

# **IPS2 24 VDC**

## **Fault Detector**



**IPS2 24 VDC is a fault detector for overcurrent and directional earth faults that indicates faults using its relay outputs and IEC 60870-5-101.**

**Since the algorithm for earth fault detection does not require a voltage transformer, IPS2 gives a very cost-efficient fault detection with high sensitivity for pass through faults in impedance earthed networks.**

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## 2 Schematic Overview

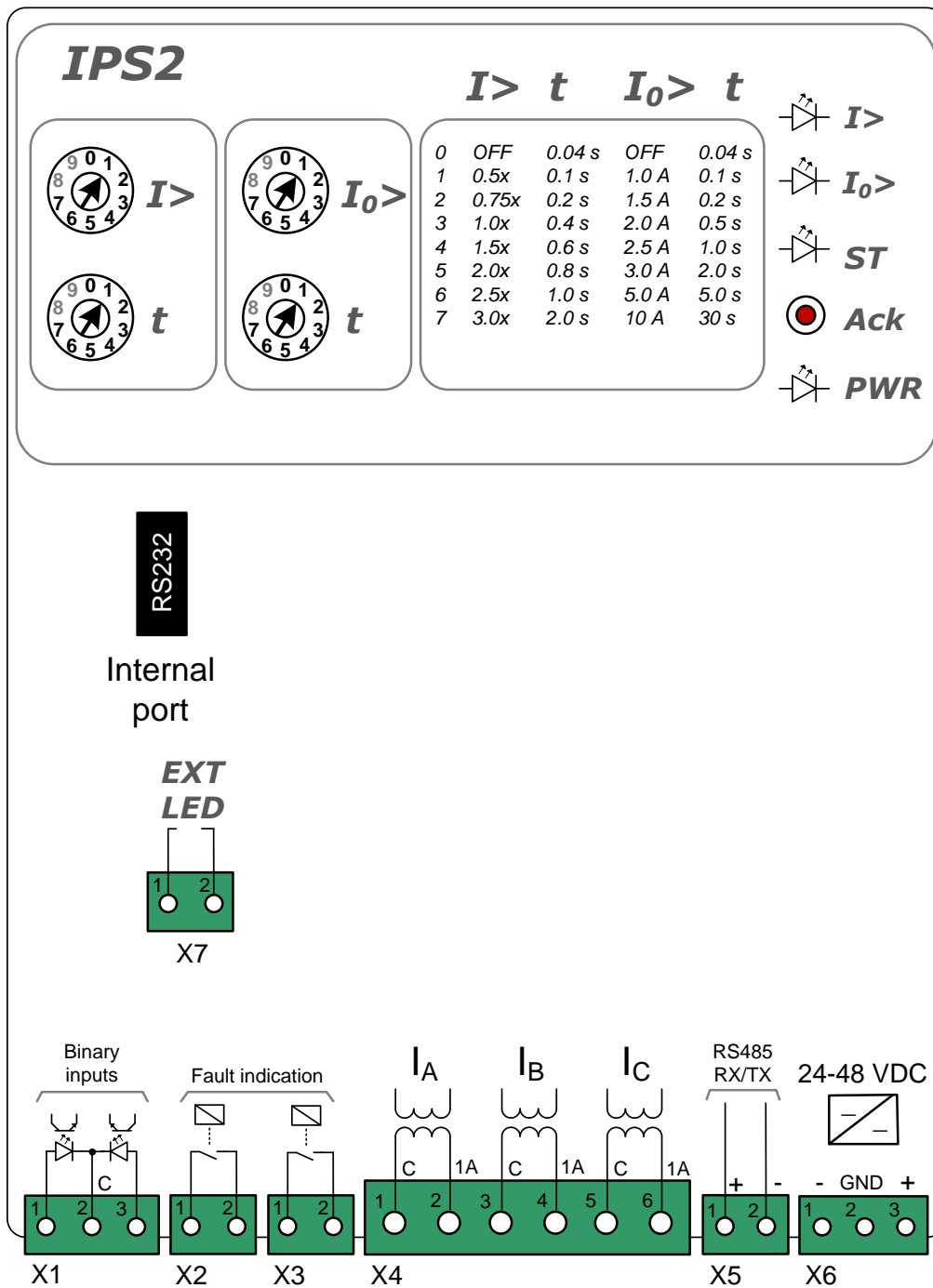







Figure 1. IPS2 24 VDC overview.

### 3 Safety Information

-  The device should be connected to a ground terminal.
-  If the cover is removed, avoid contact with the main circuit board and terminals. The unit is powered by 24 VDC but the wires to binary inputs and outputs are designed for higher signal voltages.
-  If the unit is disconnected and the cover is removed, make sure that proper precautions are made to protect the unit from electrostatic discharges.
-  When connecting and disconnecting the current terminals always short-circuit the current path to avoid open circuits!
-  Short circuiting the current terminals when the earth fault detector is enabled is likely to be interpreted as an apparent earth fault. If the EF detector has no binary input qualification enabled the IPS2 unit should either be switched off or pluggable connectors in X2-X3 should be disconnected.

*Hint: This “feature” can be used for example in a test situation when the whole chain from IPS2 to the SCADA system should be verified. When the IPS2 unit is in operation and there is a normal load current it is usually possible to activate the earth fault detector by short-circuiting one phase on the terminal screws with a short cable.*

## 4 Functional Description

### 4.1 Detector Function

#### True Fault Pass Through Earth Fault Detection

Protrol's patented Fault Pass Through earth fault detection is suitable for all indirectly earthed networks. It is capable of detecting high impedance and arcing earth faults. It analyses the transient nature of phase and neutral currents and points reliably out the fault direction with respect to the measurement point. Note that no voltage measurement is necessary for good selectivity at very low currents. The sensitivity is comparable with that of a directional earth fault protective relay.

At an earth fault the detector will set itself into **Trig** state and evaluate if the fault is upstream or downstream the unit. If the fault is downstream, it will switch to **Start** state. In this mode, the detector evaluates the  $I_0$  residual current until the *Operation Delay* has passed. If the residual is high after the set time, the detector will enter **Trip** state.

Note that both a **Start** and a **Trip** indication means that an earth fault has occurred downstream the detector. A **Start** without a subsequent **Trip** indication means that either the fault current is too low, or the fault was of transient type and was gone after the *Operation Delay* time. Thus, the **Start** object, available remotely, can be used as an early indication of an incipient fault.

Some periods after the disturbance has vanished, the detector returns to its normal state.

#### High $I_0$ Detection

The IPS2 supervision alarm for high residual current if the steady-state  $I_0$  current exceeds 16 times the  $I_0$  pickup level, as specified by the rotary switch on the front panel<sup>1</sup>.

The main purpose of this alarm is to indicate that something is wrongly connected, either wrong polarity or missing phase.

An alarm is indicated by flashing the  $I_0 >$  LED, also see the Section 5.2 IPS2 24 VDC Top Printed Circuit Board.

#### Overcurrent Detection

The IPS2 unit has one overcurrent stage that can be configured using the rotary switch at the front panel.

#### Phase Break Detection

The phase break detection alarm is activated - if one phase is "dead" while the other two are "alive", a phase break is signaled locally and on the system interface. A phase is considered "dead" if the current is lower than the  $I_0$  pickup level, and "alive" if the current is higher than 4 x the  $I_0$  pickup level.<sup>2</sup>

An alarm is indicated by flashing the  $I >$  LED, also see the Section 5.2 IPS2 24 VDC Top Printed Circuit Board.

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<sup>1</sup> If the earth fault stage is deactivated, the High  $I_0$  steady-state limit is set to 160 A.

<sup>2</sup> If the earth fault stage is deactivated, the "dead" threshold is set to 5 A while "alive" is 20 A.

## Output relays

The output power relays in the IPS detector enable direct operation of switching devices. Thus, it is possible to disconnect faults before the protection in the distribution substation reacts, minimizing the consequences for the users upstream the fault.

## Fault acknowledgement

The LEDs including the external LED can be reset either by pressing the **Ack**-button or automatically when the time of the Protrol Tool parameter *LED flashing time* has elapsed.

## 4.2 Remote Terminal Unit Function

The IPS2 unit includes a Remote Terminal Unit (RTU) function that can be employed to share Start and Trip information as well as other binary and analogue objects.

### Binary objects

There are nine objects for internal signals and the two binary inputs of the IPS2 unit that can be transmitted on the RS485 System Interface (Single Point) using the IEC 60870-5-101 protocol.

- I<sub>0</sub>> Start
- I<sub>0</sub>> Trip
- I> Start
- I> Trip
- I<sub>0</sub>> Arcing
- Phase break
- Binary Input 1
- Binary Input 2
- High residual current

### Analogue objects

Five analogue objects, three phase currents, residual current and fault detected phase, can be transmitted for supervision/ information purposes. See the Table 1 Explanation of the Protrol IPS2 24 VDC Configuration settings for more information.

### Protocol

The available protocol is:

- IEC 60870-5-101

Supported selection of ASDUs:

| Standard range |                        |   |
|----------------|------------------------|---|
| No             | Type ID                | Description                                 |
| <1>            | M_SP_NA_1              | Single-point information                    |
| <2>            | M_SP_TA_1              | Single-point information with time tag      |
| <9>            | M_ME_NA_1              | Measured value, normalized value            |
| <11>           | M_ME_NB_1              | Measured value, scaled value                |
| <13>           | M_ME_NC_1 <sup>3</sup> | Measured value, short floating point number |
| <100>          | C_IC_NA_1              | Interrogation command                       |
| <103>          | C_CS_NA_1              | Clock synchronization command               |

<sup>3</sup> M\_ME\_NC\_1 R32-IEEE STD 754

## 4.3 System and service interfaces

The IPS2 unit has a system interface for RTU communication and a service interface for handling of transient fault recorder data.

A hardware and a protocol configuration must be made to switch between the two different interfaces.

Hardware configuration is made with a jumper on a 3-pole header, see the coming chapter “IPS2 24 VDC Main Printed Circuit Board Rev. ” for details.

The device protocol is switched by pressing and holding the ACK button until the changed mode is indicated by a short flash on the **I>** or **Io>** LED.

### System interface

The physical port for the system interface is the RS485 port (X5), see the chapter “Schematic Overview” for connector placement.

The jumper in the 3-pole header must be placed in position 2 – 3 for RS485 communication.

The device protocol is switched by pressing and holding the ACK button until the changed mode is indicated by a short flash on the **Io>** LED.

The device is always initiated, after a power down or reset, with the system interface protocol activated.

### Service interface

The physical port for the service interface is the internal RS232 port, see chapter “IPS2 24 VDC Main Printed Circuit Board Rev. ” for details.

The jumper in the 3-pole header must be placed in position 1 – 2 for RS232 communication.

The device protocol is switched by pressing and holding the ACK button until the changed mode is indicated by a short flash on the **I>** LED.

Please observe that the IPS2 is always initiated, after a power down or reset, with the system interface protocol activated.

## 5 Hardware

The IPS2 unit is composed of two printed circuit boards (PCBs); one large circuit board forming the base and a top circuit board that is located above of the other just beneath the front panel.

To access the reset button, firmware download port (C2 interface) and the internal serial port of IPS2, the front cover must be removed. This is easily accomplished by removing the four screws in the corners of the cover. **Note that the screws need only to be turned 90 degrees.**

### 5.1 IPS2 24 VDC Main Printed Circuit Board Rev. C

#### Pluggable Terminal Blocks

External cables are attached to the lower side of the IPS2 using pluggable contacts. For more information about each conductor in the contacts, please refer to the Schematic Overview in Figure 1.

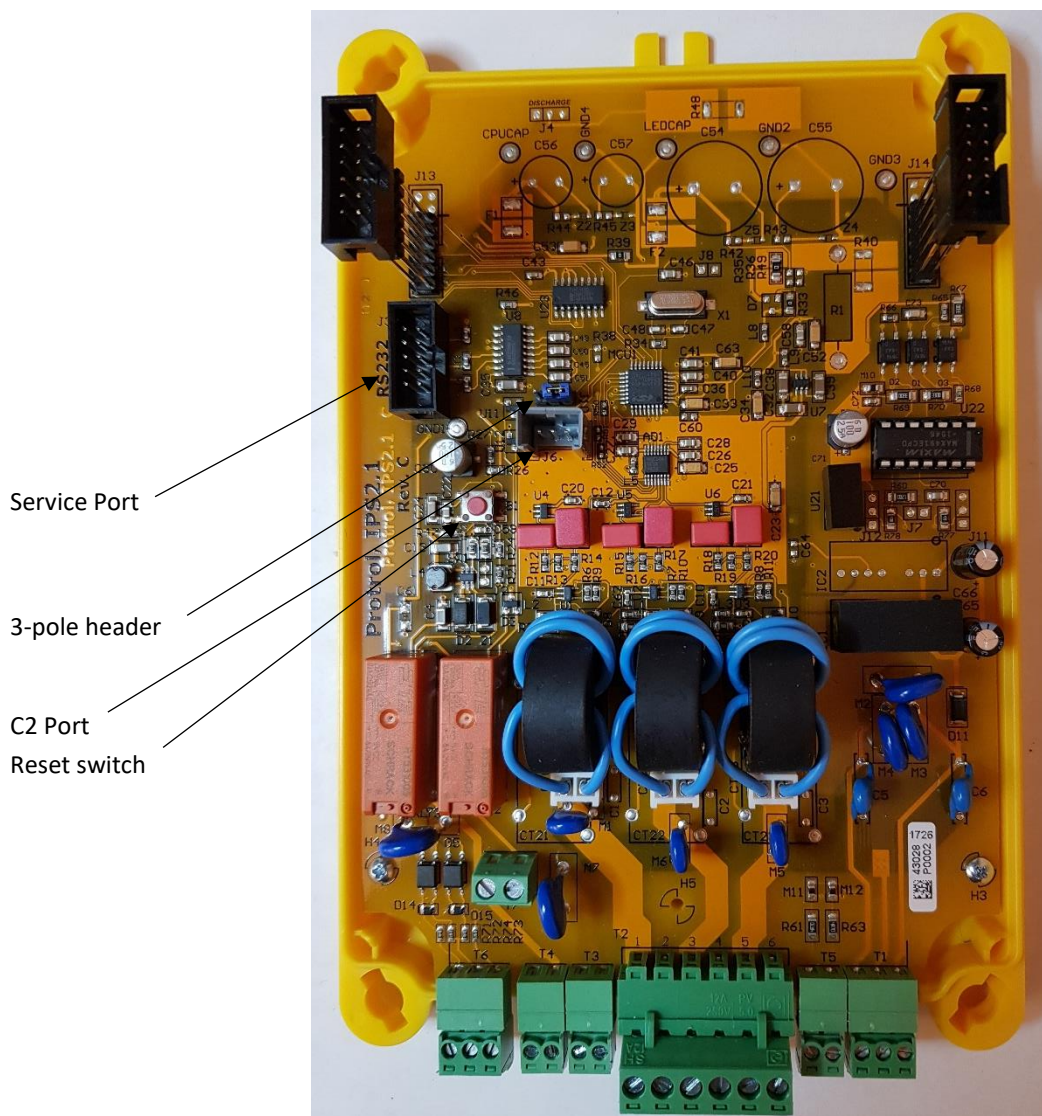


Figure 2. IPS 24 VDC Main PCB Rev C.

## Reset button

Pressing the orange button results in a reset of the unit. All recordings from previous faults and events are lost. Configuration settings are kept during reset.

## Service Port

The service port connector is found on the upper side of the circuit board. The service port is used together with any computer with Protrol Tool. Protrol Tool is a service tool for analysis of transient fault recordings and is described more in details in the following chapter. Analysis requires the 9-pole DSUB adapter cable with article number 606535.

## C2 Port

Configuration of the IEC 60870-5-101 protocol is done using the C2 Port which is the grey socket labeled J6 on the Main PCB. Configuration is described in the following chapter, and requires the 9-pole DSUB adapter cable with article number 606537.

## 3-pole Header

There is a 3-pole header located on the Main PCB. Using a jumper to short circuit two leads will configure the IPS2 unit to use the RS232 Service Port or the RS485 System Interface. The connectors are number 1-2-3 from left to right.

- Jumper position 1 – 2: RS232 Service Port
- Jumper position 2 – 3: RS485 System Interface Port.

The device protocol is switched by pressing and holding the ACK button until the changed mode is indicated by a short flash on the **I>** or **Io>** LED.

A flash on the **Io>** LED indicates that the service protocol is activated.

The device is always initiated, after a power down or reset, with the system interface protocol activated.

## 5.2 IPS2 24 VDC Top Printed Circuit Board

The top printed circuit board for IPS2 serves as local Human Machine Interface (HMI) and offers basic settings and status information.

The IPS2 HMI has rotary switches for settings, Light Emitting Diodes (LEDs) for status information and an acknowledge button.

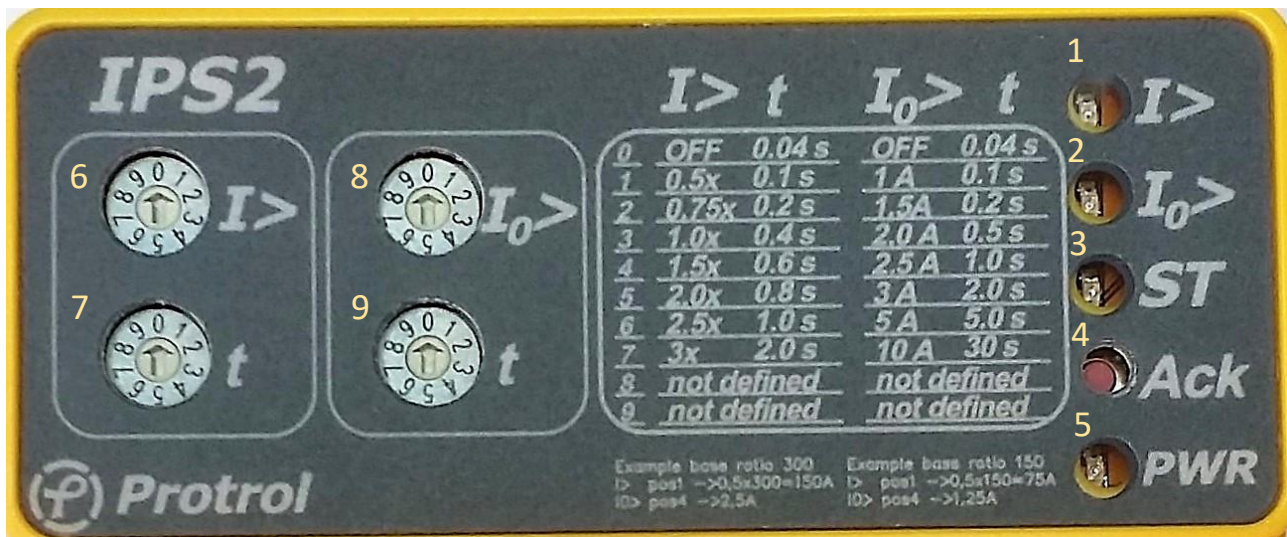


Figure 3. IPS2 24 VDC front panel HMI.

The yellow numbers in Figure 3 are explained in the following.

1.  **$I >$**  – A solid LED indicates a detected but unacknowledged overcurrent. A ½ Hertz flashing LED indicates that there is a phase break.
2.  **$I_0 >$**  – A solid LED indicates a detected but unacknowledged earth fault. A ½ Hertz flashing LED indicates a high  $I_0$ .
3. **ST** – ST is a ½ Hertz flashing LED indicating correct operation.
4. **Ack** – Acknowledge button for LEDs. – Turns off the  $I_0 >$  LED,  $I >$  LED and the external LED.
5. **PWR** – PWR is lit when power is applied.
6. Rotary switch for overcurrent settings, start level as a nominal current multiplier.
7. Rotary switch for overcurrent settings, time in seconds.
8. Rotary switch for earth fault settings, start level in primary current.
9. Rotary switch for earth fault settings, time in seconds.

### Rotary switches

After changing position of a rotary switch the IPS2 unit needs to be powered off/on or reset for the new settings to come into effect. Keep the power off for at least 5 seconds before restoring the power supply. To reach the reset button the front cover must be removed.

| <b>I&gt;</b> | Position | Pickup level [pu] |
|--------------|----------|-------------------|
|              | 0        | OFF               |
|              | 1        | 0.5               |
|              | 2        | 0.75              |
|              | 3        | 1.0               |
|              | 4        | 1.5               |
|              | 5        | 2.0               |
|              | 6        | 2.5               |
|              | 7        | 3                 |
|              | 8-9      | Not used          |

| <b>t</b> | Position | Pickup delay [s] |
|----------|----------|------------------|
|          | 0        | 0.04             |
|          | 1        | 0.1              |
|          | 2        | 0.2              |
|          | 3        | 0.4              |
|          | 4        | 0.6              |
|          | 5        | 0.8              |
|          | 6        | 1.0              |
|          | 7        | 2.0              |
|          | 8-9      | Not used         |

The I> pickup level setting is a per unit value related to the current transformer ratio.

Example: 300/1 ratio and pickup level 2.5 corresponds to a primary current level of  $300 \times 2.5 \text{ A} = 750 \text{ A}$

| <b>I<sub>0</sub>&gt;</b> | Position | Pickup level [A] |
|--------------------------|----------|------------------|
|                          | 0        | OFF              |
|                          | 1        | 1.0              |
|                          | 2        | 1.5              |
|                          | 3        | 2.0              |
|                          | 4        | 2.5              |
|                          | 5        | 3                |
|                          | 6        | 5                |
|                          | 7        | 10               |
|                          | 8-9      | Not used         |

| <b>t</b> | Position | Pickup delay [s] |
|----------|----------|------------------|
|          | 0        | 0.04             |
|          | 1        | 0.1              |
|          | 2        | 0.2              |
|          | 3        | 0.5              |
|          | 4        | 1.0              |
|          | 5        | 2.0              |
|          | 6        | 5.0              |
|          | 7        | 30               |
|          | 8-9      | Not used         |

The I<sub>0</sub>> pickup settings in Amperes are based on a current transformer ratio of 300/1. In the case a different ratio is used the levels are scaled proportionally.

Example: 150/1 ratio and pickup level of 2 corresponds to a primary current setting of  $150/300 \times 2 \text{ A} = 1 \text{ A}$

### 5.3 Protrol Tool for IPS2

Protrol Tool is available for Windows 7/8.1/10 and can be downloaded from Protrol's web page ([www.protrol.se](http://www.protrol.se)).

### 5.4 Setting the IPS2 to Service Interface Mode

Set the jumper on the 3-pole header in position 1-2, see chapter "IPS2 24 VDC Main Printed Circuit Board Rev. " and figure 2.

Change the device protocol by pressing and holding the ACK button. Changed mode is indicated by a short flash on the **I<sub>o</sub>** LED.

### 5.5 Communication Cable

To be able to use Protrol Tool with the IPS2 24 VDC unit, a special 9-pole DSUB adapter cable with article number 606535 is required. If the workstation lacks a physical COM port, which most new laptops do, a special USB – COM converter must be added between the computer and the DSUB adapter cable. Such adapter cables can be acquired where computer accessories are available.

The service port connector is found on the upper side of the circuit board.

Note that the 3-pole header must have the jumper in position 1 – 2 to enable the Service Port.

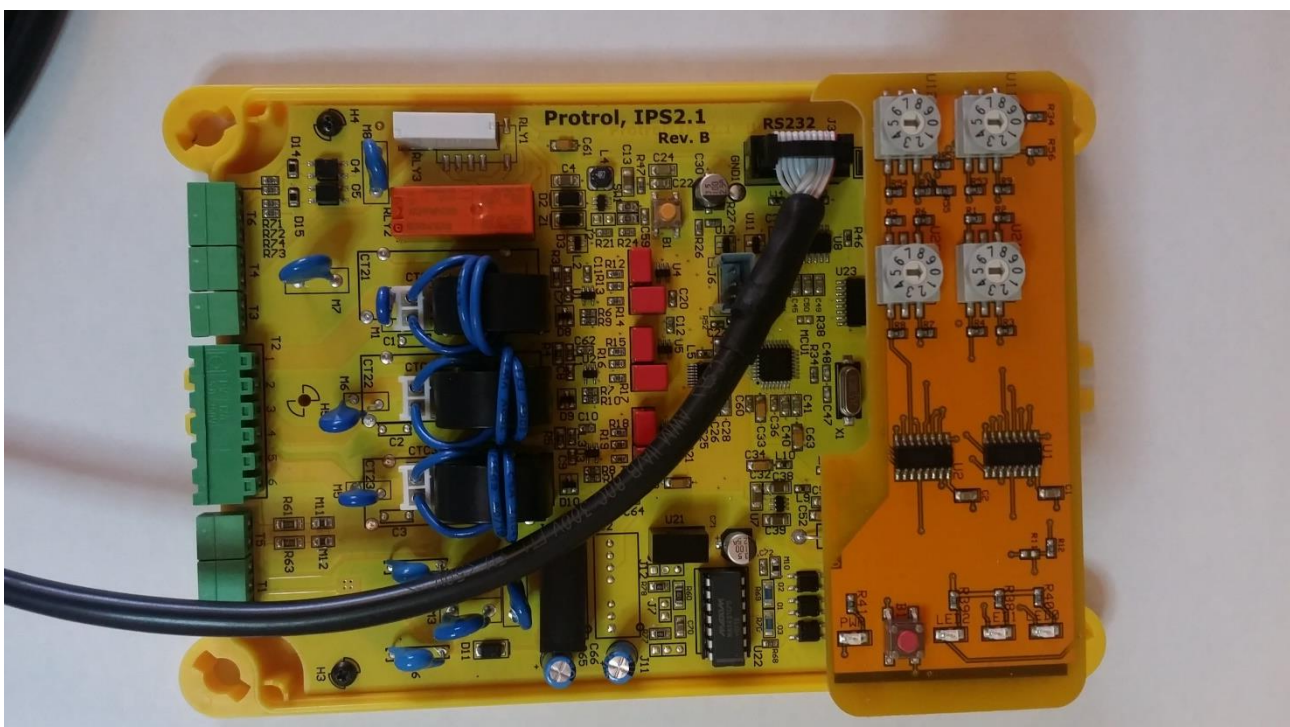


Figure 4. The RS232 adapter cable is attached to the RS232 socket in the upper left corner of the Main PCB.

## 5.6 Protrol Main Window

Protrol Tool is used for the following IPS application:

- TFR, Transient Fault Recorder

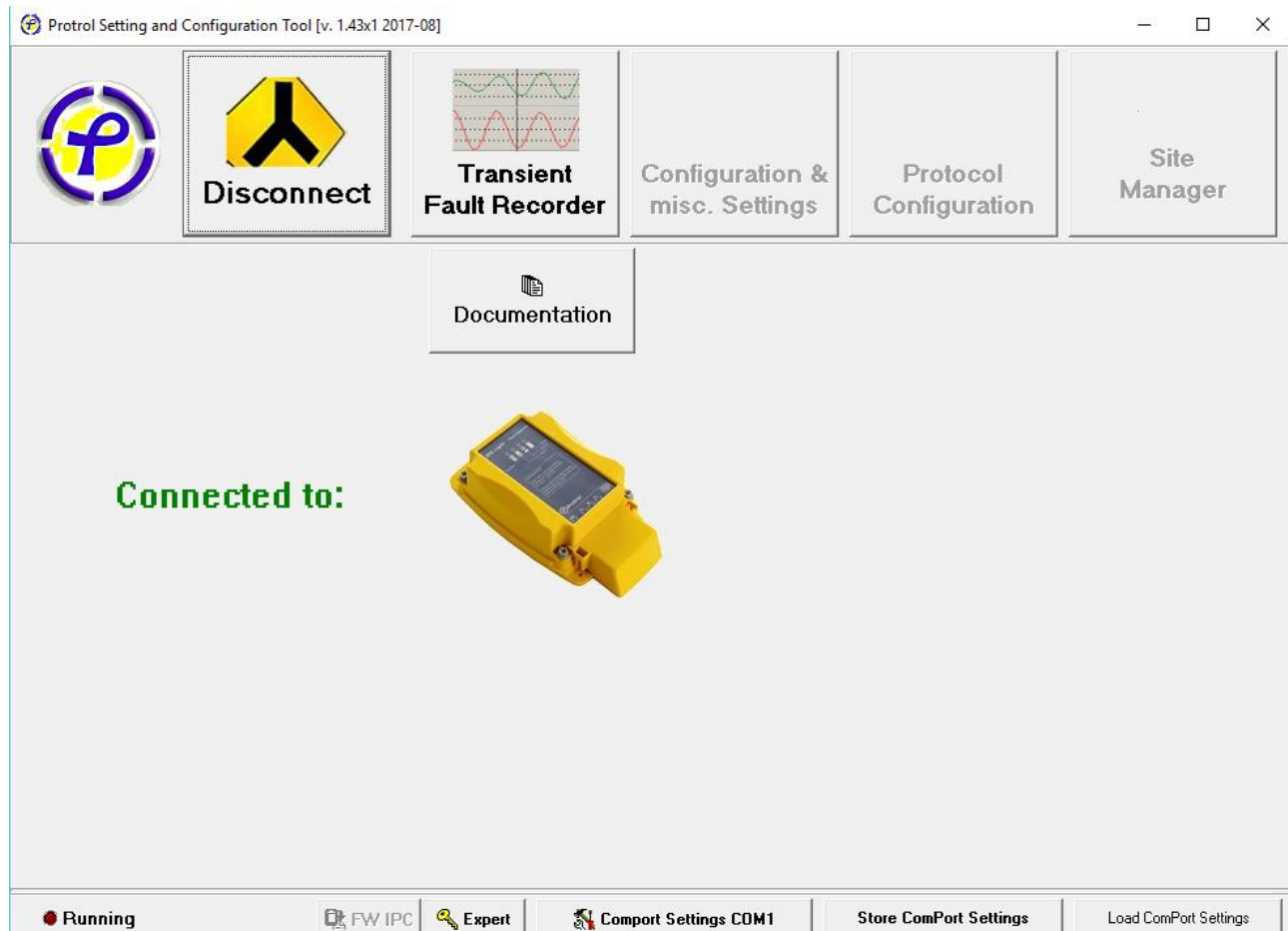


Figure 5. Protrol Tool main window.

Protrol Tool uses the serial port of the engineering workstation. However, this has in most computers been replaced by the more common USB interface. Before using Protrol Tool for the first time, the corresponding serial port - USB driver must be installed in your computer. If it will not be automatically installed by your operating system, a link is available at [www.protrol.se](http://www.protrol.se) in the download section. When starting Protrol Tool for the first time, verify that the COM port settings are correct, see Figure 6. The *Port* shall be the specific COM port associated with the USB driver on the engineering workstation. A description how this is found is available at the download page for Protrol Tool on [www.protrol.se](http://www.protrol.se).

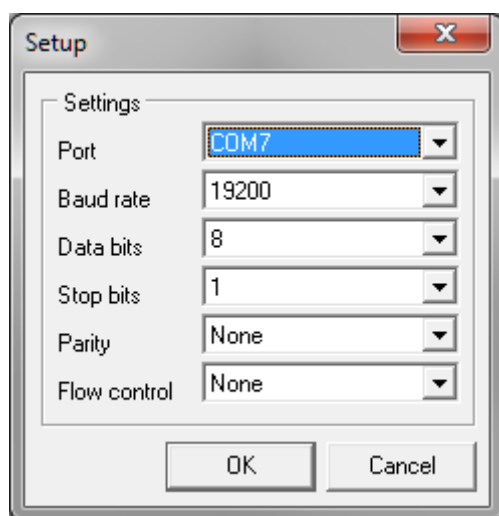


Figure 6. COM port settings pop-up. Important: Select the assigned USB - COM port!

Acknowledge by pressing *OK* and then try to connect by pressing *Connect*. If the dialog LED *Running* is flashing, connection has been established.

Communication settings can be stored in the Registry by pressing the *Store ComPort Settings* button. Next time Protrol-Tool is started the selected port is opened automatically.

## 5.7 IPS2 Transient Fault Recorder

The IPS2 detector has a built-in transient fault recorder which can be accessed from Protrol-Tool for further analysis of the recordings.

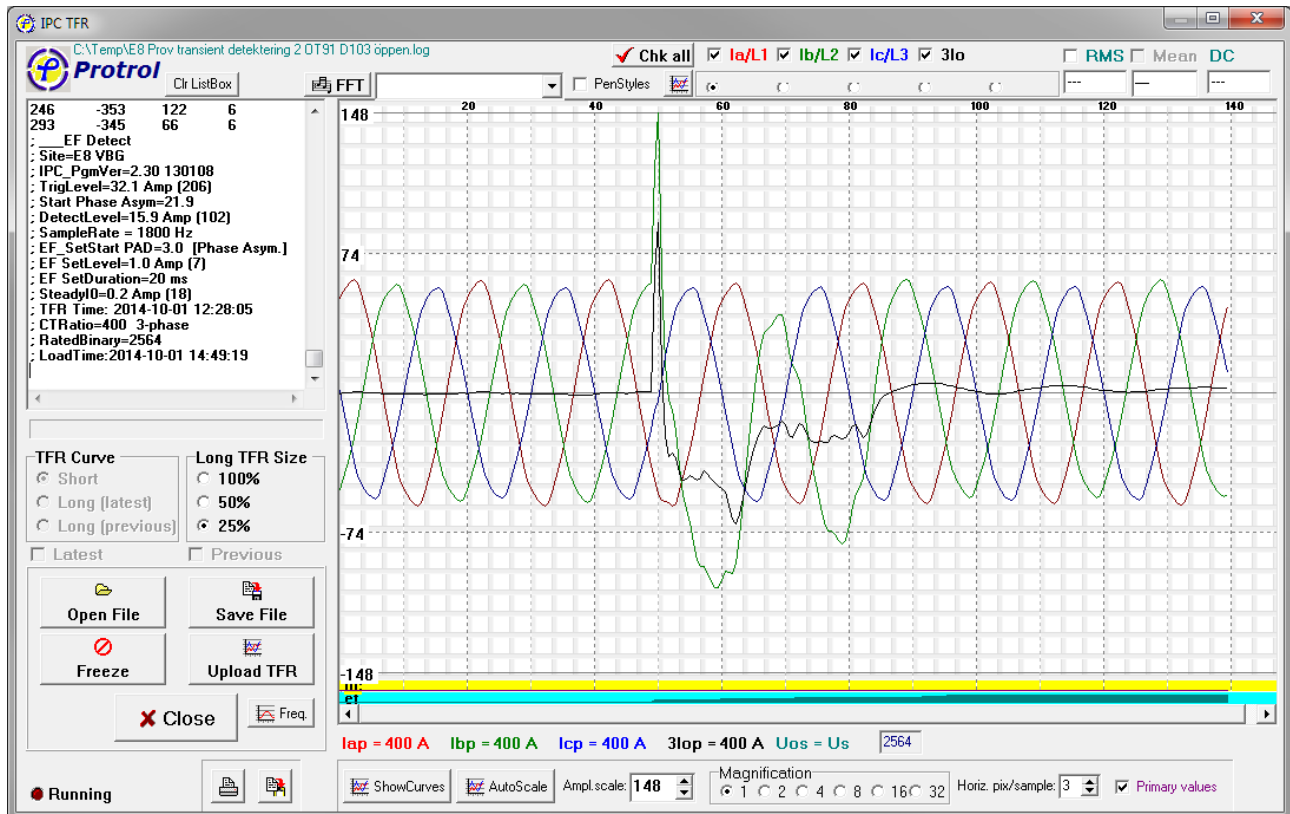


Figure 7. The Transient Fault Recorder

If the IPS detector has registered a fault, the Transient Fault Recordings, TFR, for the last faults can be uploaded by pressing the *Upload TFR* button. A curve is three power frequency cycles with approximately 10 ms of pre-fault data.

By pressing the *ShowCurves* or *AutoScale* buttons, the TFR data will be displayed in the oscillogram. If *Primary values* is checked the curves are scaled to primary values, otherwise they represent unscaled binary values.

If *AutoScale* is not pressed the amplitude scale can be selected arbitrarily by changing the *Ampl. scale* field shown in Figure 8. Magnification of the amplitude axis is done in the *Magnification* field while *Horiz. pix/sample* zooms in on the time axis.

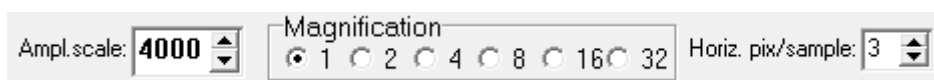


Figure 8. The amplitude and time scaling fields.

The *Phase* checkboxes above the oscillogram is used to display the signals graphically, while the radio buttons below each signal are used for *phase selection*.

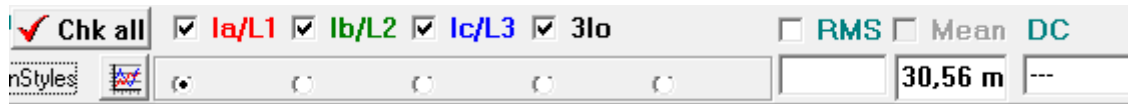


Figure 9. Checkboxes and radio buttons for graphical display options.

It is possible to *trace* a single curve. Select the curve of interest with the phase selection radio buttons above the graph, then push the left mouse button on the graph and drag the cursor horizontally along the time axis until the marker is at the desired location.

Each sample value is displayed numerically together with the time tag to the right of the phase selection radio buttons. If the *RMS* checkbox is checked the corresponding RMS value for one cycle ahead of the cursor is shown instead of the sample value.

Instead, if the right mouse button is pressed anywhere along a signal, all sample values at a given time are displayed in a popup, see Figure 10.

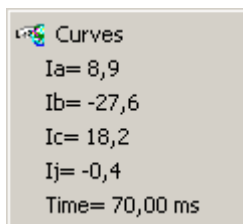


Figure 10. Sample popup.

A useful feature of the transient fault recorder is the possibility to make a snapshot of the actual phase currents by pressing the *Freeze* button and then the *Upload TFR* button. The *Freeze* button is not available unless any registered faults have been *Acknowledged* (see Section 4.1 Detector Function)! Observe that a manually initiated TFR replaces the last saved TFR – it is therefore recommended to upload any recordings of interest **before** a snapshot is made.

Please notice the scroll box to the left containing the samples as a numerical table. It also contains meta information that describes the conditions when the recording was made. It is possible to add additional observations or notes to the scroll box by starting each row with a “;”.

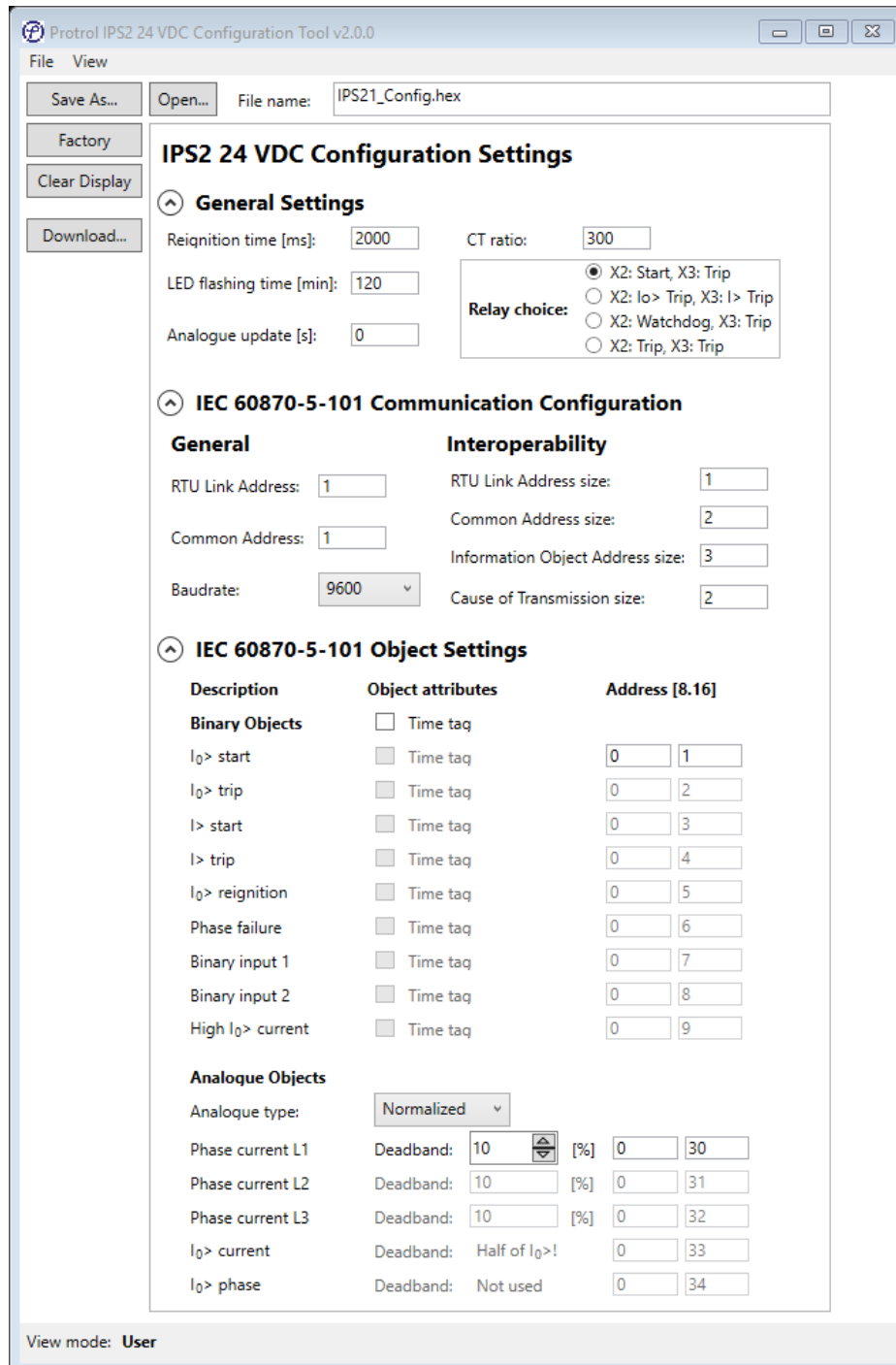
## File Handling

When uploading a TFR from the IPS2 a question dialog is displayed asking for saving the file. This can also be done later by pressing the *Save File* button. Saved files can be retrieved later by pressing the *Open File* button.

## 6 Configuration of IPS2 24 VDC

### 6.1 Creating or Adjusting a Configuration File

Configuration of an IPS2 24 VDC is done with a stand-alone tool for Windows. This tool is used for basic configuration and allows the user to create or edit settings for an IPS2, to save and load this information to/from disk and download a file to a unit. A screenshot of the configuration tool with factory settings is shown in the figure below.



The screenshot shows the Protrol IPS2 24 VDC Configuration Tool v2.0.0 interface. The window title is "Protrol IPS2 24 VDC Configuration Tool v2.0.0". The menu bar includes "File" and "View". The "File" menu is open, showing "Save As...", "Open...", and "File name: IPS21\_Config.hex". On the left side, there are buttons for "Factory", "Clear Display", and "Download...". The main area is titled "IPS2 24 VDC Configuration Settings" and is divided into several sections:

- General Settings:**
  - Reignition time [ms]: 2000
  - LED flashing time [min]: 120
  - Analogue update [s]: 0
  - CT ratio: 300
  - Relay choice:
    - X2: Start, X3: Trip
    - X2: I<sub>0</sub>> Trip, X3: I> Trip
    - X2: Watchdog, X3: Trip
    - X2: Trip, X3: Trip
- IEC 60870-5-101 Communication Configuration:**
  - General:**
    - RTU Link Address: 1
    - Common Address: 1
    - Baudrate: 9600
  - Interoperability:**
    - RTU Link Address size: 1
    - Common Address size: 2
    - Information Object Address size: 3
    - Cause of Transmission size: 2
- IEC 60870-5-101 Object Settings:**

| Description                   | Object attributes                   | Address [8.16] |    |
|-------------------------------|-------------------------------------|----------------|----|
| <b>Binary Objects</b>         |                                     |                |    |
| I <sub>0</sub> > start        | <input type="checkbox"/> Time taq   | 0              | 1  |
| I <sub>0</sub> > trip         | <input type="checkbox"/> Time taq   | 0              | 2  |
| I> start                      | <input type="checkbox"/> Time taq   | 0              | 3  |
| I> trip                       | <input type="checkbox"/> Time taq   | 0              | 4  |
| I <sub>0</sub> > reignition   | <input type="checkbox"/> Time taq   | 0              | 5  |
| Phase failure                 | <input type="checkbox"/> Time taq   | 0              | 6  |
| Binary input 1                | <input type="checkbox"/> Time taq   | 0              | 7  |
| Binary input 2                | <input type="checkbox"/> Time taq   | 0              | 8  |
| High I <sub>0</sub> > current | <input type="checkbox"/> Time taq   | 0              | 9  |
| <b>Analogue Objects</b>       |                                     |                |    |
| Analogue type: Normalized     |                                     |                |    |
| Phase current L1              | Deadband: 10 [%]                    | 0              | 30 |
| Phase current L2              | Deadband: 10 [%]                    | 0              | 31 |
| Phase current L3              | Deadband: 10 [%]                    | 0              | 32 |
| I <sub>0</sub> > current      | Deadband: Half of I <sub>0</sub> >! | 0              | 33 |
| I <sub>0</sub> > phase        | Deadband: Not used                  | 0              | 34 |

At the bottom, the "View mode" is set to "User".

Figure 14. The Protrol IPS2 24 VDC Configuration Tool with factory settings.

## IP22 24 VDC Configuration Settings

Table 1: Explanation of the Protrol IP22 24 VDC Configuration settings.

| Parameter  | Range       | Unit  | Default                     | Comment  |
|--|-------------|-------|-----------------------------|--|
| <b>General Settings</b>                            |             |       |                             |  |
| Reignition time [ms]                               | 0..10000    | ms    | 2000                        | A reoccurring fault within the reignition time window overrides the EF time rotary switch and sets the operate time to a minimum. 0 disables the reigniting faults function  |
| LED flashing time [min]                            | 0..1440     | min   | 120                         | The flashing time of the external LED in minutes also is used to acknowledge the front panel indication LEDs.  |
| Analogue update [s]                                | 0..65535    | s     | 0                           | Cyclic update of analogue values. No cyclic update if the set value is 0, however, the deadband is activated instead   |
| CT ratio   | 50..1200    | -     | 300                         |  |
| Relay choice                                       | 0..3        | -     | 0                           | <b>0:</b> X2: Start, X3: Trip.<br><b>1:</b> X2: EF Trip, X3: OC Trip<br><b>2:</b> X2: Watchdog, X3: Trip (Hardware version 3 only)<br><b>3:</b> X2 and X3: General Trip  |
| Operation mode                                     | 0..1        |       | Bit 5: On<br>All other: Off | <b>Checkbox 7:</b> DIR bit in balanced mode<br><b>Checkbox 6:</b> Balanced mode<br><b>Checkbox 5:</b> Send analog objects<br><b>Checkbox 4:</b> Time tag<br><b>Checkbox 3:</b> Not used<br><b>Checkbox 2:</b> Not used<br><b>Checkbox 1:</b> See relay choice<br><b>Checkbox 0:</b> See relay choice |
| OC level shift factor                              | 0..8        | -     | 0                           | <b>0:</b> Not used<br><b>1:</b> Trip level divided by 2<br><b>2:</b> Trip level divided by 4, etc.   |
| <b>IEC 60870-5-101 Communication Configuration</b> |             |       |                             |  |
| RTU Link Address                                   | 1..255      | -     | 1                           |  |
| Common Address                                     | 1..65534    | -     | 1                           | Common Address of ASDU   |
| RTU Link Address size                              | 1..2        | -     | 1                           | Number of octets for RTU Link Address  |
| Cause of Transmission size                         | 1..2        | -     | 2                           | Number of octets for Cause of Transmission   |
| Common Address size                                | 1..2        | -     | 2                           | Number of octets for Common Address  |
| Information Object Address size                    | 1..3        | -     | 3                           | Number of octets for Information Object Address  |
| Baudrate   | 9600, 19200 | bit/s | 9600                        | Standard rates for the IEC-101 port  |

| <i>IEC 60870-5-101 Object Settings</i> |           |   |        |   |
|--|-----------|---|--------|---|
| Time Tag                               | 0..1      |   | 0      | <b>0:</b> No time tag included<br><b>1:</b> Time tag included   |
| Address [8]                            | 1..255    |   | 0      | The highest address octet   |
| Address [16]                           | 0.. 65534 |   | 1 to 9 | The two lowest address octets   |
| Analogue type                          | 0..3      |   | 1      | <b>0:</b> Raw, rated current 3800 units<br><b>1:</b> Normalized to the nominal CT ratio<br><b>2:</b> Scaled to integer primary current in Amperes.<br><b>3:</b> Floating point primary current in Amperes         |
| Deadband                               | 1..50     | % | 10     | Deadband for the update of analogue objects in percent of rated current ( <i>CT ratio</i> )<br>Remark: The deadband for $I_0$ is half of the $I_0$ setting. If the $I_0$ stage is disabled, the deadband is 2.5 A |

## Factory Defaults

It is possible to reset all settings in the configuration tool to factory defaults by pressing the *Factory* button.

## Open Configuration File

Previously saved settings can be reloaded to the configuration tool by pressing the *Open* button. A dialog opens and it is possible to browse and choose the desired configuration file. Press *Open* to read the file.

## Edit Configuration Data

After the *Factory* or *Open* buttons have been pressed it is possible to adjust configuration data.

## Save Configuration File

The current settings can be save by pressing the *Save* button. A dialog opens and it is possible to adjust the file name before *Save* is pressed a second time.

## Clear Display

It is possible to clear all settings in the configuration tool by pressing the *Clear Display* button.

## Download Configuration File

The current configuration file can be downloaded to a connected IPS2 unit by pressing the *Download...* button. Please see the chapter "Download a Configuration File to the IPS2 Device" for detailed information and instructions.

## 6.2 Download a Configuration File to the IPS2 Device

### Equipment and preparation

For downloading configurations to an IPS2 a USB Debug Adapter for C8051Fxxx from Silicon Labs and corresponding software is needed.



Figure 15. 8-Bit USB Debug Adapter.

The adapter shall be connected to the C2 contact on the IPS2. For that you need a special cable that can be ordered from Protrol, article number 606537. See figure below.



Figure 16. USB Debug Adapter connected to IPS2.

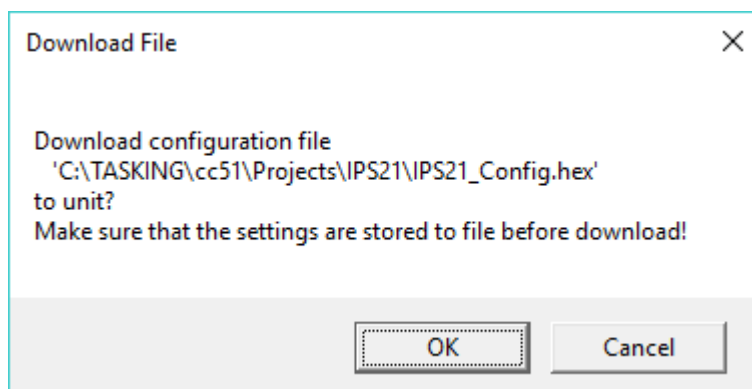
Connect the adapter to the maintenance PC using an USB cable.

The needed extra files for the adapter are included in the Protrol IPS2 24 VDC Configuration Tool installation package, version 2.0.0 and higher. Make sure that you have the files “SiUtil.dll” and “USBHIB.dll” in the same folder as the configuration tool.

## Downloading configuration file

Follow the steps below to download the configuration file.

1. Connect the IPS2 device as described above.
2. Power-up the IPS2.
3. Start the Protrol IPS2 24 VDC Configuration Tool (if not already started).
  - a. Make sure you have version 2.0.0 or later of the tool.
  - b. Check also that you have the files “SiUtil.dll” and “USBHIB.dll” in the same folder as the configuration tool.
4. Open the configuration file to download (the *Open...* button) or make sure you save the settings you currently made (press the *Save As...* button).
  - a. Please observe that the download function only uses the file name in the field and download that file to the IPS unit. It will not check for any differences or unsaved settings in other settings fields.
5. Press the *Download* button.



6. Press *OK*.
  - a. A confirmation dialog will be displayed with information.
7. Done!

## 7 Testing and Commissioning of IPS2

Before taking an IPS unit into operation it can be tested either in off site or installed in the station. It can be tested with a single current source for both overcurrent and earth fault functions.

### 7.1 Binary I/O

#### Test of Binary Inputs

Apply a test voltage to the binary inputs and verify that the IPS2 unit detects the signals and transmits them to the dispatch centre.

### 7.2 Current Injection Test

#### Test circuit

Connect the current source to phases A and B (or any other combination of two phases) according to Figure 11. Apply a current of 0.5 A. The measured sum of the phases shall now be zero. Verify with the built-in transient fault recorder of Protrol Tool. See section below for details.

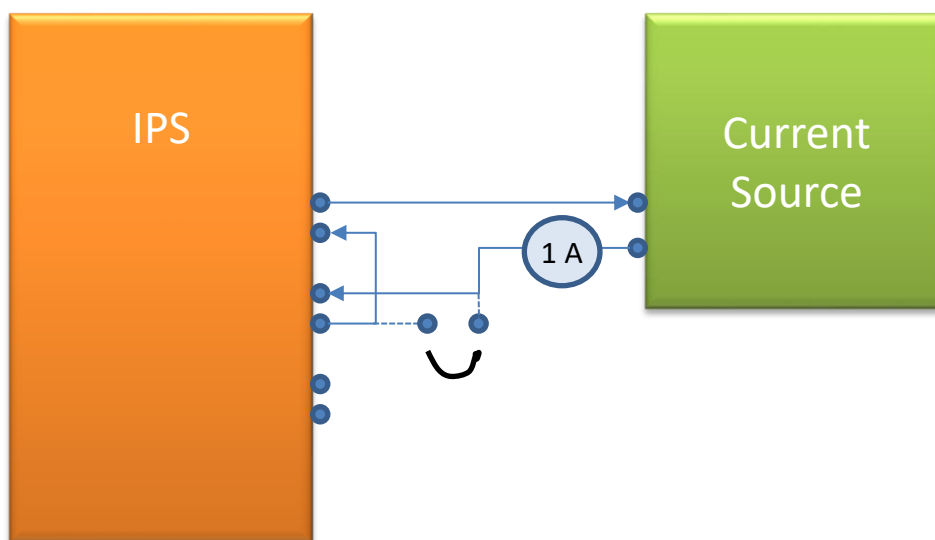


Figure 11. Current injection test.

#### Overcurrent Test

Increase the current of the current source until overcurrent is detected. This is indicated by the OC LED and the output relay will close for the set time, if applicable. Note: If an input is used to release the output signal this input must be set high.

Verify that the OC Start and Trip signals are transferred to the dispatch center.

## Earth Fault Test

Put a short circuit over one of the phases according to the drawing above using a **short** test cord. The current in the short circuit will simulate the measured earth current, and needs to be applied longer than the set *Operation Delay*. Earth fault detection is indicated by the EF LED and closing of the output relay, if applicable. If connected to a PC, check the transient fault record using Protrol-Tool.

A typical recording from an earth fault test is shown in Figure 12.

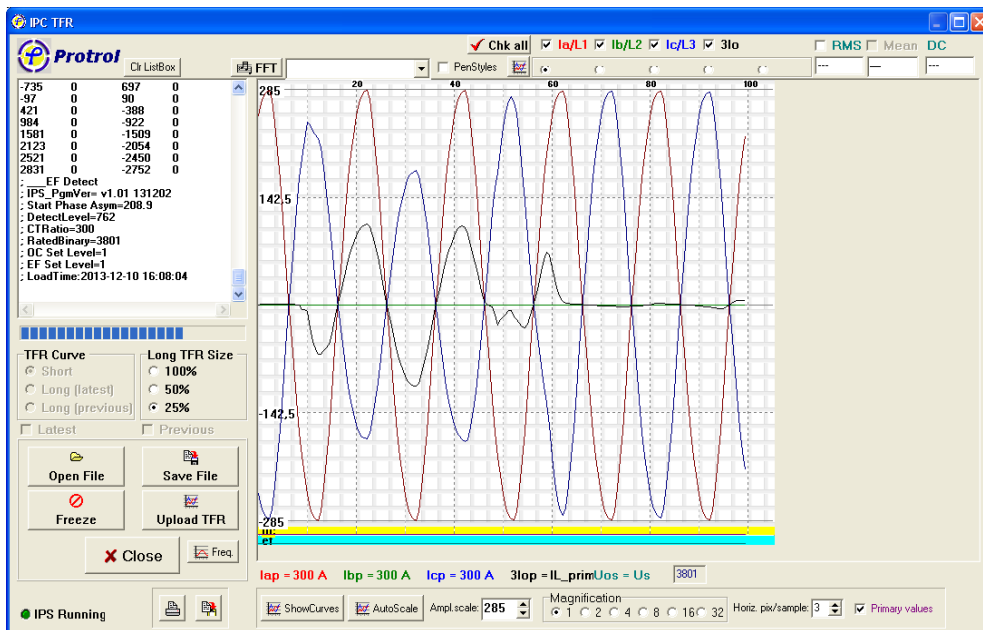


Figure 12. Typical transient fault recording after an earth fault test.

Verify that the EF Start and Trip signals are transferred to the dispatch center.

## 7.3 EF Trig Level Check

After connection to the current transformers, verify that the EF LED does not flicker vaguely. This indicates that the *EF Trig Level* may be set too low.

## 7.4 Test of IPS after Commissioning

Testing of earth fault detection is possible by simply short circuiting one of the three phases directly on the input terminal. Disconnect the output relay to avoid any unwanted actions. There must be a primary current (at least a few Amperes) in all three phases.

## 7.5 Offset Elimination (zero offset calibration)

A zero-offset calibration is made during manufacturing.

If needed a calibration can also be manually made.

Follow the steps below to initiate a calibration:

1. Short circuit and disconnect the current terminals.
2. Press and hold the **Ack** button while power cycling the device.
3. Release the **Ack** button when the **ST** LED turns on.
4. The **I<sub>0</sub>>** LED should now start flashing to indicate the calibration phase.



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