer to the technical data in your operating instructions for information about permitted ambient conditions.

Qualified Personnel



The service information in these operating instructions is only intended for qualified personnel. An electrical shock can be fatal. Please do not carry out any activities other than those referred to in the documentation even if you are suitably qualified.



All cables and wires must be secured, undamaged, insulated and adequately dimensioned. Loose connections, scorched, damaged or under-dimensioned cables and wires must be repaired immediately by an authorized specialist.

Qualified Personnel
(continued)



Maintenance and repair may only be carried out by an authorized specialist.

The use of third-party parts does not guarantee that they were designed and manufactured according to operational demands and safety requirements. Use only original spare parts (also applies to standard parts).

Do not carry out any alterations, installations or modifications to the device without first obtaining the manufacturer's permission.

Immediately replace any components that are not in perfect condition.

Safety Precautions at Equipment Location

When installing devices with air vents, make sure that cool air can flow freely through the vents unobstructed. The device should only be operated in accordance with the protection class listed on the rating plate.

EMC Precautions



Care must be taken during installation to ensure that there is no electromagnetic interference with electrical and electronic equipment.

Electrical Installations



Electrical installations may only be carried out in accordance with relevant national and local standards and regulations.

ESD Precautions



Danger of damage to electronic components due to electrostatic discharge. Take appropriate ESD precautions when replacing and installing components.

Safety Precautions in Normal-Operation



The device should only be operated when all safety equipment is fully functional. If safety equipment is not fully functional, there is a danger to

- the life and well-being of the operator or third parties
- the equipment and other property of the owner/operator
- the efficient operation of the equipment

Safety equipment that is not fully functional must be repaired by an authorized specialist before the device is turned on.

Never bypass or disable safety equipment.

Safety Markings



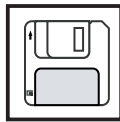
Equipment with the CE marking fulfils the basic requirements of the Guideline Governing Low-Voltage and Electromagnetic Compatibility. (For more information, please see the attachment and/or the „Technical Data“ section in your documentation).

Disposal



This device should not be disposed of in residential waste. To comply with European Directive 2002/96/EC on Waste Electrical and Electronic Equipment and its implementation as national law, electrical equipment that has reached the end of its life must be collected separately and returned to an approved recycling facility. Any device that you no longer require must be returned to your dealer or you must find an approved collection and recycling facility in your area. Ignoring this EU Directive may have adverse affects on the environment and your health.

Data Security



The user is responsible for backing up data relating to changes made to factory settings. The manufacturer will not accept liability if personal settings are deleted.

Copyright



The manufacturer maintains the copyright to these operating instructions.

Text and illustrations are technically correct at the time of going to print. The right to make modifications is reserved. The contents of the operating instructions shall not provide the basis for any claims whatsoever on the part of the purchaser. We would be grateful for any comments or suggestions regarding improvements and/or error corrections for the operating instructions.

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General

SolarNet - Basics



DATCOM / Plug-in Card Principle

SolarNet is the basis for unlimited, individual application of DATCOM components. SolarNet is a data network used to exchange data between several FRONIUS IG or Fronius IG Plus devices and DATCOM components.

The SolarNet data network operates as a ring-shaped bus system. A single data link between the individual components enables communication between one or more Fronius IG or Fronius IG Plus devices and DATCOM components. This minimizes the cabling effort for the individual DATCOM components.

DATCOM components are available as plug-in cards (similar to the PC). The Fronius IG and the Fronius IG Plus can be equipped with up to three plug-in cards within the housing.

For increased flexibility, DATCOM components are also available in versions with an external housing (box).

**DATCOM /
Plug-in Card
Principle**
(continued)

The following maximum number of DATCOM components and inverters can be connected to a total system (as of May 2008):

- 100 Fronius IG or Fronius IG Plus series inverters (a combination of different types is possible, e.g. IG 15 and IG 60 with an internal and external housing, or IG Plus 100)
- 1 Datalogger pro or easy card / box or Datalogger Web
- 10 sensor cards / boxes
- 10 public display cards / boxes
- 1 interface card / box
- 200 string controls

However, the system is designed to be easily upgradeable as new DATCOM components are developed.

Datalogger

The heart of SolarNet is the Datalogger. It coordinates data traffic and makes sure that even large amounts of data are distributed quickly and securely. In addition, the Datalogger also records data for the entire system over long periods of time.

The Datalogger is equipped with three data interfaces

- Two for direct data transmission to the PC (RS232 and USB)
- One for remote PC data queries via modem and telephone line (RS232)

The Datalogger is available in three versions.

Datalogger pro:

Datalogger pro can record data from up to 100 inverters and 10 sensor cards/boxes.

Datalogger easy:

Datalogger easy can only record data from the inverter and sensor card / box using Address 1.

Datalogger Web:

Datalogger Web can record data transmitted via the Internet from up to 100 inverters and 10 sensor cards/boxes.

Important In the rest of this manual, Datalogger pro, Datalogger easy and Datalogger Web are only referred to specifically if the information relates solely to that version. The term „Datalogger“ is used on its own for information that relates to Datalogger pro, Datalogger easy and Datalogger Web.

Com Cards

Com cards provide the data link from the Fronius IG or Fronius IG Plus to the SolarNet and to the associated DATCOM components. In addition, Com cards also offer galvanic isolation between the photovoltaic system and the inverters providing additional safety. Each inverter connected to SolarNet must be equipped with Com cards.



NOTE Every Fronius IG or Fronius IG Plus that is to be monitored requires a Com card, even if the system only contains one Fronius IG or Fronius IG Plus. In this case, the Com card serves as a link between the internal network of the Fronius IG or Fronius IG Plus and the SolarNet interface of the Datalogger.



SolarNet - Installing System Components

Safety Instructions



WARNING! An electrical shock can be fatal. Danger from mains voltage and DC voltage from solar modules.

- The connection area should only be opened by a licensed electrician.
- The separate power module area should only be disconnected from the connection area after first being disconnected from the mains power.
- The separate power module area should only be opened by Fronius-trained service personnel.

Before making any connections, make sure that the AC and DC sides are disconnected from the inverter, e.g.:

- Switch off the AC automatic circuit breaker for the inverter
- Cover solar modules

Please observe the 5 safety rules.



WARNING! An electrical shock can be fatal. Danger from residual voltage from capacitors.

You must wait until the capacitors have discharged. Discharge takes 5 minutes.

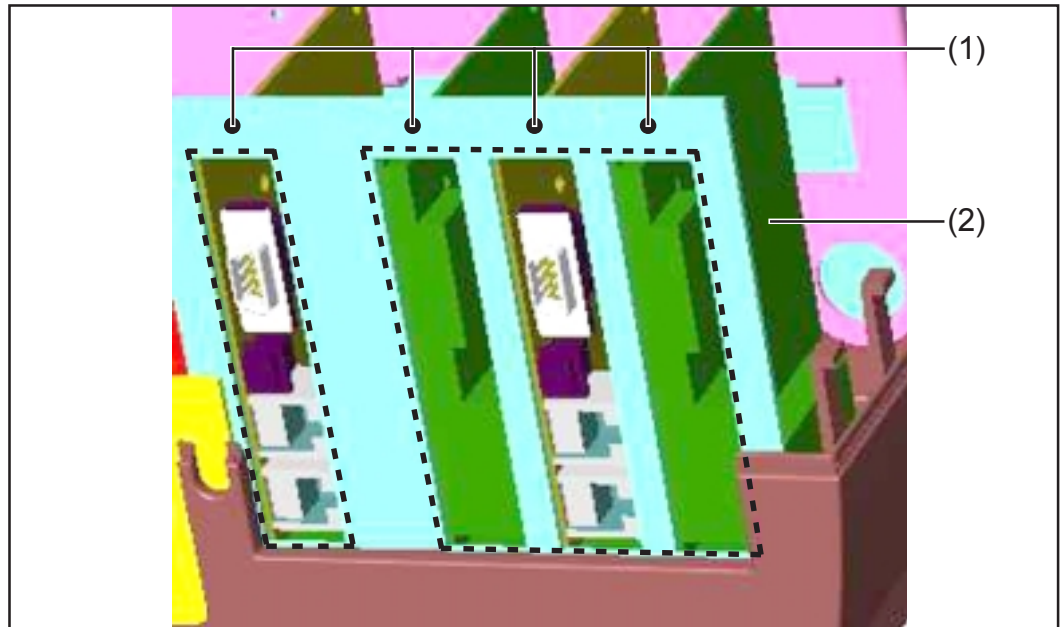


NOTE! Follow general ESD precautions when handling plug-in cards.

Installing Plug-in Cards Fronius IG

To install plug-in cards, proceed as follows:

- Set the Fronius IG to „Standby“ (see „The Setup Menu“ in the Fronius IG operating instructions)
2. Disconnect the Fronius IG from both the AC and DC-sides
3. Open connection area - see „Opening Housing“ in the Fronius IG operating instructions
4. Slide the display to the left, lift up and remove.
5. Loosen the fixing screw (1) from a free slot and remove the slot cover



NOTE Plug-in cards may be damaged. Follow general ESD precautions when handling plug-in cards.

In general, each plug-in card will fit into each slot. However, we recommend the following:

- ENS card (only required in specific countries):
 - When using all card slots:
Insert the Com card into the farthest slot on the right
Insert the remaining plug-in cards into the center slots
 - When not using all card slots: Insert plug-in cards as required
- ENS card not present:
 - Insert the Com card into the farthest slot on the left
 - Insert the remaining plug-in cards as required
- Insert plug-in card (2) into the slot
- Secure plug-in card (2) using fixing screw (1)
- Close housing
- Connect AC and DC lines to the Fronius IG

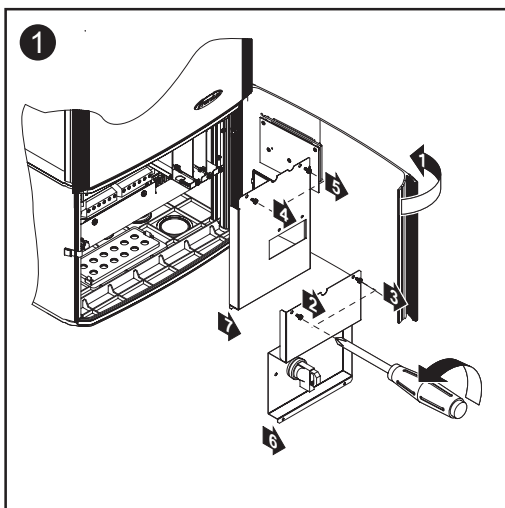
Installing Plug-in Cards Fronius IG Plus

The following describes how to replace plug-in cards for the Fronius IG Plus. The Fronius IG Plus can be equipped with three plug-in cards.

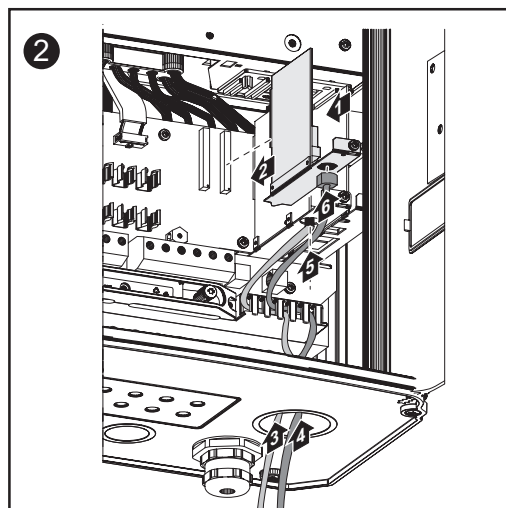
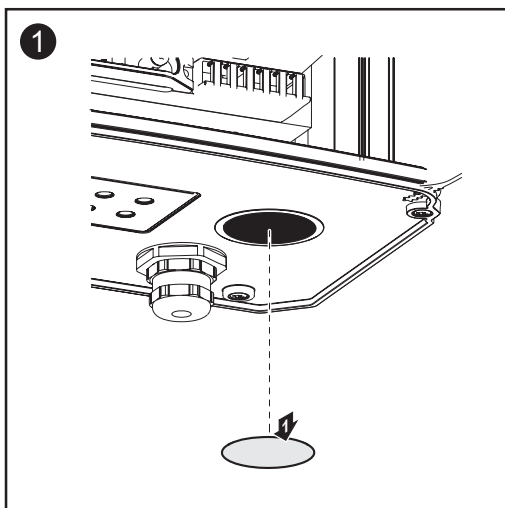
Opening Fronius IG Plus



WARNING! An electrical shock can be fatal. Danger from mains voltage and DC voltage from solar modules. When adding plug-in cards to the Fronius IG Plus, please follow all inverter safety instructions and information.

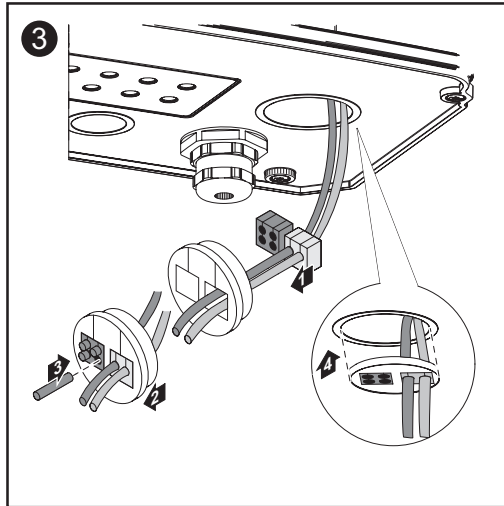


Inserting Plug-in Cards



Important Depending on the number of plug-in card cables, please use the corresponding square sealing inserts.

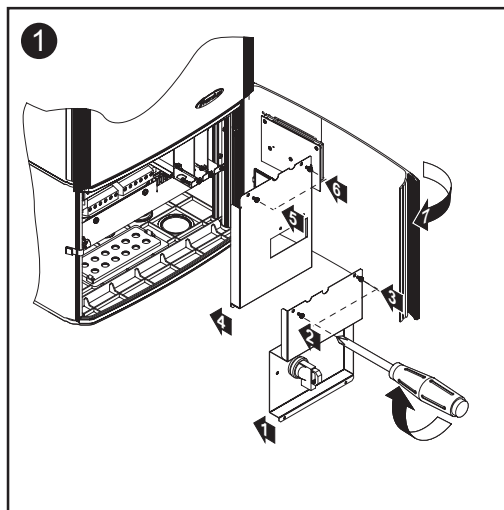
Inserting Plug-in Cards (continued)



Square sealing inserts are part of the plug-in card scope of delivery.

The round sealing insert is included in the Com card option scope of delivery.

Closing Fronius IG Plus

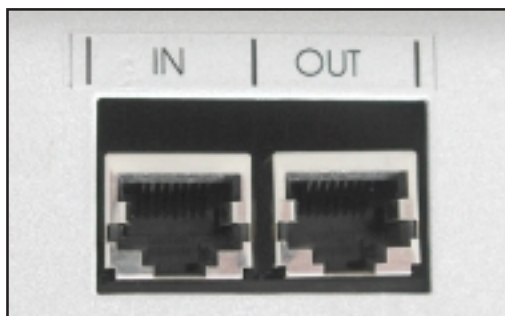


DATCOM Components with External Housing

DATCOM components with an external housing are designed in accordance with protection class IP 20. For this reason, they are suitable for interior applications only or must be placed in an appropriately rated weather-proof housing.

Cable Connection

Plug-in cards communicate within the Fronius IG or Fronius IG Plus via its internal network. External communication (SolarNet) takes place via the Com cards. Each Com Card is equipped with two RS-485 interfaces - an input and an output. The input is labeled „IN“ and the output is labeled „OUT.“

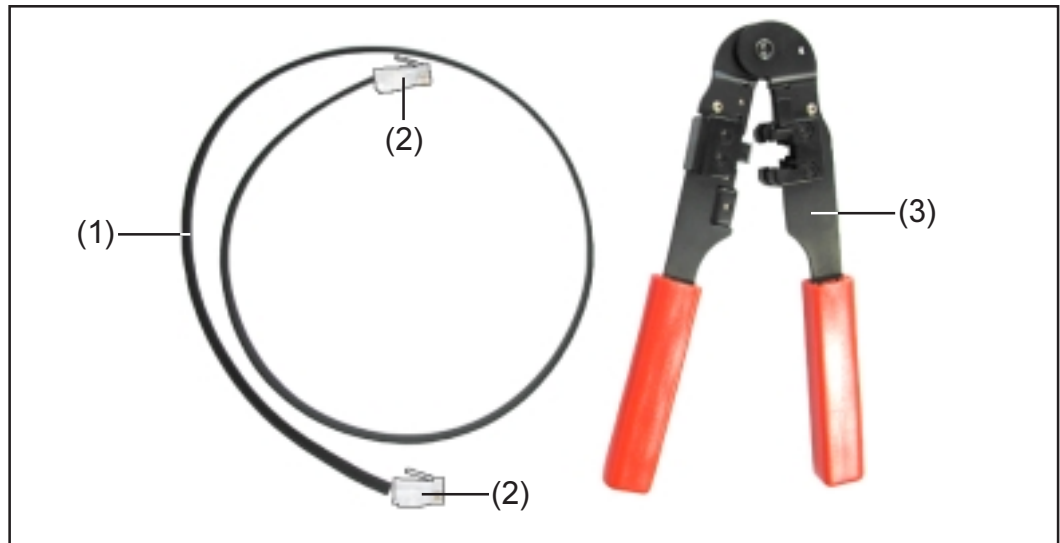


DATCOM components with external housings are also equipped with an input „IN“ and output „OUT“ for data communication within the network.

A Fronius IG or Fronius IG Plus with a Com card or DATCOM component with an external housing will be referred to as a SolarNet client in the following.

Data Cable

The data connection for the SolarNet client uses 8-pin data cables (1:1-connection) and RJ-45 plugs. A commercially-available crimping tool can be used to easily adjust the cable to the desired length.

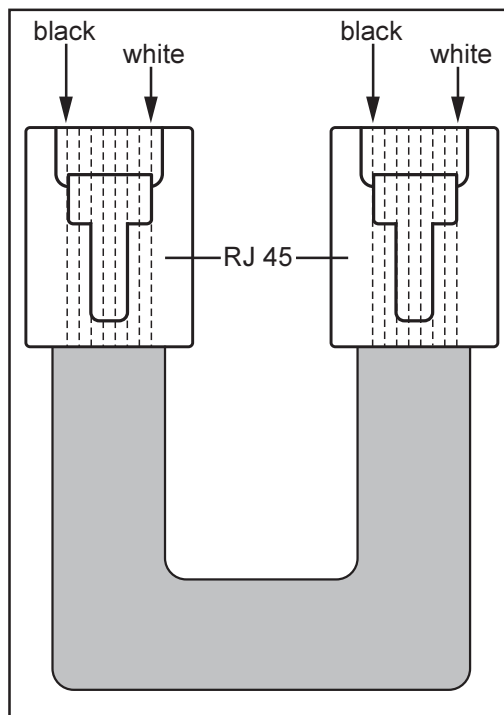


This requires:

- (1) One 8-pin ribbon cable
- (2) Two RJ45 plugs (8-pin telephone plug)
- (3) One crimping tool

The items mentioned above are available from Fronius under the following item numbers:

- (1) 8-pin ribbon cable 100 m (328 ft) roll (40,0003,0384)
- (2) RJ 45 plug (43,0003,0815)
- (3) Crimping tool (42,0435,0019)



Proceed as follows to assemble the data cables:

- Shorten cable to the desired length using the crimping tool
- Insulate outer insulation of the cable ends using the crimping tool

NOTE When fitting RJ45 plugs, please note the following: The wires must have the same position in both plugs (e.g. black = PIN1, white = PIN8)

- Insert RJ45 plug

Data Cable (continued)

For increased data security in an insecure environment, we recommend an 8-pin 1:1 LAN network cable (e.g. CAT5 cable, screened and twisted) as an alternative to the ribbon cable. These cables can be obtained from Fronius pre-assembled:

- CAT5 cable 1 m - 3.28 ft - (43,0004,2435)
- CAT5 cable 20 m - 65.6 ft - (43,0004,2434)
- CAT5 cable 60 m - 196.8 ft - (43,0004,2436)

If you would like to assemble these twisted cables yourself, it is vital that you adhere to the following pin assignment for the RJ45 plug:

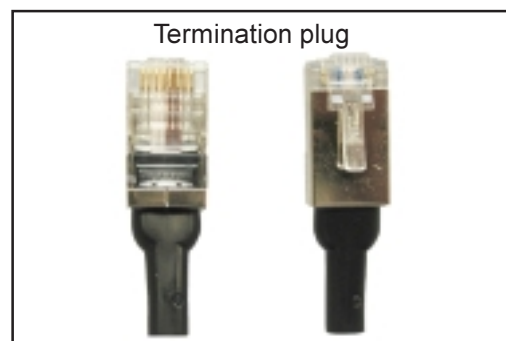
- Pin 1: +12V (white/orange)
- Pin 2: GND (orange)
- Pin 3: RX+ (white/green)
- Pin 4: TX+ (blue)
- Pin 5: TX- (white/blue)
- Pin 6: RX- (green)
- Pin 7: GND (white/brown)
- Pin 8: +12 V (brown)



NOTE Data cables are not UV resistant. They should be protected from sunlight when laid outdoors.

Cabling

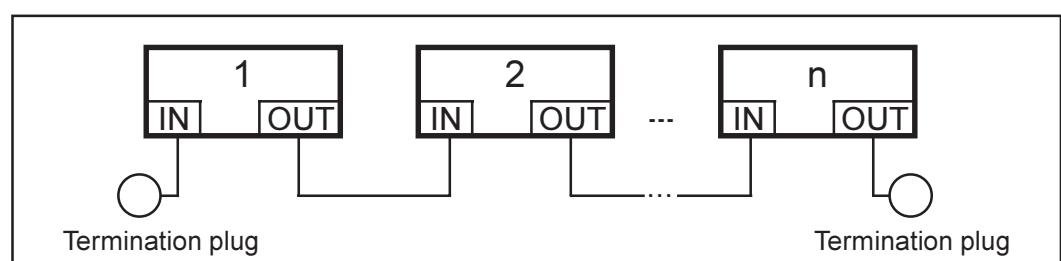
Following the cable connections described below, connect each „OUT“ socket of the previous SolarNet client to the „IN“ socket of the next client. The total individual lengths of all connection cables should not exceed 1000 m (3280 ft).



The Datalogger is equipped with two termination plugs.

Insert termination plugs as follows:

- At the „IN“ input of the first SolarNet client
- At the „OUT“ output of the last SolarNet client



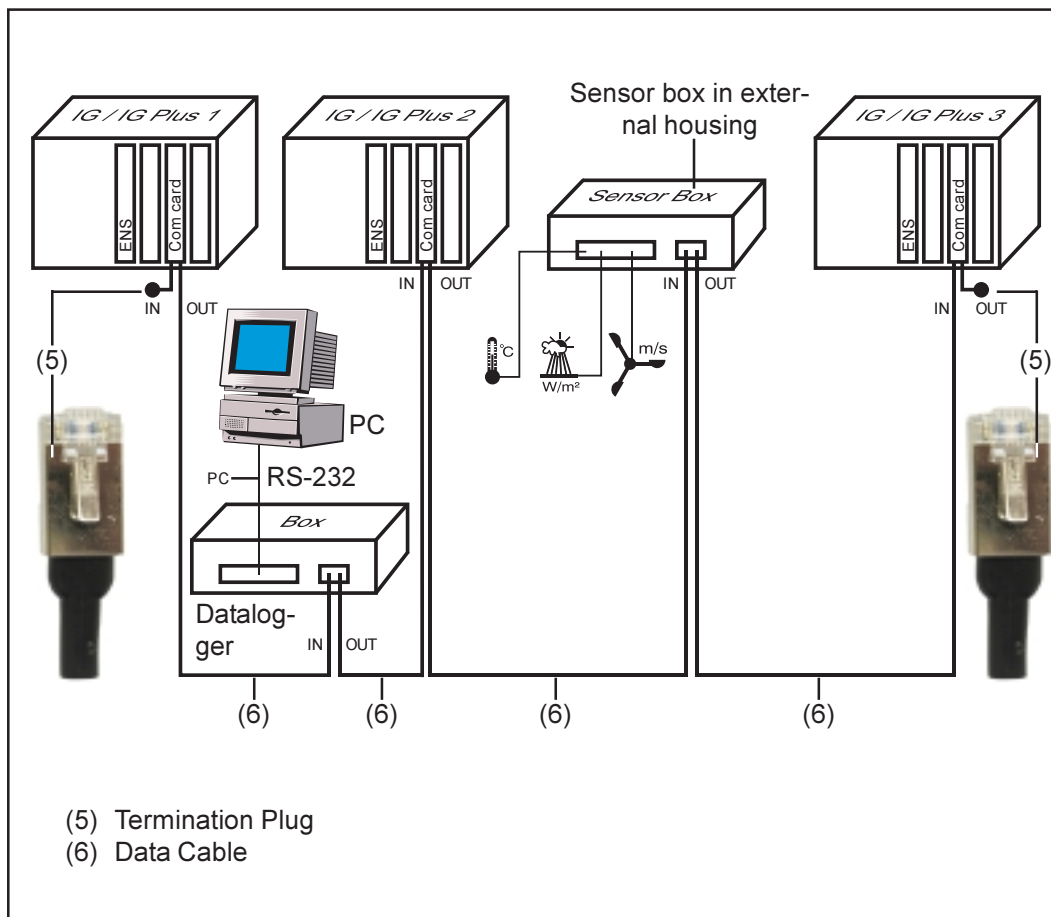
Cabling (continued)



NOTE All inputs „IN“ and outputs „OUT“ of SolarNet clients must be filled with either cable connections or termination plugs. This also applies to Com card inputs and outputs.

- In systems with only one Fronius IG or Fronius IG Plus and
- No DATCOM components in the external housing

Example of System Com- ponent Net- working on SolarNet

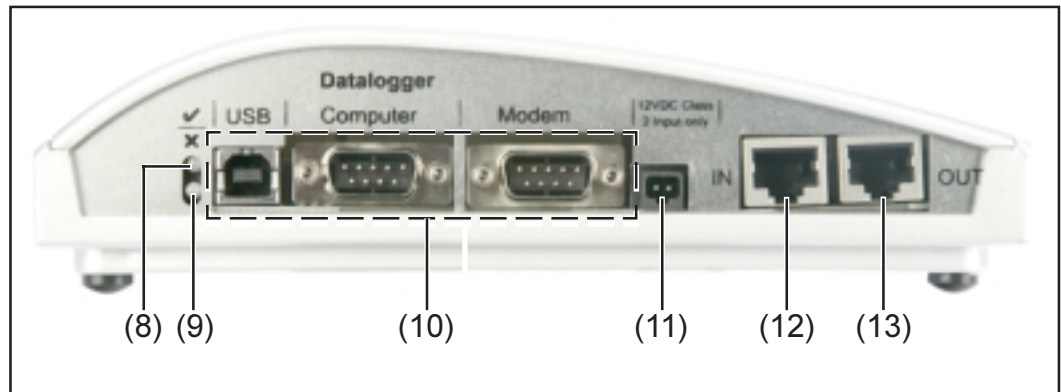


Connections and Displays

General Connections and Displays

View

Important The following figure shows the connection area for DATCOM components using the Datalogger pro box as an example. Area (13) may differ depending on the DATCOM components.



Explanation

- (8) **Green status LED** ... lights up when there is sufficient power supply to the components. When the green LED is not lit, sufficient power supply should be provided (chapter „Power Supply“).
- (9) **Red status LED** ... lights up continually when there is sufficient supply, but an error has occurred in the data communication (e.g. two sensor cards with the same address).

Also lights up when the termination plug is not inserted correctly.

Important The „red status LED“ may turn on briefly during operation. This does not indicate an error. The „red status LED“ is used for additional functions for various DATCOM components.

- (10) **Specific connections** ... depending on the functionality of the respective component.
- (11) **Power supply connection socket** ... used to connect the power pack to the power supply (chapter „Power Supply“).
- (12) **Data communication input „IN“**
- (13) **Data communication output „OUT“**

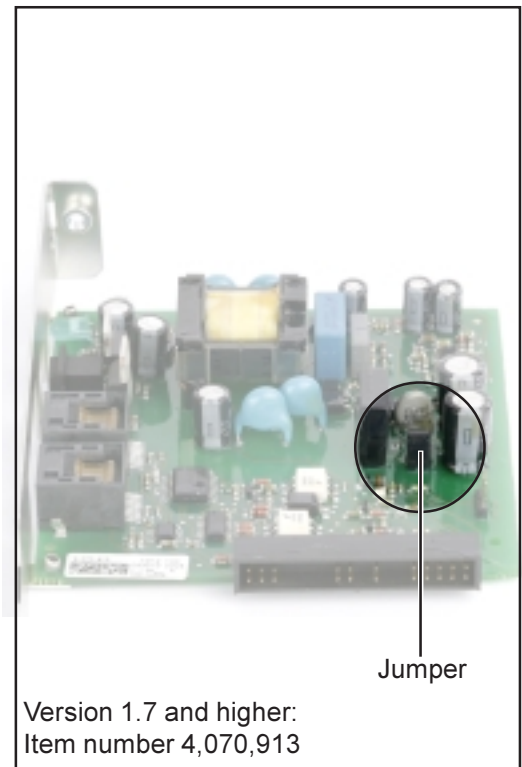
Power Supply

Supply to DATCOM Components

General

Power is supplied to DATCOM components independent of the Fronius IG or Fronius IG Plus. This ensures a power supply when there is no power from the photovoltaic modules. Power is supplied to DATCOM components via Com cards or plug-in power packs. This is particularly important when using a sensor card because this ensures that the Datalogger will be able to record all data even at night.

Com Cards



WARNING! An electrical shock can be fatal. Danger of an electrical shock due to insufficient dimensioning for US-specific mains voltages. Com cards up to version 1.4B (item number 4,070,769) cannot be used with the FRONIUS IG Plus USA.

Com Cards (continued)

Com Cards are responsible for powering DATCOM components. The integrated power supply of these Com cards is implemented via special contacts in the slot, which continue to supply power even when there is no power from the photovoltaic modules.

Com cards version 1.7 and higher are equipped with a switched-mode power supply and can be used with several supply voltages (208 V / 220 V / 230 V / 240 V / 277 V).

One Com card can supply three additional DATCOM components or one additional DATCOM component if it is located in a Datalogger Web. Because the power is supplied via the data cable, the DATCOM components in an external housing are also supplied.



NOTE When using more than 12 Fronius IG or Fronius IG Plus devices in a system, the power supply can be deactivated for individual Com cards to decrease the power consumption for the DATCOM.

- This can be done by removing the AC fuse (MST 315 mA / 250 V - see figure) or the jumper for every second Com card.
- Make sure that the powered Com cards are equally distributed in all phases.



NOTE Once cabling and installation of system components is complete, including the network connection to all Fronius IG or Fronius IG Plus devices, the green LED should light up on all SolarNet clients. If this is not the case:

- Check cable connections
- Check that all Fronius IG or Fronius IG Plus devices are connected to the network

Important Once the power has been turned on, the Com card requires approx. 10 s until the green LED lights up.

If the green LED is not lit for individual system components:

- Plug another power pack into the corresponding DATCOM component

Power Pack



Each DATCOM component (both card or box) is equipped with a 12 V power pack connection socket.



NOTE If a system only has one Fronius IG or Fronius IG Plus but more than 3 DATCOM components, the Com card in the Fronius IG or Fronius IG Plus may not provide sufficient power for all DATCOM components. This means that the green LED would not light up on all DATCOM components. In this case, the additional power pack should be plugged into one of the DATCOM components with no green LED.

The note provided above is also valid for a DATCOM component that is located in a Datalogger Web.

One power pack can supply up to eight DATCOM components. No additional supply cables are needed for this. The data communication cable is used to provide power between components.



NOTE The power pack available from Fronius was designed specifically for DATCOM components. Do not use any other power pack.

Important The scope of delivery for the power pack includes a power adapter for the following regions:

- Australia
- EU
- UK
- USA

Addressing

Defining System Components on SolarNet



General

The SolarNet will recognize different DATCOM components automatically (Datalogger, sensor card, ...). However, there is no automatic distinction between several identical DATCOM components. For this reason, each system component must have an individual number (address) to uniquely identify each system component in SolarNet (Fronius IG, Fronius IG Plus or DATCOM component).

The Fronius IG or Fronius IG Plus gives you the option to set the address directly on the display. However, some versions of Fronius IG are not equipped with a display. In this case, the address can be set via two keys. DATCOM components are equipped with a special setting wheel for addresses. A small screwdriver is required for this.

Fronius IG

Please see the Fronius IG or Fronius IG Plus operating instructions for information on address setting.

DATCOM Components General

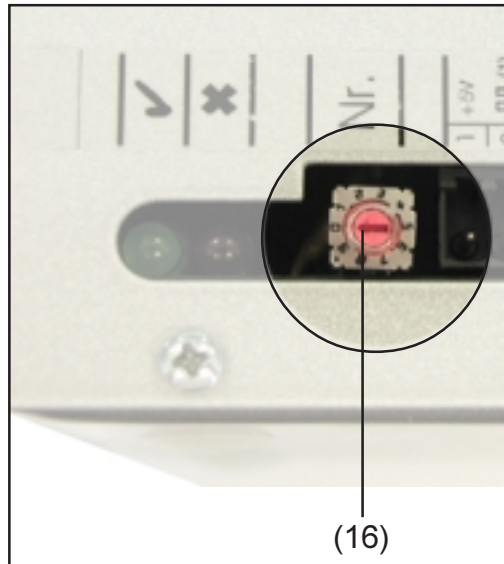


NOTE Two identical devices should never have the same address in a network.

Example:

- Permitted:
Fronius IG „Address 1,“ Sensor Card „Address 1“
- Not permitted:
Fronius IG 20 „Address 1,“ Fronius IG 30 „Address 1“

**DATCOM
Components
General**
(continued)



Proceed as follows for all DATCOM components (both card and box):

- Turn the setting wheel (16) to the desired address using a screwdriver

Important You do not have to set the address for the Datalogger because there is always only one Datalogger per system.

Detailed Description of DATCOM Components

Available DATCOM Components

General

The following DATCOM components are currently available (as of May 2008):

These operating instructions deal with the following hardware:

- Datalogger
- Com Card
- Sensor Card / Box
- Public Display Card / Box
- Interface Card / Box

The following hardware are dealt with in their own separate operating instructions:

- Datalogger Web
- String Control

Software

- Solar.access
- Solar.web

General (continued)

Important „Solar.access“ is only dealt with briefly in these operation instructions. For a more detailed explanation of the functions of „Solar.access“ and „Solar.web,“ please see the respective help.

Datalogger



General

The Datalogger is available as a card or box. The Datalogger is required for networking several DATCOM components with the Fronius IG or Fronius IG Plus.



NOTE The entire network may not contain more than one Datalogger.

The Datalogger is available in the following versions

- Datalogger pro as card and box
- Datalogger easy as card or box
- Datalogger & Interface as box
- Datalogger Web

As the only system component with a real-time clock, the Datalogger is responsible for system management. It continuously identifies which devices are in the system and regulates the data traffic between the individual system components.

The Datalogger also establishes PC connections for external data processing. In addition, Datalogger Pro and Datalogger & Interface record data from all inverters and sensor cards / boxes in the system.

Datalogger Pro and Datalogger & Interface can manage and store operating data for the following max. number of system components:

- 100 solar inverters from the Fronius IG or Fronius IG Plus series (several types may be combined, e.g. IG 15 and IG 60 with an internal and external housing)
- 10 sensor cards / boxes
- 10 public display cards / boxes
- 1 interface card / box
- 200 string controls



NOTE Datalogger easy can only record data from the inverter and sensor card / box using Address 1. The data from the remaining components are saved unrestricted.

Connections

The Datalogger is equipped with the following connections:

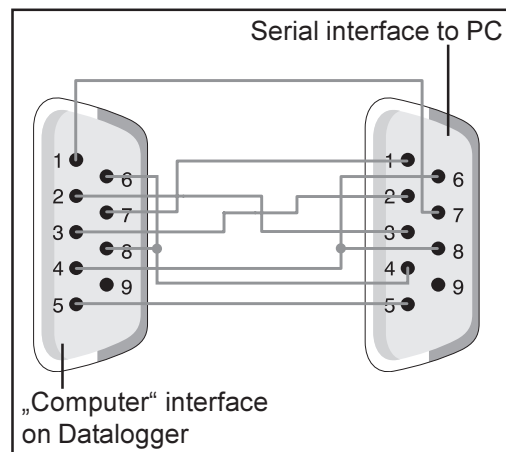
- two RS232 interfaces with 9-pin submin connections
- a USB port

The connections are used for data transmissions

- one directly to the PC
- one for remote PC data queries via modem and telephone line

The Datalogger & Interface is equipped with an additional RS 232 interface that is used to transmit operating data in another format. For more information, please see chapter „Interface Card/Box.“

Terminal assignment of connection cable between Datalogger Card and PC:



NOTE The 9-pin cable may not exceed 20 m (65.6 ft) in length.

Important The interface cable is not included with the Datalogger. A 1.8 m (5.9 ft) interface cable can be purchased from Fronius (43,0004,1692).

Please use a USB A/B cable to connect the Datalogger Box to the PC.

Please use the cable that comes with the modem to connect the modem to the Datalogger. For cable connection instructions, please see your modem's operating instructions.

General connections and display elements are described in the chapter „Connections and Displays.“

Modem

General

Different modems can be connected to the Datalogger for reading system data via modem. All modems described in the following have been tested by Fronius. The „Solar.access“ software enables easy configuration.

You can also use other 56K modems that support the V.90 standard. However, please note the following:

- Only the modems listed below are guaranteed to work correctly with the Datalogger
- When using other modems, you may be required to modify the initialization string (see chapter „Solar.access“)

1. Tixi Message Modem

The Datalogger supports various Tixi Message Modems. Message modems can be used to send service messages as a fax or e-mail. There is also an ISDN version of this modem that is also compatible with the Datalogger.

IMPORTANT When the ISDN Message Modem is connected to the Datalogger, it will only be possible to dial in with an ISDN modem.

2. US Robotics (or 3COM Courier) „V.Everything 56 K“

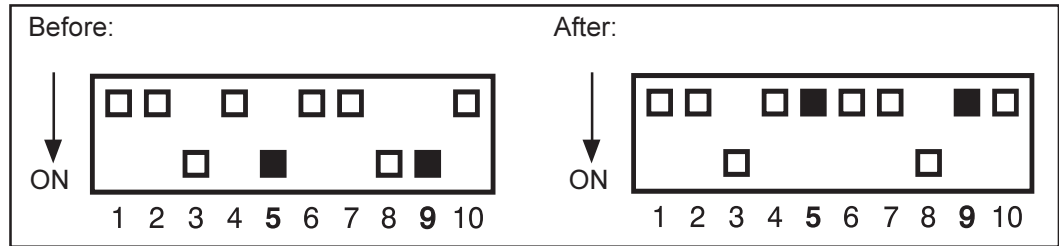


NOTE Automatic call acceptance must be activated on the modem in order to function correctly with the Datalogger.

To activate automatic call acceptance:

- Set DIP switches (5) and (9) underneath the modem to the „OFF“ position

Modem (continued)



- The „AA“ LED on the modem must light up

3. Siemens TC35i Terminal

We recommend this modem for GSM applications (EGSM 900 MHz, GSM 1800 MHz). However, given the lower data rate, communication between the Datalogger and the „Solar.access“ software is likely to be slower, particularly during data transfers and when making settings.



NOTE Deactivate the PIN request function on the SIM card before you insert the SIM card into the GSM modem.

Important An analog modem cannot connect to a GSM modem in some countries.

Using a GSM modem instead of an analog modem will rectify the situation.

Important Some SMS providers also cannot connect to a GSM modem.

Using an analog modem instead of a GSM modem will rectify the situation.

SMS messages using the Datalogger

The Datalogger has SMS capability when connected to a modem. In this configuration, the Datalogger can send an SMS to up to 3 mobile phones. In this mode, the Datalogger automatically dials into a special service offered by the telecom provider. This service is called an SMS Center (SMSC), which converts the data into a text message.

Services

The following services have been tested by Fronius:

- Germany: „D1 alphaservice“ 0049 (0) 1712521002
- Austria: „A1“ 0043 (0) 900 664914
- United Kingdom: „Vodafone“ 0044 (0) 7785 499993
- United Kingdom: „One 2 One“ 0044 (0) 7958 879889

Modem (continued)

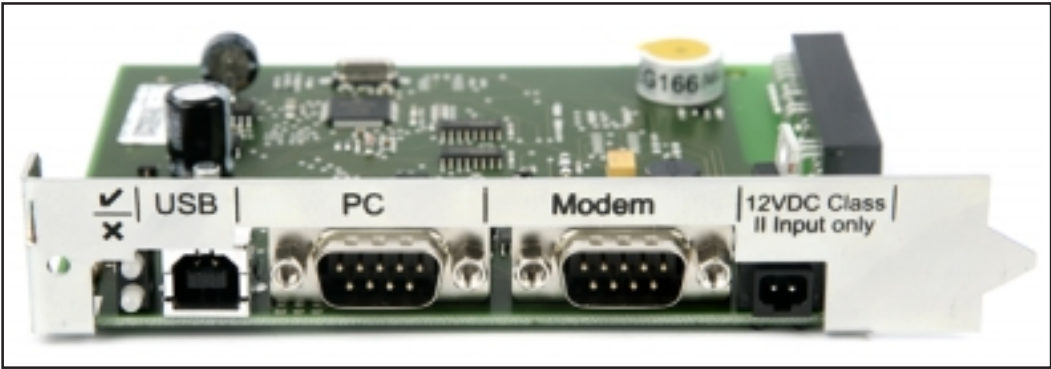
However, the services listed above do not all offer the same features. Some can only be called from within the country and others only allow a text message.

Overview of features:

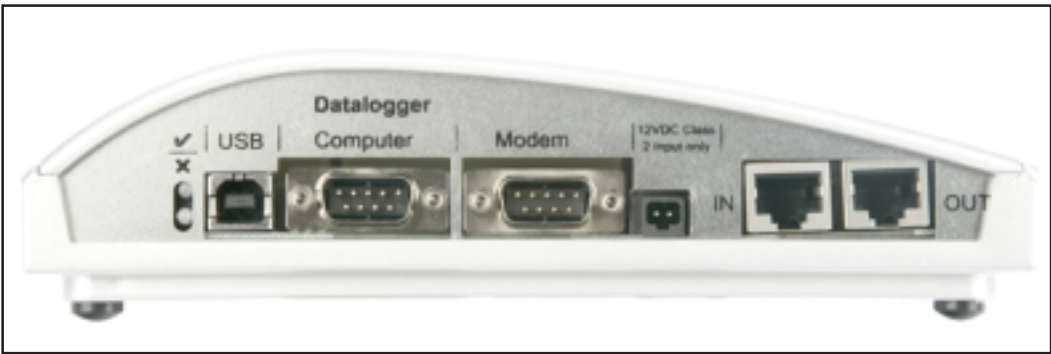
- „D1“: Can be dialed from Germany and Austria
Number of text messages: 3
Compatible with ISDN and analog telephone network
- „E-Plus“: Can be dialed from Germany and Austria
Number of text messages: 3
- „A1“: Can be dialed from Austria
Number of text messages: 3
Compatible with analog telephone networks
- „Vodafone“: Can be dialed from the UK and Austria
Number of text messages: 1
Compatible with analog telephone networks
- „One 2 One“: Can be dialed from the UK, Germany, Austria and Spain
Number of text messages: 1
Compatible with analog telephone networks



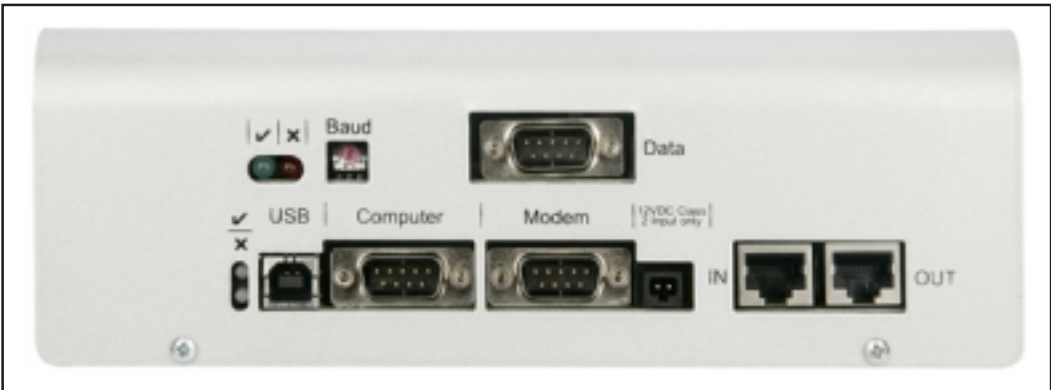
Datalogger
Card



Datalogger
Box



Datalogger &
Interface



Saving Data

The Datalogger saves the current data of all Fronius IG or Fronius IG Plus units and sensor cards / boxes integrated into the system at regular intervals. This interval can be set using the „Solar.access“ software (range of 5 to 30 minutes).

The saved data can be downloaded for further processing using a PC. The „Solar.access“ software enables efficient and organized editing, archiving and display of data.

If the system has only one inverter, the Datalogger can store data for a duration of up to 3 years (approx. 1000 days). However, this duration is reduced accordingly depending on the number of Fronius IG, Fronius IG Plus units and/or sensor cards / boxes that are integrated into the system. If the SolarNet has 10 Fronius IG, Fronius IG Plus units and/or sensor cards / boxes, this duration is reduced by a tenth (=100 days).

Important Even when the maximum number of 100 Fronius IG or Fronius IG Plus units and 10 sensor cards is used, the storage duration of the Datalogger is still $1000/110 =$ approximately 9 days (for a storage interval of 30 minutes).

Please note the following when decreasing the save interval using the „Solar.access“ software: If the interval is decreased from 30 to 15 minutes, for example, the data storage duration will be reduced by half (e.g. from 1000 days to 500 days).

Important When the Datalogger memory is full, all data is not immediately deleted. The oldest data will be continually overwritten by the newest data. The latest data at the last PC download will therefore remain in the Datalogger over the entire storage time.

Com Card

General



Com cards provide the data link from the Fronius IG or Fronius IG Plus to the SolarNet and to the associated DATCOM components. For this reason, Com cards are only available as plug-in cards. One Com card is required for each Fronius IG and Fronius IG Plus.

Connections

The Com card is equipped with two RS 485 interfaces for data transmission

- Data communication input „IN“
- Data communication output „OUT“

For more information regarding plug and cable setup for data transmission, please see chapter „SolarNet - Installing System Components.“

General connections and display elements are described in the chapter „Connections and Displays.“

Power Supply

Com cards are equipped with an integrated power supply to provide power to DATCOM components. The integrated power supply of these Com Cards is implemented via special contacts in the slot. These contacts continue to supply power even when there is no power from the photovoltaic modules. One Com card with an integrated power supply can supply three additional DATCOM components or one additional DATCOM component if it is located in a Datalogger Web.

Power Supply (continued)

Important Additional DATCOM components can be supplied even if they are located in a different Fronius IG, Fronius IG Plus unit or in an external housing.

Each DATCOM component has an LED that lights up green when there is sufficient power. The green light for the Com cards described here indicates that the integrated power supply is functioning.

 **NOTE** When a Com card is inserted and the Fronius IG or Fronius IG Plus is connected to the AC side, the green LED must light up.

If this is not the case, please check for the following errors:

- The Com card is not inserted correctly.
- The Fronius IG or Fronius IG Plus is not correctly connected to the AC side.
- There is a short circuit in the connection cables to the other system components.
- The Com card has to supply more than three DATCOM components.

If too many DATCOM components are being supplied by one Com card, proceed as follows:

- Plug a power pack into the DATCOM component lacking the green LED.

 **NOTE** If a system only has one Fronius IG or Fronius IG Plus but more than three DATCOM components, the Com card in the Fronius IG or Fronius IG Plus may not provide sufficient power for all DATCOM components. This means that the green LED would not light up on all DATCOM components. In this case, the additional power pack should be plugged into one of the DATCOM components with no green LED.

For more information about Com cards, please see the chapter „Power Supply.“

Com Card Power Output

The output of a Com card with an integrated power supply for additional DATCOM components is approx. a max. of 3 W (depending on the mains voltage).

 **NOTE** At particularly weak points in the grid (where the AC voltage is less than 200 V), one Com card may only be able to supply two additional DATCOM components or only one additional DATCOM component if it is located in a Datalogger Web.

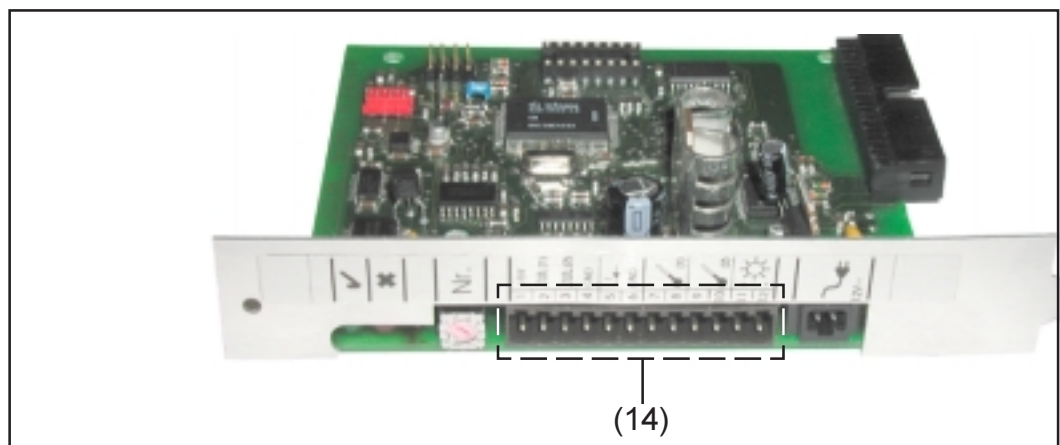
Sensor Cards

General

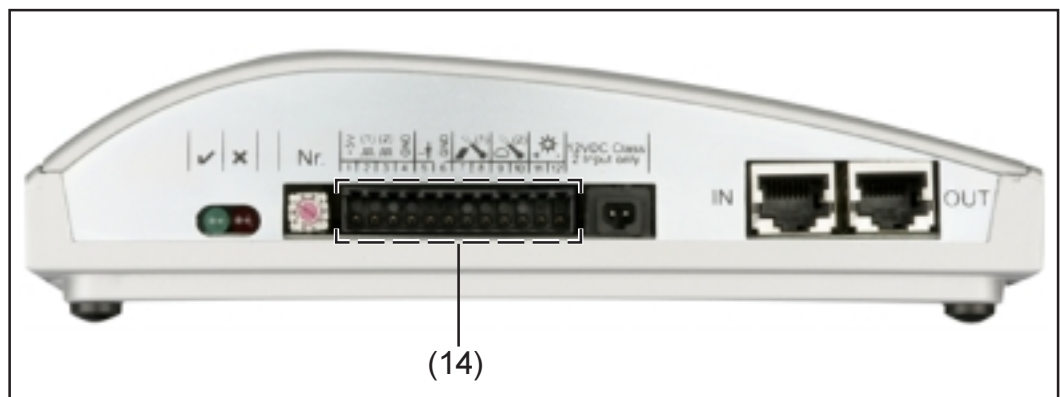
The sensor card is available as a card or box. The sensor card / box is equipped with inputs for a total of six measurement signals:

- Two analog inputs for two PT1000 temperature sensors
- One analog input for analyzing a voltage signal from an irradiance sensor
- Two digital inputs, e.g. for a power consumption sensor and a wind speed sensor
- One analog input for analyzing a current signal (0 to 20 mA, 4 to 20 mA)

Sensor card



Sensor Box



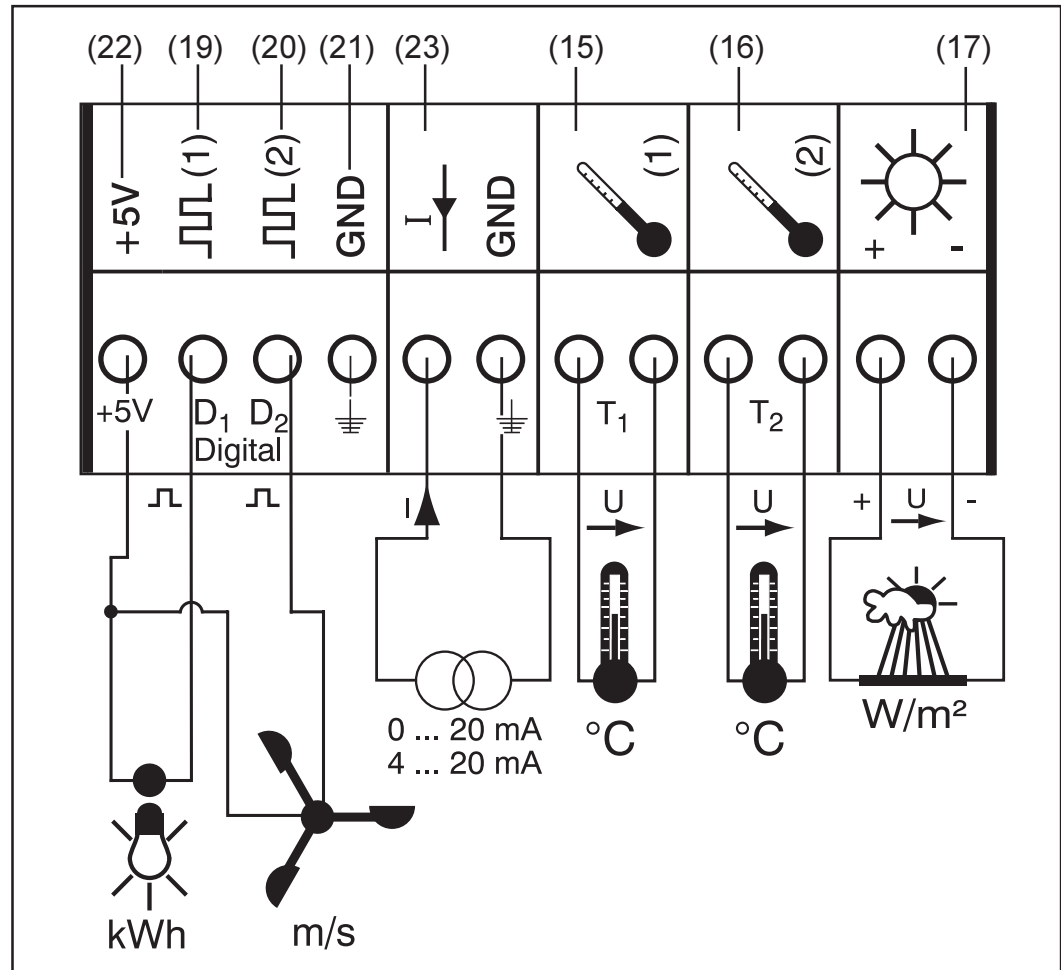
Connections

General connections and display elements are described in the chapter „Connections and Displays.“

(14) Connection area for measurement signal inputs. Screw-type terminals are used to connected the sensor wires.



NOTE The maximum cross section of the sensor wires at the screw terminals should not exceed 1.5 mm² (AWG 17).



The following describes in detail each measurement signal input in the connection area. Fronius also offers ready-made sensors for measuring ambient temperature, module temperature, irradiance, wind speed and energy.



NOTE Each measurement signal input must be activated and configured before use via the „Solar.access“ software. Activated inputs will always be associated with a corresponding sensor. Unassigned inputs will be accessed by the Datalogger. This could result in a misleading value for the parameter that is not based on a measurement signal.

Channels T1 / T2

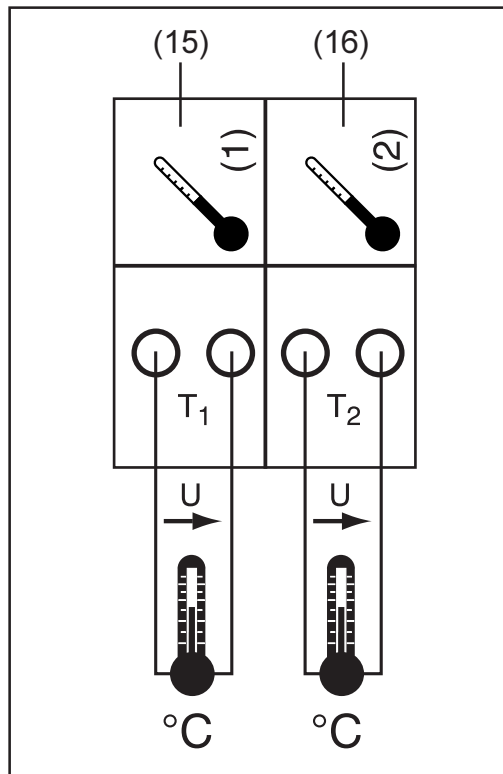
General explanation:

Channels T1 (15) and T2 (16) are used for temperature measurements using PT1000 temperature sensors.



NOTE PT 100 temperature sensors are not permitted.

The analysis can take place on the display of the Fronius IG or Fronius IG Plus as well as via the „Solar.access“ software. Channel T1 is used for module temperature and channel T2 is used for ambient temperature.



Channel assignment example:

- Channel T1 (15) for module temperature
- Channel T2 (16) for outside temperature

Functional principle:

- Temperature sensors consist of resistors that change their resistance value in response to changes in temperature
- The sensor card / box measures the voltage drop at the resistor when a constant current is flowing through the resistor
- The sensor card calculates the temperature from this voltage drop

Setup and installation example:

Temperature measurement at solar modules using PT1000 temperature sensor at connection T1 (15).

- Attach PT1000 temperature sensor to solar module
- Connect PT1000 temperature sensor to T1
- Activate channel T1 (15) via the „Solar.access“ software
 - Assign desired channel name (e.g. „Module Temperature“)
 - Select unit (°C / °F)

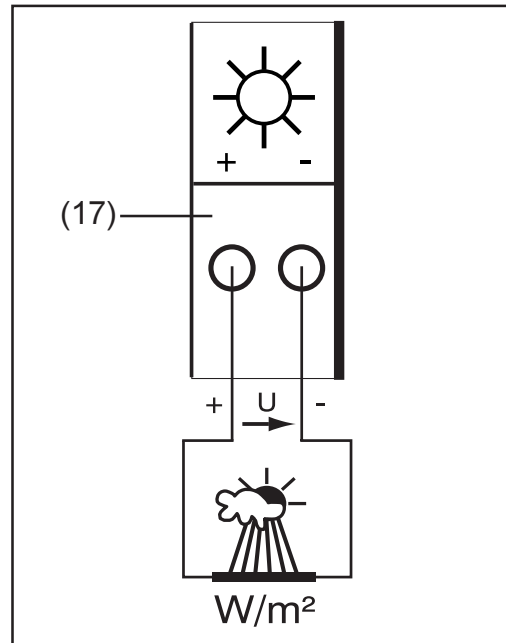


NOTE The length of the sensor cable should not exceed 20 m (65.6 ft) so that measurement results are not distorted.

Analog Input for Voltage Signal

General explanation:

The analog input (17) is used to analyze a voltage signal from an irradiance sensor. The analysis can take place on the display of the Fronius IG or Fronius IG Plus as well as via the „Solar.access“ software.



Channel assignment example:

- Irradiance sensor at solar module level

Functional principle:

- An irradiance sensor with a voltage signal is an active sensor that sends out voltage that rises as the irradiance increases.
- The sensor card / box measures the voltage between both connections of the analog input (17).
- The irradiance level is derived from the measured voltage.

Specific values:

The sensor card has three measuring ranges at the analog input (17).

Select the measuring range using the „Solar.access“ software

- Measuring range 1 ... 0 to 100 mV
- Measuring range 2 ... 0 to 200 mV
- Measuring range 3 ... 0 to 1000 mV

Important Enter the conversion factor using the „Solar.access“ software so that the sensor card can convert from mV to the desired unit. The conversion factor depends on the irradiance sensor and is specified in the sensor datasheet (e.g. 70 mV corresponds to 1000 W/m²).

Setup and installation example:

Measurement of solar radiation at the solar modules using an irradiance sensor at the analog input (17).

- Attach irradiance sensor parallel to the solar modules
- Connect irradiance sensor to the analog input (17)
- Activate the analog input (17) via the „Solar.access“ software
 - Assign desired channel name (e.g. „Solar Radiation“)
 - Set measuring range
 - Enter conversion factor



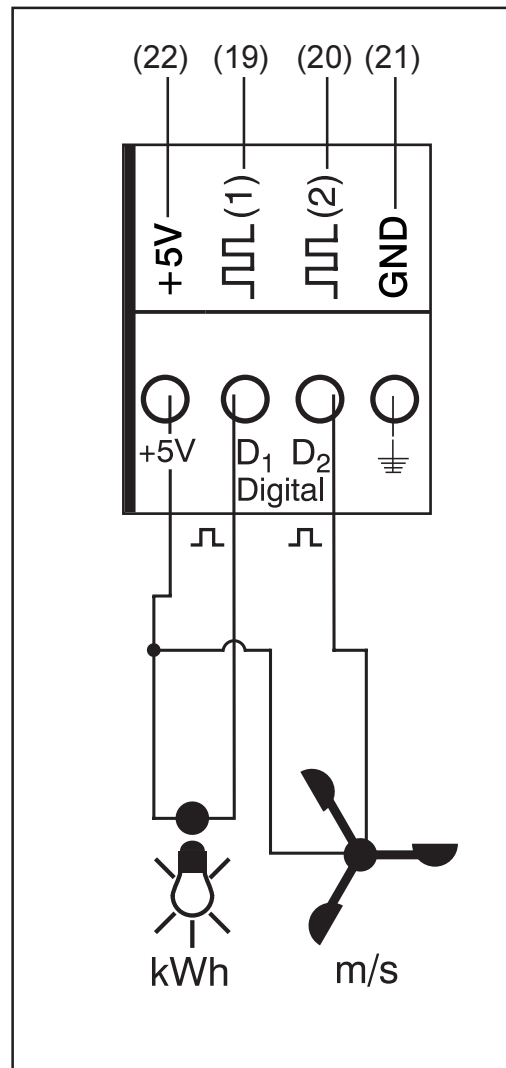
NOTE The length of the sensor cable should not exceed 30 m (65.6 ft) so that measurement results are not distorted.

Digital Inputs

General explanation:

Digital inputs D_1 (19) and D_2 (20) are used to analyze voltage pulses (e.g. electricity meter). Sensor data is analyzed using the „Solar.access“ software.

When a sensor is connected to one of the sensor card / box digital channels (19), (20), the signal can also be analyzed on the Fronius IG or Fronius IG Plus display.



Channel assignment example:

- Channel D_1 (19) for electricity meter
- Channel D_2 (20) for wind speed sensor

Connect sensors without their own power supply to:

- D_1 (19) or D_2 (20)
- „+ 5 V“ (22)

Connect sensors with their own power supply to:

- D_1 (19) or D_2 (20)
- „GND“ (21)

Functional principle using electricity meter as an example:

- The sensor card / box counts the pulses of the electricity meter
- The sensor card calculates the kWh being used from the number of pulses
- You need to set the conversion factor using the „Solar.access“ software (e.g. 10,240 pulses = one kWh)

Functional principle using wind speed sensor as an example:

- The sensor card counts the pulses of the wind speed sensor
- The sensor card calculates the wind speed per second from the number of pulses
- You need to set the conversion factor using the „Solar.access“ software (e.g. 7 pulses/second = one km/h)

Digital Inputs (continued)

Setup and installation first example:

Measuring the energy used via the electricity meter at channel D₁ (19).

- Install electricity meter to the corresponding AC lines
- Connect the pulse output of the electricity meter to channel D₁ (19) and „+5V“
- Activate channel D₁ (19) via the „Solar.access“ software
 - Assign desired channel name (e.g. „Power Consumption“)
 - Select unit (e.g. „kWh“)
 - Enter conversion factor

Setup and installation second example:

Measuring wind speed using wind speed sensor at channel D₂ (20).

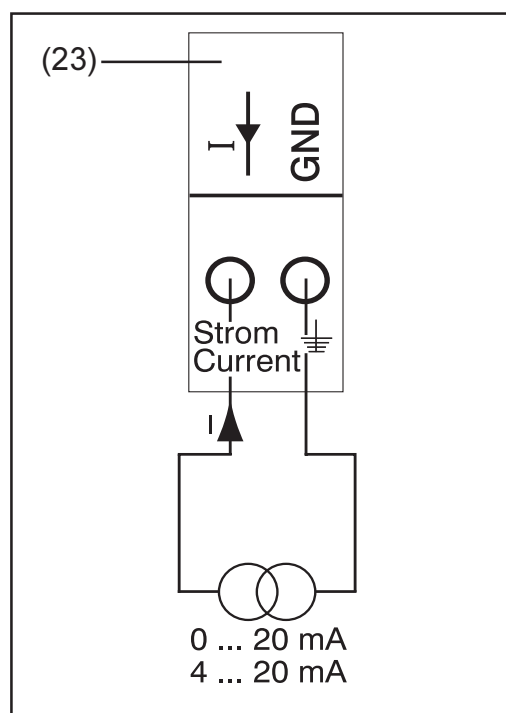
- Install wind speed sensor in the proper position
- Connect the wind speed sensor to channel D₂ (20) and „+5V“ or „GND“
- Activate channel D₂ (20) via the „Solar.access“ software
 - Assign desired channel name (e.g. „Wind Speed“)
 - Select unit (e.g. „km/h“)
 - Enter conversion factor



NOTE The length of the sensor cable should not exceed 30 m (65.6 ft) so that measurement results are not distorted.

Analog Input for Current Signal

The analog input (23) is used to connect a sensor using a standard 20 mA current interface. Analysis can only take place using the „Solar.access“ software.



Channel assignment example:

- Connecting a humidity sensor with a current signal to the analog input (23)

Functional principle:

- A humidity sensor with a current signal is an active sensor that sends out current that rises as the humidity increases.
- The sensor card the current between both connections of the analog input (23).
- The humidity level is derived from the measured current

**Analog Input
for Current
Signal**
(continued)

Specific values:

The sensor card / box has two measuring ranges at the analog input (23).

Select the measuring range using the „Solar.access“ software

- Measuring range 1 ... 0 to 20 mA
- Measuring range 2 ... 4 to 20 mA

Important Enter the conversion factor using the „Solar.access“ software so that the sensor card / box can convert from mA to the desired unit. The conversion factor depends on the sensor and can be obtained from the respective sensor datasheet.

Setup and installation example:

Measuring the humidity using a humidity sensor at the analog input (23).

- Install the humidity sensor at the proper position
- Connect humidity sensor to the analog input (23)
- Activate the analog input (23) via the „Solar.access“ software
 - Assign desired channel name (e.g. „Humidity“)
 - Select unit (e.g. „%“)
 - Set measuring range
 - Enter conversion factor

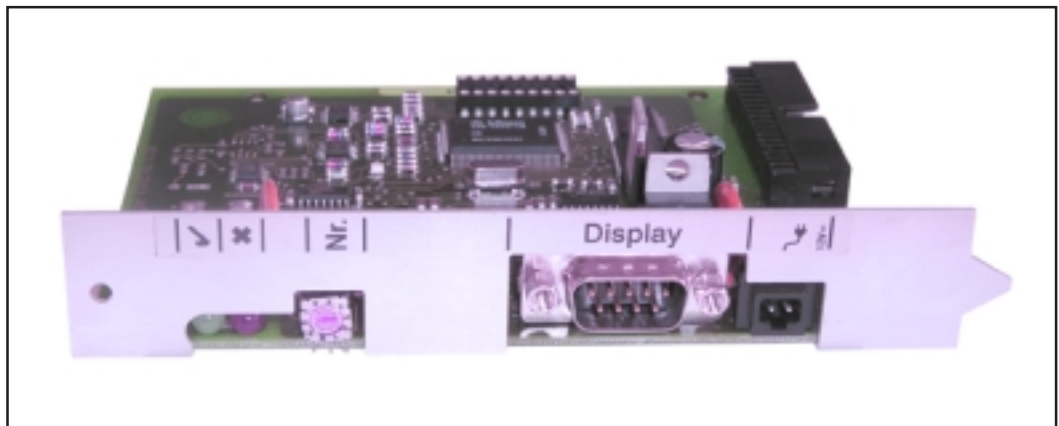
Public Display Card / Box

General

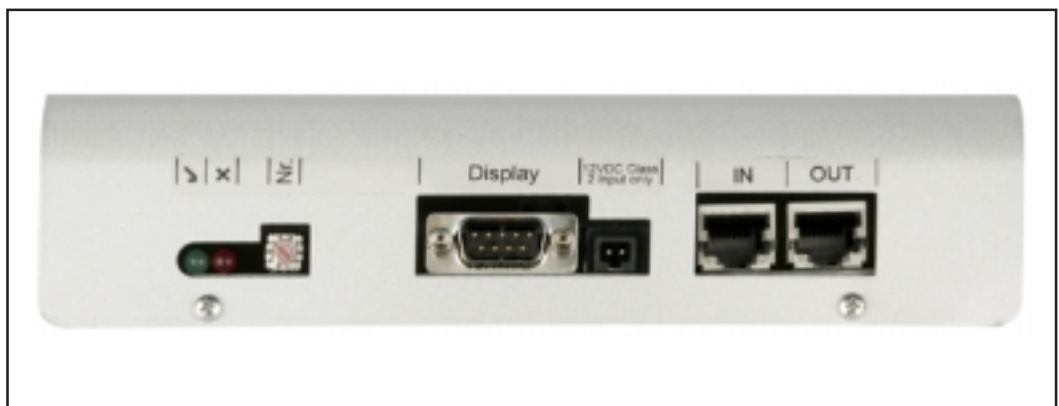
The public display card is available as a card or box. The public display card / box is used to connect different large displays. The general connections have the same function as the other DATCOM components (setting wheel for the address, socket for power supply, LEDs).

The public display card / box is equipped with a RS232 interface for a 9-pin submin plug. The 9-pin submin plug is used to connect a large display. Up to 10 public display cards / boxes can be integrated into one photovoltaic system. This means that one system can have up to 10 different large displays.

Public Display Card



Public Display Box



Configuration The public display card / box can be configured for two different display types using the „Solar.access“ software.

Display type A:

The „Display Type A“ setting is used for alphanumeric Fronius displays or Rico displays connected to the display card / box. The public display card / box is programmed to recognize the display type automatically. No other settings are required.

Important If the display is to show the irradiance, module temperature or outside temperature values, the corresponding sensors must be connected to the sensor card / box with address 1.

Additional, optional settings may also be made using „Solar.access.“ Detailed information on settings options can be found in the chapter „Solar.access.“

Important The public display card is already integrated into the Fronius Public Display, which reduces the cabling effort considerably.

Display type B:

When the „Display Type B“ setting is selected, the public display card / box sends a defined data record via the serial interface.

Interface parameters:

- 2400 Baud
- 8 data bits
- 1 stop bit
- No parity
- Handshake off

The data record contains the following values:

- Total energy (kWh)
- Today's energy (kWh)
- Current output (kW)
- Irradiance (W/m²) only available when a corresponding sensor is connected to the sensor card / box with address 1.

The data record output corresponds to the following format:

- Total energy: 6-digit, no decimal point, in kWh
- Today's energy: 4-digit, no decimal point, in kWh
- Current output: 4-digit, two before and two after the decimal point, in kW (the decimal point is not transferred since it is always in the same place)
- Irradiance: 4-digit, no decimal point, in W/m²

Configuration (continued)

The data record is made up of ASCII characters (97 bytes) and is structured as follows:

- Start: #
- Total energy: 6 bytes
- Today's energy: 4 bytes
- Output: 4 bytes
- Empty field: 16 bytes, 20 hex
- Empty field: 2 bytes, 30 hex
- Irradiance: 4 bytes
- Empty field: 2 bytes, 30 hex
- Empty field: 56 bytes, 20 hex
- End : CR LF

Leading zeros are not suppressed.

Important For „Insolence“: If no corresponding sensor is available, then this value will be treated as a „0 W / m²“ measured valued.

Interface Card / Box

General

The interface card / box is available as a card or box and is used to transmit various system data in a freely accessible format. The communication interface is RS 232 for a 9-pin submin plug.

The following can be integrated into one system:

- Interface Card / Box or
- One Datalogger & Interface

Transferable data (serial interface)

Inverter: Pac, Uac, Iac, fac, Udc, Idc, Eac

Sensors: The values from temperature, irradiance and digital channels of all sensor cards / boxes in the system

For a detailed protocol description, please go to www.fronius.com.

The baud rate can be set via the „Baud“ adjuster on the device:

Adjuster setting	Speed (baud)
0	2400
1	4800
2	9600
3	14400
4	19200

Important A setting of 5 - 9 on the „Baud“ adjuster means a speed of 2400 baud.

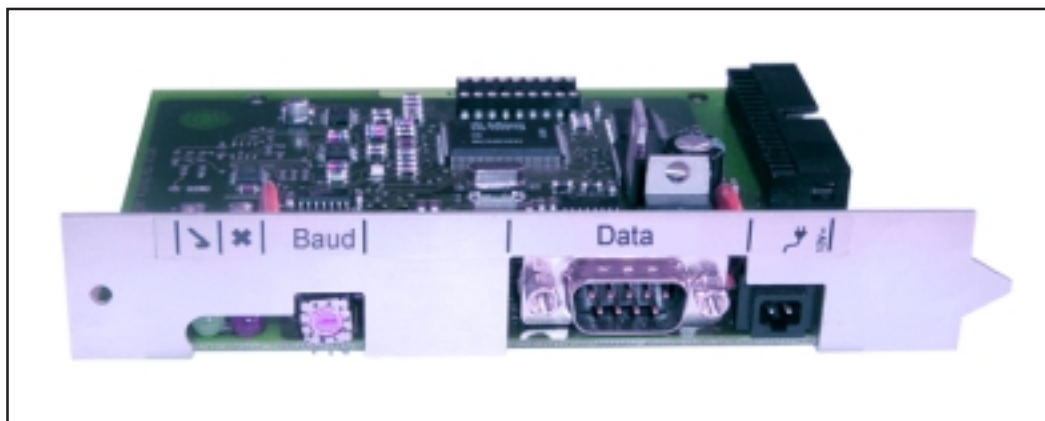
RS 232 pin assignment

2: RxD

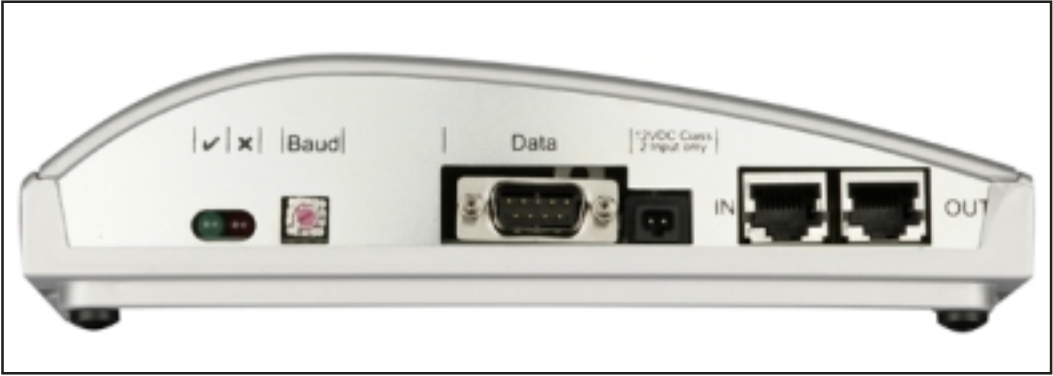
3: TxD

5: GND

Interface Card



Interface Box



„Solar.access“ Software

General

The „Solar.access“ software is the user interface to your photovoltaic system. „Solar.access“ communicates as follows with your photovoltaic system

- via Ethernet through Datalogger Web
- via USB, RS 232 or an analog modem through Datalogger easy / pro

„Solar.access“ can be used for the following for your photovoltaic system

- It can change parameters for all inverters and DATCOM components
- It can display current data for all inverters, sensors and string controls
- It can download saved archived data from the Datalogger and display it graphically

Properties

- Graphical analysis of archived data
- Graphical display of current data
 - Total view
 - Comparison view
 - Detailed view of inverters
 - String control
 - Sensor view
 - Component view
- Total view of all systems / system comparison
- Automatic download
- Export function of archived data to Excel files
- It can send an energy report automatically as an Excel file via e-mail
- It can send an energy comparison / service messages via e-mail
- Configuration for Fronius IG / Fronius IG Plus
- DATCOM component

System Requirements

„Solar.access“ has the following hardware requirements

Min. requirements:

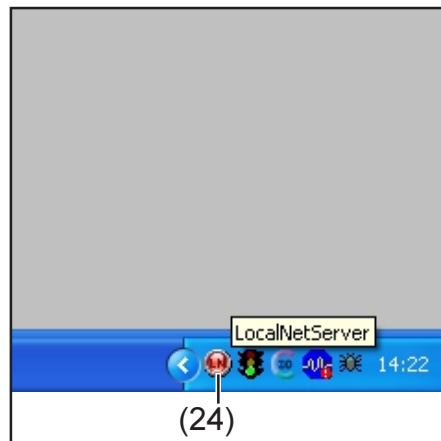
- 600 MB free hard disk space
- CD-ROM drive
- Datalogger Web: Ethernet connection
- Datalogger easy / pro: USB, RS232 or analog modem
- MS-Windows compatible mouse
- The following operating systems are suitable:
 - Microsoft Windows 2000 SP4
 - Microsoft Windows XP
 - Microsoft Windows Vista
 - Internet Explorer 6 or higher

Recommended requirements:

- PC with Pentium 4 (1.3 GHz)
- 1024 MB RAM

Installing the Modem

An analog modem must be installed in the PC in order to be able to access your Datalogger remotely. If you already have an analog modem installed on your PC, you can skip this step.



NOTE If „Solar.access“ is already installed, proceed as follows:

- Close „Solar.access“
- Click on the the SolarNet Server icon (24) using the right mouse button and close the SolarNet server

Important Once you have installed a modem, you will be able to use all „Solar.access“ functions - even from a remote location.

Installing Solar.access

„Solar.access“ installation is mostly automatic and requires no previous knowledge.

1. Close all applications and programs on your PC
2. Insert the CD-ROM that came with the Datalogger into the drive
3. Select the „Fronius Solar.access“ folder
4. Start the „setup.exe“ file contained therein
5. Follow the instructions of the installation software (Wizard)

The selection window for the required database appears.

6. Select the recommended database from the selection menu

Establishing Datalogger / PC Connection

- Connect the Datalogger to a serial or USB interface on your PC

Important Connecting the Datalogger via the USB interface requires the installation of the USB driver.

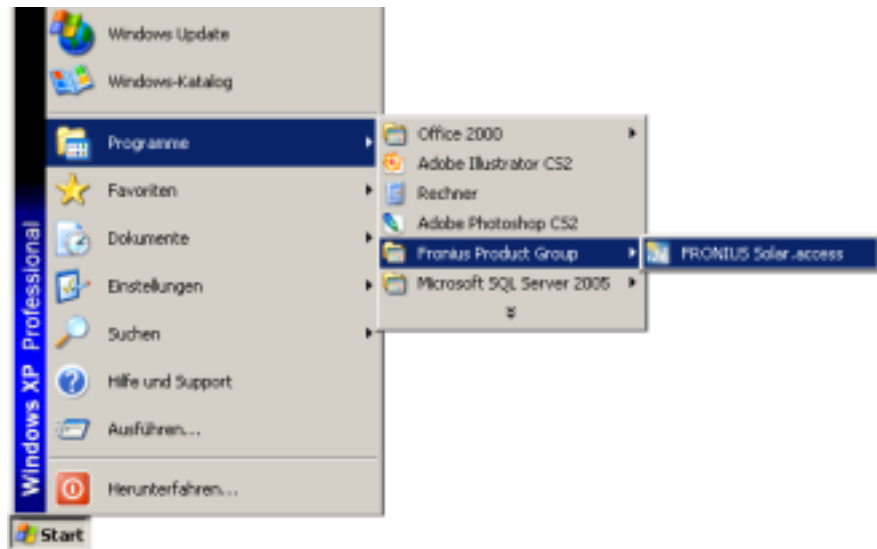
- When the Datalogger is connected via the USB interface, „New Hardware Found“ appears in the display window.
- Follow the Wizard instructions to search for the new hardware.
- The USB driver for the Datalogger is included in the scope of delivery for „Solar.access.“

If you installed „Solar.access“ to the predefined folder, the USB driver is located at „C:\ Program Files \ Fronius \ Austria \ Solar.access \ Driver \ USB.“

- Enter the path for driver installation and follow the Wizard instructions.

The USB interface is setup and „Solar.access“ is ready for use.

Starting Solar.access



„Solar.access“ is started as follows:

- „Start \ All Programs \ Fronius Product Group \ Fronius Solar.access“

You can also start „Solar.access“ from the desktop.

Importing Data from IG.access

If data is available from „IG.access,“ you can import it to „Solar.access.“
The import also takes care of archived data as well as settings.

Important Check the settings after import.

Setting up Photovoltaic Systems

To create a new photovoltaic system

- Open the „Administration \ PV Systems \ Create PV System menu



- Fill out all fields marked with a *

Datalogger Web:

1. Set connection type as „Ethernet“
2. The following settings should be made for Datalogger Web in the „IP Address“ field:
 - IP address (e.g. „192.168.1.180“)
 - or host name + domain name (e.g. „samplesystem.fronius.com“)

Datalogger easy / pro - USB:

1. Connect Datalogger
2. Install USB driver software
3. Set connection type as „USB“
4. Select the Datalogger in the „USB Connections“ field

Setting up Photovoltaic Systems

(continued)

Datalogger easy / pro - RS232:

1. Insert the Datalogger into the serial interface
2. Select the right COM port (e.g. COM1, COM2, COM3, ...)

Datalogger easy / pro - Modem:

1. Phone number of the photovoltaic system
2. Select modem - must be installed on PC

Connecting to the System

1. Open the „PV Systems“ menu and select one of the photovoltaic systems
2. Click on the corresponding photovoltaic system, the connection to the PV system will take place automatically

Exception: When using a modem, the PV system connection must take place manually.

Help

For a more detailed explanation of the functions of „Solar.access,“ please see the respective help in the software.



Technical Data

Datalogger Card / Box

Datalogger Card / Box		
Memory Capacity	540 KB	
Memory duration (1 Fronius IG or Fronius IG Plus, memory cycle 30 minutes)	approx. 1000 days	
Supply voltage	12 V DC	
Power consumption	0.4 W	
- With wireless transceiver box:	max. 0.6 W	
Box protection class	IP 20	
Dimensions (l x w x h)		
- Datalogger card:	140 x 100 x 26 mm	
- Datalogger box:	190 x 115 x 53 mm	
Datalogger card interfaces	Socket:	Description:
- USB:	USB	„USB“
- RS 232:	9-pin submin	„PC“
- RS 232:	9-pin submin	„Modem“
Datalogger box interfaces		
- USB:	USB	„USB“
- RS 232:	9-pin submin	„PC“
- RS 232:	9-pin submin	„Modem“
- RS 485:	RJ 45	„IN“
- RS 485:	RJ 45	„OUT“

Datalogger & Interface

Datalogger & Interface (Box)		
Memory Capacity	540 KB	
Memory duration (1 Fronius IG or Fronius IG Plus, memory cycle 30 minutes)	approx. 1000 days	
Supply voltage	12 V DC	
Power consumption	2.8 W	
Box protection class	IP 20	
Dimensions (l x w x h)	210 x 110 x 72 mm	
Interfaces	Socket:	Description:
- USB:	USB	„USB“
- RS 232:	9-pin submin	„PC“
- RS 232:	9-pin submin	„Modem“
- RS 232:	9-pin submin	„Data“
- RS 485:	RJ 45	„IN“
- RS 485:	RJ 45	„OUT“

Sensor Card / Box

Sensor Card / Box		
Supply voltage	12 V DC	
Power consumption		
- Sensor card:	1.1 W	
- Sensor box:	1.3 W	
Box protection class	IP 20	
Abmessungen (l x b x h)		
- Sensor card:	140 x 100 x 26 mm	
- Sensor box:	197 x 110 x 57 mm	
Interfaces (only sensor box)	Socket:	Description:
- RS 485:	RJ 45	„IN“
- RS 485:	RJ 45	„OUT“
Channels T1, T2		
- Sensors:	PT1000	
- Measuring range:	-25°C...75°C; -13°F...167°F	
- Accuracy:	0.5°C; 0.8°F	
- Resolution:	1 °C; 1 °F	
Irradiance channel		
- Measuring range:	0...100 mV 0...200 mV 0...1 V	
- Accuracy:	3 %	
Channels D1, D2		
- Max. voltage level	5.5 V	
- Max. frequency	2500 Hz	
- Min. pulse duration	250 us	
- Switching threshold „OFF“ („LOW“):	0...0.5 V	
- Switching threshold „ON“ („HIGH“):	3...5.5 V	
Channel current input		
- Measuring range:	0...20 mA 4...20 mA	
- Accuracy:	5 %	

Com Card

Com card up to version 1.4B (4,070,769)		
Supply voltage	230 V (+10% / -15%)	
Dimensions (l x w x h)		
- Plug-in card only:	140 x 100 x 33 mm	
Interfaces	Socket:	Description:
- RS 485:	RJ 45	„IN“
- RS 485:	RJ 45	„OUT“
Com card version 1.7 and higher (4,070,913)		
Supply voltage	208 V / 220 V / 230 V / 240 V / 277 V (+10% / -15%)	
Dimensions (l x w x h)		
- Plug-in card only:	140 x 100 x 28 mm	
Interfaces	Socket:	Description:
- RS 485:	RJ 45	„IN“
- RS 485:	RJ 45	„OUT“



Public Display Card / Box

Public Display Card / Box		
Supply voltage	12 V DC	
Power consumption		
- Public display card:	1.2 W	
- Public display box:	1.6 W	
Box protection class	IP 20	
Abmessungen (l x b x h)		
- Public display card:	140 x 100 x 26 mm	
- Public Display Box:	197 x 110 x 57 mm	
Interfaces	Socket:	Description:
- RS 232:	9-pole submin	„Display“
- Public display box additional:		
RS 485	RJ 45	„IN“
RS 485	RJ 45	„OUT“

Interface Card / Box

Interface Card / Box		
Supply voltage	12 V DC	
Power consumption		
- Interface card:	1.2 W	
- Interface box:	1.6 W	
Box protection class	IP 20	
Abmessungen (l x b x h)		
- Interface card:	140 x 100 x 26 mm	
- Interface box:	197 x 110 x 57 mm	
Interfaces	Socket:	Description:
- RS 232:	9-pole submin	„Data“
- Interface box additional:		
RS 485	RJ 45	„IN“
RS 485	RJ 45	„OUT“
The baud rate can be set via the „Baud“ adjuster:		
- 2400, 4800, 9600, 14400, 19200		

Warranty and Liability

Warranty Provisions and Liability

A warranty based on the general terms and conditions applies to Fronius DATCOM components. During this period, Fronius guarantees that your DATCOM component will work correctly. If a defect should occur for which Fronius is responsible, Fronius will repair the defect at the factory free of charge within the warranty period.

Please see your Fronius dealer for warranty claims.

Warranty claims will not be accepted as a result of:

- Non-intended use of your DATCOM components
- Incorrect installation and installation that is not in compliance with applicable standards or installation by unlicensed electricians
- Incorrect operation
- Unauthorized changes to DATCOM components
- Damage by foreign objects and acts of God

Warranty claims will be handled by either Fronius directly or locally by Fronius-trained service partners. For return transportation, components must be in their original or equivalent packaging.

These services will be charged to the dealer or his fitter, as will the reinstallation of the repaired device.

Scope of Warranty

This warranty only covers DATCOM components. The other components of your photovoltaic system are not covered by this warranty.

Warranty Period

24 months from date of installation.

Proof of Warranty

Purchase date on the invoice, transfer date / commissioning date and power company report.



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