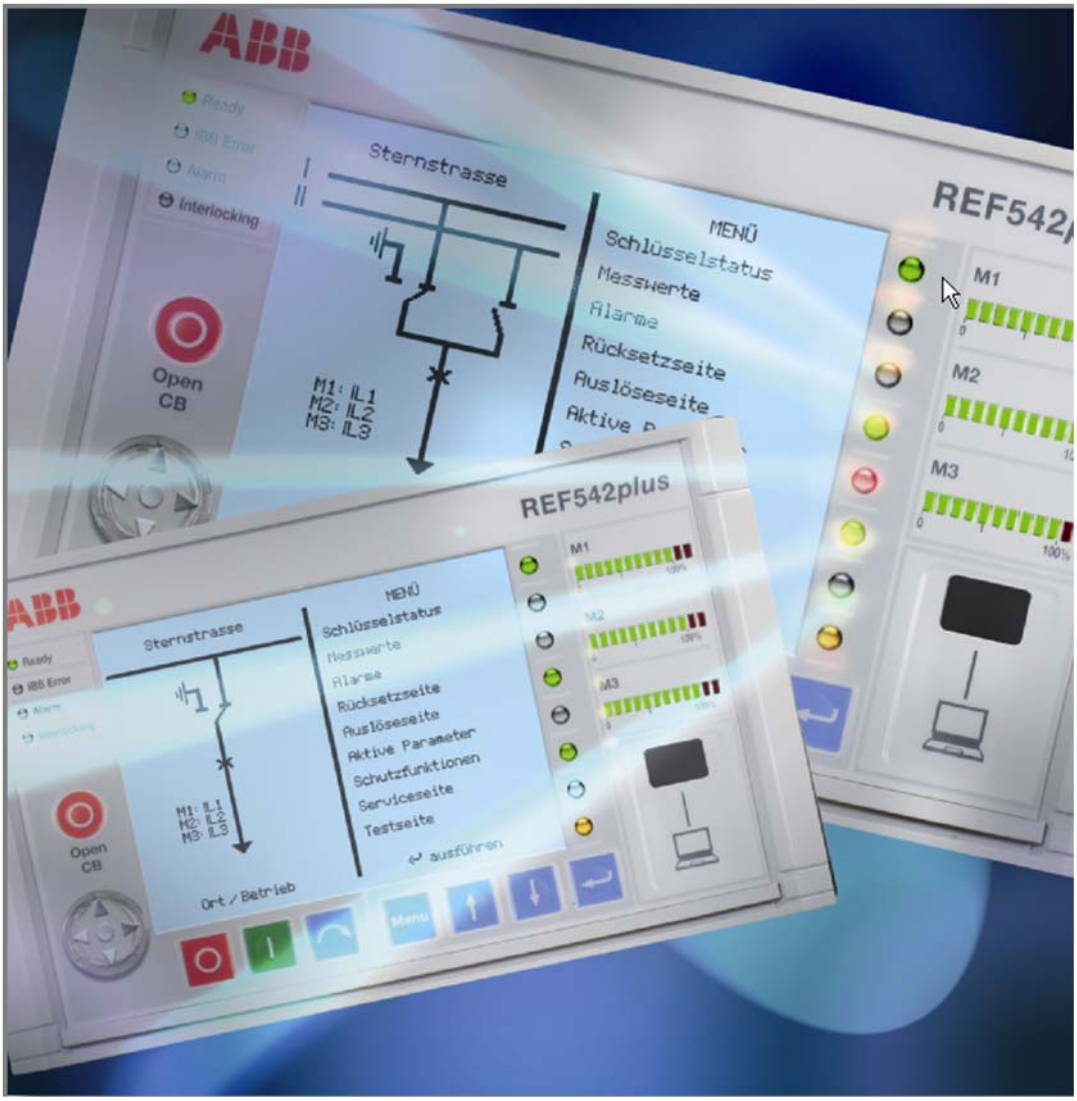
REF 542plus

Multifunction Protection and Switchgear Control Unit

Operator's manual



Contents

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1. Introduction

1.1. This manual

Before attempting any operation with REF 542plus, read this manual carefully first.

This manual describes how to use the interface of REF 542plus (LD HMI, Local Detached Human Machine Interface). Note that HMI views and pictures are to be considered exemplary.

Do not make any changes to the REF 542plus configuration unless you are authorized to do it and familiar with REF 542plus and its Operating Tool. This might result in malfunction and loss of warranty.

1.2. Use of symbols

This publication includes the following icons that point out safety-related conditions or other important information:

The electrical warning icon indicates the presence of a hazard which could result in electrical shock.

The warning icon indicates the presence of a hazard which could result in personal injury.

The caution icon indicates important information or warning related to the concept discussed in the text. It might indicate the presence of a hazard which could result in corruption of software or damage to equipment or property.

The information icon alerts the reader to relevant facts and conditions.

Although warning hazards are related to personal injury, it should be understood that operation of damaged equipment could, under certain operational conditions, result in degraded process performance leading to personal injury or death. Therefore, comply fully with all warning and caution notices.

1.3. Intended audience

This manual is intended for operators, supervisors and administrators to support normal use of the product.

1.4. Product documentation

Name of the Manual	Document ID
Real Time Clock Synchronization, IRIG-B Input Time Master	1MRS755870
Product Guide	1MRS756269
Configuration Manual	1MRS755871
iButton Programmer User Manual	1MRS755863
Manual Part 3, Installation and Commission	1 VTA100004
Manual Part 4, Communication	1VTA100005
Motor Protection with ATEX Certification, Manual	1MRS755862
SCL Tool Configuration Manual	1MRS756342
Protection Manual	1MRS755860
Technical Reference Manual	1MRS755859
Technical Reference Modbus RTU	1MRS755868
Web Manual, Installation	1MRS755865
Web Manual, Operation	1MRS755864
IEC 61850 PIXIT	1MRS756360
IEC 61850 Conformance Statement	1MRS756361
IEC61850 TISSUES Conformance Statement	1MRS756362
Lifecycle Service Tool	1MRS756725

1.5. Document revisions

Version	IED Revision number	Date	History
1VTA100172-Rev 1, en		01.11.2002	First release
1VTA100172-Rev 2, en		22.10.2003	Updated to version 4D02
1VTA100172-Rev 3, en		03.05.2004	Updated
1VTA100172-Rev 4, en		04.04.2005	Updated
A		28.02..2006	Document updated • language • layout
B	2.5	30.09.2006	Updated to software version V4E03x
C	2.5 SP1	31.05.2007	Updated to software version V4E04x
D	2.5 SP3	14.02.2008	Updated
E	2.6	19.12.2008	Updated to software version V4F06x
F	2.6	01.07.2009	Updated
G	3.0	15.02.2010	Document updated

Applicability

This manual is applicable to REF 542plus Release 3.0, software version V4F08x.

2. Safety information

Dangerous voltages can occur on the connectors, even though the auxiliary voltage has been disconnected.

Non-observance can result in death, personal injury or substantial property damage.

Only a competent electrician is allowed to carry out the electrical installation.

National and local electrical safety regulations must always be followed.

The frame of the device has to be carefully earthed.

The device contains components which are sensitive to electrostatic discharge. Unnecessary touching of electronic components must therefore be avoided.

3. HMI features

The REF 542plus is shown in Fig. 3.-1. This HMI features a back-illuminated LCD, 8 push buttons, several LEDs and an electronic key sensor. This new international HMI is a part of the product release of REF 542plus, starting from release 2.5.

The resolution of the display is 320x240 (QVGA) and the display supports full Unicode character set. Consequently, all languages, for example Chinese, can be displayed clearly. With this HMI two different languages can be handled simultaneously. The local language can be defined as the first language with the related operating tool. Then, the second language becomes automatically English. The language on the HMI can be changed from one to the other very easily.

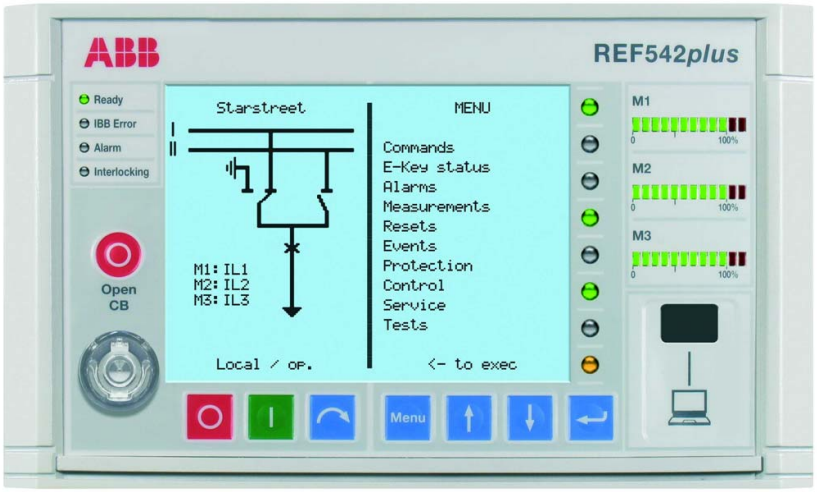

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Fig. 3.-1 REF 542plus HMI

The LCD in the SLD view provides a graphical representation of the primary objects controlled or monitored by REF 542plus in the switchgear. The right half of the LCD is for plain text visualization such as measurements and protection events. The contrast level is automatically controlled for an optimum reading, it can also be adjusted as wanted.

The HMI panel is organized in three main areas.

3.1. Control area

The left side of the HMI panel is for primary objects control. The command buttons and the information related to the switchgear control are placed on this area

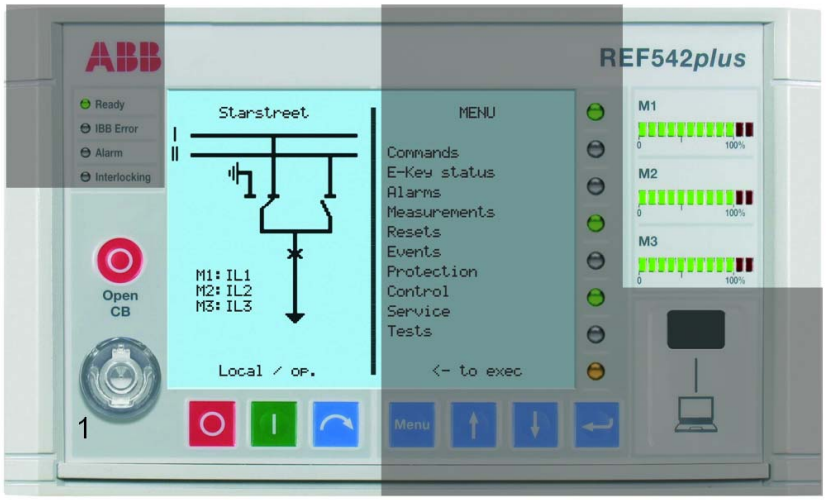

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Fig. 3.1.-1 HMI control area

This section of the display shows the Single Line Diagram (SLD) of the controlled panel and the measurement bars. Text can be added in this section to improve the understanding of SLD.

- Command buttons

The Primary Object Control can be performed with the following push buttons to allow operating the primary objects if configured as “selectable”. The command push buttons for local operation of the switching devices are:

Open: to open the selected object.

Close: to close the selected object.

Select: to select the object. The selected object appears highlighted.

CB Fast Opening: to allow opening of the circuit breaker independently from the selected control mode. When pressed simultaneously with the normal open button, this button allows opening the circuit breaker independently from the selected control mode. This feature must be enabled in the unit with the Operating Tool.

- E-Keys Sensor: this is the sensor for the electronic keys. The sensor automatically detects which key has been inserted. The two keys are usually labelled “Protect” and “Control” to distinguish them.
- Protection key: is specialized to the protection environment allowing changing of parameters and other functions related to the protection.
- Control Key: this is dedicated to the control modes. It allows changing the operating mode of REF 542plus. The different operating modes discipline the access to the primary objects by the different REF 542plus interfaces (HMI and SCADA). When required, a Super User key to access both modes can be

provided. The Super User key is also needed to access the commissioning test mode. The password codes stored in the key can be customized in each REF 542plus for access restriction purposes.

- SLD view: this is the graphical part of the LCD. This part shows the single line diagram of the switchgear. The status of the primary objects is dynamically updated after every operation. If for example the circuit breaker has been opened, its representation will reflect it.

3.2. Info and Menu area

The right side of the HMI LCD is for information and menu browsing. The buttons to navigate through the menus and to change items are placed on this area.

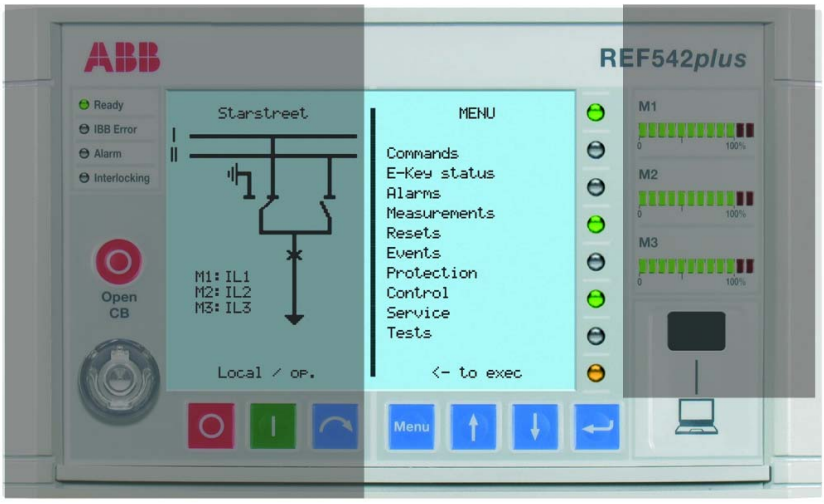

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Fig. 3.2.-1 Info and Menu area

- Menu Navigation: these push buttons allow navigation trough the REF 542plus menus.

Menu	Pressing this button, the unit goes back to the former menu.
	The up direction push button.
	The down direction push button.
	The enter push button to enter into the selected menu or to select the highlighted submenu.

The following menus are available in the main window:

- Commands: this menu shows the configured FUPLA commands.
- E-Key status: to display and change the unit modes with the electronic keys.
- Alarms: it displays the indication LED's status.
- Measurements: it displays the available measurements.
- Resets: to acknowledge alarms and other quantities.

- Events: to display protection starts and trips events.
- Protection: it displays the protection functions installed in the unit, and allows displaying and changing their settings.
- Control: it displays the control functions list installed in the unit and allows displaying and changing their settings.
- Service: relevant information on the HW and SW configurations and basic setting of REF 542plus.
- Tests: to access the test mode for the HMI and the primary objects.

Access to a few submenus is allowed only in some modes.

- LED bars: The three LED bars are available to show the most relevant measurements acquired by REF 542plus for a quick inspection of the switchgear load situation. The three bars are marked M1, M2, and M3. Each bar is composed of twelve LEDs, ten green and two red ones. The ten green LEDs are normally dedicated to display between 0% and 100% of the nominal value of the configured measurement. Each LED corresponding then to 10% of the nominal value. The two red LEDs indicate an overload condition of 20%. The measurements displayed by the bars are set with the Operating Tool.
- Indication LEDs: 8 freely programmable, three-color LEDs are available for indications. There are 4 pages of these LEDs. As a result, a total of 32 indication options can be programmed for events and status regarding protection, control, monitoring, binary inputs and so on. The assignment of the LED to a specific condition is done with the Operating Tool.
- Infrared (IrDa) interface: This is the IrDa serial interface port to connect REF 542plus to a personal computer. By using the appropriate cable and the Operating Tool, the following actions are possible:
  - Download a configuration into the unit.
  - Upload the current configuration from the unit.
  - After a fault, upload the fault recorder data. This is possible only if the fault recorder has been previously enabled with the Operating Tool.

Upload other information (measurements, binary inputs status, binary output status).

Do not make any changes to the REF 542plus configuration unless you are familiar with REF 542plus and the Operating Tool. This might result in malfunction and loss of warranty.

3.3. REF 542plus status information area

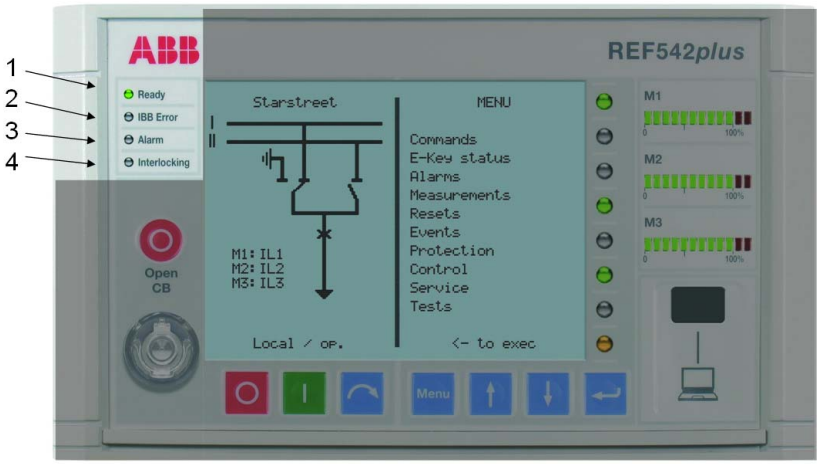

Fig. 3.3.-1 Status Information area

1 Ready: Operation status of the unit
2 IBB Error: Network communication status
3 Alarm: Indication according to the programmed alarm condition
4 Interlocking: Indication for inadmissible control action

The HMI shows the following status information:

- Ready. This green LED is turned on when the unit is in the operational state. The LED is switched off when the auxiliary power is not present or when the unit is not operational (FUPLA is not running).
- IBB(interbaybus) Error. This LED is meaningful only when the REF 542plus is equipped with a communication module. When the configured communication module is detected the LED turns on to green. If the module is not detected or fails, the LED turns red. When a Modbus communication module is installed, the LED becomes orange if the communication error rate increases. It becomes red when the communication error rate prevents good communication. The LED comes back to green when no communication errors occur or by resetting the module status registers (see the Modbus technical reference). When there is no communication module, the LED is always switched off.
  - Alarm: this LED turns to red when the user defined alarms become true. Several arbitrary alarm conditions can be defined and configured with the Operating Tool. Alarm conditions could be the trip of a protection function, loss of SF6 in the circuit breaker and so on. When this LED is on, it is not possible to close the circuit breaker or to download a new configuration. The alarm must be acknowledged first.
  - Interlocking Error: this LED is usually green. It turns temporarily to red when the user attempts an operation that would violate the programmed interlocking conditions; for example switching a disconnector with the circuit breaker in closed position.

4. Behavior at power up

Before energizing the switchgear, verify that the REF 542plus protection functions are properly set and that the unit is properly working (READY LED green).

At power up, the HMI unit shows on the LCD for a few seconds the following:

Fig. 4.-1 REF 542plus LCD during power up

After that, the LCD left part shows the switchgear single diagram while the right part shows the default menu. When the initialization is completed and the unit is operational, the ready LED is on.

5. Changing the language displayed

The international HMI version V5 can support up to two different languages. The first one can be used to display the local language. Due to the high QVGA resolution, it is possible to display, for example, Chinese on the HMI. Then the second language becomes English. If no local language is defined, the language used is always English, which is the default one.

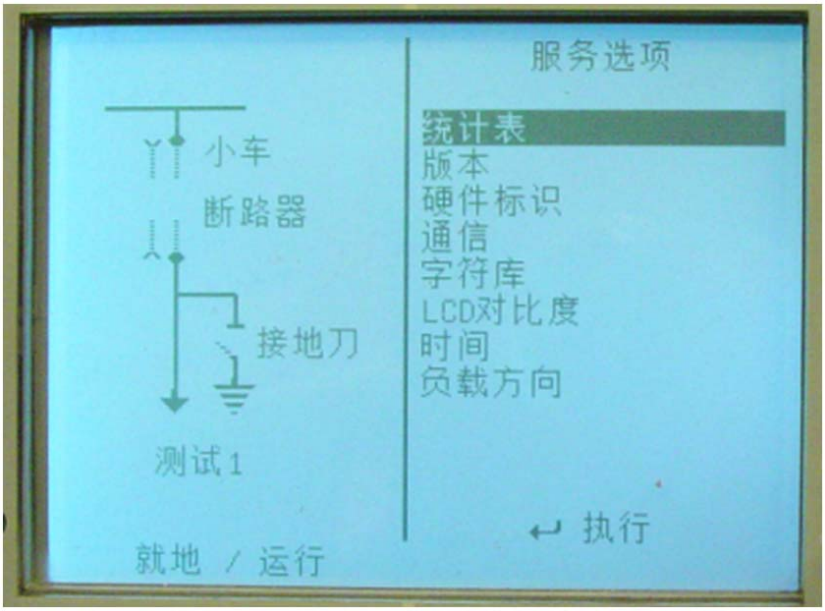

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Fig. 5.-1 Display of Chinese as first language

The following Fig. 5.-2 shows how to change the active language on the HMI. The prerequisite is that there is a local language defined. Do as follows:

- Go to the main menu by pressing MENU Menu.
- Press UP and DOWN simultaneously to get to the Language page.
- Press ENTER to execute the language change.

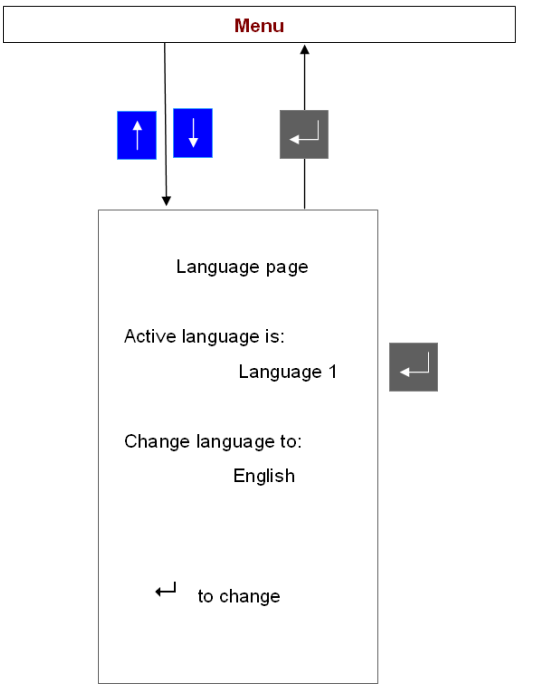


Fig. 5.-2 Changing the language displayed on the HMI

The former HMI of the REF 542plus (HMI Version V4) can still be applied together with the base unit having the new firmware of release 2.5. provided the firmware of the HMI is upgraded accordingly. After upgrading the firmware the HMI V4 behaves almost the same as the new international HMI V5. Due to the low resolution of the LCD on the former HMI, the displaying certain languages, such as Chinese, is not possible. Other languages, such as Russian with cyrillic characters, can be used as the first language.

Starting from release 2.5 SP1, an optional Ethernet module for the IEC 61850 communication protocol can be applied. Therefore, new menu items appear on the HMI display. Because of the limitation of the existing memory, the use of the HMI version V4 is not reasonable and it is not recommended anymore.

The design of the new international HMI V5 has been improved by extending the existing memory on the related mainboard. The information files for both languages are stored on the HMI after the download of the configuration file by the operating tool. The display of the language file is immediately available after the language change. In case of HMI V4 the language files are stored in the base unit. If the

display shall be changed, the relating language file must first be uploaded. After reset of the LCD the requested language will be displayed.

6. Control modes

6.1. Available control modes

Local Control

It is possible to control the circuit breaker and other primary objects from the HMI using the object control buttons. Open and close operations are possible only if the interlocking logic programmed into the unit allow them. Remote control from the SCADA is inhibited. Uploading and downloading the configuration via the optical interface is possible.

Remote Control

The control of the circuit breaker and other primary objects from the HMI is inhibited. The control is possible only remotely. Uploading and downloading the configuration via the optical interface is possible.

No Control

It is not possible to control the circuit breaker and other primary objects both from the HMI and remotely. Any kind of operation apart from the protection trip is inhibited. Uploading and downloading the configuration via the optical interface is possible.

Local and Remote Control

Both the local control and remote control from HMI are possible. Uploading and downloading the configuration via the optical interface is possible.

The selection of this control mode requires caution, because operations are allowed both from the HMI and remotely.

6.2. Changing the control modes

The next figure shows how to change the control mode. At first the menu E-Key must be selected. Then the control key must be placed in the electronic key sensor.

Select then the desired control mode by using UP and DOWN until it is highlighted. Confirm the selection by pressing ENTER . After pressing ENTER , the E-key status menu will appear again. Verify that the required control mode has been properly set in the unit looking in the lower left corner of the HMI. A text string there indicates the currently selected control and protection mode.

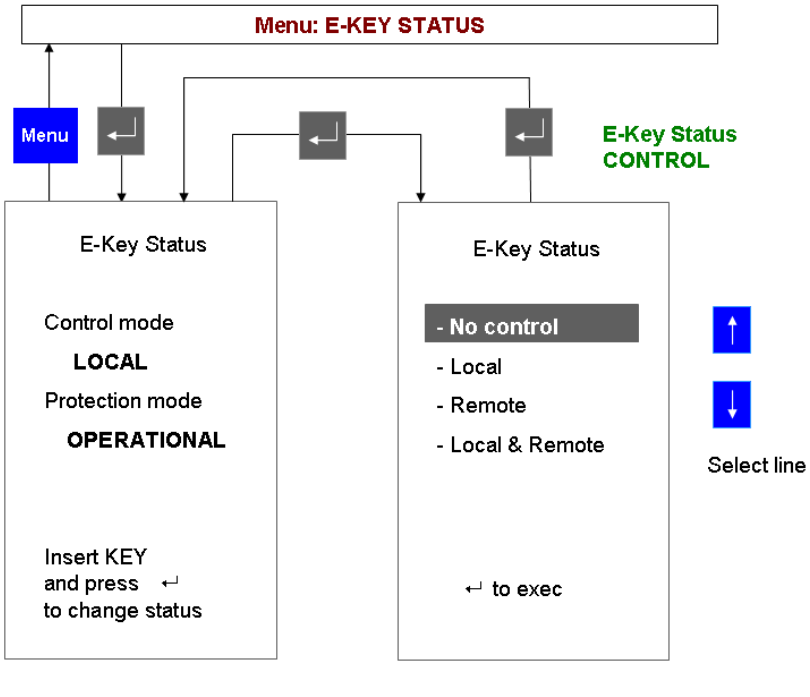


Fig. 6.2.-1 Changing the control mode by using the control key

7. Operating the primary objects

The primary objects can be operated from the HMI when the selected control mode is local or local and remote. The Object control push buttons allow operating the primary objects.

Press to step through the available objects until the desired object is selected (it will appear highlighted in the SLD). The object remains highlighted until the open or close push button is pressed or the time-out has elapsed.

Press to open the selected object.

Press to close the selected object.

Only primary objects controlled directly by REF 542plus can be selected. For example, REF 542plus will show the correct position of a manual disconnect switch after an operation, but it will not be possible to select it.

8. Viewing and resetting alarms

8.1. Viewing alarms

The presence of an alarm, when latched, is indicated by the alarm LED turned on or by one of the 8 x 4 pages user programmable LED's turned on to red. The conditions or the events that generate an alarm are defined and programmed with the Operating Tool.

When an alarm is active, the corresponding LED is turned on to red. Select the alarm menu with the navigation buttons. Then, this menu displays the text associated to the alarm condition. The displayed text is defined with the Operating Tool.

There are four pages of alarms and each page reports eight alarms at most. Use the navigation button to browse through the pages.

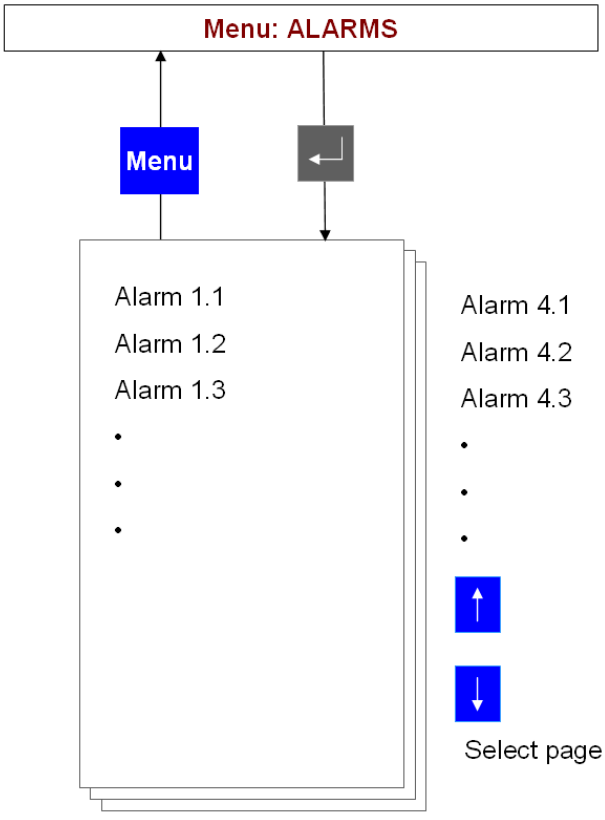


Fig. 8.1.-1 Alarm visualization

8.2. Resetting alarms

At first, the reset menu must be selected. Select the reset menu with the navigation buttons. Highlight the reset alarm line in the menu and then press ENTER .

Some alarms might not be reset before the cause that generated it has been removed. For example, an alarm due to an error in the tripping circuit (coil supervision) cannot be reset before the tripping coil is replaced. Whereas an alarm generated by a trip of a protection function is normally reset with this procedure.

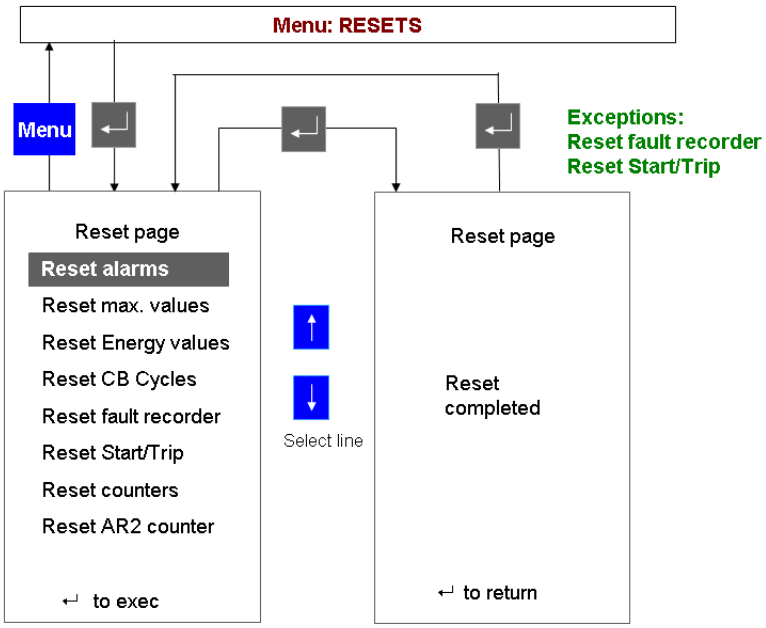


Fig. 8.2.-1 Resetting alarms

9. Viewing measurements

REF 542plus offers complete measurements set to the user. To view the measurements, select the measurement menu with the navigation button. Use the UP and DOWN buttons to browse the measurement pages.

The available measurements depend upon the unit configuration. In the maximum configuration, the following measurements are displayed:

- IL1, IL2, IL3, in A; line currents, measured values
- U1E, U2E, U3E, in kV; phase to earth voltages, measured values
- UL12, UL23, UL31, in kV; phase-to-phase voltages, computed values.[1)]
- IL1 mean, IL2 mean, IL3 mean, in A; mean currents in the observation period, computed values
- IL1 max, IL2 max, IL3 max, in A; maximum peak currents in the observation period, computed values
- Frequency, in Hz; measured values
- Active power, in kW; reactive power in kVAr, apparent power in kVA, computed values
- Power factor, computed value
- Active energy in MWh, reactive energy in Mvarh; computed values
- Operating hours, in hours. This is the total working hours of the unit
- Switch cycle, number the circuit breaker close-open cycles
- Added switched current, in kA; sum of the interrupted currents by the circuit breaker
- THD (total harmonic distortion)

The observation period is set with the Operating Tool. It can be from 0 minutes up to 30 minutes. If the observation period is set to 0, the corresponding measurements are disabled.

The refresh time for the displayed measurements is about half second.

1) REF 542plus can also use phase-to-phase voltage transformers. When used, phase-to-phase voltages are measured and phase to earth voltages are computed.

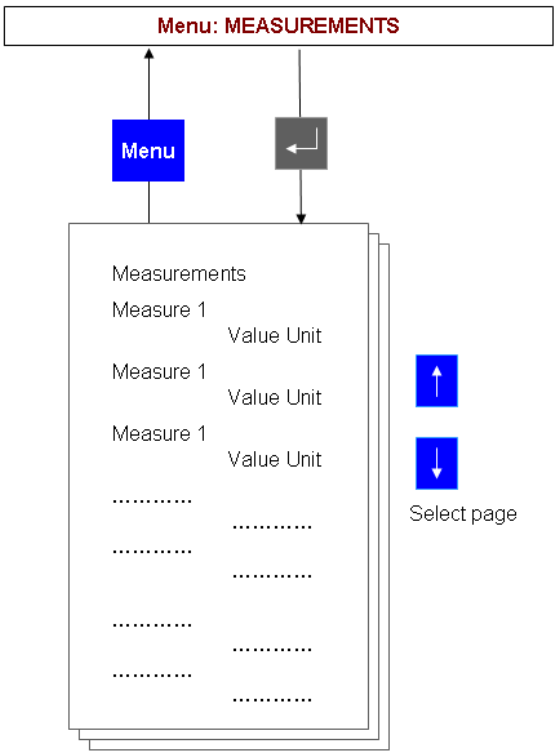


Fig. 9.-1 Measurements visualization

The available measurements depend upon the analogue input module type and the unit configuration.

10. Viewing events

REF 542plus records the last 30 protection events (start, trips, block and other). This internal memory is managed as a circular buffer, for example the 31st event overwrites the 1st oldest one. In case of a power loss, events are kept because they are stored in the non-volatile memory.

For each event, the following information is recorded: involved protection function, event type, relevant measurement (current, voltage, frequency), date and time (up to milliseconds). Events are displayed using the full screen; the single line diagram is thus not visible.

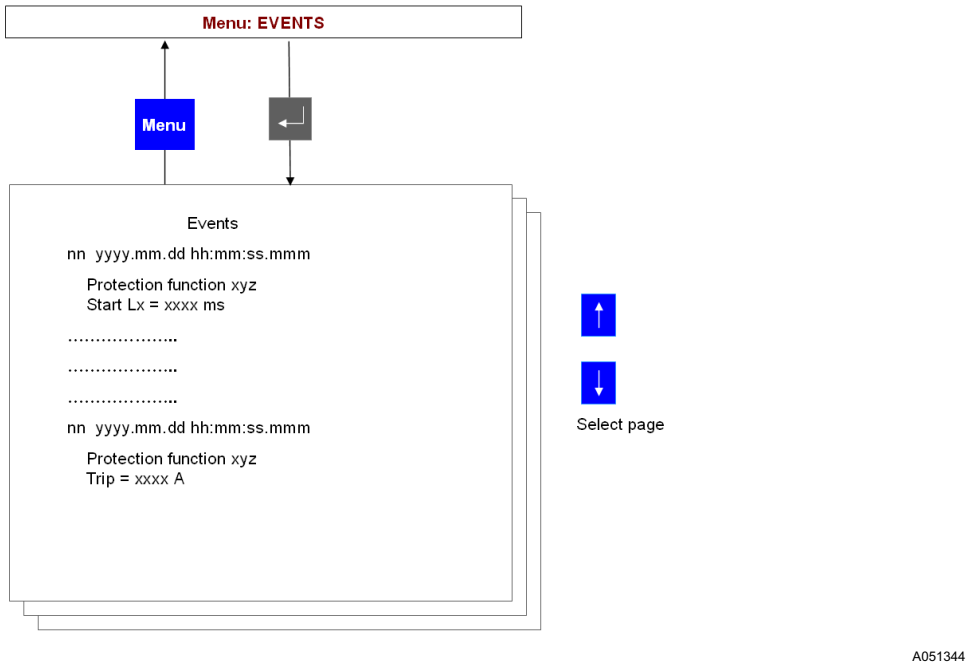


Fig. 10.-1 Events display

To display the protection events, select the **Start/Trip** menu with the navigation buttons. Use UP and DOWN to browse through the events.

11. Viewing and changing the protection settings

11.1. Viewing the protection settings

The protection functions currently installed in the unit can be seen in the menu protection functions. Select the menu protection functions with the navigation push buttons.

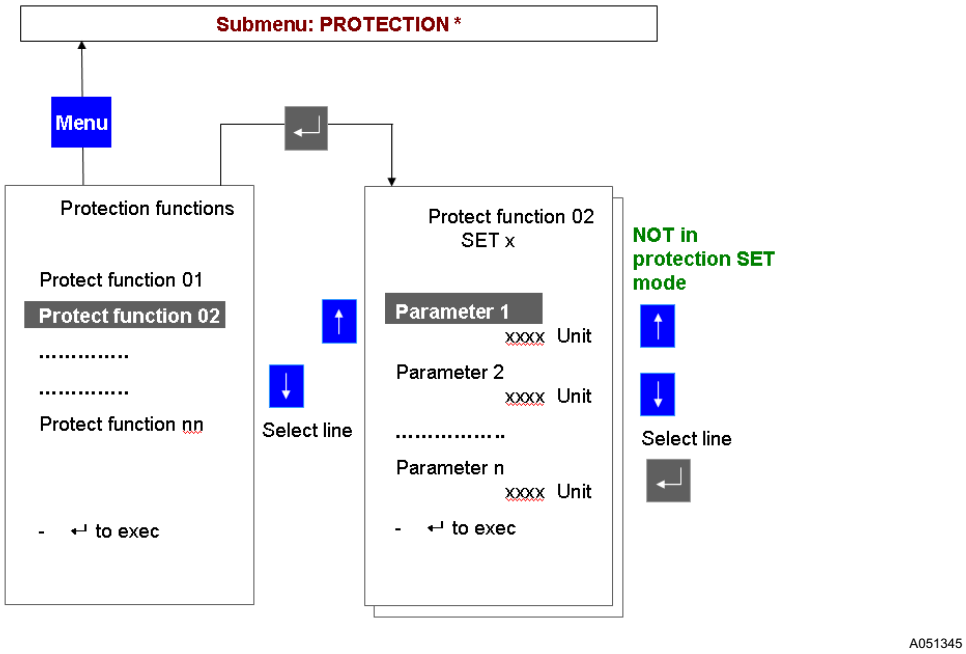


Fig. 11.1.-1 Viewing the installed protection functions

Use UP and DOWN to highlight the desired protection function and press ENTER . Then, the protection parameters will be displayed in one or more pages.

11.2. Changing the protection settings

11.2.1. Changing the protection key mode

Two different modes are available for the protection functions:

- Set: It is possible both to visualize and to change the protection settings.
- Operational: It is possible to visualize the protection settings but it is not possible to modify them.

In both modes, the protection functions are active.

In the operational mode, parameterization of the protection functions is also possible by a SCADA when present. In the set mode, parameterization from a SCADA is inhibited.

The procedure to change the protection mode is identical to changing the control mode. At first, the menu **E-Key** must be selected. Then the protection key must be placed in the electronic key sensor. Select then the required protection mode by using UP and DOWN until it is highlighted. Confirm the selection by pressing ENTER . After having pressed ENTER push button, the **E-key status menu** will appear again. Verify that the required protection mode has been properly set in the unit, looking in the HMI lower left corner.

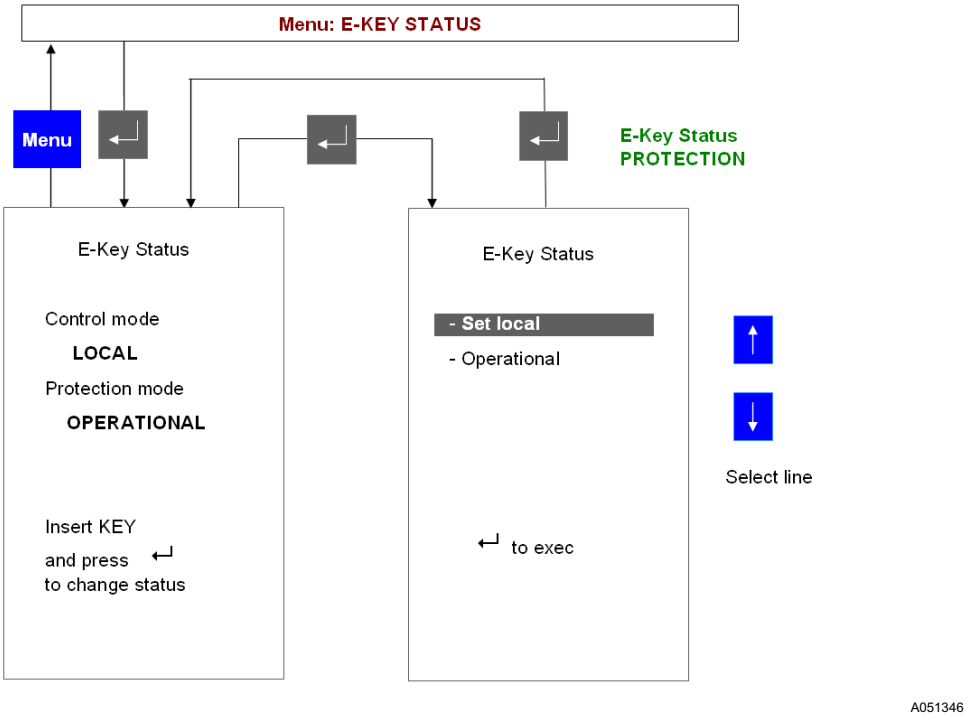


Fig. 11.2.1.-1 Changing the protection mode by using the protection key

11.2.2. Changing the protection parameters

Select the menu protection functions with the navigation push buttons and highlight the desired protection function. Press ENTER to select it. Press ENTER again and the cursor will automatically go to the first parameter. Use Up or Down buttons to modify the parameter as wished. After completed, press ENTER and use Up and Down button to select the next parameter to change.

Repeat the procedure for all the parameters that need to be modified. Then press Menu to go back to the list of currently installed protection functions. Repeat the procedure for every protection function that needs to have the setting modified.

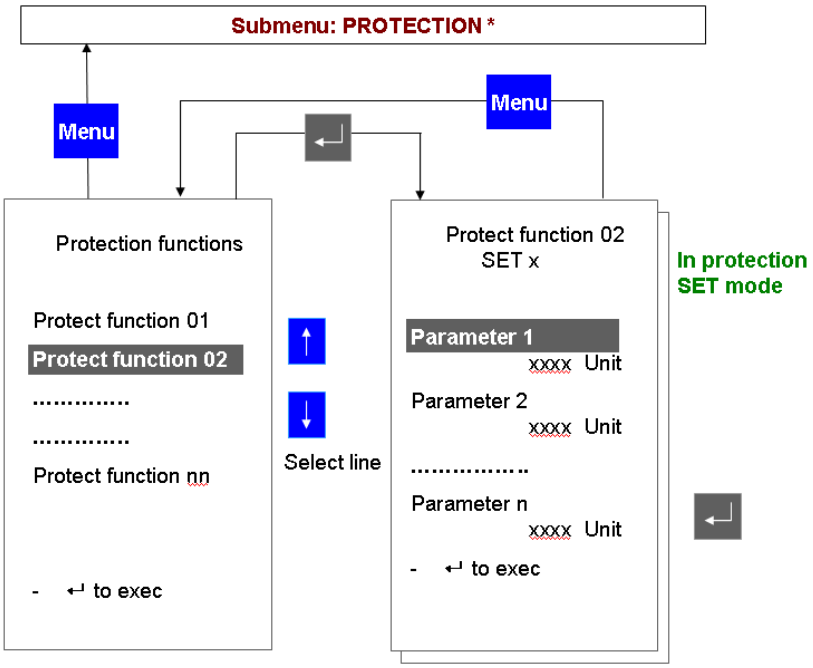


Fig. 11.2.2.-1 Changing protection parameters

Press Menu again to leave the protection functions menu. The unit will then ask what to do with the changes:

The following screen will appear:

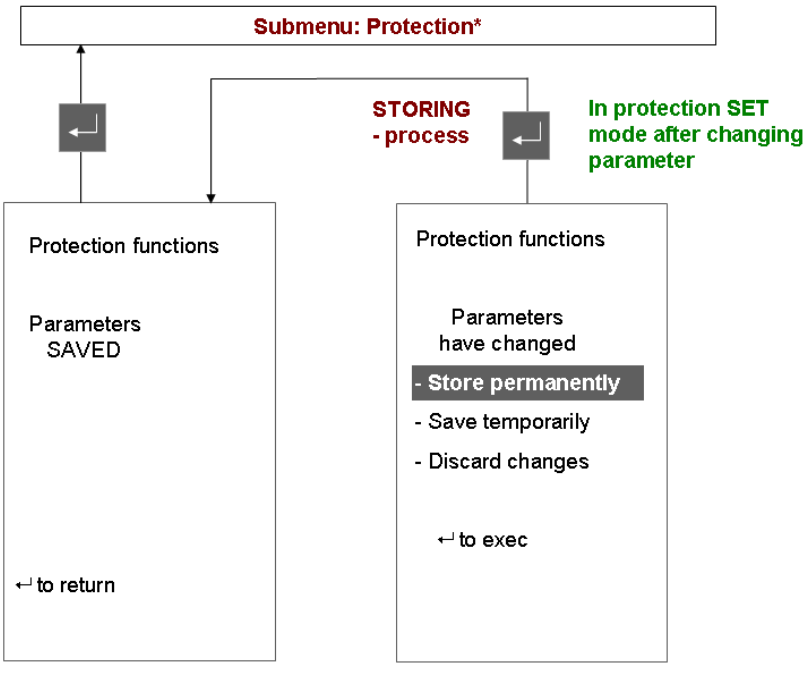


Fig. 11.2.2.-2 Unit right screen after protection parameters modification

Select the desired choice with Up or Down and then press ENTER to confirm it. The meaning of the choices is as follows:

Store permanently: The new parameters are stored in the unit internal memory. They will be used immediately and for all the next starts.

Save temporarily: The new parameters are used immediately but are not saved in the unit internal memory. Next starts will use the old parameters.

Discard changes: The new parameters are discarded. There are no effects.

Do not switch off the Base Unit power supply during parameter storing. The whole unit configuration might be corrupted and a new configuration download might be necessary.

11.2.3. Changing the active parameter set

Most of the protection functions have two different parameter sets to cope with different plant situations. This menu allows seeing and changing the active parameter set.

Changing the active parameter set is possible only with the protection in the set mode.

Select the active set page menu and press ENTER to make the change.

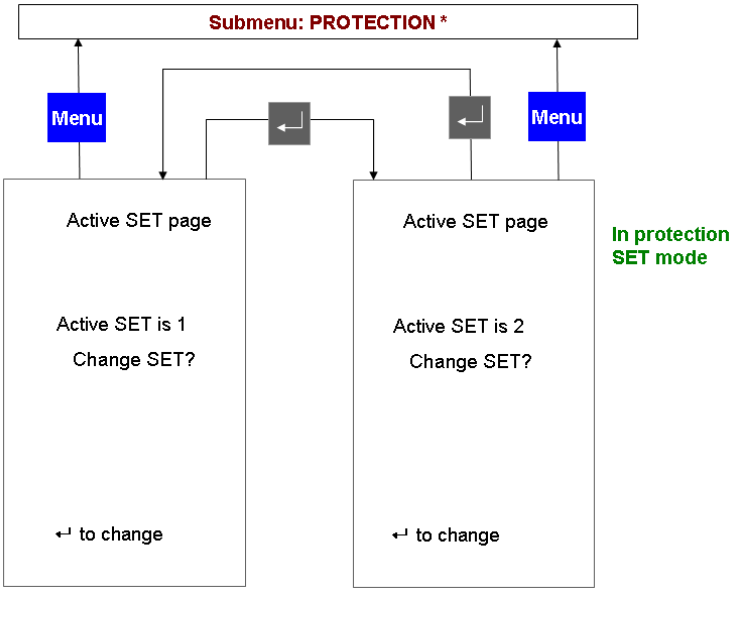


Fig. 11.2.3.-1 Changing the protection active parameter set

11.2.4. Viewing and changing control parameters

Select the **Control** menu with the navigation push buttons and highlight the desired control function. Press ENTER to select it. Press again and the cursor will automatically go to the first control parameter. Use the Up or Down button to modify the parameter as wished. After the modification, press and use Up Down to select the next parameter to change.

Repeat the procedure for all the parameters that need to be modified. Then press Menu to go back to the list of currently installed protection functions. Repeat the procedure for every control function that needs to have the setting modified.

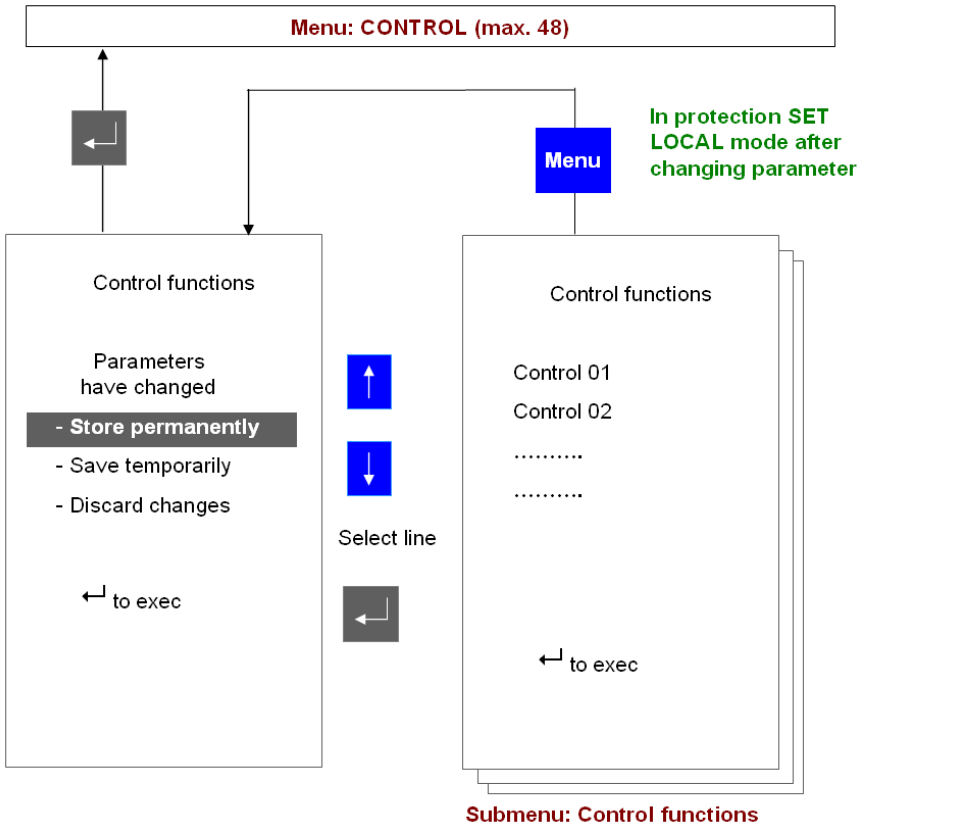


Fig. 11.2.4.-1 Control parameters page

12. Setting the time and date

During commissioning, the internal time and date of the unit should be set to the current values. There are a few differences according to the unit configuration.

Standalone unit: The internal time of the unit has to be set to the current value. To do it, select the service menu and then the MC time submenu with the navigation buttons.

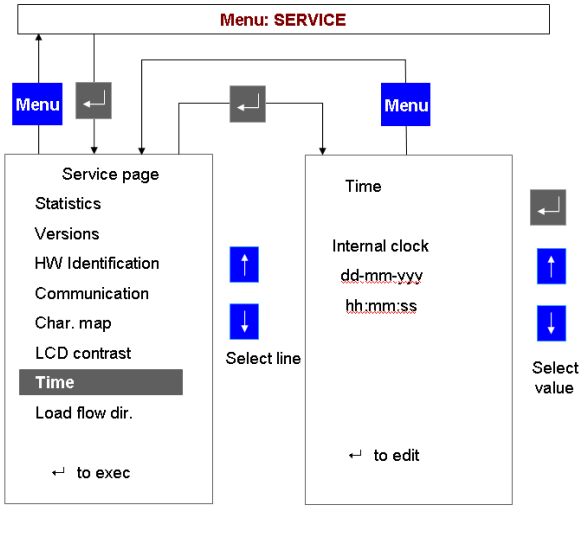


Fig. 12.-1 Setting the time

The time is edited by using UP, DOWN and then ENTER to confirm. The complete date and time must be inserted: year, month, day, hour, minutes and seconds.

Unit connected to a master clock:

- When the unit is connected via IRIG-B to a master clock, only the year can be set. The clock typically receives its signal from a GPS and sends it to the main module by an optical connection. The remaining part of the date and time is received from the master clock.
- When the unit is connected via SNTP to a master clock, a clock which typically receives its signal from a GPS and makes it available to the main module or Ethernet module via the Ethernet interface, the setting of the time and date form the HMI is inhibited.

Unit connected to a SCADA system:

Usually, the SCADA transmits to the unit the time and date according to the used protocol services. There are some differences depending on the used protocol.

- IEC 60870–5–103 protocol: The IEC 60870–5–103 module is the time master. Setting the time and date from the HMI is inhibited.
- LON LAG 1.4 protocol: The LON module is the time master. Setting the time and date from the HMI is inhibited.
- SPA bus and MODBUS protocol: usually, the SCADA sets the time and date, and setting the time and date from the HMI is inhibited.

13. Command page

From this page, it is possible to access the HMI command objects configured in the application software of REF 542plus. For more information on these objects, refer to Operating Tool user manual.

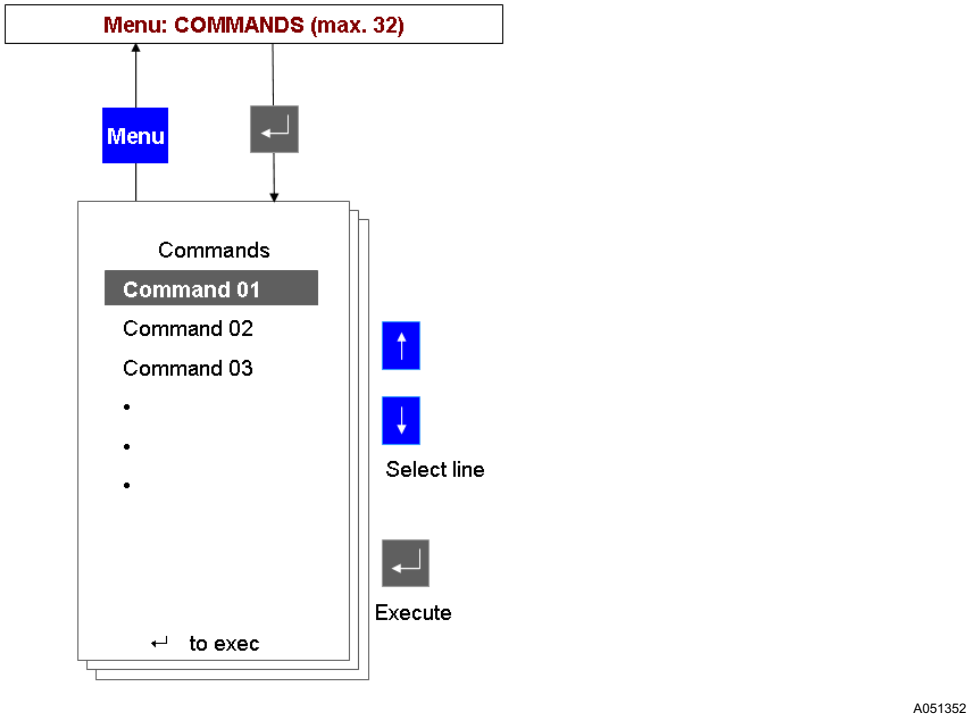


Fig. 13.-1 Command page

By selecting the desired command and pressing ENTER the command is executed.

14. REF 542plus commissioning mode

The commissioning test mode allows accessing all the digital and analogue inputs and outputs of REF 542plus. This mode is independent of the REF 542plus application. This working mode has been designed to make easier the wiring verification.

The super user key is required to enter this mode.

Entering this mode STOPS the execution of the protection and control functions. The application software is not running. However, it is not deleted from the permanent memory of the unit. The commissioning test mode should be entered when the switchgear is de-energized and in a safe state.

To switch on this mode the following actions have to be performed in sequence.

- Switch off the REF 542plus Base Unit.
- Place the super user key on the e-key sensor and keep it contacted.
- Switch on the Base Unit.

When the Base Unit starts the e-key is detected. The commissioning mode is entered. Verify this reading on the start-up status line “COMMISSIONING MODE”. When this text is visible, the e-key can be unplugged from the e-key sensor.

This mode allows driving directly the binary outputs of the Base Unit. If they are connected to primary objects, operations are thus possible. The interlocking functions are disabled. Before accessing this mode, put the switchgear in safe conditions.

When entering the commissioning mode, the following screen is displayed.

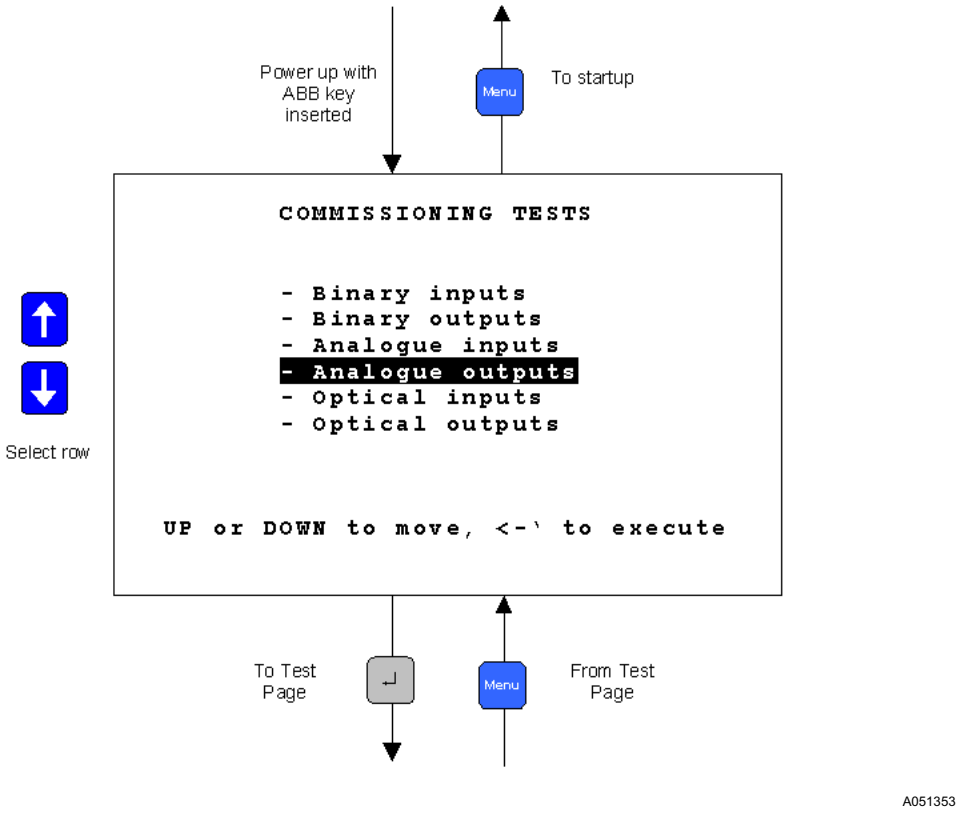


Fig. 14.-1 Commissioning mode display

14.1. Binary input commissioning page

This page displays the current status of the binary input channels on the binary IO modules. There are 14 binary inputs per module available. For the binary inputs numbering see Section 19.2. Binary inputs and outputs.

Line description:	“Channel descriptor” “Channel number “: “Values”
Channel descriptor:	Binary input
Channel number:	x-yy. Where x addresses the binary IO slot, yy is the binary input number. 1 means X20 slot and so forth.
Values:	0 → input is not active. Applied voltage is below the activation threshold. 1 → input is active. Applied voltage is above the activation threshold.

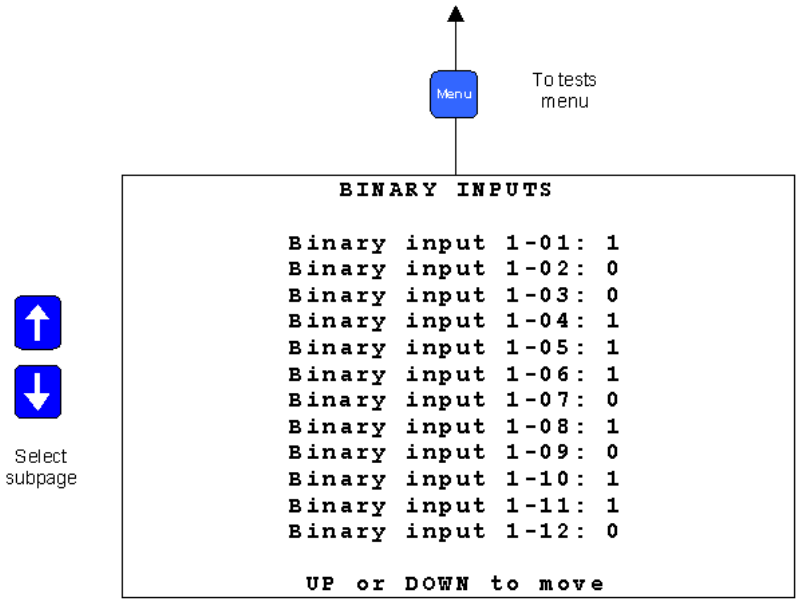


Fig. 14.1.-1 Binary inputs commissioning page

14.2. Binary output commissioning page

On this page, it is possible to force the status of the binary outputs. All the outputs can be driven with the exception of the watchdog.

Line description:	“Channel descriptor” “Channel number “: “Values”
Channel descriptor:	Binary output
Channel number:	x-yy. Where x addresses the binary IO slot, yy is the binary output number. 1 identifies the X21 connector and so forth.
Values:	0 → output is opened. The relay is not energized. 1 → output is closed. The relay is energized. Normally opened contacts are closed.

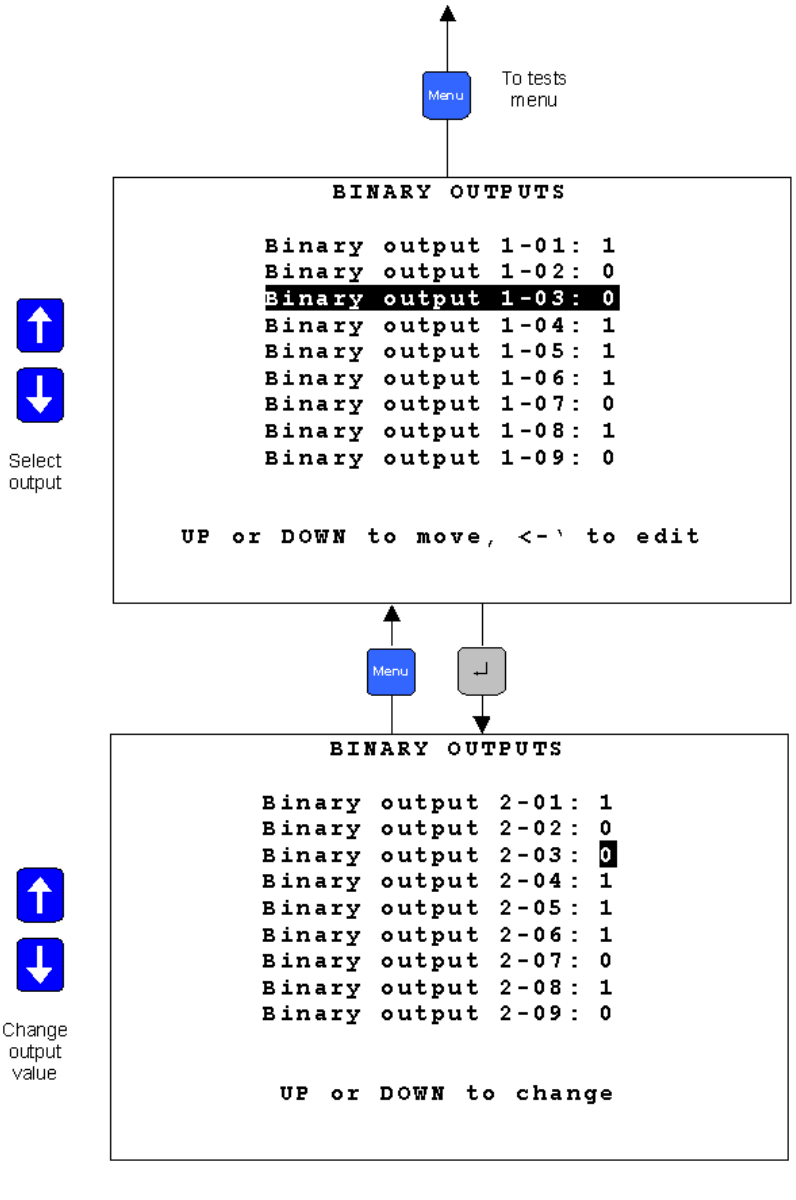
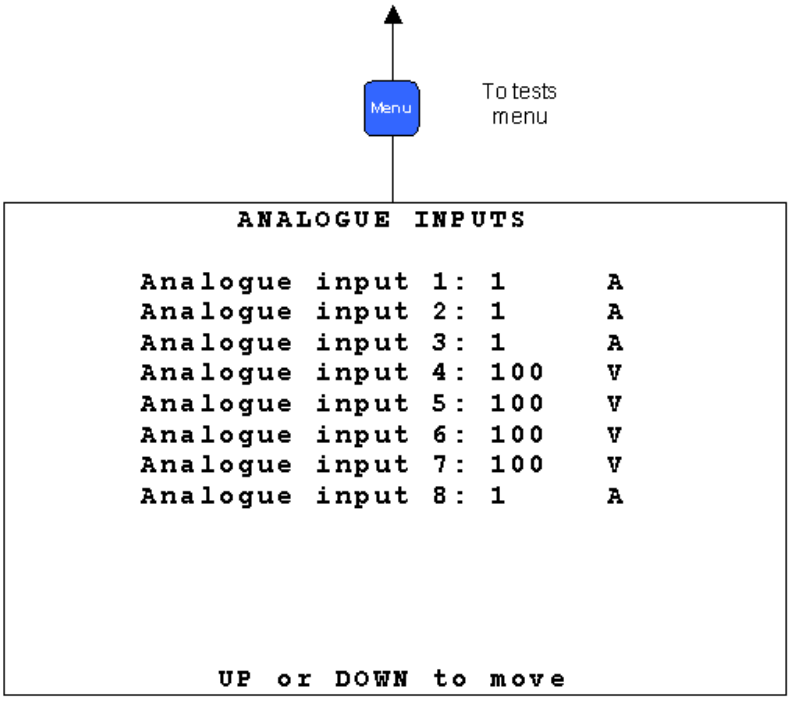


Fig. 14.2.-1 Binary outputs commissioning page

14.3. Analog input commissioning page

This page shows the analog measurements acquired by the analog input module. The shown values are independent on the rated primary current or voltage of the primary sensors. The measurements are reported in absolute values taking into consideration as nominal values of the secondary windings 1 Amp and 100 V. If the 5 Amp current inputs are connected applying the nominal rated current, it will be shown 1 A.

Line description:	“Channel descriptor” “Channel number “: “Values”
Channel descriptor:	Analog input
Channel number:	x, where x addresses the analog input channel.
Values:	CT (1-5 A) → Rated secondary current related to the current input. CT (0,2 A) → Rated secondary current. VT (100 V) → Rated secondary voltage (Volt). Sensor → Voltage output of the sensor (Volt).



A051356

Fig. 14.3.-1 Analog inputs commissioning page for the 3CT, 3VT, 1VT, 1CT module

With sensor inputs, the displayed values are the voltages read by the analog channels. For example, by using the voltage divider 10.000/1 applying 20 kV on the sensor, the measurement will show 2 Volt. For the current sensor 80 A/150 mV, applying 80 Amp on the sensor the measure will be 0.150 Volt.

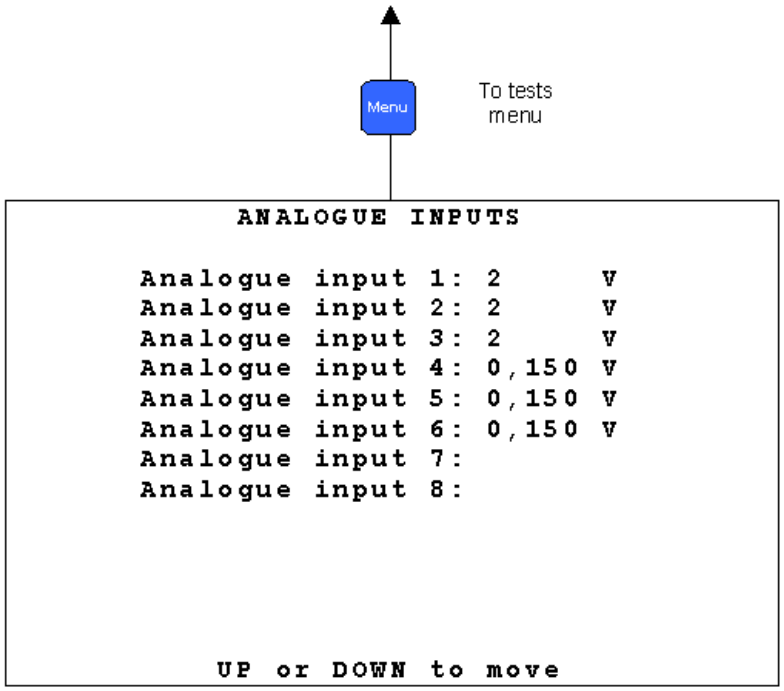


Fig. 14.3.-2 Analog inputs commissioning page for the 6 sensor module connected to 3 voltage divider and 3 Rogowski coils

14.4. Analog output 4- 20 mA commissioning page

This page allows setting the value of the analog channels in the 4-20 mA module.

Line description:	“Channel descriptor” “Channel number “: “Values”
Channel descriptor:	Analog Output
Channel number:	x. Where x addresses the analog output channel.
Values:	0/4 mA to 20 mA, step 1 mA. The value can be set with UP , DOWN .

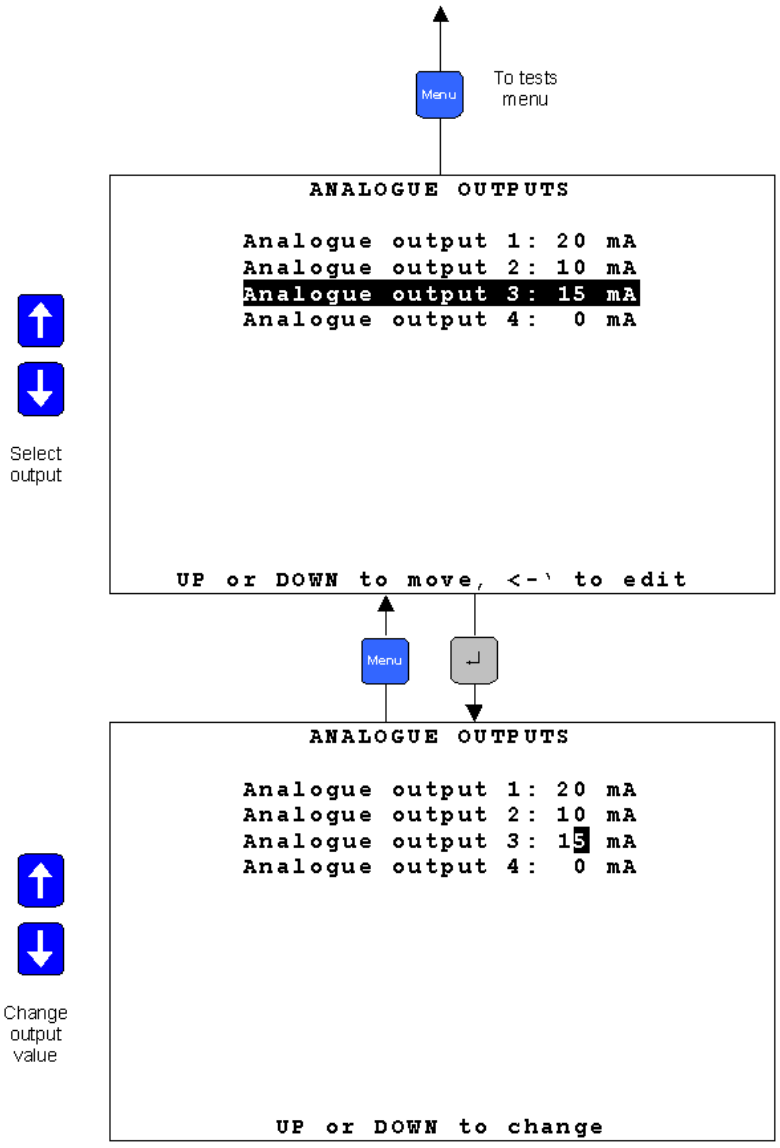
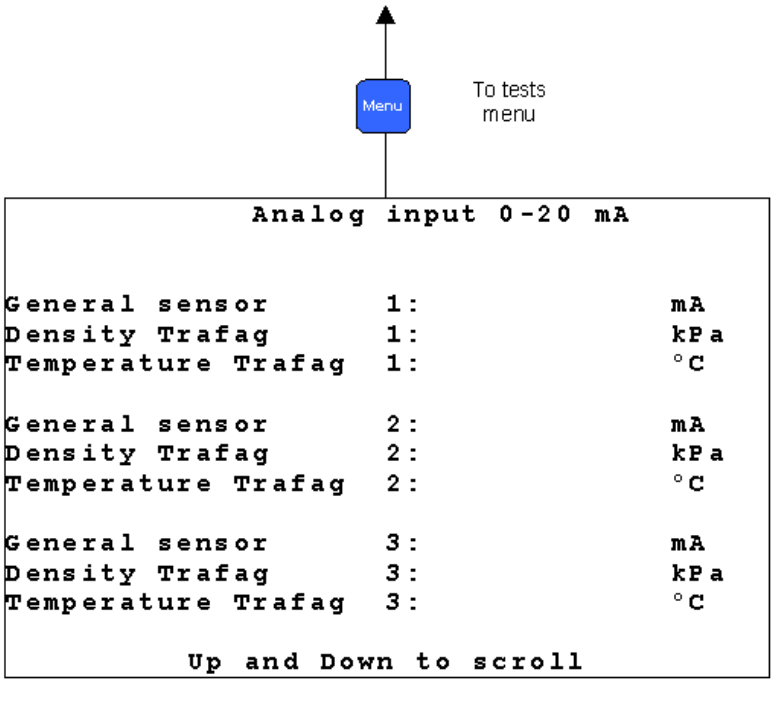


Fig. 14.4.-1 A 4-20 mA analog outputs commissioning page

14.5. Analog input 4-20 mA commissioning page

From this page, it is possible to read the analog measurements of the Analog Input 4-20 mA module. The shown measurements will be depending on the connected sensor type. In case of a general 4-20 mA sensor, the value of the applied current to the channel is displayed. In case of a SF6 Trafag sensor, the density and the temperature are displayed.

Line description:	“Channel descriptor” “Channel number “: “Values”
Channel descriptor:	General 4-20 mA sensor → General sensor Trafag → Density, Temperature
Channel number:	x. Where x addresses the analog input channel.
Values:	General Sensor → 4-20 mA, for Trafag the density and the temperature.



A051359

Fig. 14.5.-1 4-20 mA analog inputs commissioning page

14.6. Optical inputs commissioning page

This page displays the status of the optical inputs on the main module. This mode is available only with main modules equipped with the optical inputs (1VCF751021R0803, X74 only and 1VCF751021R0801 for all).

Line description:	“Channel descriptor” “Channel number “: “Values”
Channel descriptor:	Optical Input
Channel number:	x. Where x addresses the optical Input channel. 1: X74 (time synch input) 2: X75 3: X76
Values:	0: Optical input is off (no light is present). 1: Optical input is on (light is present).

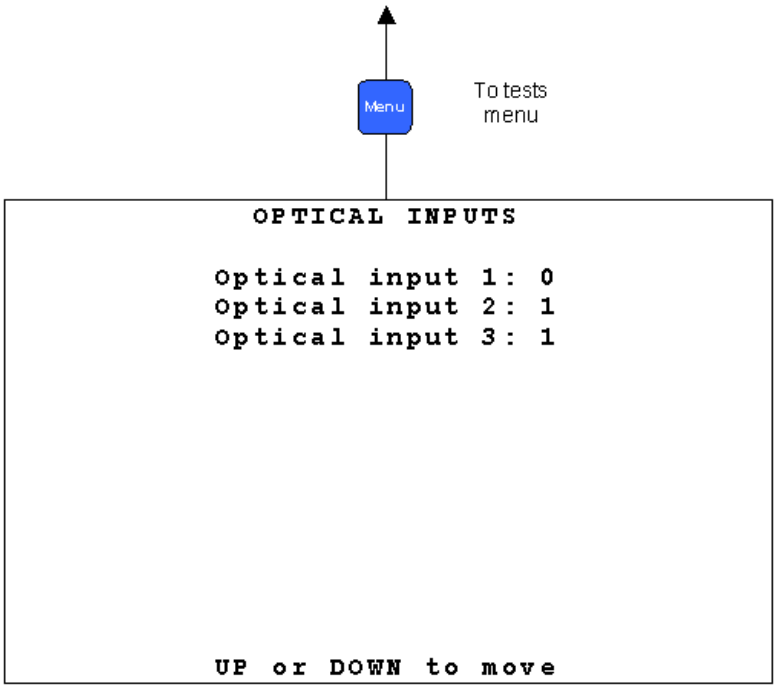


Fig. 14.6.-1 Optical inputs commissioning page

14.7. Optical output commissioning page

This page allows driving the optical output on the main module (only type 1VCF751021R801).

Line description:	“Channel descriptor” “Channel number “: “Values”
Channel descriptor:	Optical output
Channel number:	x. Where x addresses the optical output channel.
Values:	0: Optical output is off (light not present). 1: Optical output is on (light present).

The value can be selected with UP , DOWN .

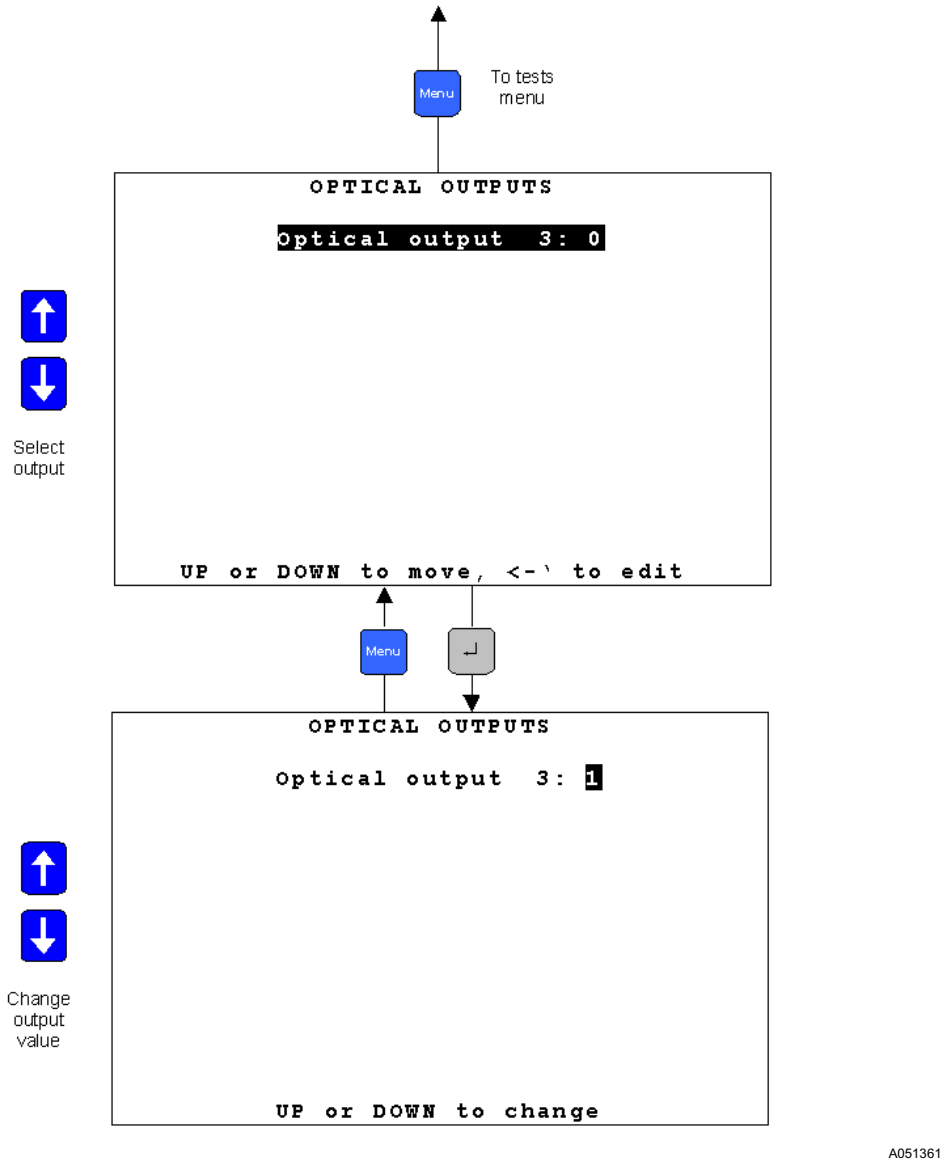


Fig. 14.7.-1 Optical output commissioning page

15. Connection to PC

15.1. Infrared (IrDa) to RS232 converter cable

A special cable with an optical infrared (IrDa) interface is needed to connect REF 542plus to a serial port of a PC. This cable is available from ABB.

Fig. 15.1.-1 REF 542plus serial cable with optical infrared (IrDa) interface

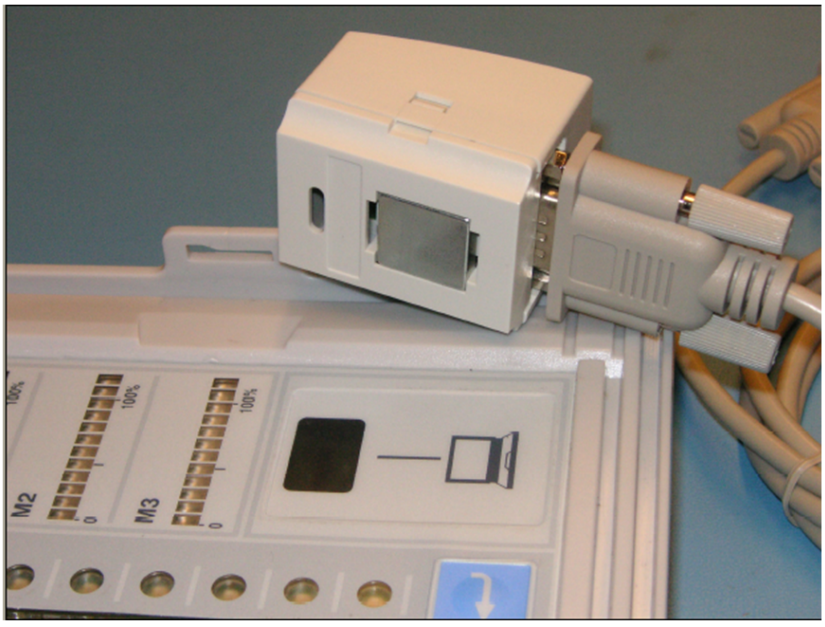


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Fig. 15.1.-2 Interface on the HMI for the serial cable with optical infrared (IrDa)

15.2. Null-modem cable

If there is no HMI applied or a direct connection to the base unit is preferred, a standard null-modem cable can be used to connect the base unit via the so called RS 232 service interface (X72) to the PC.

15.3. Ethernet TCP/IP cable

A standard Ethernet cable can be used to connect the base unit via the TCP/IP port interface to the PC.

15.4. Downloading a configuration

When the connection is set up with the appropriate cable, it is possible to download the configuration into REF 542plus with the Operating Tool. Connect the infrared (IrDa) converter to the foreseen connector on the HMI and the D-sub connector to the PC or connect the base unit to the TCP/IP port of the PC with an Ethernet cable. Start Operating Tool on the PC and configure the serial port or the TCP/IP port to be used inside the program.

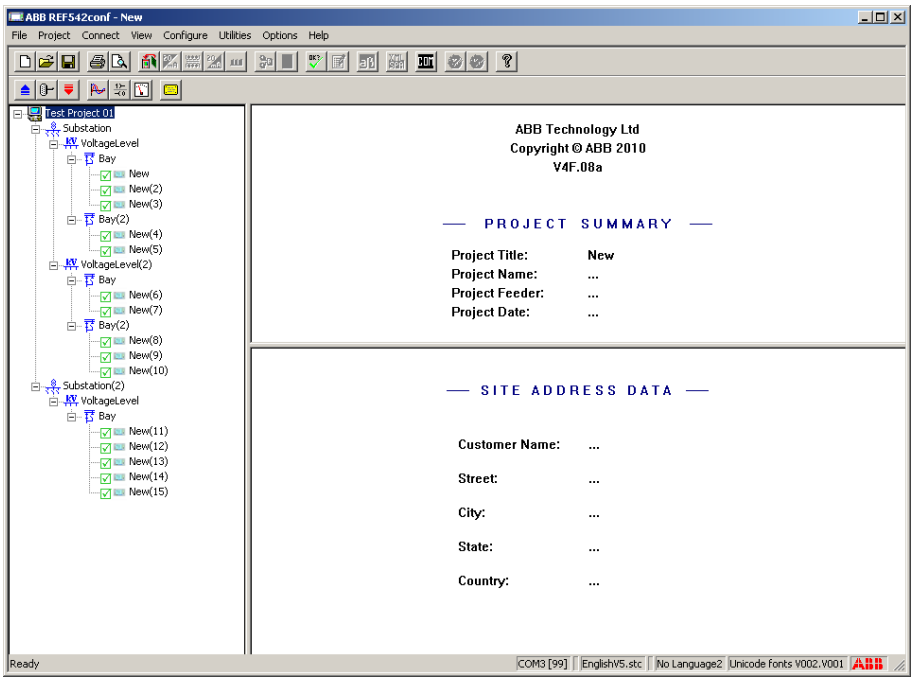

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Fig. 15.4.-1 Operating Tool's transfer menu

15.5. PC communication properties

REF 542plus Configuration Tool is able to configure the REF 542plus device connected via a serial port RS232 or an Ethernet TCP/IP port. To configure the communication port (serial RS232 or TCP/IP) of the computer to be used to transmit the configuration for the application, the corresponding applicable dialog must be edited. After starting the Configuration Tool software, open **Main menu > Connect > Port configuration**. The opening dialog window has three tabs.

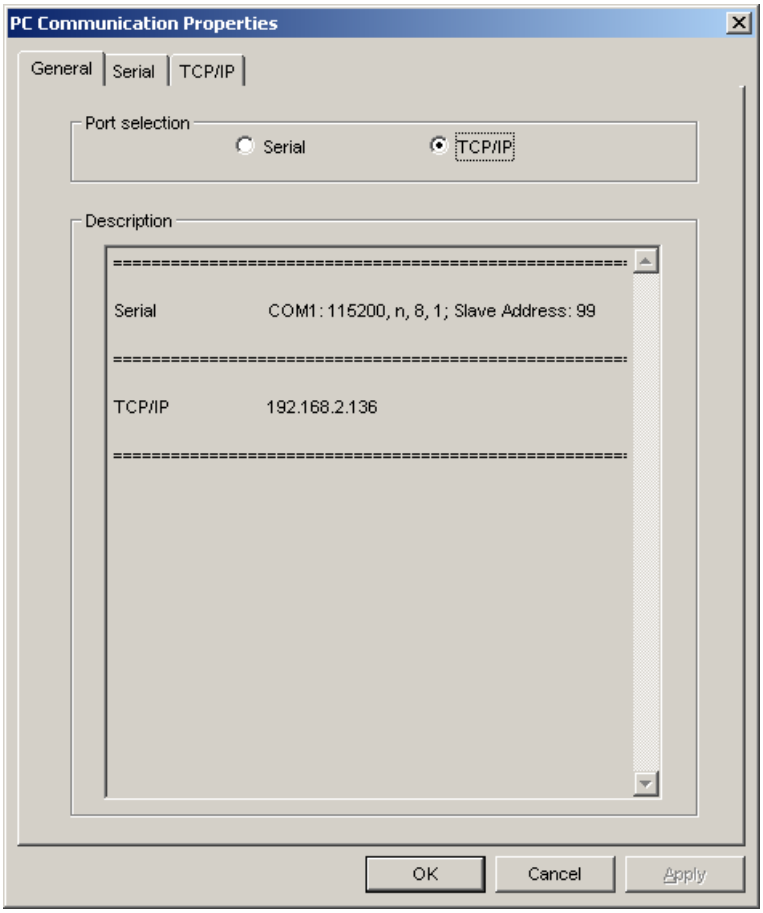

Fig. 15.5.-1 PC communication properties

On the first tab it is possible to select the communication port. The other two tabs are for configuring the serial port and TCP/IP settings.

General tab

The first tab is used to select the type of connection of REF 542plus to the PC. The connection can be Serial or TCP/IP. The type of communication must be selected before configuring it in the other tabs of the window. A section with a description of all the current settings regarding both serial port and the TCP/IP port is also provided.

If a serial port or a TCP/IP port is not available, the serial or TCP/IP port configuration tabs are not displayed. In the General tab, an empty value is displayed instead.

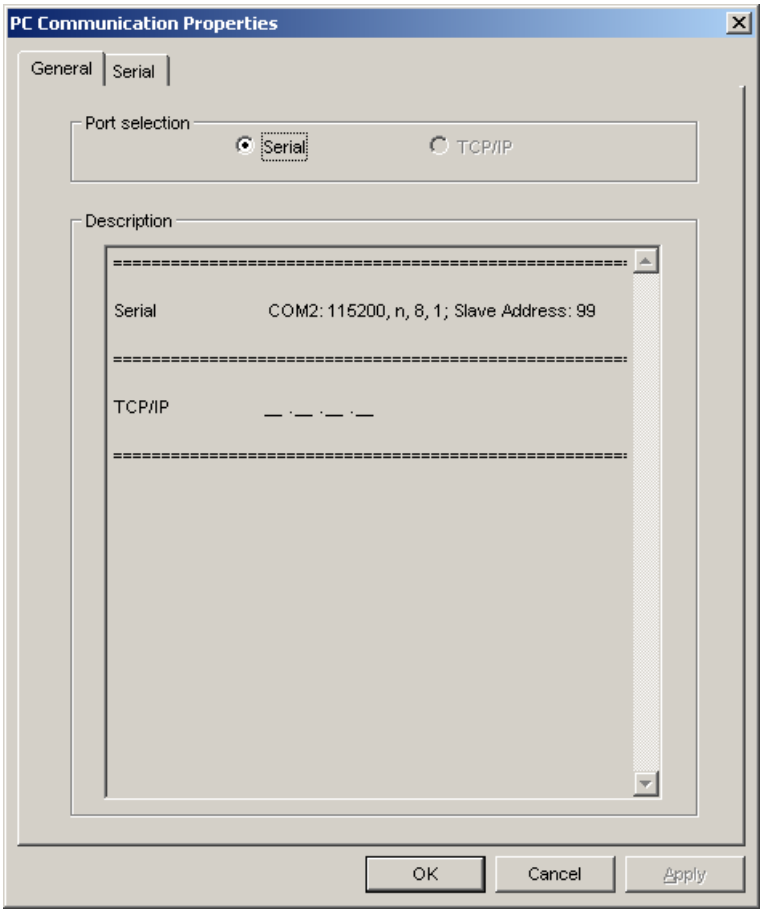

Fig. 15.5.-2 TCP/IP port disabled

15.5.1. Serial port settings

To configure the serial port (RS232) of the computer, the applicable Serial tab must be activated.

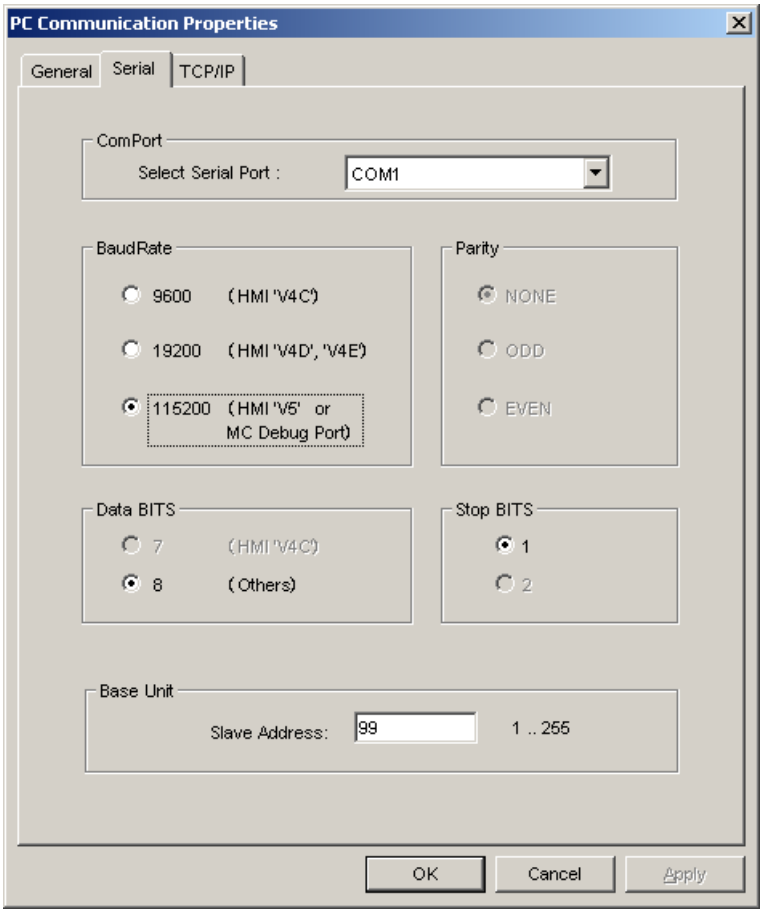

Fig. 15.5.1.-1 Serial port properties

The tab has five option fields where the settings for the computer serial port can be made.

Select the COM port where the RS232/Infrared (IrDa) cable or RS232 null-modem cable is plugged in.

Apply the following settings:

Application with the new international HMI V5 or connection with a null-modem cable directly to the base unit:

Baud rate	115,200
Data bits	8
Stop bits	1
Parity	None

Baud rate	19,200
Data bits	8
Stop bits	1
Parity	Even

After the download of the configuration file by using the service or the debug port, press ENTER to end the download process.

Base Unit slave address: This number can be from 1 to 254. When several Base Units are connected to the same HMI, this number uniquely identifies the Base Unit. The default address is 99. To configure or change the Base Unit slave address, there are two methods:

- Open the application file with the Operating Tool and change it in the hardware settings.

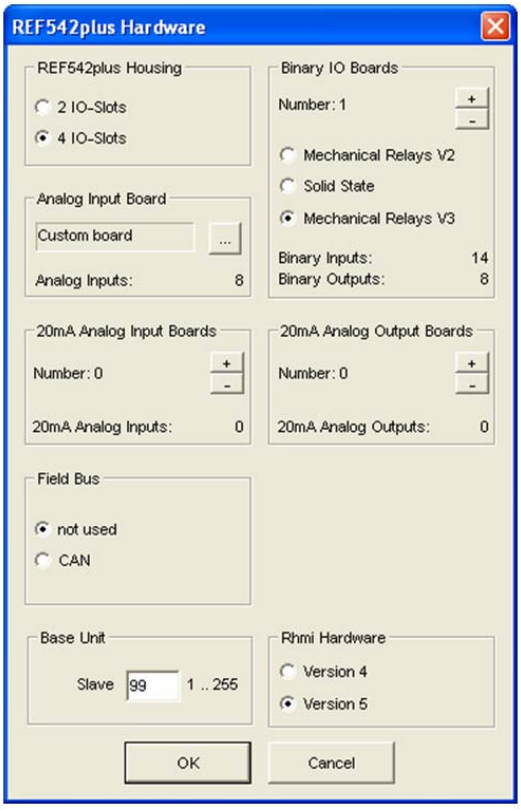

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Fig. 15.5.1.-2 Changing the Base Unit address

- Via the **HMI menu > Service page > Communication > HMI PORT**

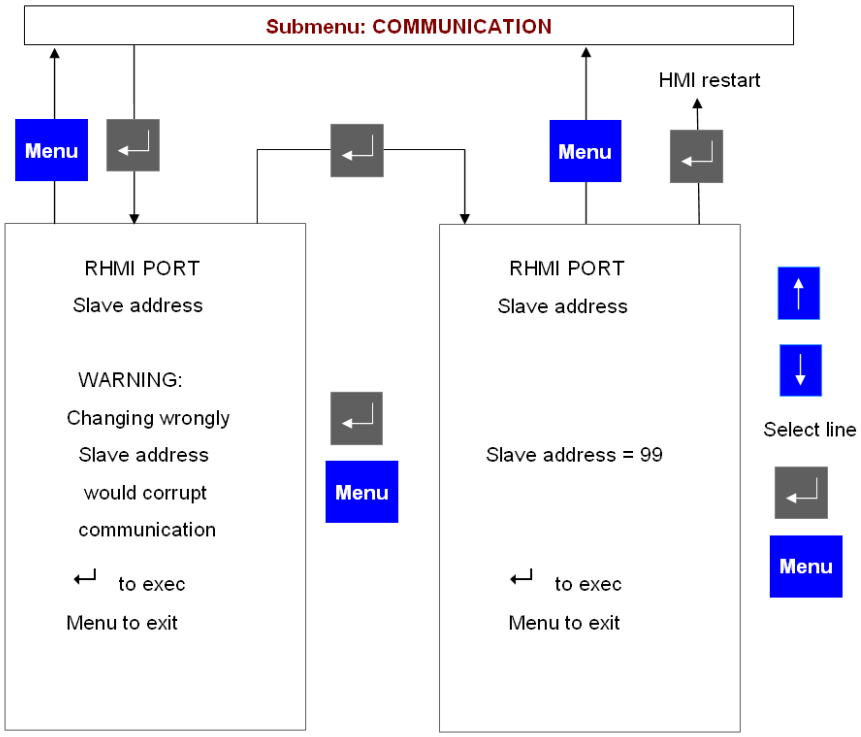


Fig. 15.5.1.-3 Changing the Base Unit address from the HMI

Please note:

When the ALARM LED is on, the download is inhibited.

The configuration download starts as soon as the relevant push button on the Operating Tool is clicked.

The previous configuration inside REF 542plus is destroyed and overwritten by the new one.

REF 542plus is fully operational during the download. After the download, REF 542plus starts to write the new configuration in the non-volatile with a low priority task in background. This task might take several seconds.

Do not switch off Base Unit power supply during the storing. The whole unit configuration might be corrupted and a new configuration download might be necessary.

The download is possible in all control modes, provided the status of the protection is switched by the corresponding electronic key in operational mode.

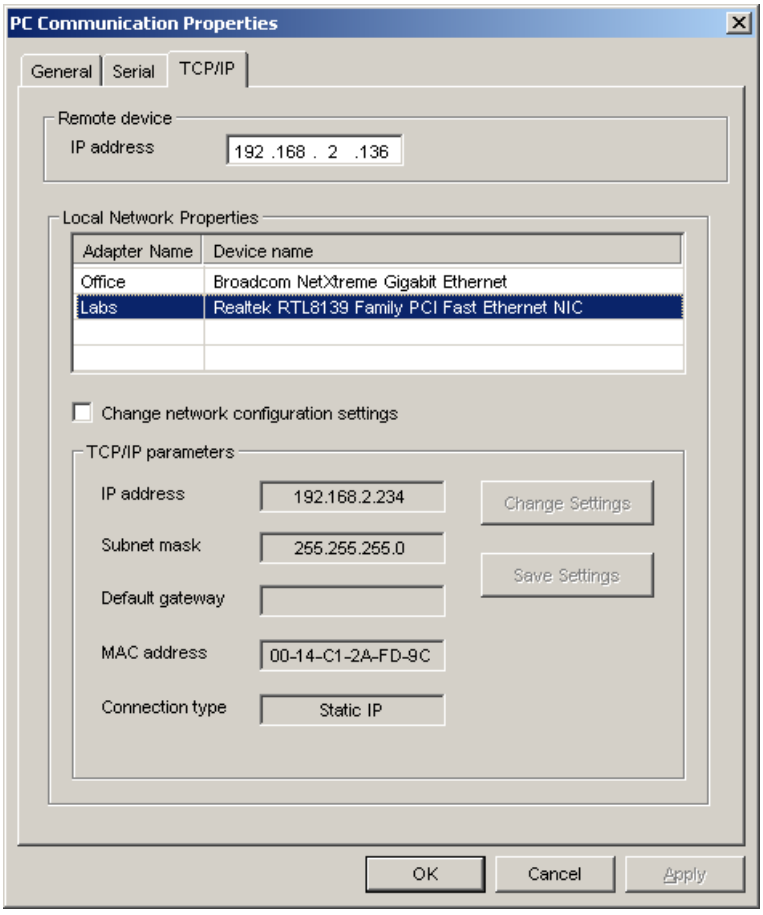
Communication to the SCADA system is operational during the download.

After the download, REF 542plus automatically starts with the new configuration.

When the download is completed, the unit may change the operational status of the output relays due to the new logic configured in the application file. It is strongly recommended to put the switchgear in safe conditions before performing the download.

15.5.2. TCP/IP port settings

To configure the TCP/IP port of the computer to be used to transmit the configuration file of the application, the applicable TCP/IP tab must be edited. In this tab it is also possible to set the IP address of the REF 542plus unit involved in the TCP/IP communication.



A100576

Fig. 15.5.2.-1 TCP/IP port properties

The "Remote device" section allows setting the IP address of the REF 542plus unit involved in a direct communication with Configuration Tool.

The "Local Network Properties" section shows a list of the Ethernet adapters currently installed in the PC. Once an Ethernet adapter is selected, the related TCP/IP parameters are shown as read-only:

- Mac address
- Type of connection (static or DHCP)
- IP address
- Subnet mask
- Default gateway

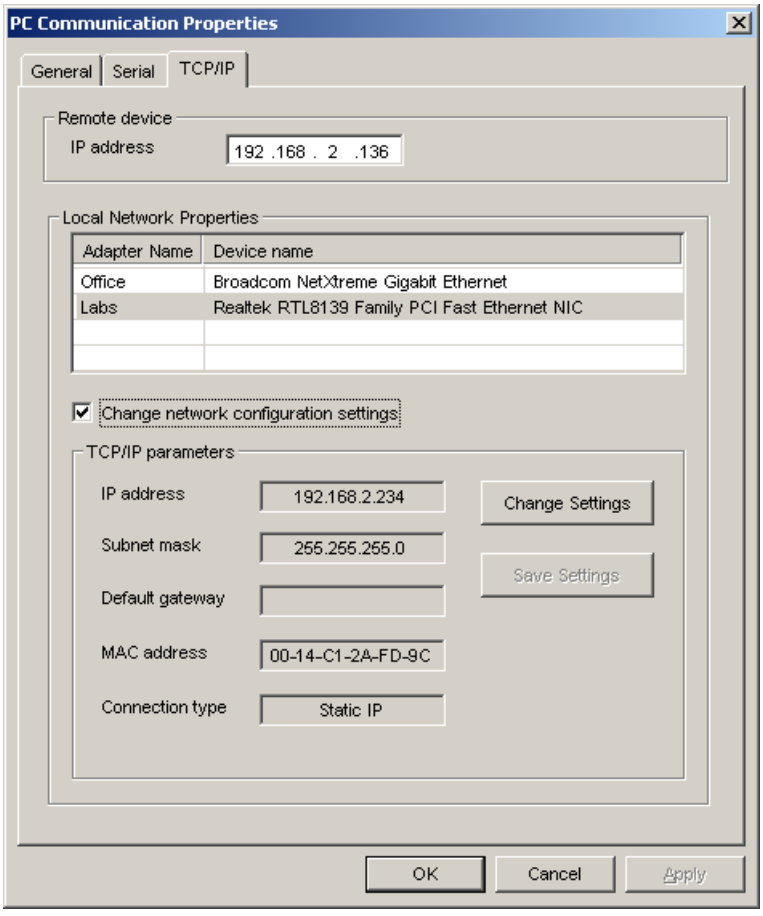
Both the REF 542plus unit and the PC must be connected to the same network.

To adjust the IP parameters of the PC Ethernet adapter so that it is in the same subnet or in general to modify other TCP/IP parameters, a utility is provided in the TCP/IP settings tab.

To change the parameters of a PC Ethernet adapter:

- select the adapter from the list
- select "Change network configuration settings"

  The **Change Settings** button becomes available.



A100578

Fig. 15.5.2.-2 Enabling PC for TCP/IP change

- Click **Change Settings** to open the TCP/IP dialog window to enter the new settings.

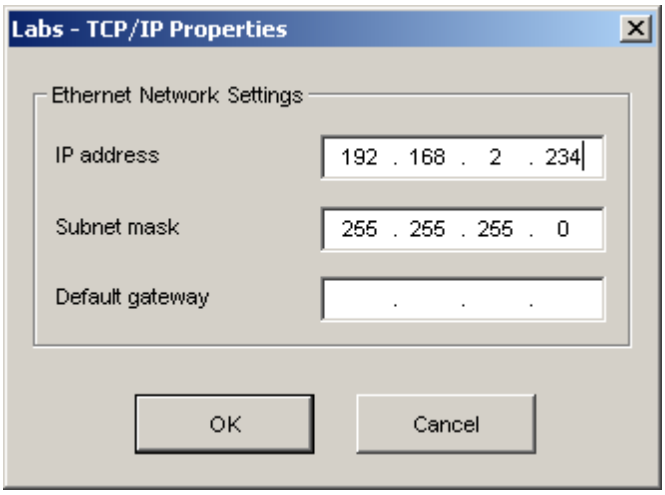


Fig. 15.5.2.-3 Changing the TCP/IP settings of the PC

If the new parameters are correct, the **Save Settings** button becomes available.

- Click **Save Settings** to start the renewing of the PC Ethernet card.

The settings can be changed also outside Configuration Tool.

- From **Control Panel > Network Connections**, select the Ethernet adapter whose parameters need to be modified.
- Click **Properties** and select from the list "Internet Protocol (TCP/IP)."

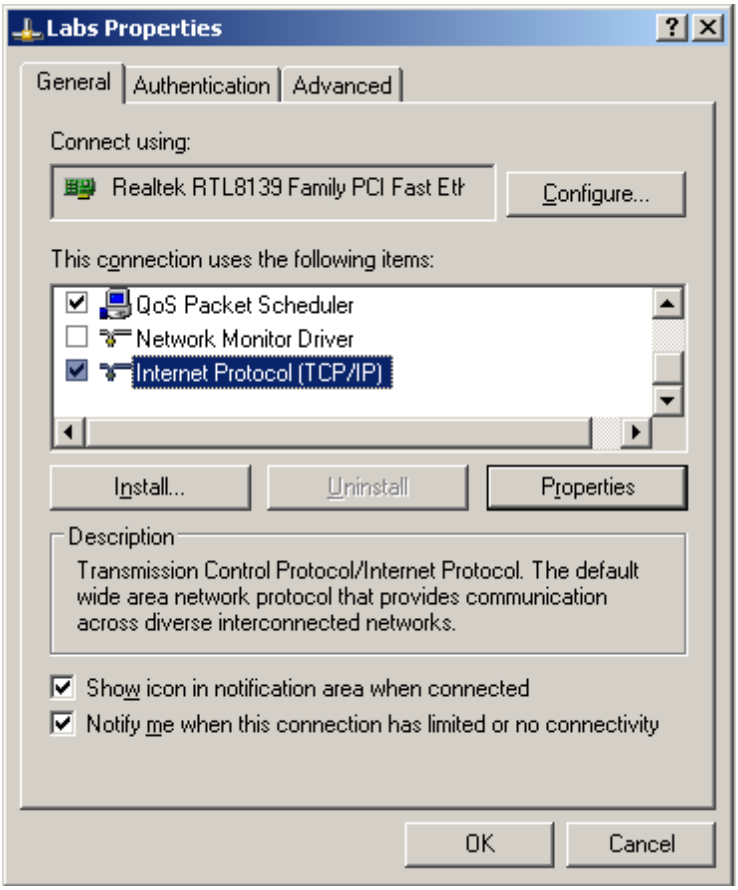


Fig. 15.5.2.-4 Changing the PC TCP/IP settings and properties from Control Panel

- Click Internet Protocol to open a dialog window that allows making changes to the TCP/IP parameters.

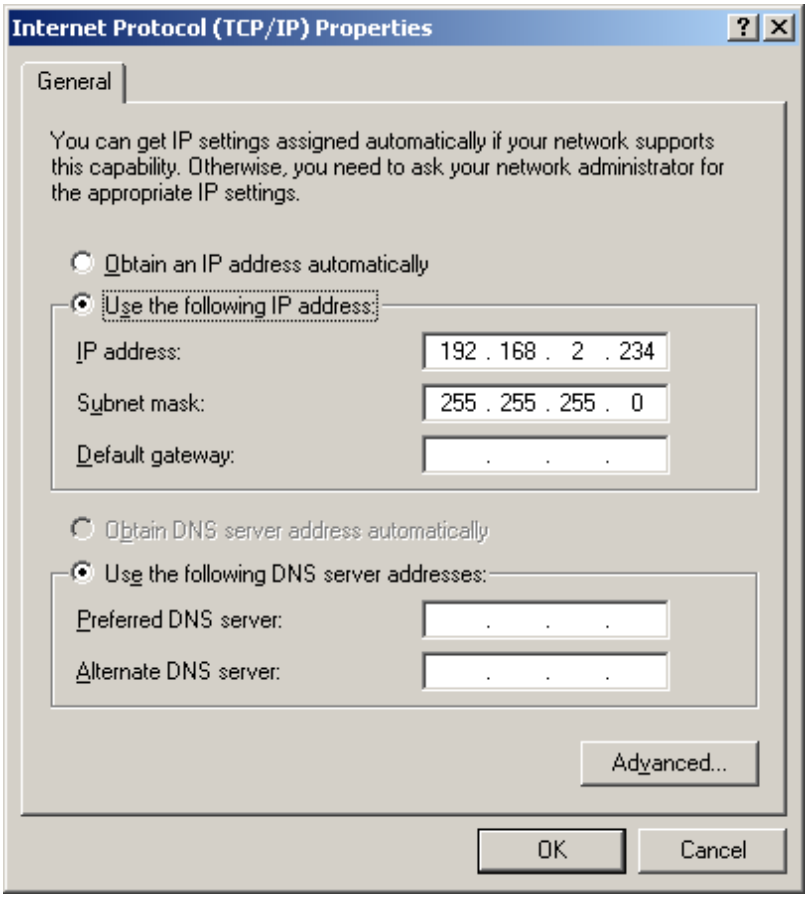


Fig. 15.5.2.-5 Internet Protocol properties

The PC Ethernet port is configured to communicate with the address 192.168.2.234 and with the subnet 255.255.255.0. The subnet value must match the subnet value set in the REF 542plus unit, while only the first three digits of the IP address must match the ones of the REF 542plus unit with the fourth digit being different. After that, it is possible to verify a remote connection with a ping command.

15.6. Uploading the configuration

With the Operating Tool, it is possible to upload the current configuration inside REF 542plus. Set the Operating Tool and the PC as for the download and click the menu Transfer/load from REF 542plus.

Please note:

The uploaded configuration overwrites the current one inside the Operating Tool.

The upload is possible in all control modes and does not affect the functioning of the unit.

15.7. Uploading other information

With the Operating Tool, other information can be uploaded from REF 542plus. Different data can be uploaded:

- The fault recorder file
- The binary input status
- The binary output status
- The measurements
- The software version

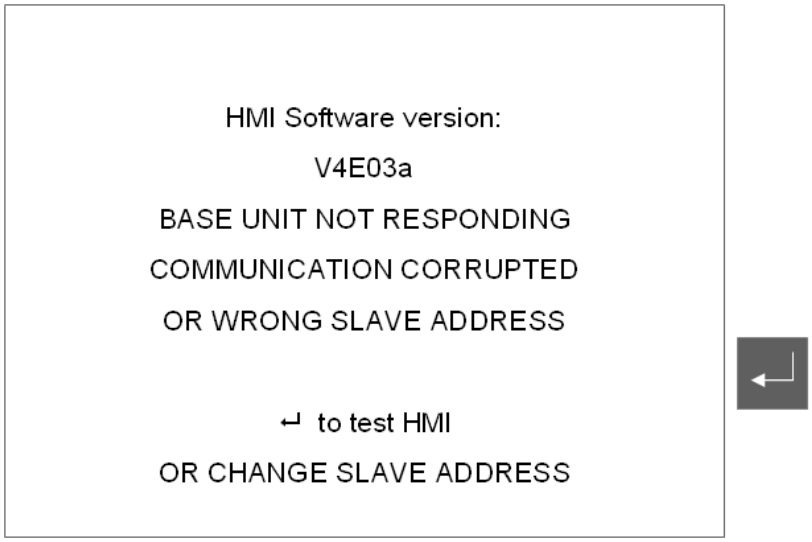
All this data is accessible with the Operating Tool from the transfer menu. Refer to the Operating Tool manual for more details.

16. Troubleshooting

16.1. Error messages

Base Unit not responding, communication corrupted or wrong slave address

When the HMI is not able to communicate with the Base Unit, the following information appears on the LCD:



A051367 2

Fig. 16.1.-1 HMI is not able to communicate with the Base Unit

Solution:

Check that the Base Unit is powered and regularly working. Look at the status LED on the connector panel (Slot X7).

The LED close to the analog inputs is related to the watchdog. When the Base Units is working this LED is on with a weak light.

The other LED is related to the communication with the HMI. When the communication is properly working, this LED is blinking. When the communication is not working, the LED can be either ON or OFF. It depends on when the communication is interrupted.

Check that the connection cable between the HMI and the Base Unit is inserted both in the HMI and in the Base Unit (Base Unit connector X73 and HMI connector X20) and properly tighten.

Check the slave address of the connected Base Unit to be polled. The address is configured in the application file. If you do not know you can enter the following page by pressing ENTER.

Power Up Operations

After pressing the ↵ key the Power Up Operation menu is shown as in the following Fig. 16.1.-2.

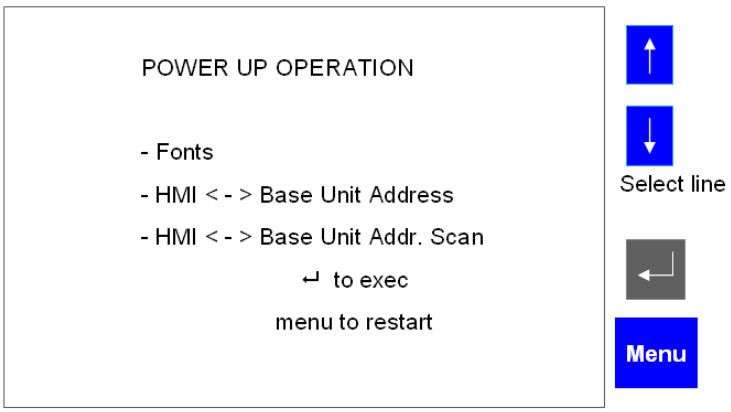


Fig. 16.1.-2 Menu for Power Up Operations for HMI V5

If the older version of the HMI V4 is used, the menu of the Power Up Operations is slightly different in accordance to the menu in the former release 2.0. The menu is as shown in the following Fig. 16.1.-3.

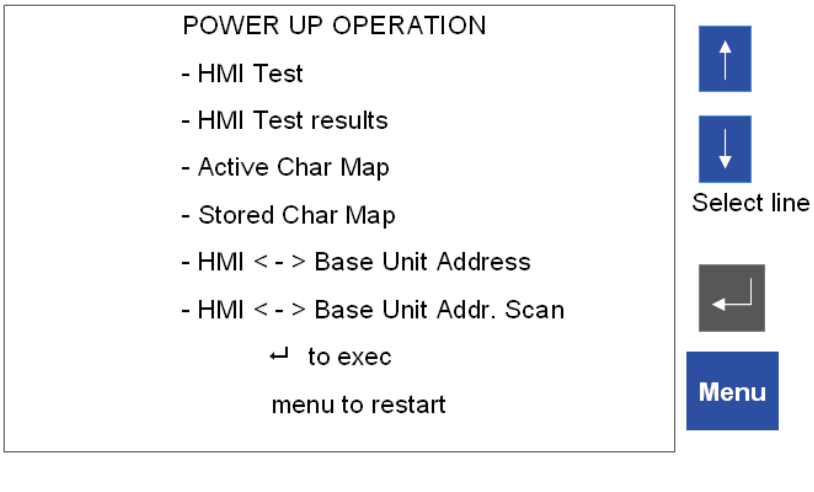
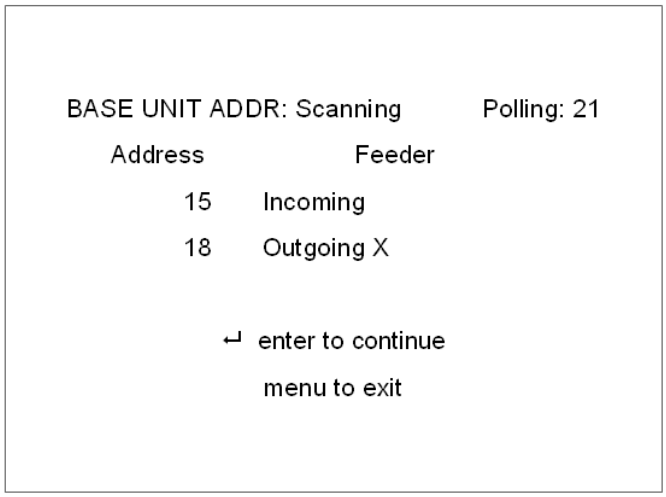


Fig. 16.1.-3 Menu for Power Up Operations for HMI V4

Select **HMI <-> Base Unit address scanning** menu item and press ENTER.

The HMI will start polling all the addresses to find the connected Base Units. When a unit is found, its address and the feeder name are reported.



A051438 2

Fig. 16.1.-4 HMI is polling the Base unit addresses

Select the **HMI <-> Base Unit address** to change the address to be polled.

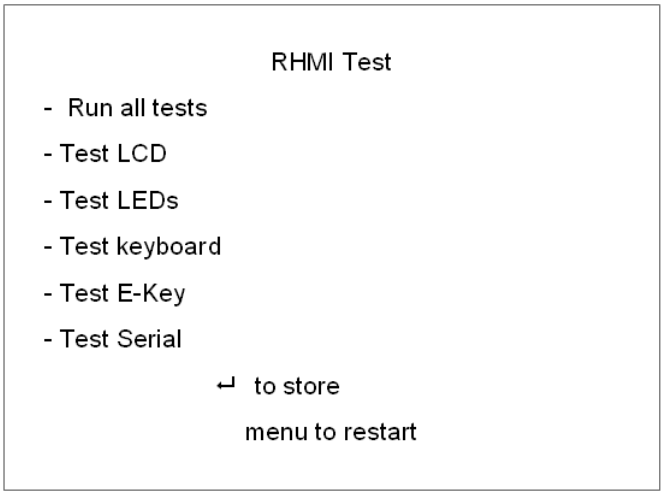
A051439 2

Fig. 16.1.-5 Changing the Base Unit address to be polled.

HMI Self Test

Only with the older version of the HMI V4, the HMI can be tested without connection to the base unit. The test must be done by using the foreseen menu item on the Power Up Operations. The HMI V5 must only be tested in connection to the base unit and by using the related test menu after reaching the ready status.

Press ENTER ↵ to start the test for the HMI.

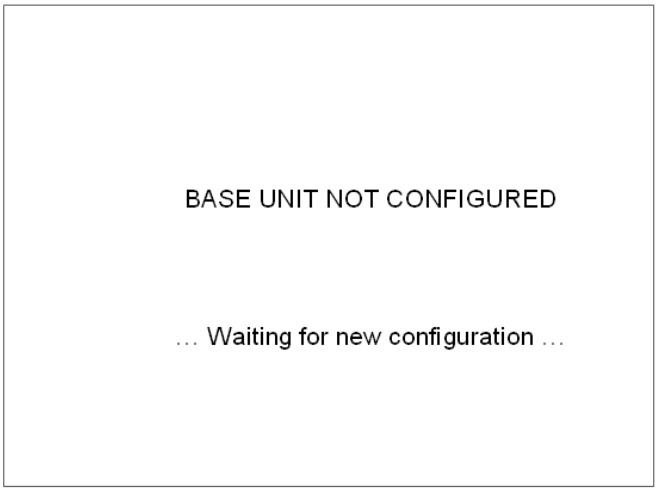


A051440 2

Fig. 16.1.-6 HMI test page

Base Unit not configured

REF 542plus is without configuration when the following message appears:



A051441 2

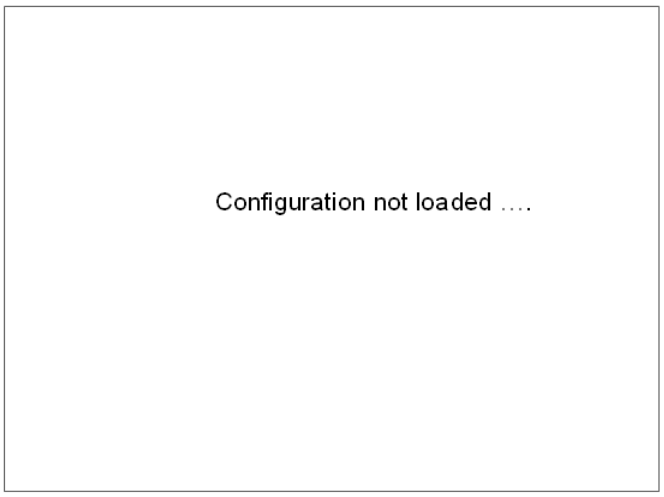
Fig. 16.1.-7 REF 542plus without configuration

Solution:

Download the configuration into the unit by using the serial cable and the Operating Tool.

Configuration not loaded

The following message appears when the downloaded configuration has not been saved inside the unit due to an internal error.



A051442 2

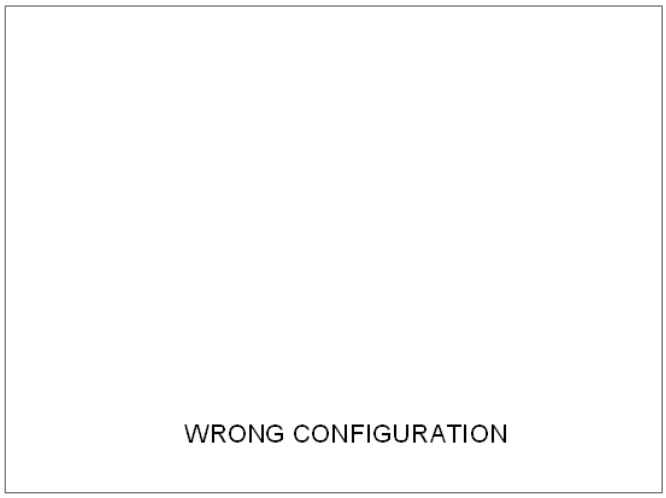
Fig. 16.1.-8 REF 542plus configuration is not stored in the unit internal memory

Solution:

Try to download the configuration again. If after two or three attempts the error remains, contact ABB.

Wrong configuration

The following message appears when a not correct configuration has been downloaded in the Base Unit. This message can also appear when the configuration contains protection functions that exceed the unit functionality level.



A051443 2

Fig. 16.1.-9 REF 542plus with wrong configuration

The WRONG CONFIGURATION can also be caused by other reasons. The error handling will be described in Appendix D, where the Self Supervision is explained.

• WRONG COM CONFIG	Invalid file format
• WRONG TCP-IP CONFIG	Invalid TCP-IP configuration or version not compatible
• WRONG MODTCP CONFIG	Invalid MODTCP configuration or version not compatible
• WRONG WEBREF CONFIG	Invalid WEBREF configuration or version not compatible
• WRONG SMS CONFIG	Invalid SMS configuration or version not compatible
• WRONG COMBOARD CONF	Invalid COM board configuration
• WRONG COMBOARD TYPE	COM board configured does not match with the one detected
• WRONG COMBOARD VERS	COM board configuration version does not match with the one handled by the installed COM board
• COMBOARD NOT INSTALL	COM board configured but not installed. It is physical check on DPM presence.
• COMBOARD NOT DETECT	COM board configured but not detected or the COM is present but it doesn't work properly
• COMBOARD NOT CONFIG	COM board detected but it has not been configured

For any other error message, contact ABB.

16.2. Clearing the configuration inside the unit

In some cases, there might be the need to delete the configuration stored inside the REF 542plus. For example, when the RED alarm is on, it is not possible to download a new configuration inside REF 542plus. The following procedure deletes the configuration inside REF 542plus:

- Switch off the Base Unit power supply (disconnect the X10 connector from the Base Unit).
- Press simultaneously the UP and DOWN buttons on the HMI and keep them pressed.
- Switch on the Base Unit again.

After this procedure, REF 542plus is without configuration. Download a new configuration in the unit.

This procedure deletes the configuration stored inside REF 542plus. The configuration cannot be recovered. Upload the configuration and save it before deleting it from the unit.

16.3. Primary objects incorrect visualization

The primary object status is usually acquired by REF 542plus with two distinct contacts: one that is closed when the object is closed and another that is opened. When the object is opened, the same two contacts with two different positions are needed.

The primary object is visualized in open position with a dotted line when both contacts are opened (REF 542plus has no voltage at both contact inputs).

A051444

Fig. 16.3.-1 REF 542plus has no voltage at both inputs indicating the primary object position

The primary object is visualized both in open and closed positions when both contacts are closed (REF 542plus has voltage at both its contact inputs).

A051445

Fig. 16.3.-2 REF 542plus has voltage at both inputs indicating the primary object position

Solution:

Check the wiring of the primary object. Verify that REF 542plus connectors are properly inserted and tightened.

Note: When the primary object in such an undefined positions, issuing an open command will activate the open coil on the circuit breaker. The open operation is never blocked. The close operation with the object in the undefined position is blocked. A close command will be discarded and will turn the interlocking error LED on.

17. Terminology

Term	Description
Ethernet	Physical communication network to transfer Internet data of the REF 542plus to the PC and back.
Modbus	By extension, communication board implementing the Modbus protocol for REF 542plus.

18. Abbreviations

Abbreviation	Description
BIO	Binary input and output board
CAN	Controller area network
CB	Circuit-breaker
CT	Current transformer
EEPROM	Electrically Erasable Programmable Read-Only Memory
FUPLA	Function block programming language; Functional programming language; Function plan; Function chart
GPS	Global positioning system
HMI	Human-machine interface
HW	Hardware
IBB	Interbaybus
ID	Identifier; identification
IEC	International Electrotechnical Commission
IP	Internet protocol
LCD	Liquid crystal display
LD	Logical device
LED	Light-emitting diode
LON	Local operating network
MC	Micro controller
PC	Personal computer
RAM	Random access memory
SCADA	Supervision, control and data acquisition
SLD	Single-line diagram
SNTP	Simple Network Time Protocol
SPA	Data communication protocol developed by ABB
TCP	Transmission Control Protocol
VT	Voltage transformer

19. Appendix A: Connection diagrams

The pictures below show the connections plate for REF 542plus both in the wide and standard housing versions. The wide housing version can house three binary input and output modules; the communication module, the analog output module or alternatively the analog 4-20 mA input module. The standard housing version can house at most two binary input and output modules and alternatively the communication or the analog output module.

The connectors meaning is explained in the following.

Do not operate a switchgear unless the REF542plus connections are properly done and verified by an expert electrician and tightened.

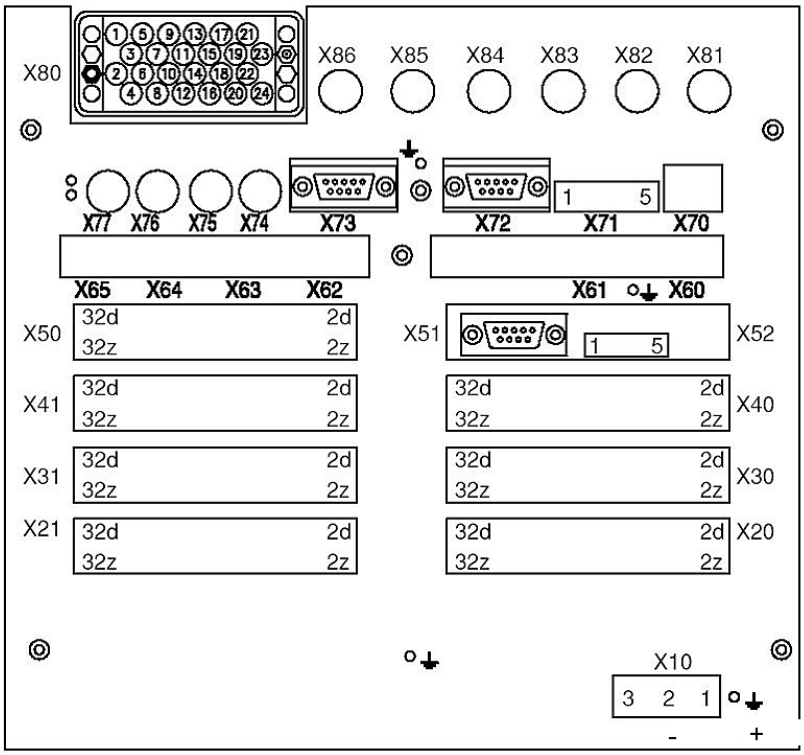


Fig. 19.-1 REF 542plus wide housing connections plate with mixed analog input connector

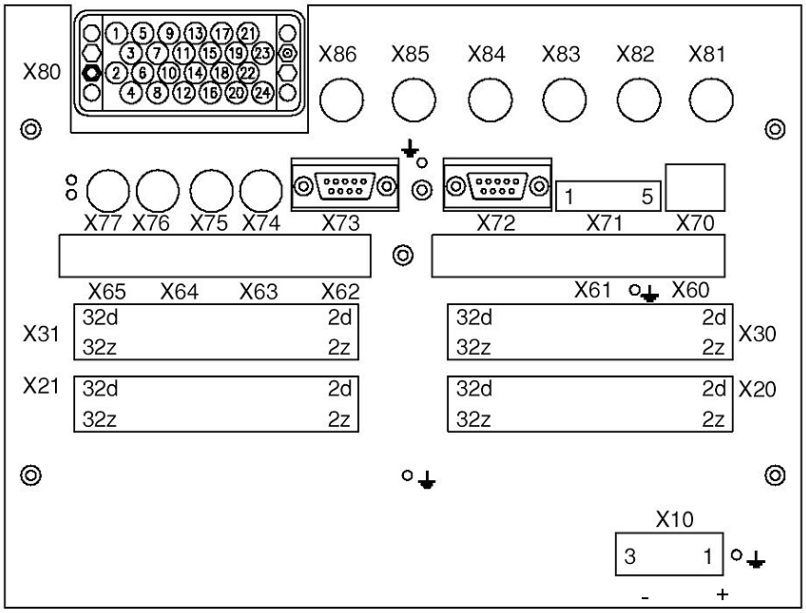


Fig. 19.-2 REF 542plus standard housing connections plate with mixed analog input connector

Table 19.-1 summarizes the connectors.

Table 19.-1 Connectors

Connector	Meaning
X10	Base Unit power supply
X20	First BIO, input
X21	First BIO, output
X30	Second BIO, input
X31	Second BIO, output
X40	Third BIO, input
X41	Third BIO, output
X50	4-20 mA analog outputs, 4-20 mA analog inputs
X51	4-20 mA analog input RS 232 service interface
X52	4-20 mA analog CAN service interface
X60	Modbus RS 485, channel 2; COM L-COM I TX; SPABUS RX
X61	Modbus RS 485, channel 1; COM L-COM I RX; SPABUS TX
X62	Modbus optical, RX channel 1
X63	Modbus optical, TX channel 1
X64	Modbus optical, RX channel 2
X65	Modbus optical, TX channel 2
X66	Optical LC connector on the Ethernet module
X67	Optical LC connector on the Ethernet module
X68	Electrical RJ-45 connector on the Ethernet module
X69	Electrical RJ-45 connector on the Ethernet module
X70	Ethernet 10 Mb/s RJ-45
X71	CAN Open ISO11898 connector

Connector	Meaning
X72	Mainmodule RS232 service or debug interface
X73	HMI connection
X74	Time synch input
X75	HSTS Input
X76	HSTS Input
X77	HSTS Output
X80	Analog inputs
X81	Sensor 1
X82	Sensor 2
X83	Sensor 3
X84	Sensor 4
X85	Sensor 5
X86	Sensor 6
X87	Sensor 7
X88	Sensor 8

19.1. Analog Inputs

REF 542plus can have a maximum of 8 analog input channels. These inputs are divided into three measurement groups:

- Measurement Group 1: channel 1, channel 2, channel 3
- Measurement Group 2: channel 4, channel 5, channel 6
- Measurement Group 3: channel 7, channel 8

Group 1 and group 2 have to be homogeneous, which means they can measure 3 currents or 3 voltages. For example, measurements of 1 current and 2 voltages are not allowed.

Group 3 can get any type of signals: 2 currents, 2 voltages, 1 current and 1 voltage and so on. Group 1 and group 2 can be used for homogeneous current or voltage measurements both from instrument transformers and non-conventional sensors. Group 3 can be used in a heterogeneous way.

Channel 7 and 8 in group 3 can be used for earth-fault current with CT type input; residual voltage, or for the synchrocheck function with VT or sensor type input.

The input CT 0.2A is commonly used with a toroidal transformer for sensitive earth-fault current measurement.

Instrument current transformers can have secondary windings ratio /1 A or /5 A. The primary nominal current (for example 400 A) is selected with the Operating Tool. The secondary current (for example /5 A) is automatically selected connecting the right wire to the analog input module.

The Rogowsky coil can be used for current sensing. The correct ratio of the Rogowsky coil is selected with the Operating Tool. The resistive divider can be used for voltage sensing. The ratio is selected with the Operating Tool. The physical input on the unit is the same both for voltage and current sensing, the selection is done via the Operating Tool. Therefore, it is possible for example to use 6 Rogowsky coils, 6 voltage dividers, or 3 Rogowsky coils and 3 voltage dividers.

To detect which analog input module is present inside the unit, look in the identification label stick on the unit itself, or on the HMI service page under the HW identification submenu.

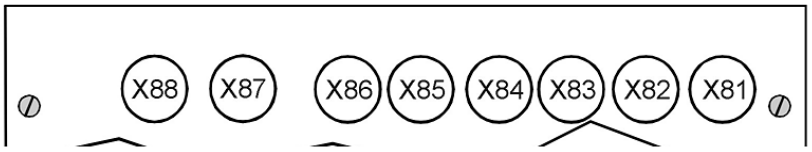


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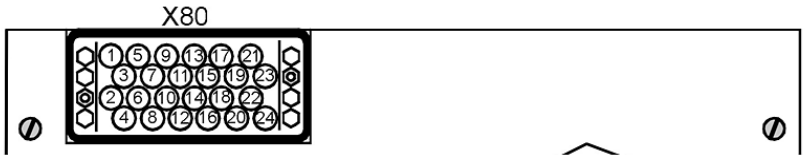
Fig. 19.1.-1 Connector for sensors analog input module

The analog input for sensor is the same both for voltage and current sensing. To find out whether an input is for current or for voltage, the Operating Tool is needed. X81 corresponds to analog input 1 (sensor 1 in the Operating Tool), X82 to analog input 2 (sensor 2 in the Operating Tool) and so forth.



A051451

Fig. 19.1.-2 Connector for conventional instrument transformers

The connector for conventional instrument transformer has twenty-four pins. The following Table 19.1.-1 defines which input is connected to what:

Table 19.1.-1 Connection table for conventional instrument transformers

	VT (100-110/)	CT (1-5A)	CT (0.2A)
1	T5/B	T5/2	
2	T3/B	T3/2	
3	T1/B	T1/2	
4	T8/B	T8/2	T8/A
5	T5/R	T5/1	
6	T3/R	T3/3	
7		T1/3	
8	T8/R	T8/3	T8/B
9		T5/3	
10		T3/1	
11	T1/R	T1/1	

12		T8/1	
13		T4/3	
14	T2/B	T2/2	
15		T6/3	
16	T7/B	T7/2	T7/A
17	T4/B	T4/2	
18		T2/3	
19	T6/B	T6/2	
20	T7/R	T7/3	T7/B
21	T4/R	T4/1	
22	T2/R	T2/1	
23	T6/R	T6/1	
24		T7/1	

B: Black wire for voltage transformer.

R: Red wire for voltage transformer.

1: 1 A input for current transformer.

2: Common input for current transformer.

3: 5 A input for current transformer.

Example:

To determine the pins for the analog input module 1VCF750170R0817: 3CTs, 3VTs, 1CTs; used with transformers with 1 A on the secondary windings.

The following connection must be done:

Analog input 1; the current transformer for phase 1 must be connected on pins 11 and 3 (common).

Analog input 2; the current transformer for phase 2 must be connected on pins 22 and 14 (common).

Analog input 3; the current transformer for phase 3 must be connected on pins 10 and 2 (common).

Analog input 4; the voltage transformer for phase 1 to earth must be connected on pins 21 and 17.

Analog input 5; the voltage transformer for phase 2 to earth must be connected on pins 5 and 1.

Analog input 6; the voltage transformer for phase 3 to earth must be connected on pins 23 and 19.

Analog input 7, for the toroidal transformer for the residual current must be connected on pins 24 and 16 (common).

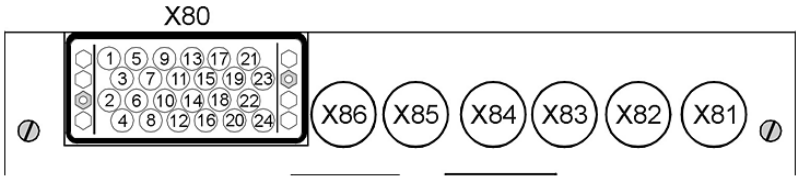


Fig. 19.1.-3 Connector for mixed analog input module

The picture above shows the connector for the mixed analog input module when both sensors and conventional instrument transformers are used. To find out which connector is used for what, identify the module code from the identification label stick on the unit and see Table 19.1.-1.

19.2. Binary inputs and outputs

Binary input and output modules use the following connectors:

X20 (inputs), X21 (outputs) for the first module.

X30 (inputs), X31 (outputs) for the second module.

X40 (inputs), X41 (outputs) for the third module, available with the wide housing only.

REF 542plus can be equipped with two different types of binary inputs and outputs modules: static or with electromechanical relays.

19.2.1. Static

In the static module, digital inputs are implemented with optocouplers and digital outputs are implemented with power transistors. Two different module types are available, with control coil continuity and without.

Each module features: 14 digital inputs, 3 power outputs, 4 normal outputs, 2 signal outputs, 1 watchdog output and optionally 2 coil supervision circuits. For more information, refer to the REF 542plus Technical Reference Manual.

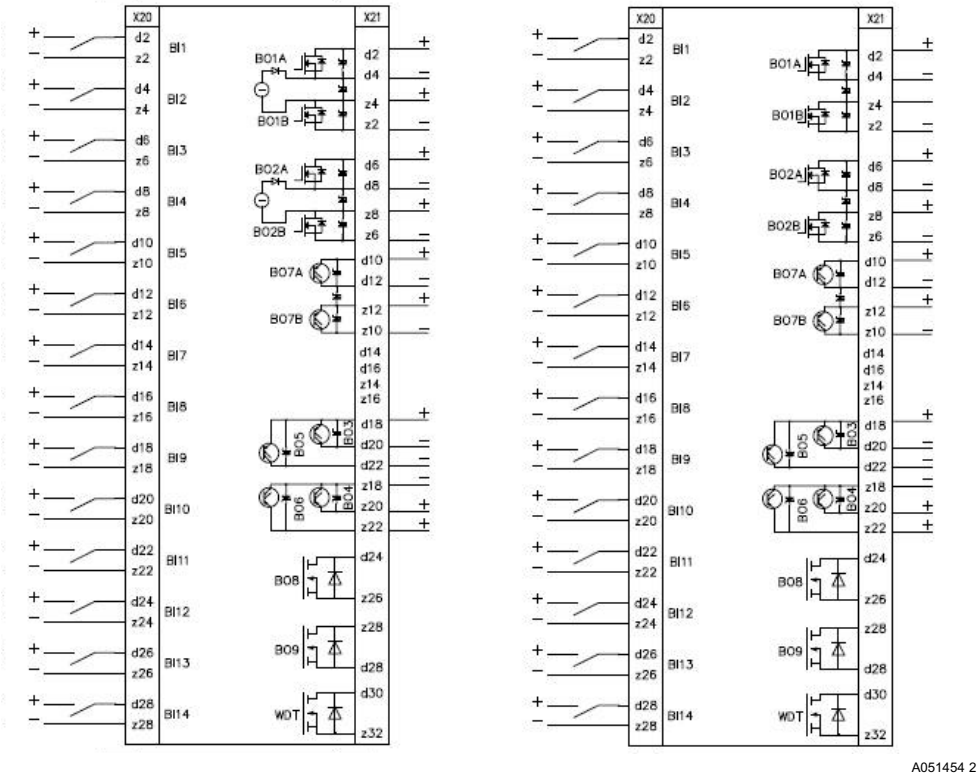


Fig. 19.2.1.-1 Two static binary input and output modules with and without coil continuity check

19.2.2. Electromechanical

In the electromechanical module, digital inputs are implemented with optocouplers and digital outputs are implemented with electromechanical relays.

REF 542plus can be equipped with electromechanical module type BIO3.

19.2.2.1. BIO3

Twelve different types of BIO3 are available depending upon the supply voltage and other features.

Table 19.2.2.1.-1 BIO3 types and codes

BIO3 Code	Description
1VCF750132R0801	Binary I/O3 - 19..72 V DC/ 14 V DC Standard
1VCF750132R0803	Binary I/O3 - 19..72 V DC/ 14 V DC Standard with Static Channel
1VCF750161R0801	Binary I/O3 - 19..72 V DC/ 14 V DC Standard with interconnected '-' on inputs
1VCF750161R0803	Binary I/O3 - 19..72 V DC/ 14 V DC with Static Channel and with interconnected '-' on inputs
1VCF750132R0802	Binary I/O3 - 88..132 V DC/ 50 V DC Standard

BIO3 Code	Description
1VCF750132R0804	Binary I/O3 - 88..132 V DC/ 50 V DC Standard with Static Channel
1VCF750161R0802	Binary I/O3 - 88..132 V DC/ 50 V DC Standard with interconnected '-' on inputs
1VCF750161R0804	Binary I/O3 - 88..132 V DC/ 50 V DC Standard with Static Channel and with interconnected '-' on inputs
1VCF750132R0805	Binary I/O3 - 88..132 V DC/ 72 V DC Standard
1VCF750132R0806	Binary I/O3 - 88..132 V DC/ 72 V DC Standard with Static Channel
1VCF750132R0807	Binary I/O3 - 176..264 V DC/ 143 V DC Standard
1VCF750132R0808	Binary I/O3 - 176..264 V DC/ 143 V DC Standard with Static Channel

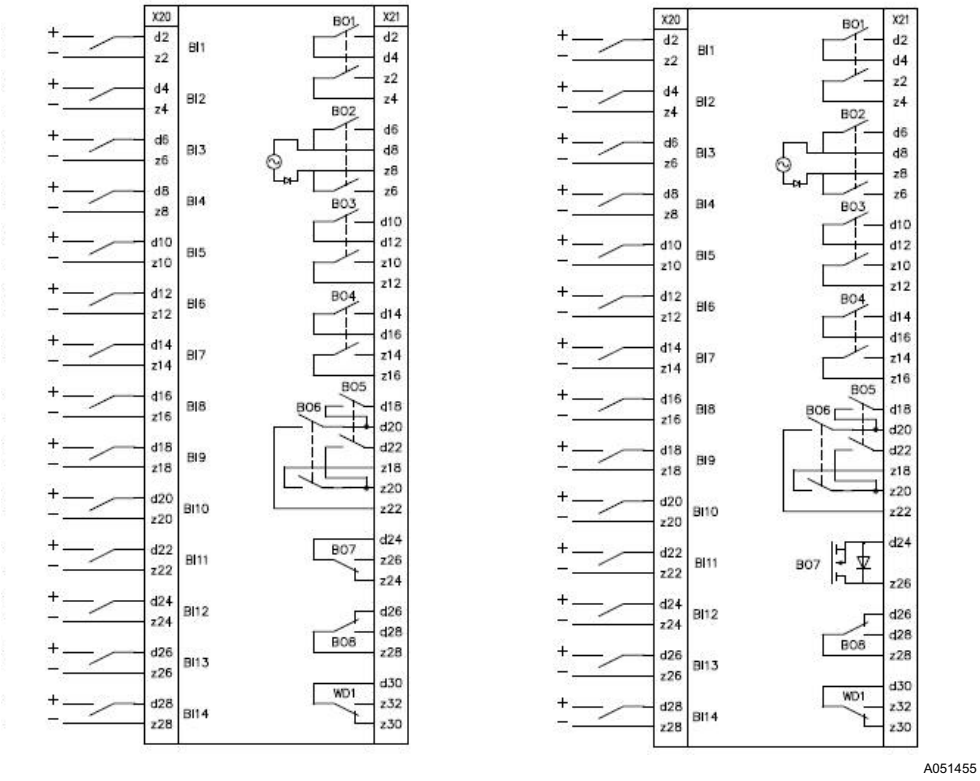


Fig. 19.2.2.1.-1 2 BIO3 modules with interconnected inputs and the static output

19.3. Other connections

19.3.1. Analog outputs 0/4-20 mA

The 4 analog outputs, when present, are available at connector X50 accordingly to the following diagram (see Fig. 19.3.1.-1). The not used pins, including the shielding of the cable are connected to ground.

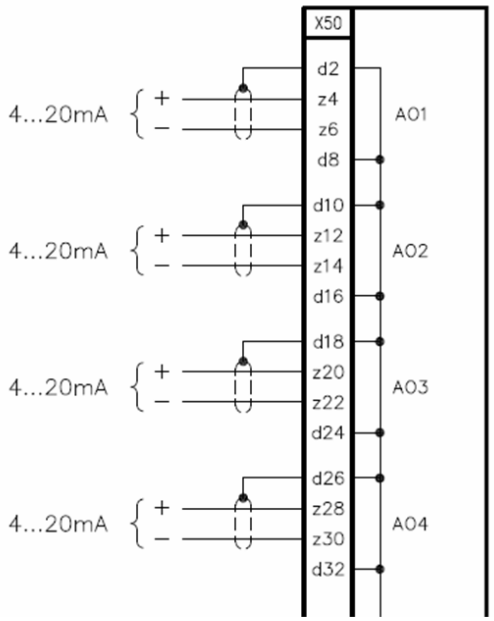


Fig. 19.3.1.-1 0/4-20 mA analog outputs (Version 2.x since 06/2006)

19.3.2. Analog inputs 4-20 mA

When present, the 4-20 mA analog input module uses connector X50. Sensor's connections are shown in Fig. 19.3.2.-1 X51 and X52 are service interfaces of no use for the user. The output contact BO1 is for the future use.

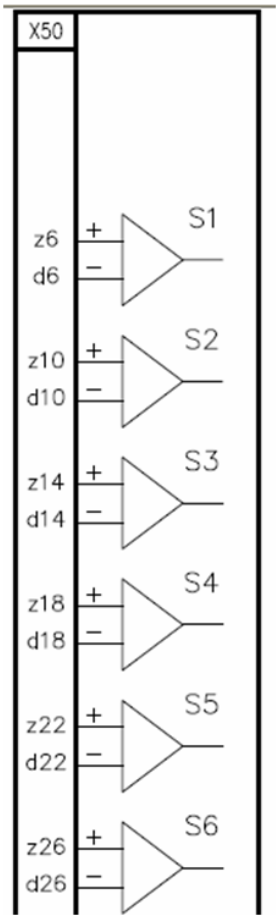


Fig. 19.3.2.-1 4-20 mA analog inputs

Only passive sensors, for example those that are powered from the loop can be connected to the 4…20 mA analog input module.

19.3.3. Communication module

The communication module uses connectors from X60, X61, X62, X63, X64 and X65 depending on the physical media type (RS 845, glass or plastic fiber).

19.3.4. Power supply

Power supply for the Base Unit is X10.

19.3.5. Time synchronization

The optical input for time synchronization is X74.

19.3.6. HMI

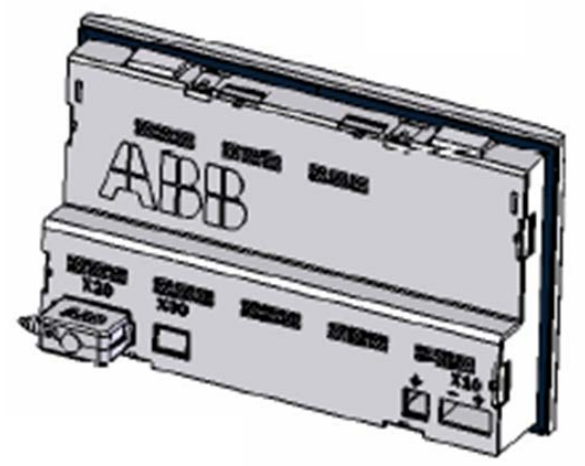


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Fig. 19.3.6.-1 HMI connectors

Fig. 19.3.6.-1 shows the back side of the HMI. The connector for the HMI power supply is X10, which is located on the right-hand side of the Fig. 19.3.6.-1. The serial cable for the connection to the base unit is to place on the other connector X20 on the left-hand side.

Respect the right polarity on the HMI power supply to avoid damages to the unit.

20. Appendix B: Menu structure

This chapter illustrates the HMI menu structure with the submenus not described in the document.

To access the menu structure, press ↵.

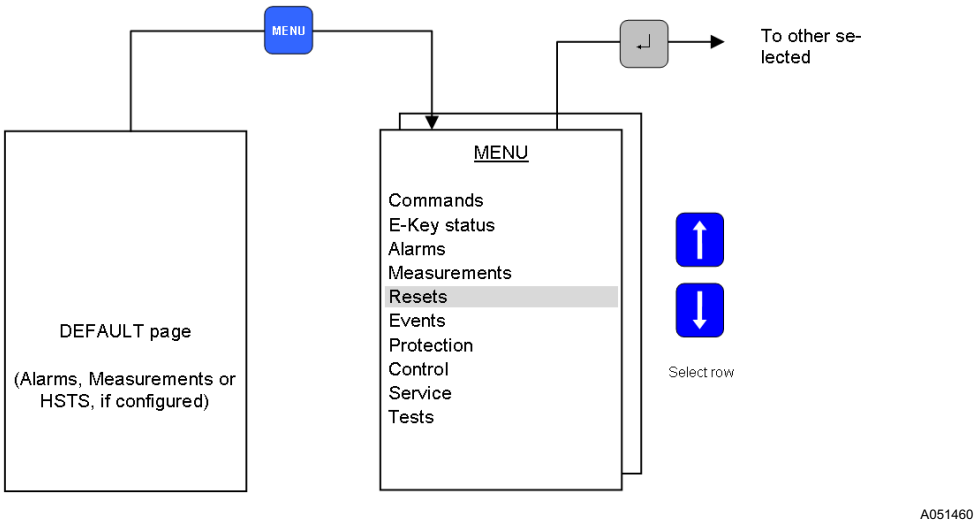

Fig. 20.-1 REF 542plus menu

The access to some submenus to change parameters or to reset indication depends on the actual operating modes. The operating mode is set with two different electronic keys. With the CONTROL key the following operation modes are selectable:

- No Control
- Local
- Remote
- Local & Remote

With the PROTECTION key the following mode can be achieved:

- Set local
- Operational

20.1. Commands

The command in this submenu can be activated if the active mode is Local or Local & Remote. In other modes the activation will be denied.

20.2. Reset page

From this page, it is possible to reset alarms and other quantities. Some reset actions are possible only if REF 542plus is in the proper mode. The possibility of reset in the different submenus is described in the following:

Reset alarm: the LED's alarm indication can be reset in this submenu, independent of the active mode

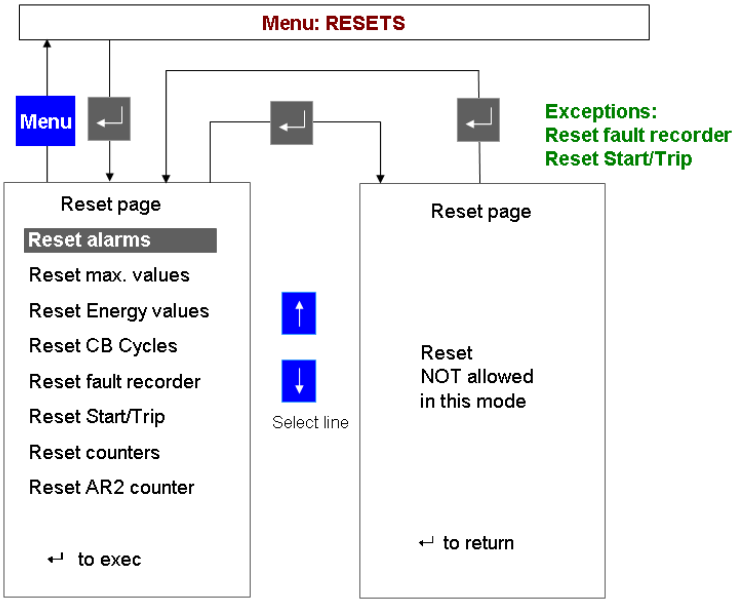

Fig. 20.2.-1 Attempt to resetting the fault recorder in the wrong mode

Select the quantity to reset with UP and DOWN and press ENTER to execute.

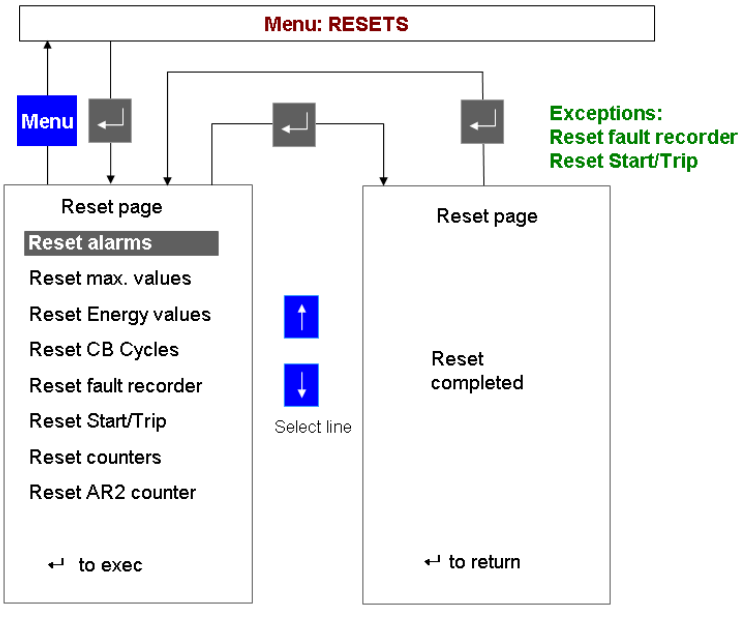

Fig. 20.2.-2 Resetting a quantity in the proper mode

The quantities that can be reset are:

Reset alarm: can only be reset, if there is no active alarm present anymore. An attempt to reset an alarm caused for example by an interrupted open coil is impossible as long as the coil is not replaced.

Reset max. values: this sub menu resets the maximum and mean current values in the observation period. Also the sum of switched off current is reset from here. Reset is only possible in Local or Local & Remote modes.

Reset energy values: all the energy values (active, reactive, apparent) are reset from here. Reset is only possible in Local or Local & Remote modes.

Reset CB cycles: a circuit breaker cycle is a close operation and the subsequent open operation. The unit sums the cycles. This cycle number is reset from here. Reset is only possible in Local or Local & Remote modes.

Reset fault recorder: the fault recorder data is cleared from here. Reset is only possible in Local or Set Local modes.

Reset events: the events are cleared from here, if the mode is in Set Local.

Reset counters: the unit working hours are reset from here. Reset is only possible in Local or Local & Remote modes.

20.3. Protection

The parameter of the Protection submenus, Active set page and Protection, can only be changed in mode Set Local by applying the protection electronic key.

20.4. Control

The parameter of the Control submenus can only be changed in mode Set Local by applying the protection electronic key.

20.5. Test

The test of the primary object can only be performed in local mode.

20.6. Service page

The service page menu is composed of several submenus. Browse through the submenus with UP and DOWN buttons. Press ENTER to enter the selected submenu.

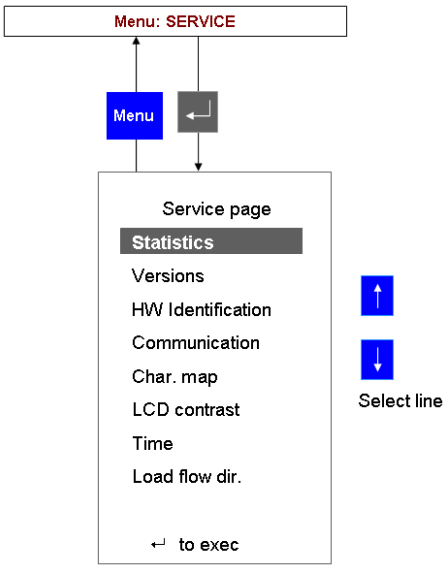

Fig. 20.6.-1 Service page menu

The service page contains the following submenus.

20.6.1. Statistics

This submenu shows the FUPLA cycle time and other information related to the current configuration in the unit.

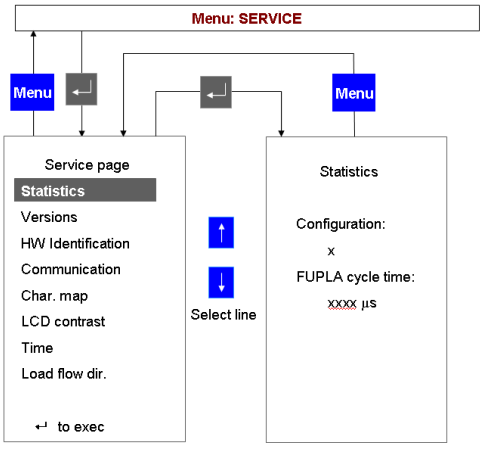

Fig. 20.6.1.-1 Statistics submenu

20.6.2. Versions

This submenu displays information on the firmware versions loaded inside the unit.

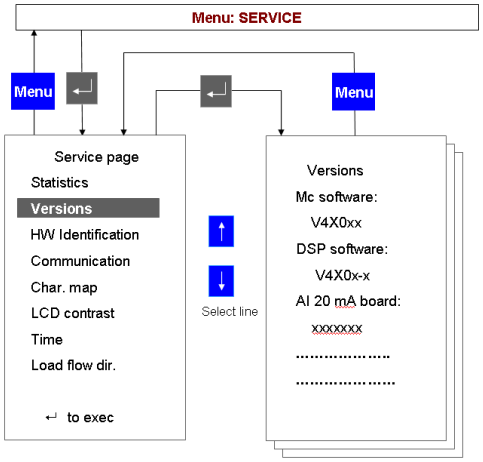

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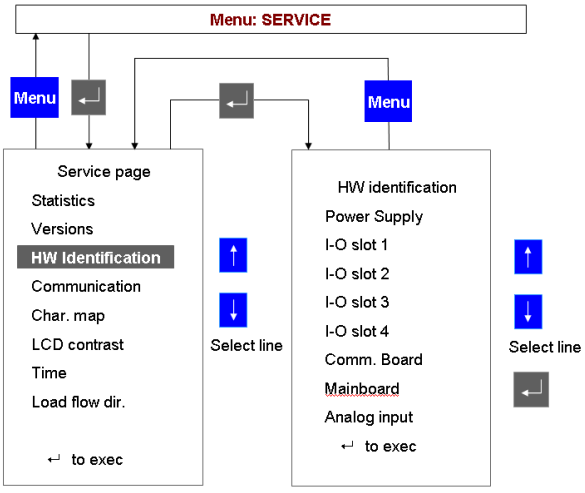
Fig. 20.6.2.-1 Versions submenu

20.6.3. Hardware identification

This submenu shows the reference information of the hardware modules installed into REF 542plus.



A051466

Fig. 20.6.3.-1 Hardware identification

Hardware information page

To display the information select the row and press ENTER . When the information is available in the selected module, the following page will be displayed (this information is stored in a dedicated EEPROM on the module itself).

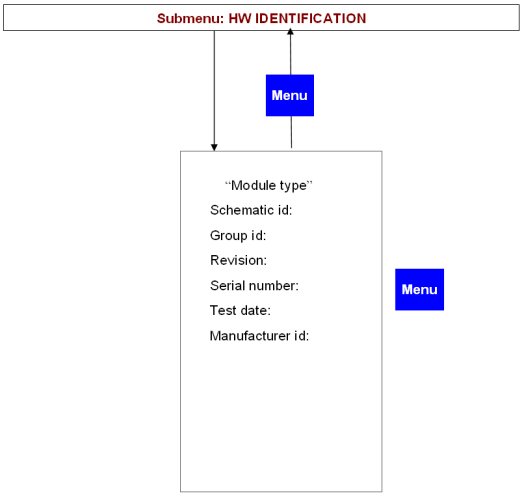


Fig. 20.6.3.-2 Hardware information page

When the information from the module is not available the following page is displayed.

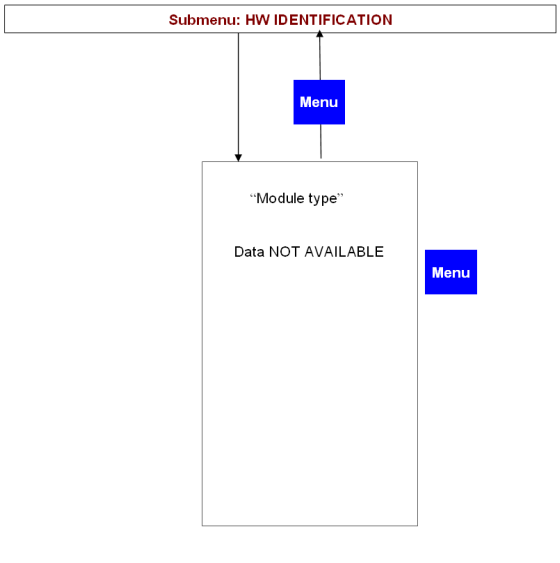


Fig. 20.6.3.-3 Hardware information is not available

When the information stored on the module is corrupted, the following page is displayed.

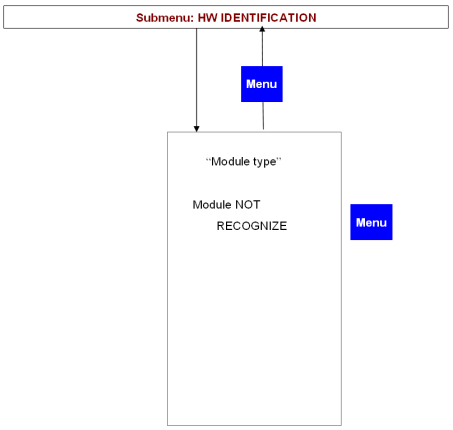


Fig. 20.6.3.-4 Hardware information corrupted

When the module is not present or the module is not able to publish the HW identification data, the following page is displayed.

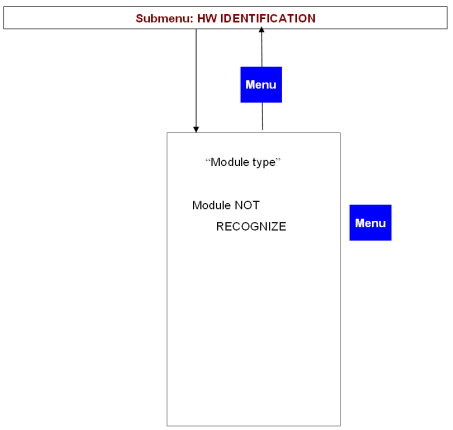


Fig. 20.6.3.-5 Hardware information not available

20.6.4. Communication

This subpage displays the information related to the communication ports available and configured in REF 542plus.

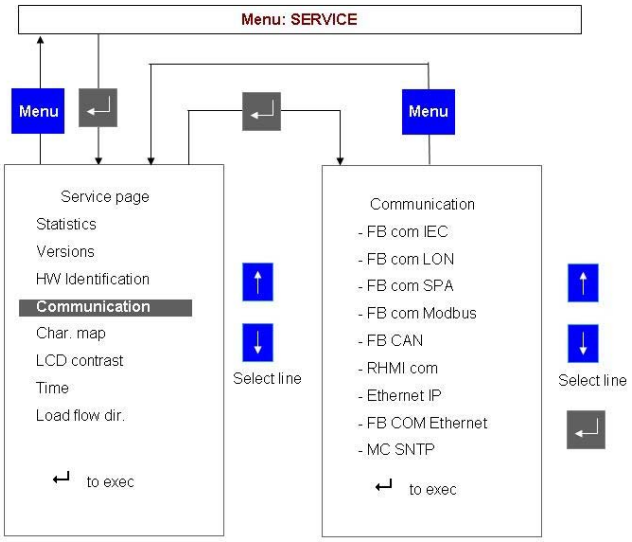


Fig. 20.6.4.-1 Communication subpage visualization

When the port is not installed or configured, the following page will be displayed.

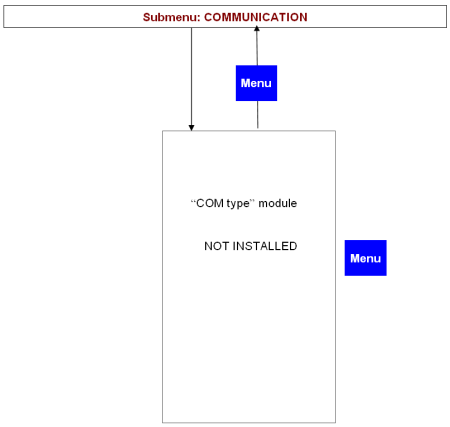


Fig. 20.6.4.-2 Communication module is not installed

20.6.4.1. IEC 103 communication page

When the IEC 60870-5-103 communication module is installed the following page is displayed.

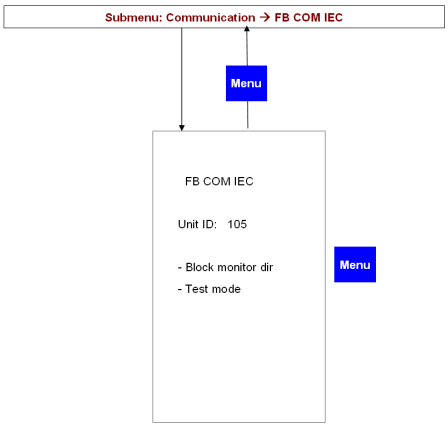


Fig. 20.6.4.1.-1 IEC 103 communication module page

In this subpage, it is possible to block the monitoring direction of the module. For more information, refer to the Communication Module User Manual.

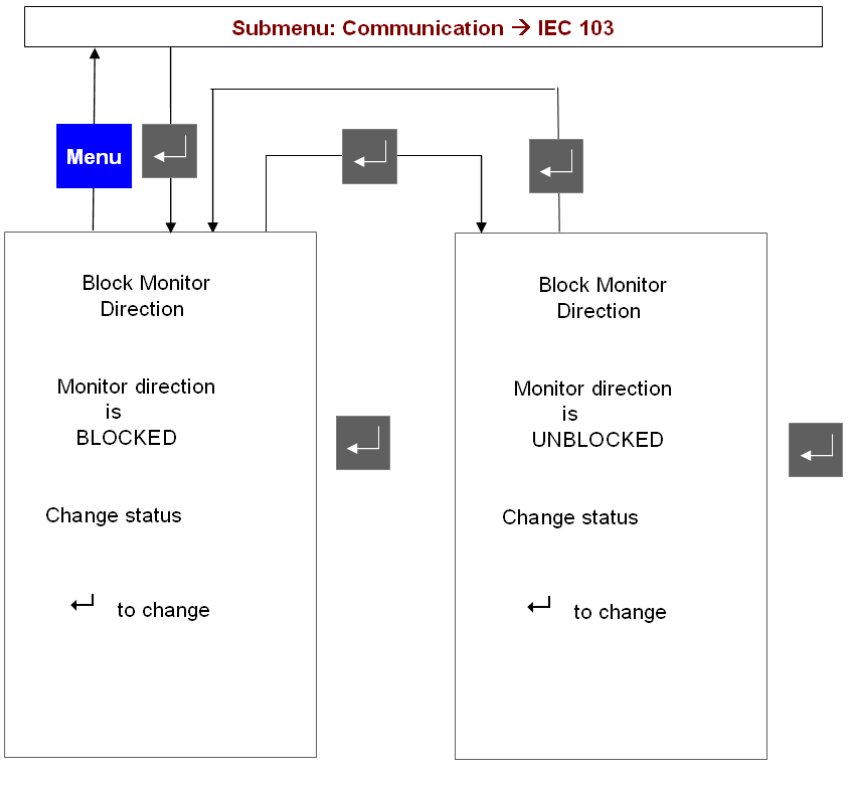


Fig. 20.6.4.1.-2 IEC 103 communication, blocking the monitoring direction

The IEC Test mode menu allows setting and resetting the test mode of the IEC module. For more information, refer to the Communication Module User Manual.

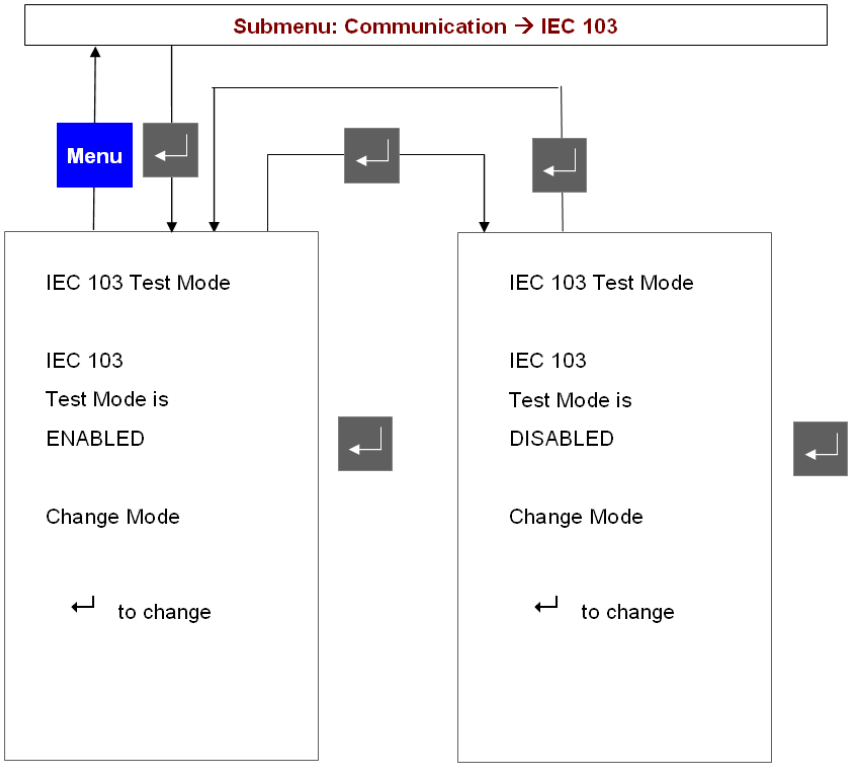


Fig. 20.6.4.1.-3 IEC 103 communication module test mode subpage

20.6.4.2. LON communication page

When the COM-L module for LON communication is installed and active, the following page displays the configured Node ID.

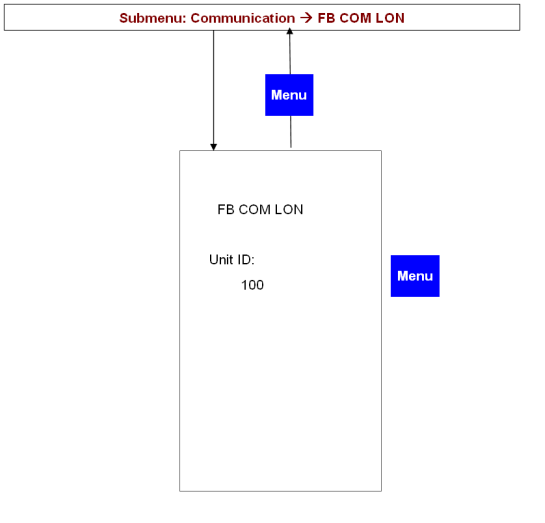


Fig. 20.6.4.2.-1 LON communication module Node Id

20.6.4.3. SPA communication page

When the SPA bus communication module is installed, the following page is displayed.

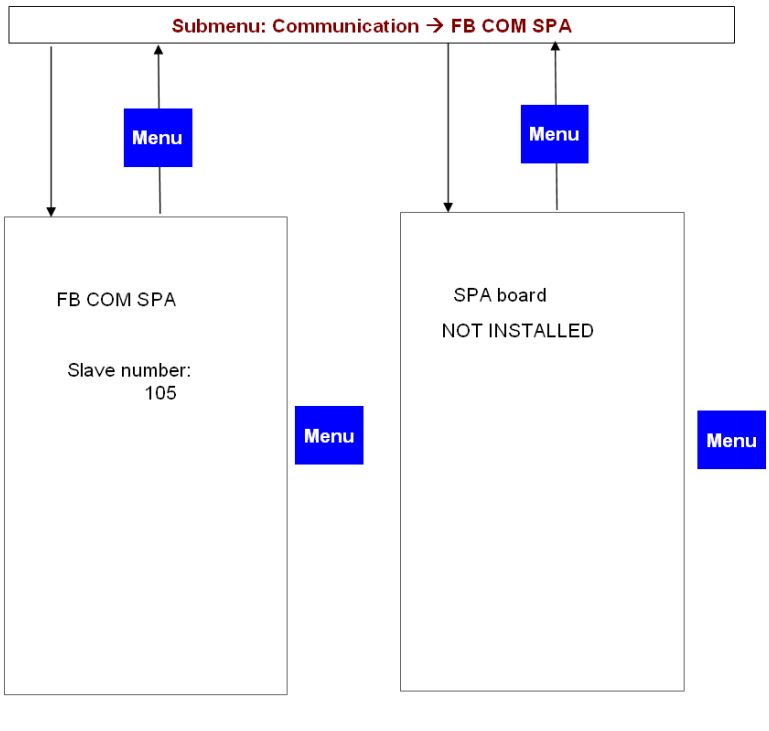


Fig. 20.6.4.3.-1 SPA bus communication module page

It is not possible to modify the SPA bus slave address of the unit on this page.

20.6.4.4. Modbus communication page

When the Modbus module is installed and properly working, the following page is displayed.

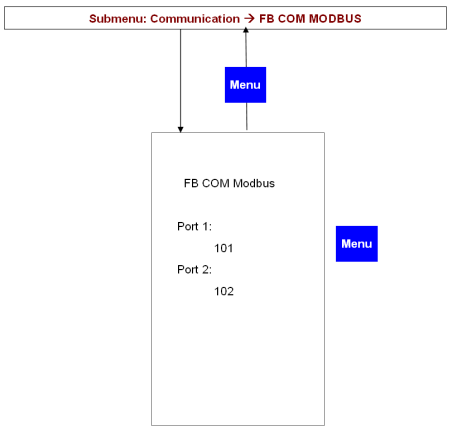


Fig. 20.6.4.4.-1 Modbus communication module page

By selecting the row related to port 1 or 2 and pressing ↵, it is possible to change the port communication address.

20.6.4.5. CAN communication page

When the CAN port has been enabled the following pages display the CAN communication settings.

The CAN communication may only be used by ABB switchgear companies.

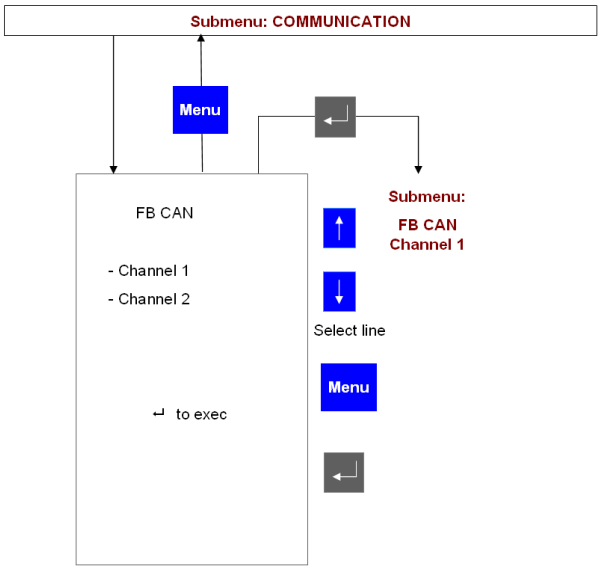
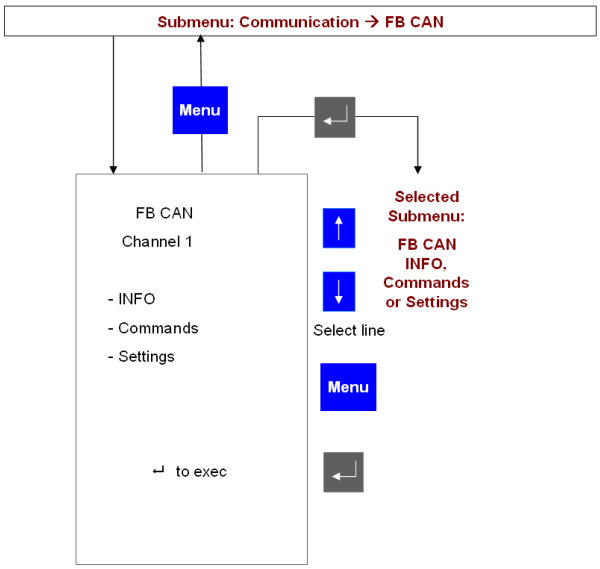


Fig. 20.6.4.5.-1 CAN communication port page

Only channel 1 is currently available. To enter the next subpage, select Channel 1 and press ENTER ↵. The following page is displayed.

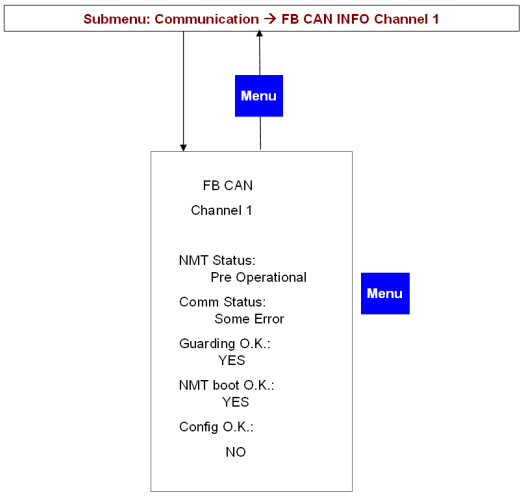


A051650

Fig. 20.6.4.5.-2 CAN communication port subpage

CAN INFO subpage

This page displays the CAN status information.



A051651

Fig. 20.6.4.5.-3 CAN communication port subpage

CAN Commands subpage

From this page, it is possible to issue direct operation to the CAN communication subsystem. For more information, refer to the CAN Communication User Manual.

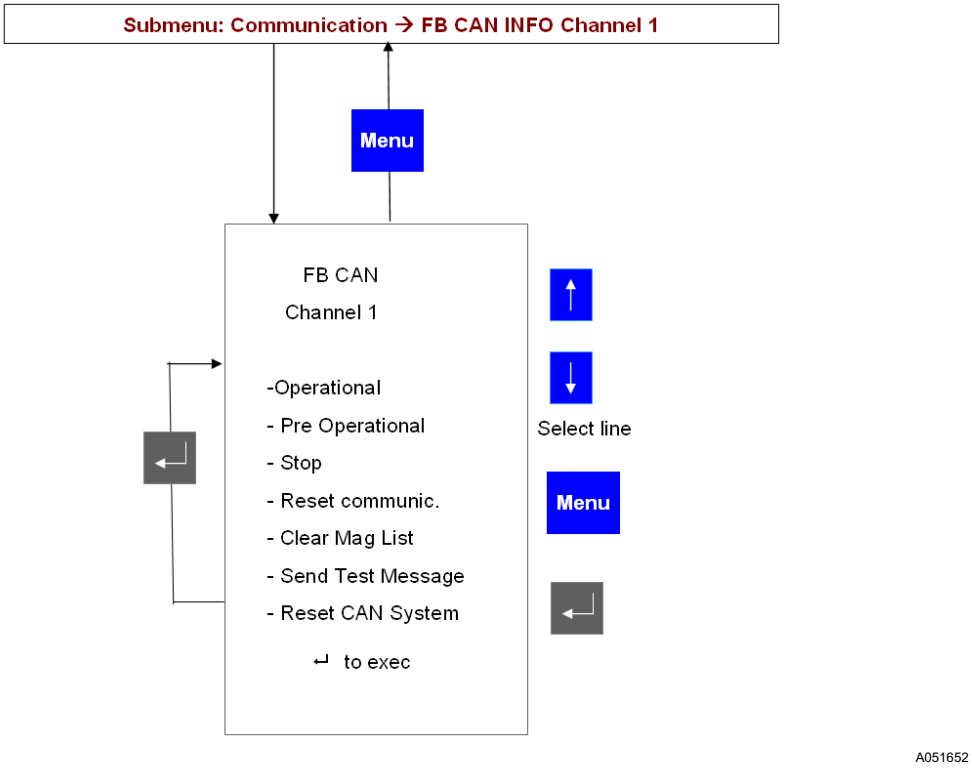


Fig. 20.6.4.5.-4 CAN communication port subpage

CAN setting subpage

In this page, it is possible to change the node address of the CAN communication. This setting is allowed only when the REF 542plus node is in the Pre-Operational status.

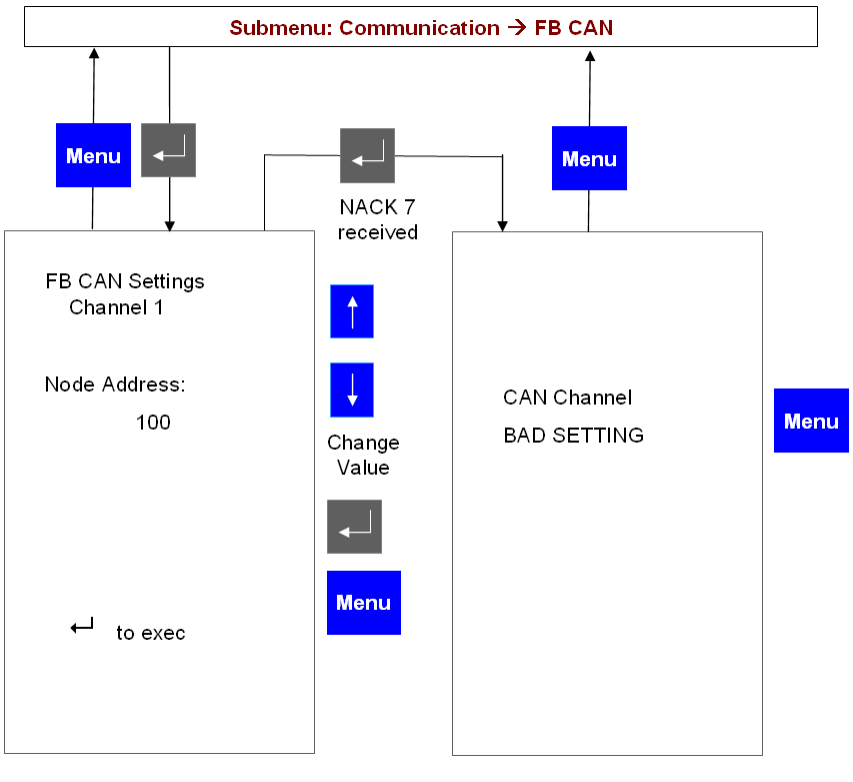


Fig. 20.6.4.5.-5 CAN communication port subpage

20.6.4.6. HMI communication page

In this page, it is possible to change the Base Unit slave address used to communicate with the HMI.

When the Base Unit address is changed, the communication with the HMI is lost. To restore it, the Base Unit address must be inserted in the HMI as well. Select the menu item Base Unit Slave Address and insert the same address of the Base Unit.

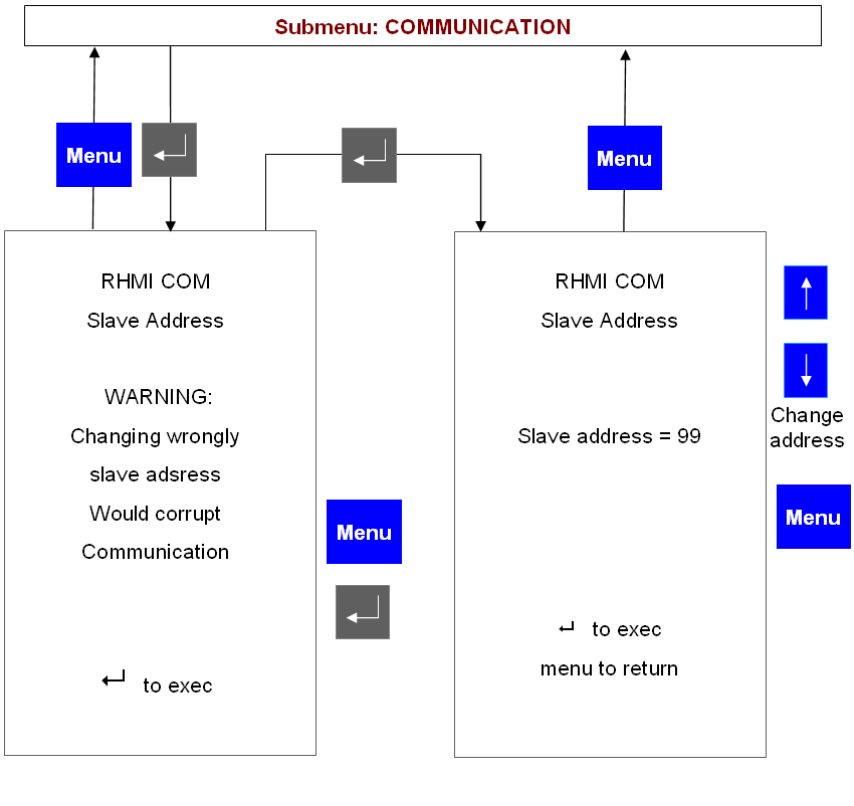


Fig. 20.6.4.6.-1 HMI, changing Base Unit address to be polled

20.6.4.7. Ethernet IP page

This page shows the current settings of the Ethernet communication subsystem. Here, it is possible to visualize the IP and MAC address. The IP and MAC addresses cannot be changed from this page.

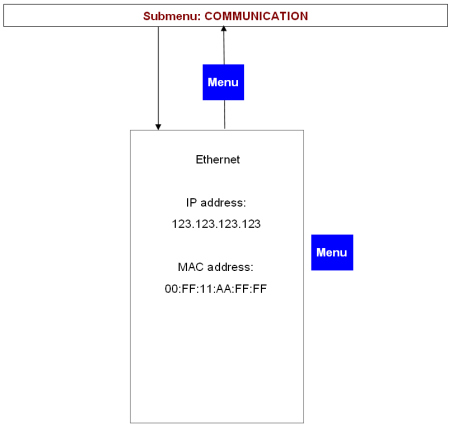


Fig. 20.6.4.7.-1 Ethernet port subpage

20.6.4.8. Ethernet communication page

When the Ethernet module is applied, the following subpages appear after you select the corresponding Ethernet communication submenu, depending on the actual condition. The following Fig. 20.6.4.8.-1 shows a case where the Ethernet board is not supported:

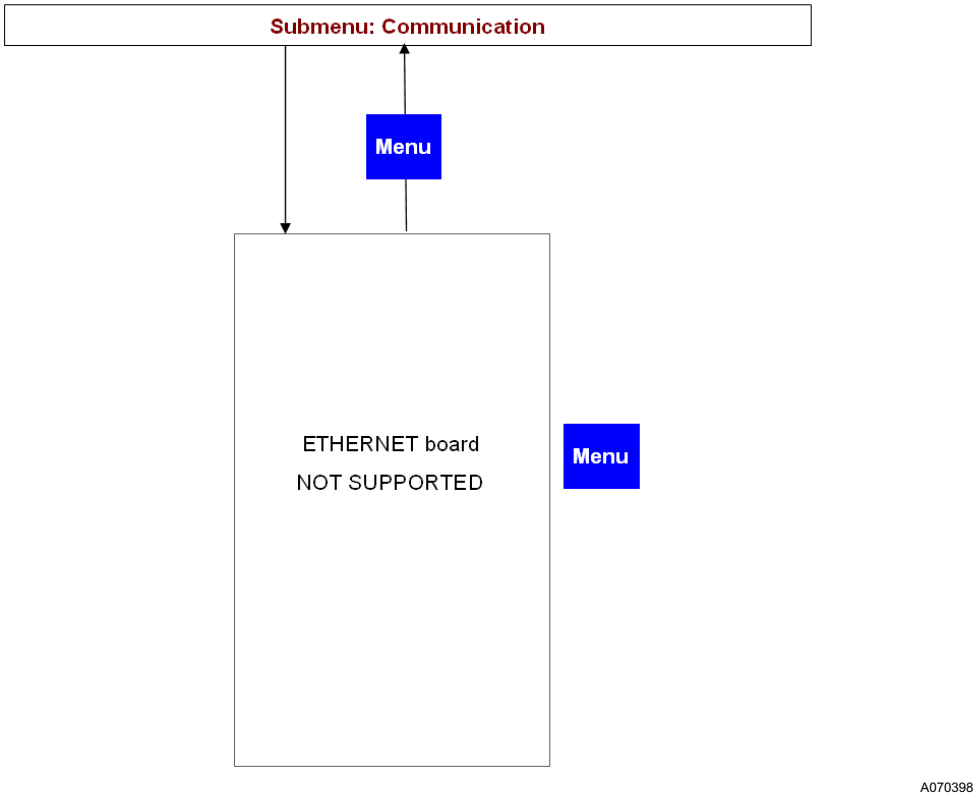


Fig. 20.6.4.8.-1 Subpage if Ethernet board is not supported

The next Fig. 20.6.4.8.-2 shows a case where there is no Ethernet module present.

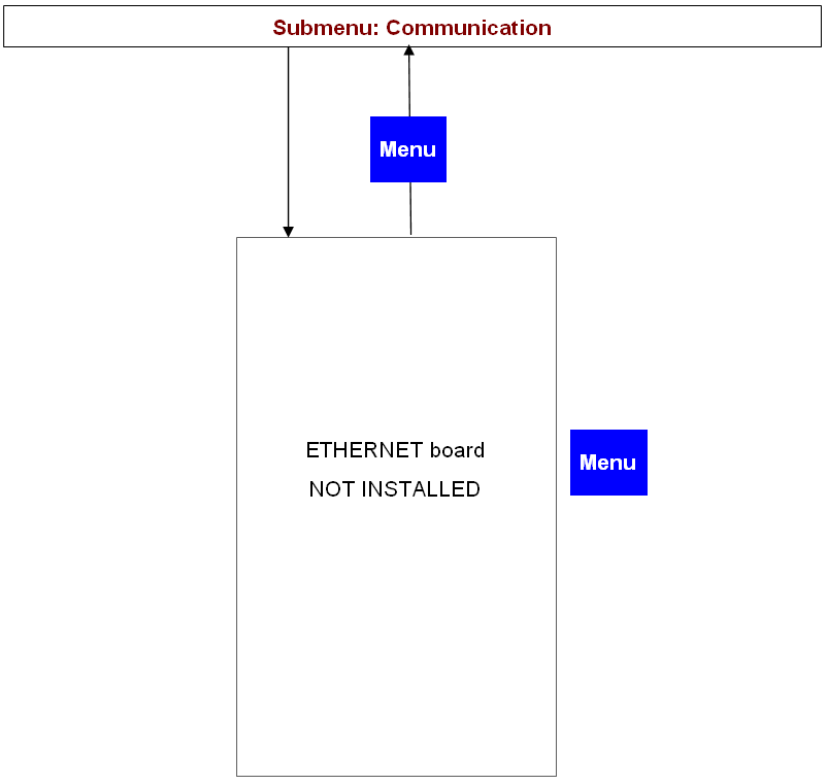


Fig. 20.6.4.8.-2 Subpage if Ethernet board is not installed

In normal situation where the Ethernet module is installed, the following subpage appears when you select another submenu, as shown in Fig. 20.6.4.8.-3:

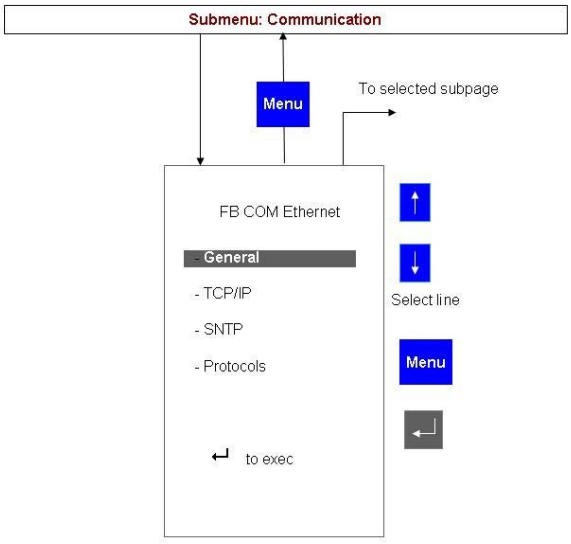


Fig. 20.6.4.8.-3 Submenu of the Ethernet module

To select the desired subpage, click the UP and DOWN buttons. The subpages are divided into two categories for value settings and info.

General Settings subpage

The General Settings subpage displays the configuration parameters coming from the REF 542plus main module, whereas the General Info subpage displays the status values and configurations coming from the Ethernet communication module. The following two figures, Fig. 20.6.4.8.-4 and Fig. 20.6.4.8.-5, show the related subpages.

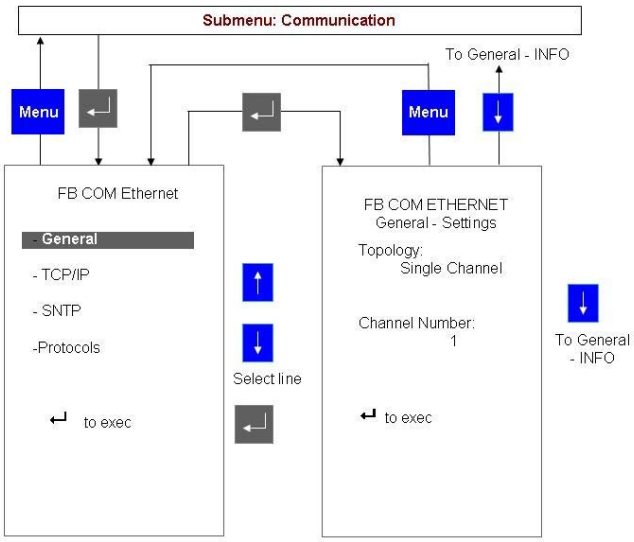


Fig. 20.6.4.8.-4 General Settings subpage

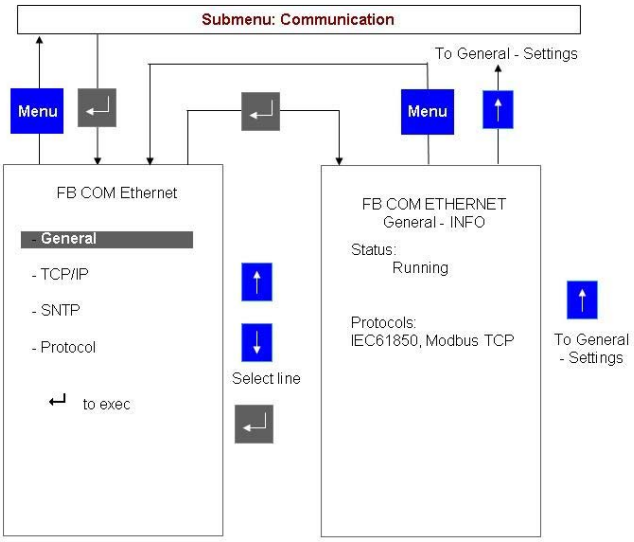


Fig. 20.6.4.8.-5 General Info subpage

To move from one subpage to another click the UP, and DOWN buttons. You can go back to the FB COM Ethernet page from each subpage by clicking the MENU Menu button.

TCP/IP subpage

The TCP/IP subpage consists of two pages for each configured communication port, port1 or port2. The following two figures Fig. 20.6.4.8.-6 and Fig. 20.6.4.8.-7 show the TCP/IP Settings subpage and the TCP/IP INFO subpage.

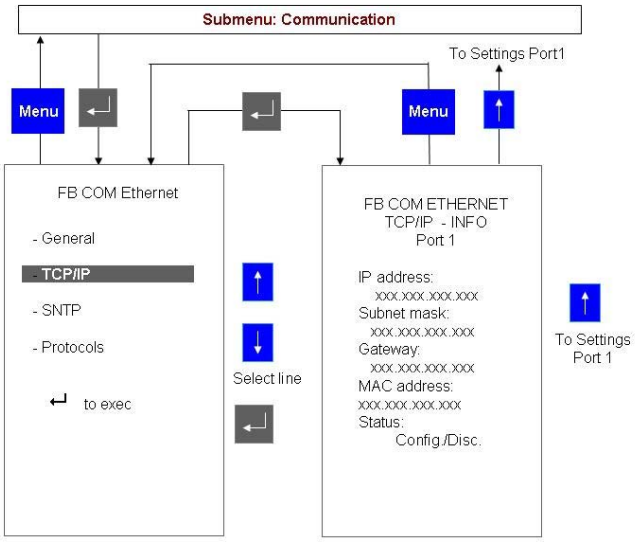


Fig. 20.6.4.8.-6 TCP/IP Settings subpage for port 1

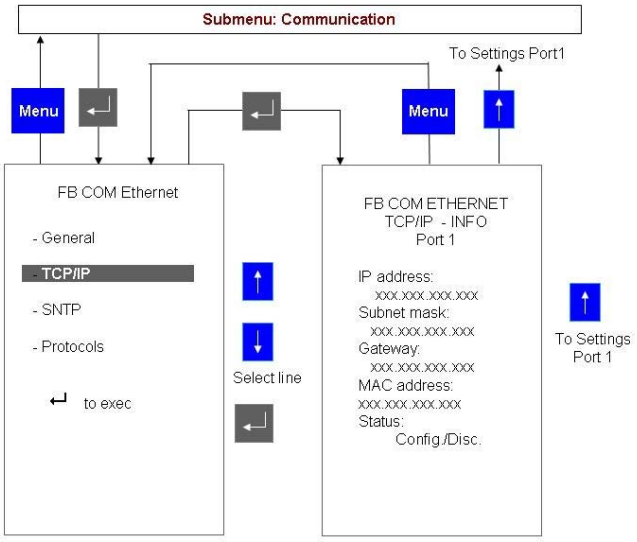


Fig. 20.6.4.8.-7 TCP/IP INFO subpage for port 1

At the moment, you can either use port 1 or port 2. If you apply port 2 , the subpages shown in the following two figures are displayed.

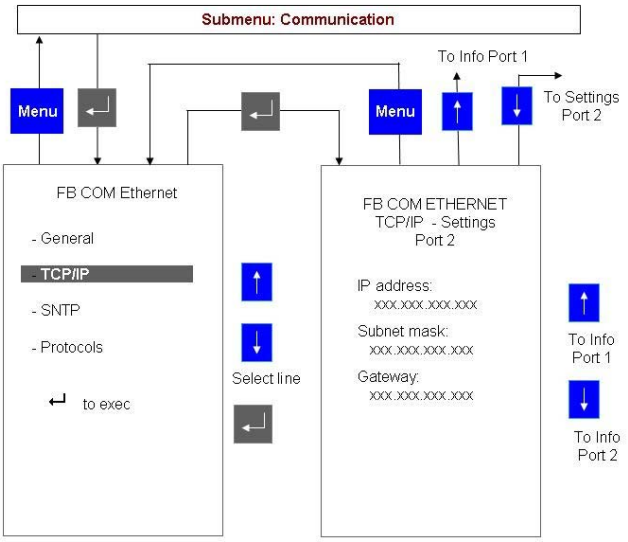


Fig. 20.6.4.8.-8 TCP/IP Settings subpage for port 2

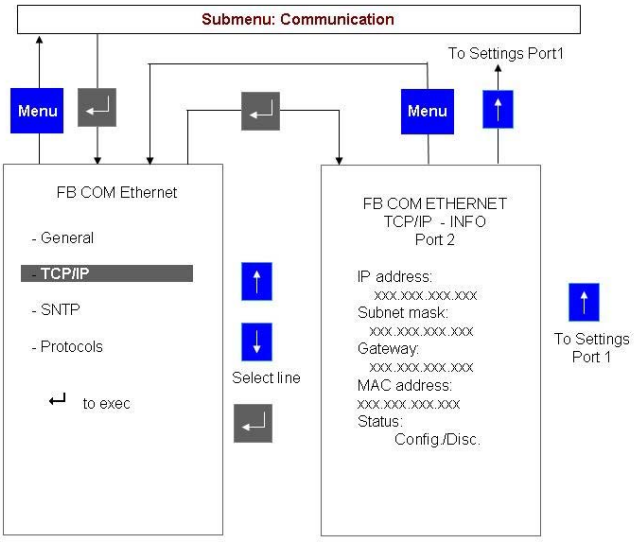


Fig. 20.6.4.8.-9 TCP/IP INFO subpage for port 2

SNTP subpage

The SNTP subpage displays whether SNTP is enabled or disabled.

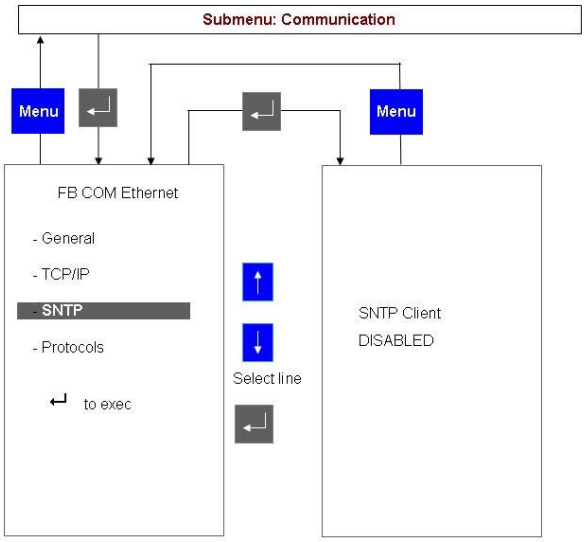


Fig. 20.6.4.8.-10 SNTP disabled

If SNTP is enabled, the related subpage consists of two different subpages, as shown in the following two figures Fig. 20.6.4.8.-11 and Fig. 20.6.4.8.-12.

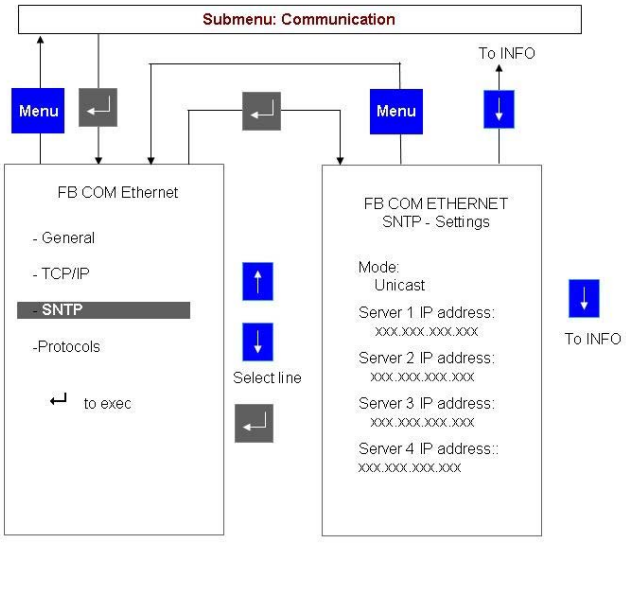


Fig. 20.6.4.8.-11 SNTP Settings subpage

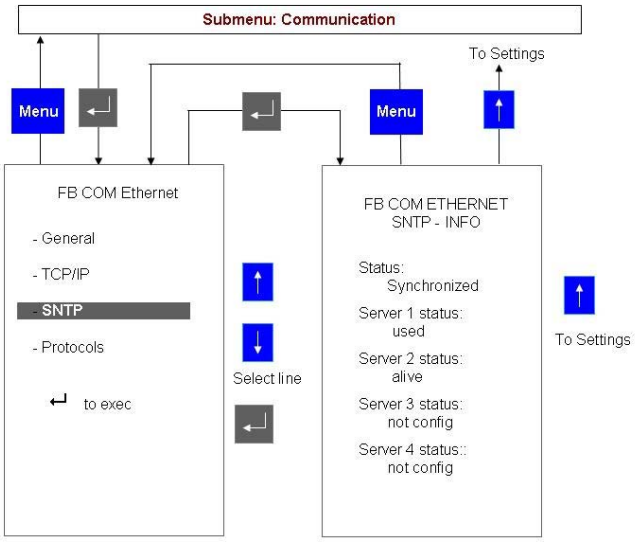


Fig. 20.6.4.8.-12 SNTP INFO subpage

You can move from one subpage to another by clicking the UP, and DOWN buttons. You can go back to the FB COM Ethernet subpage by clicking the MENU Menu button.

Protocols subpage

The Protocols subpage consists of a page for each configured protocol on Ethernet board, IEC61850 or MODBUS TCP.

The following figure 20.6.4.8.-13 shows the Protocols subpage for the IEC61850 protocol.

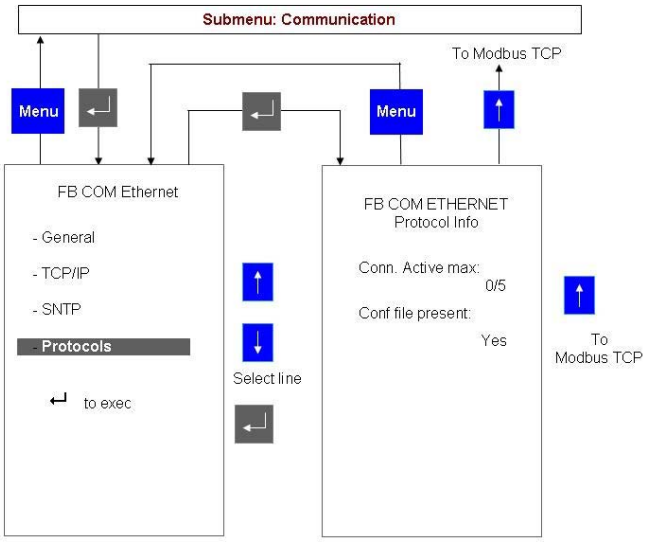


Fig. 20.6.4.8.-13 Protocols subpage for IEC61850

The following figure 20.6.4.8.-14shows the Protocols subpage for MODBUS TCP protocol.

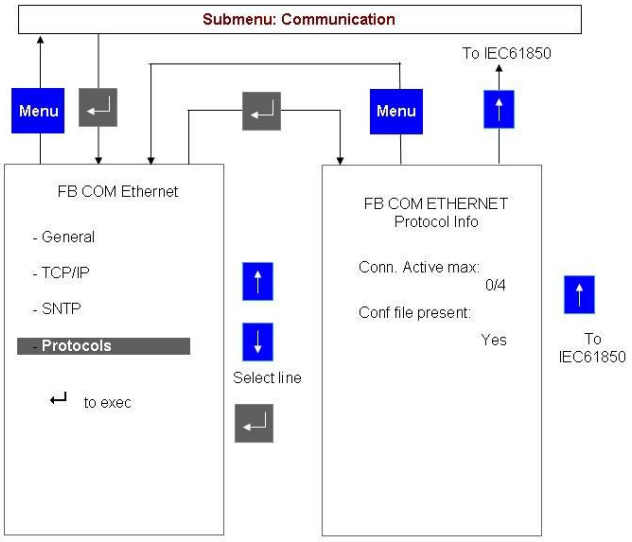


Fig. 20.6.4.8.-14 Protocols subpage for MODBUS TCP

The pages shown when the protocol is currently disabled are presented in 20.6.4.8.-15(IEC61850) and 20.6.4.8.-16(MODBUS TCP).

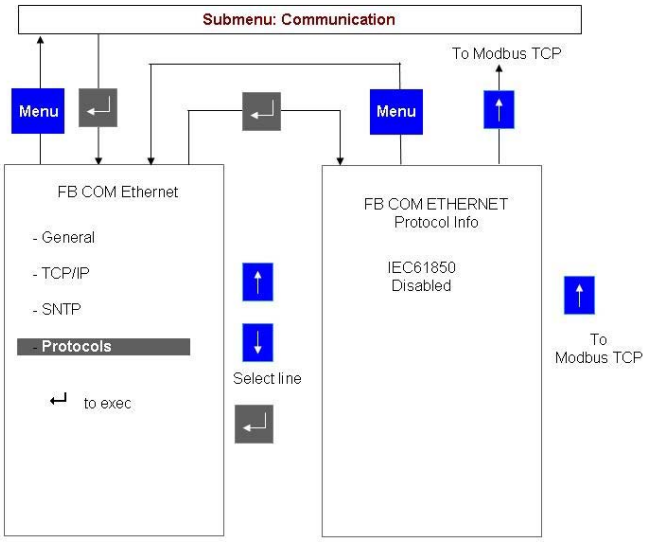


Fig. 20.6.4.8.-15 Protocols subpage in case of IEC61850 disabled

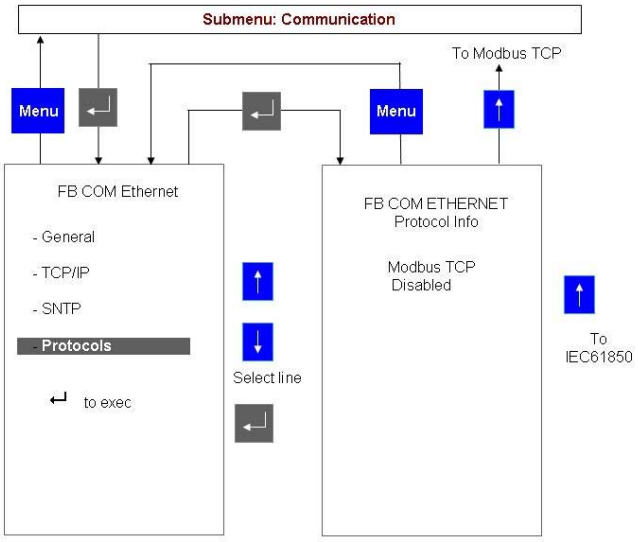
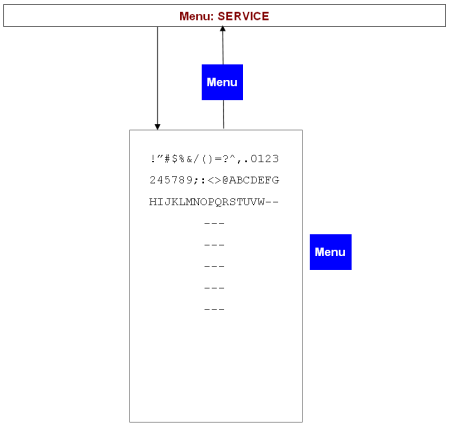


Fig. 20.6.4.8.-16 Protocols subpage in case of MODBUS TCP disabled

20.6.5. Char map

This page shows the active char map used by the HMI. Refer to the Operating Tool User Manual on how to change it.

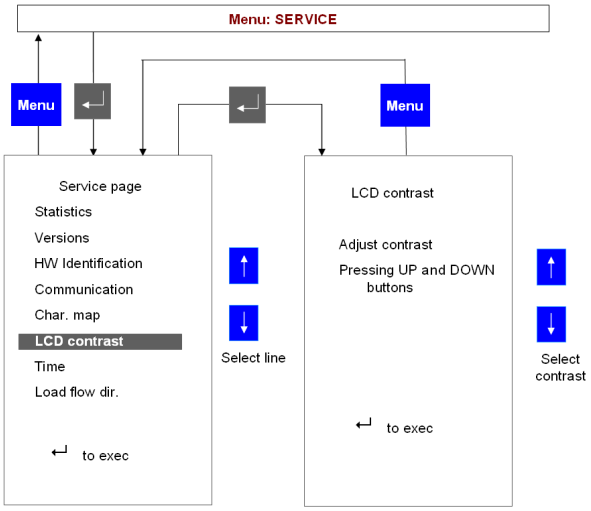


A051656

Fig. 20.6.5.-1 Char map page

20.6.6. LCD contrast

The LCD screen contrast can be adapted to different light condition from this submenu.



A051657

Fig. 20.6.6.-1 Adjusting the LCD contrast

20.6.7. Load flow direction

The load flow direction determines how REF 542plus computes energy and power. It is set with the Operating Tool and it is also dependent upon the current and voltage transformers (or sensors) connections in the primary parts.

- FORWARD: the power is flowing from the switchgear to the load (outgoing feeder).
- BACKWARD: the power is flowing into the switchgear (incoming feeder).

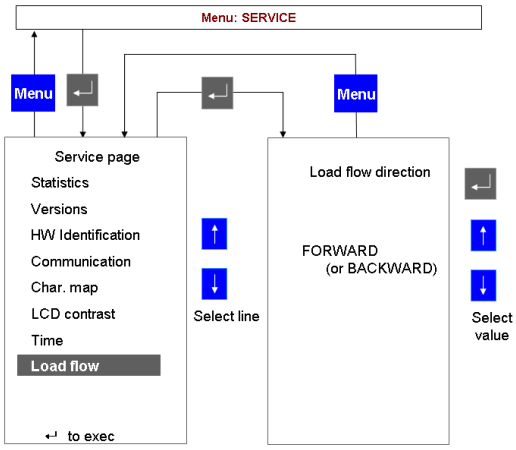


Fig. 20.6.7.-1 Load flow direction visualization

20.7. Test page

This submenu allows testing the HMI and the primary part of the switchgear.

20.7.1. Test HMI

When the test HMI is selected, all its features will be tested by switching them on and off.

HMI buttons are not available during the test. The displayed information on the HMI does not reflect the switchgear's actual status. REF 542plus is protecting the switchgear during the HMI test. The HMI test takes a few seconds.

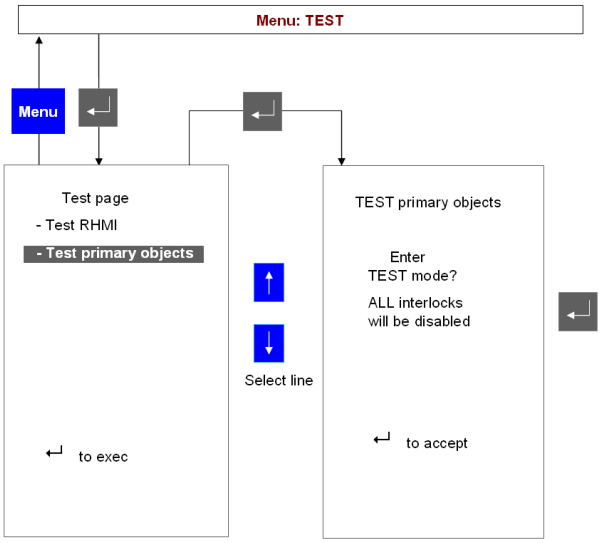


Fig. 20.7.1.-1 Test page menu

20.7.2. Test primary object

The circuit breaker and other switching devices can be tested from this submenu. The object control buttons are used to perform the desired tests. A warning message is displayed before leaving the test primary object mode.

In test mode, the interlockings are disabled. It is strongly recommended to de-energize the switchgear before activating the test mode.

Verify the primary object's correct position before leaving the test mode and before energizing the switchgear. Make sure all the primary objects are back in the correct positions.

21. Appendix C: Tripping time indication

The example below shows and explains the information on the Events page of the HMI. It refers to events generated by Overcurrent Instantaneous protection function. The test is performed with a fault current around 10 times of the current threshold setting value, simulating a two-phase fault between phase L1 and phase L3.

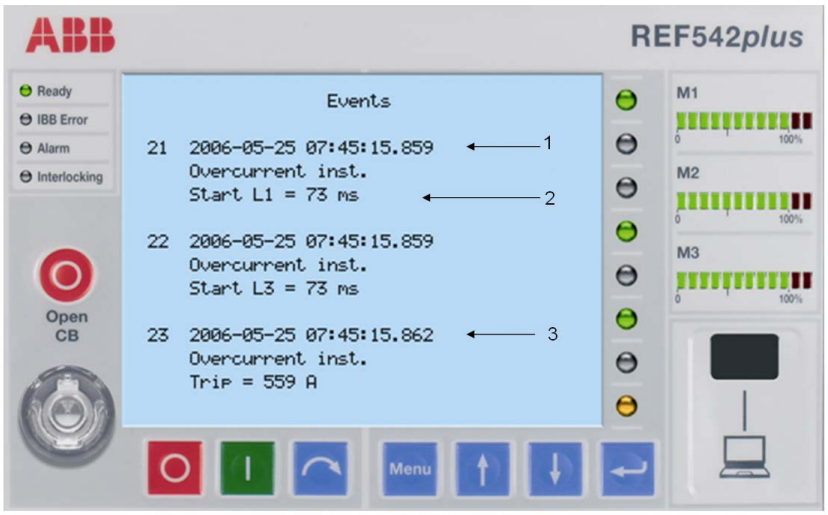


Fig. 21.-1 Start/Trip events

Event number 21:

The Overcurrent Instantaneous protection function detects the system fault condition on phase L1 at the absolute time 25/05/2006, 07:45:15.859. The time stamp is indicated by arrow 1, see Fig. 21.-1.

Event number 22:

The Overcurrent Instantaneous protection function detects the system fault condition on phase L3 at the same absolute time 25/05/2006, 07:45:15.859.

Event number 23:

The trip by the above-mentioned protection function is released at the absolute time 25/05/2006, 07:45:15.862, which is indicated by arrow 3, see Fig. 21.-1.

As long as the current is not interrupted, the start signal remains active. Arrow 2 indicates that the current is flowing for a time duration of 73 ms.

22. Appendix D: Self Supervision

The REF 542plus feeder terminal is provided with an extensive self-supervision system. The self-supervision system handles configuration and run-time fault situations and informs, if possible, the user of faults via the HMI and SPA event.

REF 542plus is a programmable device. The configuration is built by the configuration tool REF542CONF and is composed by the following files:

- FUPLA (functions sequence)
- WIRE (functions connection)
- LCU (HMI display configuration)
- COM (communication configuration)

REF 542plus is a scalable system. Optional modules can be used according to project requirements. The following list provides a definition of the terminology used when defining the state of an optional module:

- "Installed" indicates that the module is physically inserted in the REF 542plus housing.
- "Configured" indicates that the module has been configured in REF542CONF by a REF 542plus engineer.
- "Detected" indicates that the REF 542plus start-up procedure has made a successful detection check of the module.

Software supervision

Software faults require different kinds of handling and these can be modelled by defining a level that identifies the fault’s critical nature:

- Level 1

  Level 1 faults are irrecoverable fatal errors. After fault detection, the system is not able to guarantee safe execution of the protection and control functions. The irrecoverable fault forces REF 542plus to stop any activities and it can only be restarted after a power-switch cycle (power off/on) or after a configuration download (if possible).

- Level 2

  Level 2 faults are recoverable fatal errors. They are similar to level 1 faults except that REF 542plus, instead of stopping any activities, resets and therefore automatically restarts and signals the reset cause.

- Level 3

  Level 3 faults are errors that do not affect safe execution of the protection and control functions. In general, they are handled by signalling the fault via an HMI error message and a SPA event.

The fault can be signalled externally via the following mechanism:

- HMI LEDs
  - Ready:
    - Black

      Protection and control functions not active
    - Green

      Protection and control functions active
  - Network communication:
    - Black

      No communication
    - Green

      Communication works properly
    - Amber

      Some communication error on the line (handled only by MODBUS and ETHERNET module)
    - Red

      Communication error
  - Alarm Led and Interlocking errors are handled by the programmable logics
- HMI error message

  If an error message has been displayed in the MMI, no other message is displayed until:
  - a local/remote reset command has been given
  - completion of a configuration download
- SPA event

Supervision by bootloader

REF 542plus has an on-chip bootloader that handles the software upgrade and the entering into Factory test mode. The bootloader supervises RAM (Random Access Memory) and FLASH (MC non-volatile memory) application program correctness. At normal start-up, it performs a simple RAM test that verifies the presence of the RAM chip and its memory size. The exhaustive RAM test has to be performed if the Factory test mode is activated.

If the RAM test is passed, the bootloader verifies the presence and the correctness of the application program which is stored in FLASH. The presence is verified through a pre-defined pattern check in a fixed FLASH location and the correctness is verified through application program checksum calculation.

The following table presents the bootloader fault descriptions:

Faults/Errors	Signalling	Level
RAM presence	DEBUG port message "RAM error has been detected"	2
RAM size	DEBUG port message "RAM error has been detected" "RAM addressing error (?) - size too small: xx"	2
FLASH application program	DEBUG port message "No valid application found - card resetting"	2

Reset

REF 542plus performs a complete and deep analysis of the last reset cause. The reset can be the result of a normal situation or a HW/SW fault detection. A normal situation can be either of the following two:

- Power-switch cycle

  REF 542plus power is switched OFF and than ON.

- Commissioning test end

  REF 542plus is in commissioning test mode and the user exits from the commissioning test HMI menu.

The fault situations consist of the following:

- HW watchdog

  A HW watchdog supervises the SW execution. The required refresh time is about 80 ms (fault-time detection). This is the worst reset cause because the reset is beyond SW control which means that the real fault root cause in principle is unknown. The cause can be either SW or HW related and in any case there is no possibility to obtain a SW reference or description of the fault. The fault analysis depends on the fault reproducibility in laboratory. If the fault is not reproducible, a special REF 542plus SW can be built that is able to make a trace log of all the activities executed by the SW (interrupts, tasks switching, events, semaphore, etc.). This trace log is stored in the internal memory and can be displayed in the DEBUG port after a watchdog reset. The trace log contains the last operation performed by the system before the fault and it can be the starting point for further analysis to identify the real fault cause. That is, if the fault was HW or SW related, and, in case of SW, in which SW module the fault occurred or what sequence of events that produced the fault.

- SW exceptions

  The internal processor supervises all instruction executions and memory access instances. In case it detects an exception, it prepares an exception stack frame and raises a SW exception interrupt. The REF 542plus exception handler stores all the information contained in the exception stack frame in the internal memory and sets the reset cause to SW exception. The SW exception always produces a HW reset. At start-up, the SW exception is signalled through a HMI and SPA event.

Moreover, the exception stack frame data, which includes very important information needed when analysing the real root cause of the SW exception, is available on the DEBUG port.

Examples of SW exceptions are:

- access error
- address error
- illegal instruction

- Fatal errors

  Fatal errors are faults detected by the internal error checking functionality that, if it fails, compromises the system reliability (e.g. RTOS errors). The REF 542plus fatal error handler stores a fatal error description string in the internal memory. The description string contains a reference to the SW function that generated the fatal error and a description of the cause. Fatal errors always produce a HW reset. At start-up, the fatal error is signalled through a HMI and SPA event.

The following table describes signalling/handling of the reset faults:

Faults/Errors	Signalling	Level
HW watchdog	HMI event “**Reset!! Watchdog**" SPA event “**0E37**” DEBUG port command ‘**4**’ shows SW trace logs before reset (Special REF542 SW)	2
SW exception	HMI event “**Reset!! SW exception**" SPA event “**0E37**” DEBUG port command ‘**1**’ shows SW exception stack frame data	2
Fatal Error	HMI event “**Reset!! Fatal error**" SPA event “**0E37**” DEBUG port command ‘**1**’ shows fatal error description string	2

Configuration

The configuration is stored in FLASH. At start-up or after a configuration download, REF 542plus makes a consistency check on it. It consists of:

- •Version checking

  There are separate versions for protection and control functions (FUPLA) and COM configuration functions.

- •Function checking

  Every installed function must be implemented in the firmware and must have the expected configuration data/parameters format.

- •Hardware checking

  If a function requires a hardware component, this has to be installed and detected by the start-up procedure.

Note that all version checks are performed by REF542CONF before configuration download. Therefore, the fault can occur only after a REF 542plus firmware upgrade/downgrade or after FLASH configuration data corruption.

The following table describes signalling/handling of the configuration faults:

Faults/Errors	Signalling	Level
No configuration	HMI error message "**Waiting new config.**"	1
Incompatible Version	HMI error message "**Software changed**"	1
COM configuration file format	HMI error message "**WRONG COM CONFIG.**" SPA event "**102E60**"	3
COM TCP-IP incompatible version	HMI error message "**WRONG TCP-IP CONFIG.**" SPA event "**102E61**"	3
COM MOD-TCP incompatible version	HMI error message "**WRONG MODTCP CONFIG.**" SPA event "**102E62**"	3
COM WEBREF incompatible version	HMI error message "**WRONG WEBREF CONFIG.**" SPA event "**102E63**"	3
COM SMS incompatible version	HMI error message "**WRONG SMS CONFIG.**" SPA event "**102E61**"	3
COM module incompatible version	HMI error message "**WRONG COMMODULE CONF.**" SPA event "**102E61**"	3
Functions checking	HMI error message "**WRONG CONFIGURATION**" SPA event "**0E43**"	1
Hardware checking	Protection functions: See 2.4 DSP AI20mA functions: See 2.6 AI20mA	

DSP (Digital Signal Processor)

The DSP supervision verifies correct DSP start-up and correct DSP working status during normal operation.

The DSP start-up supervision verifies:

- DSP version

  It is used to verify communication at start-up and to check SW version compatibility.

- DSP Analogue Inputs calibration factors

  The data is retrieved from the Analogue Input module. If the data is not present or if it is corrupted, the system will be stopped because it is not able to guarantee reliable measurements and safe protection executions.

- DSP configuration

  The DSP configuration is built by the MC from the Analogue Input and Protections configuration. It is sent to the DSP that performs a consistency check on it.

The DSP normal operation supervision verifies:

- DSP SW watchdog

  It is based on a flag-toggle mechanism. The DSP is faulty if it does not toggle a flag for 1 second.

- MC-DSP communication

  The DSP is faulty if the number of consecutive fault requests reaches a pre-defined counter (15). Note that, during normal operation, the DSP measurements are requested every 100ms which means that the worst fault-time detection of a DSP fault is 1.5 sec.

The following table describes signalling/handling of the DSP faults:

Faults/Errors	Signalling	Level
DSP version	HMI error message "**WRONG DSP VERSION**" SPA event "**102E23**"	1
DSP Analogue Inputs calibration factors	HMI error message "**CALIB. DSP FAULT**" SPA event "**102E22**"	1
DSP configuration	HMI error message "**CONFIG. DSP ERROR**" SPA event "**102E21**"	1
DSP watchdog DSP communication	HMI event "**Reset!! DSP fail**" SPA event "**0E38**"	2

COM module (optional extension)

The COM module is an optional module that can be installed in the REF 542plus housing. Its supervision is done only if the COM module is detected at start-up or configured by REF542CONF. The supervision verifies correct COM module configuration start-up and correct COM working status during normal operation.

The COM start-up supervision verifies:

- COM module version
- COM configuration data version
- COM module type

  The COM start-up supervision verifies that the configured COM module type matches with the one detected.

The following fault situations can happen:

- The COM module type detected is different from the one configured in REF542CONF
- The COM module has been configured in REF542CONF but it is not installed in the REF 542plus housing
- The COM module has been configured in REF542CONF but it has not been detected due to an internal COM module fault (the detection timeout is 30 sec.)
- The COM module has been detected but it has not been configured

The COM normal operation supervision verifies:

- •COM module alive state

  Based on the update of a life cycle counter. If the COM module does not update the life cycle counter for 500 ms, it is considered to be faulty. NOTE: Up to release 2.5, this mechanism is implemented by the MODBUS and ETHERNET modules.

The following table describes signalling/handling of the COM module faults:

Faults/Errors	Signalling	Level
COM module configuration data version	"**Network communication**" led becomes RED HMI error message "**WRONG COM VERSION**" SPA event "**102E67**"	3
COM module type	"**Network communication**" led becomes RED HMI error message "**WRONG COMMODULE TYPE**" SPA event "**102E66**"	3
COM module not installed	"**Network communication**" led becomes RED HMI error message "**COMMODULE NOT INSTALL**" SPA event "**102E68**"	3
COM module not detected	"**Network communication**" led becomes RED HMI error message "**COMMODULE NOT DETECT**" SPA event "**102E69**"	3
COM module not configured	"**Network communication**" led becomes RED HMI error message "**COMMODULE NOT CONFIG.**" SPA event "**102E70**"	3
COM module not alive	"**Network communication**" led becomes RED	3

AI20mA module (optional extension)

The AI20mA (20 mA analogue input module) is an optional module that can be installed in the REF 542plus housing. Its supervision is done only if the AI20mA module is detected at start-up or configured by REF542CONF. The supervision verifies correct AI20mA start-up and correct AI20mA working status during normal operation.

The AI20mA start-up supervision verifies:

- AI20mA version

  A common pre-defined pattern is used for AI20mA module detection and, if detected, an internal version number is used to perform the compatibility check.

- AI20mA firmware

  No, or not valid, firmware detected.

- AI20mA HW tests

  The initial hardware test detected an error.

- AI20mA configuration

The AI20mA configuration is built by the MC from the AI20mA sensors and Warnings configuration. It is sent to the AI20mA that performs a consistency check on it.

- AI20mA-MC configuration

  The MC does not start normal operation if the AI20mA is configured but not detected at start-up.

The AI20mA normal operation supervision verifies:

- •MC-AI20mA communication

  The AI20mA sensor measurements and warnings status are requested every FUPLA cycle and so this time has to be considered as the worst fault time detection.

The following table describes signalling/handling of the AI20mA faults:

Faults/Errors	Signalling	Level
AI20mA version	HMI error message "**WRONG AI20MA VERSION**" SPA event "**102E50**"	1
AI20mA firmware	HMI error message "**AI20MA NOT READY**" SPA event "**102E52**"	3
AI20mA HW tests	HMI error message "**AI20MA NOT READY**" SPA event "**102E53**"	3
AI20mA configuration	HMI error message "**AI20MA NOT READY**" SPA event "**102E51**"	3
AI20mA-MC configuration	HMI error message "**WRONG CONFIGURATION**" SPA event "**0E43**"	1
AI20mA communication (command failure)	HMI error message "**AI20MA NOT READY**" SPA event "**102E54**"	3

FLASH data

REF 542plus uses a FLASH device to store non-volatile data/configuration. The MC supervises every FLASH erase/write operation checking that the FLASH status registers. In order to protect the FLASH data against erroneous write/erase attempts, the FLASH is write-protected which means that erroneous access will raise a SW exception (address error). The write-protection is disabled only when valid FLASH write/erase has to be performed. Moreover, in order to guarantee data integrity, all data stored in FLASH is validated with size-check and checksum verification.

The following table describes signalling/handling of the FLASH faults:

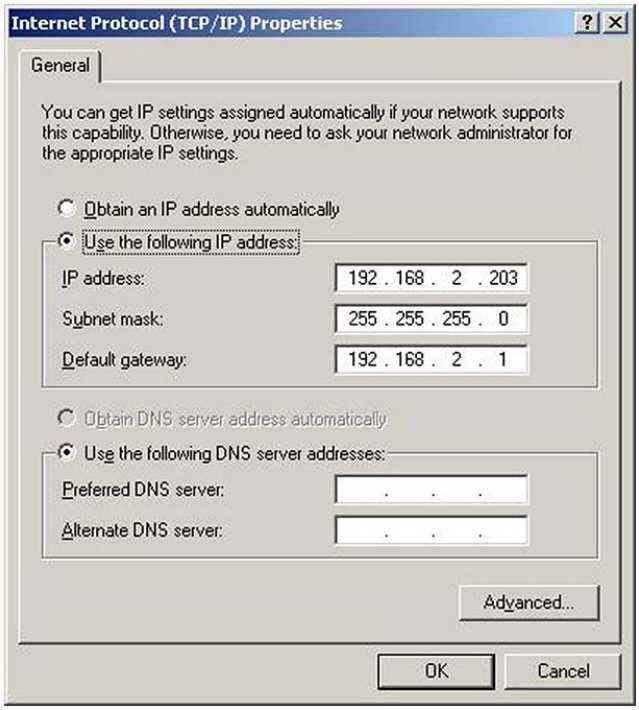
Faults/Errors	Signalling	Level
Memory full error	SPA event “**102E1**”	3
Ready error	SPA event “**102E2**”	3
Writing byte error	SPA event “**102E3**”	3
Block erase error	SPA event “**102E4**”	3
Vpp low error	SPA event “**102E5**”	3
Block locked error	SPA event “**102E6**”	3

23. Appendix E: Telnet protocol

Through the Telnet protocol it is possible to access an Ethernet module from a specific computer connected remotely to the same network. Telnet provides bidirectional communication, where the destination system (Ethernet module) is referred to as the Telnet server, while the specific local system (for example, PC) is the Telnet client. It is possible to connect only one Telnet client to the Telnet server at a time. The Telnet server appears to the connected Telnet client as a locally connected terminal.

Configuring the Telnet Terminal

To connect a Telnet client to the Ethernet module as the Telnet server, few operations are necessary. How to connect a common PC is shown below. Both the Ethernet module and PC must be connected to the same network. Adjust the IP parameters of the PC Ethernet port so that it is in the same subnet:

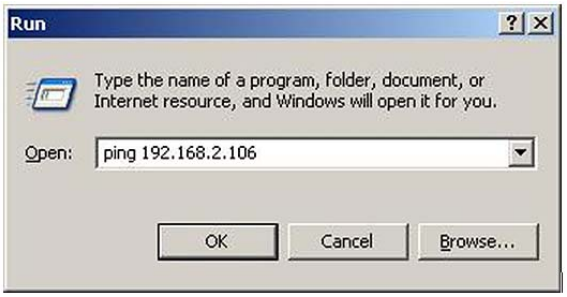


A070410

Fig. 23.-1 Setting the IP properties

In the above figure, the PC Ethernet port is configured to communicate with the address 192.168.2.203 and with subnet 255.255.255.0. The subnet value must match the subnet value set in the Ethernet module, while only the first three digits of the IP address must match with the ones of the Ethernet module, the fourth digit must be different. After that it is possible to verify a remote connection with a ping command.

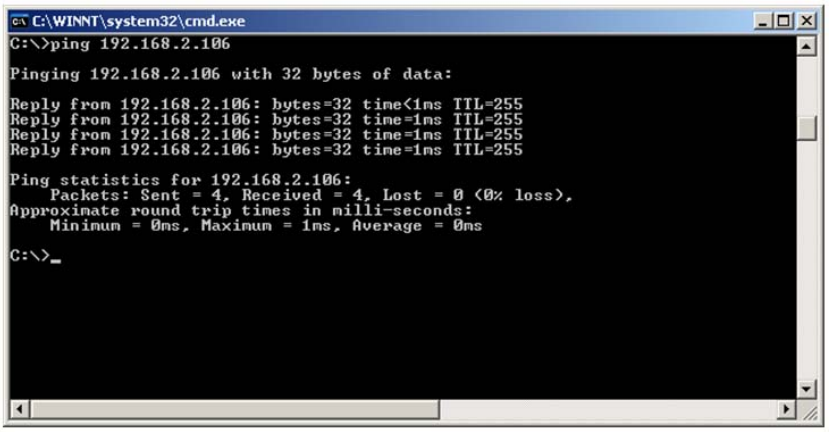
To perform the ping command, select **Run** in the PC Start menu. Then type the ping command by specifying the Ethernet board IP address, as illustrated in the following Fig. 23.-2:



A070411

Fig. 23.-2 Running a ping test

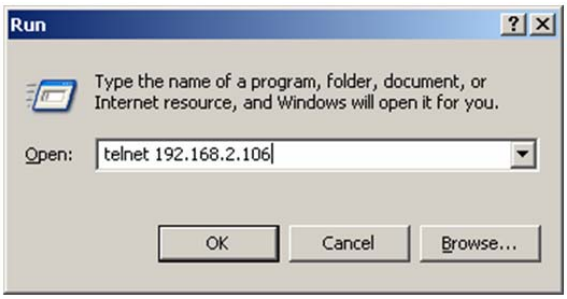
In the example above, the PC sends a ping command to an Ethernet board connected to the net with the address 192.168.2.106. If the connection is correct, the following window appears after the execution of the ping command:



A070412

Fig. 23.-3 Test result of ping command

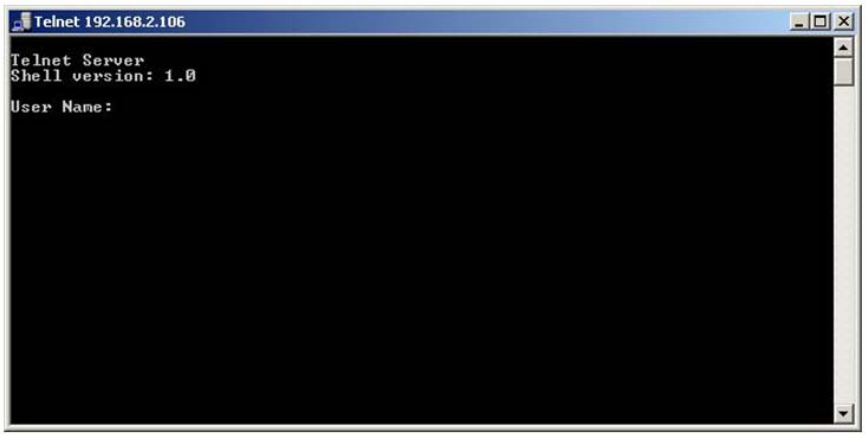
Now, it is possible to establish a connection with the Telnet server of the Ethernet module. As before, use the **Run** command in the PC Start menu. After that, type the telnet command specifying the Ethernet board IP address as displayed in the following figure:



A070413

Fig. 23.-4 Running a Telnet client

The following window appears:



A070414

Fig. 23.-5 Log into the Telnet shell

A connection with the Ethernet board Telnet server is now established. The Ethernet module Telnet server allows different logging levels to enable different functions and commands. You can access Telnet without any log in operation by simply pressing the Enter key twice. Note that the Telnet connection is automatically closed if it stays inactive for more than two minutes.

Access to Telnet as a basic user allows functions to monitor the Ethernet board status and general information.

Basic shell commands

Basic commands include:

h	shows a list of the allowed commands
v	prints a version of the loaded software modules
q	closes the active Telnet connection

Specific commands

Specific commands allow getting information on:

- Ethernet connection configurations
- disks' contents
- SNTP module state
- internal interface state
- Dual Channel state (if the option is enabled)
- Modbus TCP configuration and state
- Time configuration and state

The Ethernet connection configurations display the current Ethernet configuration. Two commands are available:

ep	shows the configuration parameters of the ports: • topology • protocol type • MAC address (for port1 and port2) • IP address (for port1 and port2) • subnet mask (for port1 and port2) • gateway IP address (for port1 and port2)
es	shows the SNTP client configuration parameters

The disks' contents display the contents of the Flash disk (C:) and Ram disk (D:). Three commands are available:

fl	allows to see the content of the selected disk (C: or D:)
fp	allows to select the current disk and path to look at
fs	shows the disk usage statistics for the current disk

You can check the SNTP module state by using the following five commands:

sa	shows some information regarding the running SNTP algorithm
sc	shows the state of the SNTP client
sk	shows information regarding the SNTP clock module
ss	shows the state of the SNTP server
st	shows the result of the last transaction
sx	shows all information reported with the previous commands

You can check the internal interface state with the command:

ih	shows internal event handler information
ii	shows current application state
ip	shows internal SPA poller information
is	shows internal interface statistics

You can also view the factory test result file with the command:

tf	shows stored factory tests report

The following set of commands can be used to check the state of the Dual Channel operation modality:

da	used to print out all the Dual Channel information
dc	shows the current Dual Channel configuration
df	shows Ethernet Controller statistics
dn	shows the table list of the nodes connected
ds	shows statistics about Dual Channel communication
dv	shows the Dual Channel module release version

Commands related to Modbus TCP protocol are:

mc	shows the Modbus TCP configuration
md	shows current connections' states and statistics for Modbus TCP server

Finally, the section Time configuration and state collects following commands:

wc	shows possible time sources and current time
wm	shows Ethernet Board and Main Card current time source and state
ws	shows the collected time statistics

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