YASKAWA

VIPA HMI

TP-cloud | HA1-L1A41-0 | Manual

HB160 | TP-cloud | HA1-L1A41-0 | en | 18-02

cloudPanel - TP110-CL

www.vipa.com/en/service-support/manuals

VIPA CONTROLS

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HA1-L1A41-0_000_TP110-CL,1,EN - © 2018

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1 General

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1.2 About this manual

Objective and contents

This manual describes the cloudPanel HA1-L1A41-0 from VIPA. It contains a description of the structure, project engineering and deployment.

Product	Order number	as of state:		
		HW	FW	OS
TP 110-CL	HA1-L1A41-0	01	V1.0.0	Linux® 3.12

Target audience

The manual is targeted at users who have a background in automation technology.

Structure of the manual

The manual consists of chapters. Every chapter provides a self-contained description of a specific topic.

Guide to the document

The following guides are available in the manual:

- An overall table of contents at the beginning of the manual
- References with page numbers

Availability

The manual is available in:

- printed form, on paper
- in electronic form as PDF-file (Adobe Acrobat Reader)

Icons Headings

Important passages in the text are highlighted by following icons and headings:

DANGER!
Immediate or likely danger. Personal injury is possible.

CAUTION!
Damages to property is likely if these warnings are not heeded.

Supplementary information and useful tips.

2 Hardware description

2.1 Safety information for users

Handling of electrostatic sensitive modules

VIPA modules make use of highly integrated components in MOS-Technology. These components are extremely sensitive to over-voltages that can occur during electrostatic discharges. The following symbol is attached to modules that can be destroyed by electrostatic discharges.

The Symbol is located on the module, the module rack or on packing material and it indicates the presence of electrostatic sensitive equipment. It is possible that electrostatic sensitive equipment is destroyed by energies and voltages that are far less than the human threshold of perception. These voltages can occur where persons do not discharge themselves before handling electrostatic sensitive modules and they can damage components thereby, causing the module to become inoperable or unusable. Modules that have been damaged by electrostatic discharges can fail after a temperature change, mechanical shock or changes in the electrical load. Only the consequent implementation of protection devices and meticulous attention to the applicable rules and regulations for handling the respective equipment can prevent failures of electrostatic sensitive modules.

Shipping of modules

Modules must be shipped in the original packing material.

Measurements and alterations on electrostatic sensitive modules

When you are conducting measurements on electrostatic sensitive modules you should take the following precautions:

- Floating instruments must be discharged before use.
- Instruments must be grounded.

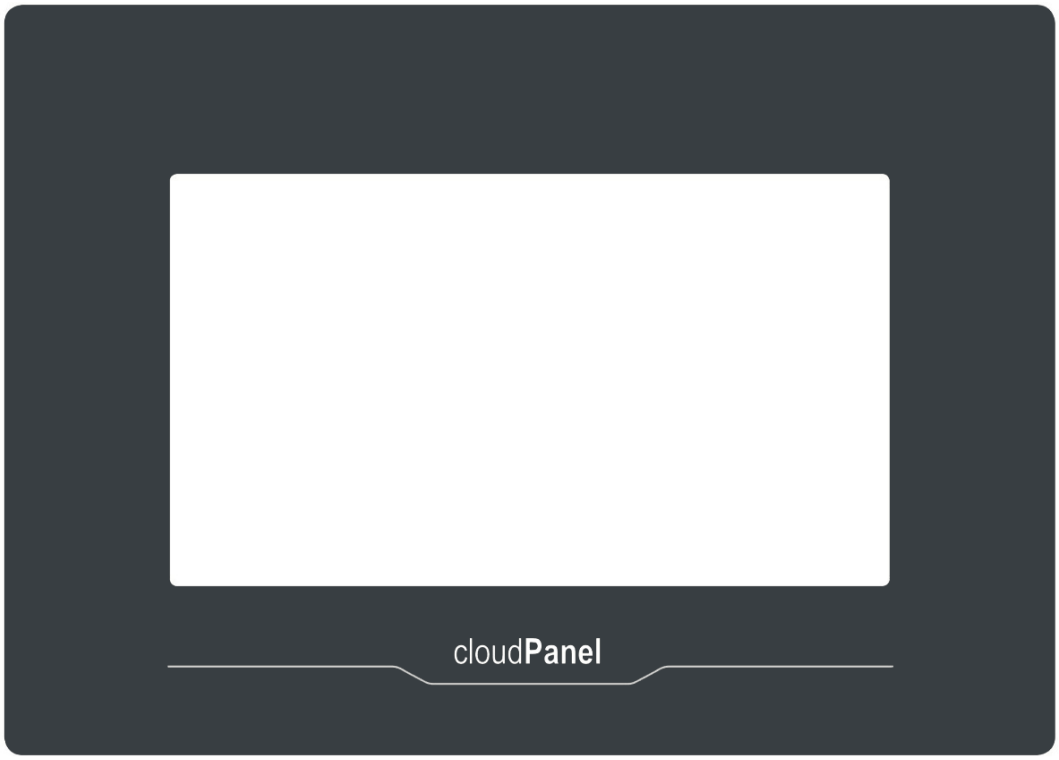
Modifying electrostatic sensitive modules you should only use soldering irons with grounded tips.

CAUTION!
Personnel and instruments should be grounded when working on electrostatic sensitive modules.

2.2 Properties

General

The VIPA cloudPanel allows you to visualize and alter operating states and recent process values of a connected PLC. The cloudPanel is a compact and modular embedded PC based on Linux®. WEB-based projects are displayed via a WEB browser. Here the cloudPanel can simply be configured, controlled and remoted.



- Operating system Linux® 3.12
- Processor ARM Cortex A8 1GHz
- Flash memory 4GB, RAM 512MB DDR
- RS232/RS422/RS485 interface (not available for WebVisu projects), USB-A and Ethernet interface
- Robust plastic case
- Display resolution 600 x 1024 / 1024 x 600, 64K colors
- Battery backed clock
- Resistive analog touch screen
- Easy mounting via mounting clips
- Protection class IP66, Type 2 and 4X (Front) / IP20 (Back)

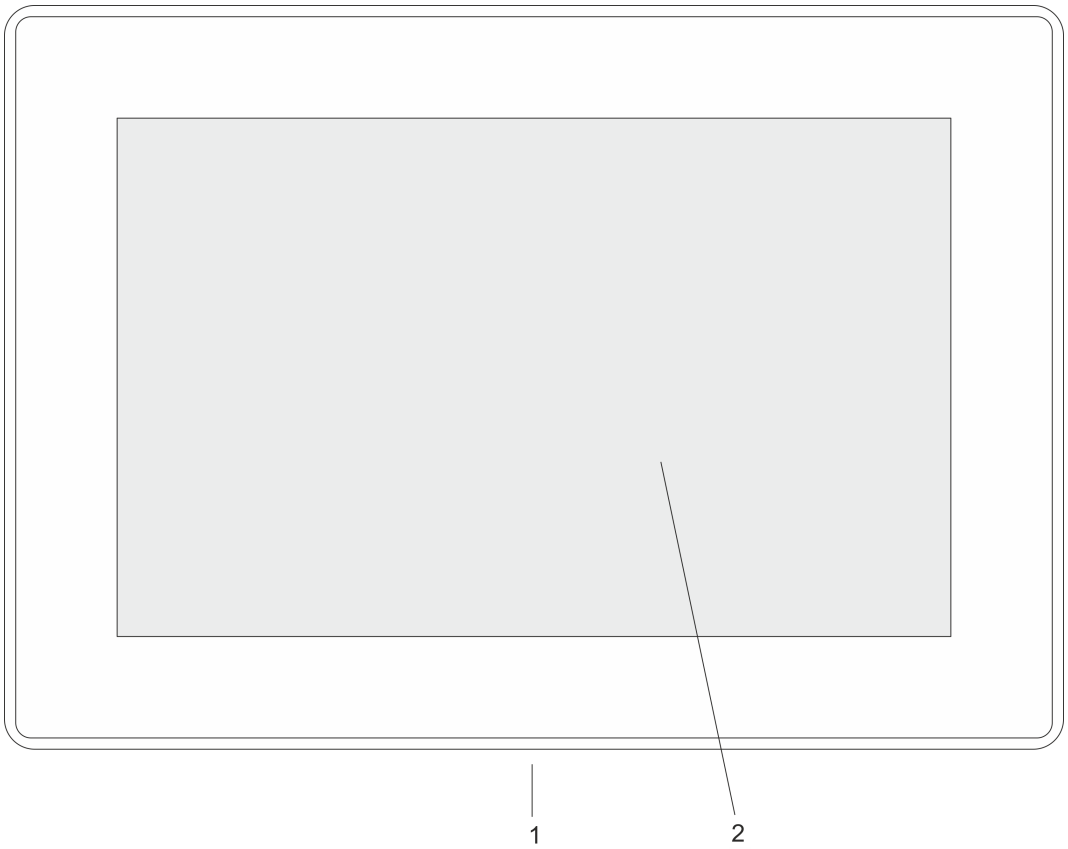
Order data

Type	Order number	Description
TP 110-CL	HA1-L1A41-0	10" TFT color, RS232/RS422/RS485, USB-A, Ethernet RJ45

2.3 Structure

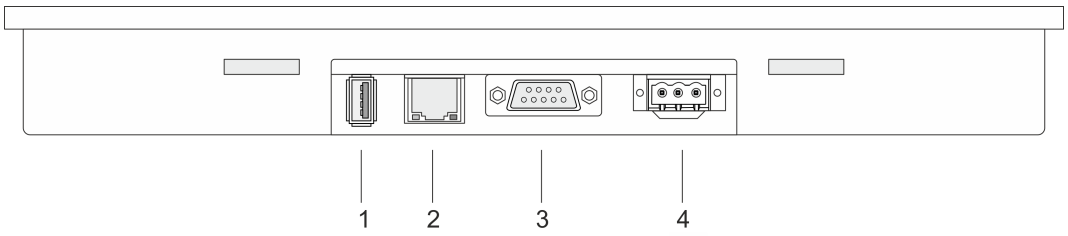
2.3.1 Overview

Front view



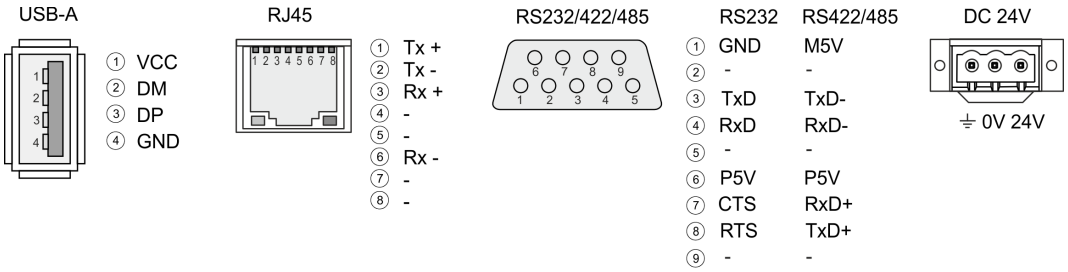
1 Interfaces
2 Display with touch sensitive area (Touch-Screen)

Bottom view



1 USB-A interface USB 2.0
2 RJ45 jack for Ethernet communication LAN
3 RS232/RS422/RS485 interface COM
4 Slot for DC 24V voltage supply

2.3.2 Interfaces



"Host"-USB-A

Using the "Host"-USB-A interface USB mouse, keyboard, stick or USB hard discs can be connected.

Ethernet connection

The RJ45 jack provides the interface to the twisted pair cable, required for Ethernet. The Ethernet interface has got two LEDs for status display.

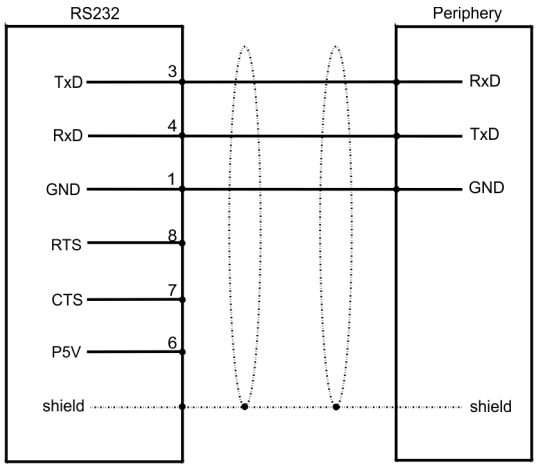
LEDs

green	yellow	Description
on	off	no link
blinks	on	100Mbit/s link
blinks	off	10Mbit/s link

RS232 interface

9 pin SubD plug

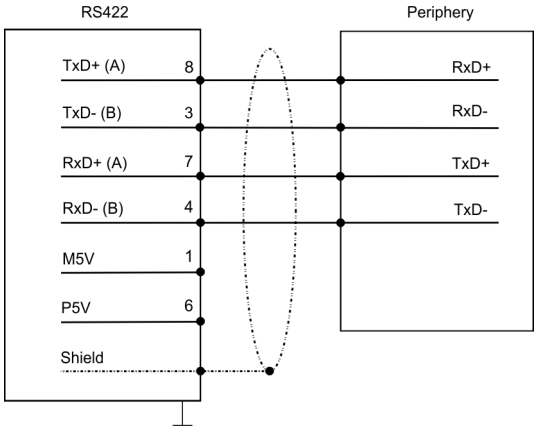
- Interface is compatible to the COM interface of a PC
- Logical signals as voltage levels
- Point-to-point links with serial full-duplex transfer in two-wire technology up to 15m distance
- Data transfer rate up to 115.2kbit/s



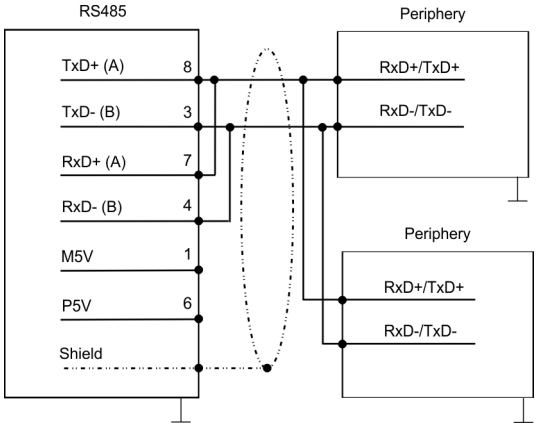
RS422/485 interface

9 pin SubD jack

- Logical states represented by voltage differences between the 4 cores
- Serial bus connection in 4-wire technology using full duplex mode
- Data communications up to a max. distance of 500m
- Data communication rate up to 115.2kBaud



- Serial bus connection in 2-wire technology using half duplex mode



Power supply

The cloudPanel has got an integrated power supply. The power supply has to be provided with DC 24V (18 ... 32 VDC). For this you find an according DC 24V slot at the bottom *'Connect power supply' on page 17*.

2.3.3 Memory management

Overview

The following memory systems are available for the cloudPanel:

- 512MB work memory (RAM)
- 4GB user memory (Flash)
- USB storage media using "Host"-USB-A interface

Work memory (RAM)

Every cloudPanel has a DDR work memory with a size of 512MB.

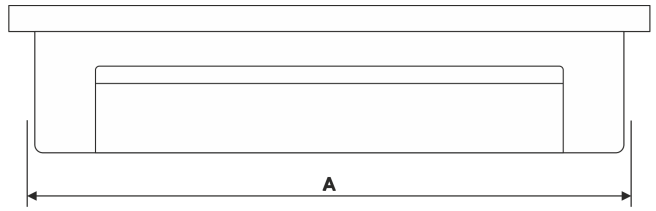
User memory (Flash)

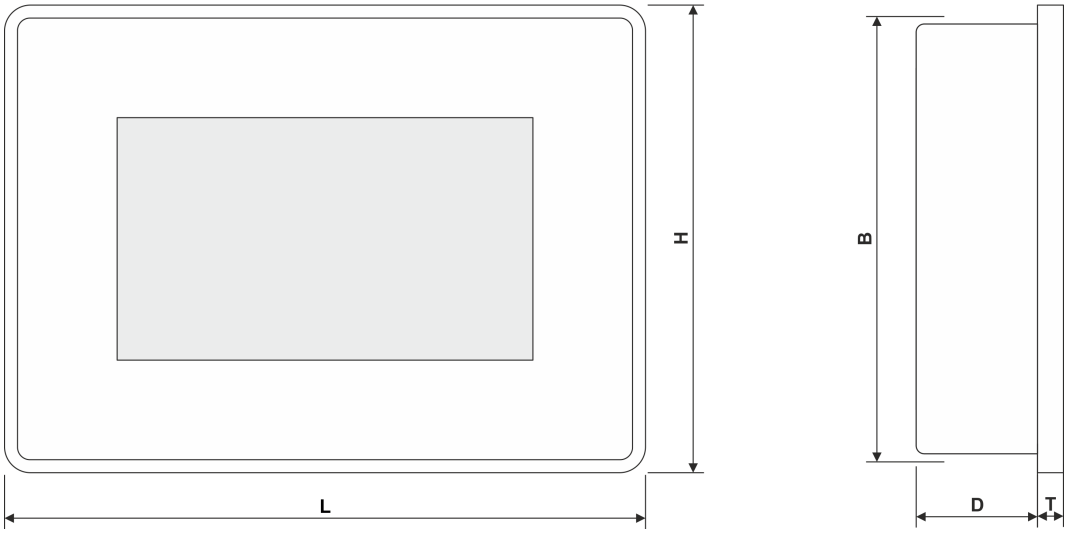
As internal permanent storage medium every cloudPanel has a user memory with a size of 4GB. 700MB of this is available to the user.

USB storage media (USB 2.0)

The connection of USB sticks and USB drives by use of the "Host"-USB-A interface is supported by the cloudPanel.

2.4 Dimensions





Installation dimensions

Front panel (L x H)	282 x 197 mm
Depth (D+T)	29 + 6 mm
Installation cutting (A x B)	271 x 186 mm

The degrees of protection are only guaranteed when the following is observed:

- *Material thickness at the mounting cut-out: 1.5 ... 6mm*
- *The deviation from the plane for the panel cut-out is ≤ 0.5mm. This condition must be fulfilled for the mounted HMI device.*
- *Permissible surface roughness in the area of the seal: ≤ 120µm (friction coefficient 120)*

2.5 General data

Conformity and approval		
Conformity		
CE	2014/30/EU	EMC directive
Approval		
UL		Refer to Technical data
others		
RoHS	2011/65/EU	Restriction of the use of certain hazardous substances in electrical and electronic equipment

Protection of persons and device protection		
Type of protection	-	Rear: IP20; Front: IP66, NEMA Type 2 and Type 4x
Electrical isolation		
to the field bus	-	electrically isolated
to the process level	-	electrically isolated
Insulation resistance		-
Insulation voltage to reference earth		
Inputs / outputs	-	AC / DC 50V, test voltage AC 500V
Protective measures	-	against short circuit

Environmental conditions to EN 61131-2		
Climatic		
Storage / transport	EN 60068-2-14	-20…+70°C
Operation		
Horizontal installation	EN 61131-2	0…+40°C
Vertical installation	EN 61131-2	0…+50°C
Air humidity	EN 60068-2-30	RH1 (without condensation, rel. humidity 5…85%)
Pollution	EN 61131-2	Degree of pollution 2
Mechanical		
Oscillation	EN 60068-2-6	1g, 9Hz ... 150Hz
Shock	EN 60068-2-27	15g, 11ms

Mounting conditions		
Mounting place	-	In the control cabinet
Mounting position	-	Horizontal and vertical

EMC	Standard		Comment
Emitted interference	EN 61000-6-4		Class A (Industrial area)
Noise immunity zone B	EN 61000-6-2		Industrial area
		EN 61000-4-2	ESD 8kV at air discharge (degree of severity 3), 4kV at contact discharge (degree of severity 2)
		EN 61000-4-3	HF field immunity (casing) 80MHz … 1000MHz, 10V/m, 80% AM (1kHz) 1.4GHz ... 2.0GHz, 3V/m, 80% AM (1kHz) 2GHz ... 2.7GHz, 1V/m, 80% AM (1kHz)
		EN 61000-4-6	HF conducted 150kHz … 80MHz, 10V, 80% AM (1kHz)
		EN 61000-4-4	Burst, degree of severity 3
		EN 61000-4-5	Surge, degree of severity 3 *

*) Due to the high-energetic single pulses with Surge an appropriate external protective circuit with lightning protection elements like conductors for lightning and overvoltage is necessary.

2.6 Technical data

Order no.	HA1-L1A41-0
Type	cloudPanel TP110-CL
Display	
Display size (diagonal)	10.1 "
Display size (width)	224 mm
Display size (height)	128 mm
Resolution	1024 x 600 / 600 x 1024
Aspect ratio	16:9
Type of display	TFT color (64K colors)
MTBF Backlights (25°C)	20000 h
System properties	
Processor	Cortex-A8 1000 MHz
Operating system	Linux 3.12
User software	Webkit Browser
Work memory	512 MB
User memory	4 GB
Available memory (user data)	700 MB
SD/MMC Slot	-
CF Card Slot Typ II	-

Order no.	HA1-L1A41-0
CFast Slot	-
Time	
Real-time clock buffered	✓
Clock buffered period (min.)	2 w
Type of buffering	Goldcap
Load time for 50% buffering period	5 h
Load time for 100% buffering period	10 h
Accuracy (max. deviation per day)	8 s
Operating controls	
Touchscreen	resistive
Touch function	Single Touch
Keyboard	external via USB
Mouse	external via USB
Interfaces	
MPI, PROFIBUS-DP	-
MPI, PROFIBUS-DP connector	-
Serial, COM1	RS232 / RS422 / RS485
COM1 connector	Sub-D, 9-pin, male
Serial, COM2	-
COM2 connector	-
Number of USB-A interfaces	1
USB-A connector	USB-A (host)
Number of USB-B interfaces	-
USB-B connector	-
Number of ethernet interfaces	1
Ethernet	Ethernet 10/100 MBit
Ethernet connector	RJ45
Integrated ethernet switch	-
Video connectors	-
Audio connections	-
Technical data power supply	
Power supply (rated value)	DC 24 V
Power supply (permitted range)	18 - 32 VDC
Reverse polarity protection	✓
Current consumption (no-load operation)	0.1 A
Current consumption (rated value)	0.25 A

Order no.	HA1-L1A41-0
Inrush current	38 A
I^2t	0.33 A^2s
Power loss	6 W
Status information, alarms, diagnostics	
Supply voltage display	none
Mechanical data	
Housing / Protection type	
Material	PC + ABS
Mounting	mounting clips
Protect type front side	IP 66
Protect type back side	IP 20
Dimensions	
Front panel	282 mm x 197 mm x 6 mm
Rear panel	268 mm x 183 mm x 29 mm
Installation cut-out	
Width	271 mm
Height	186 mm
Minimum	1.5 mm
Maximum front panel thickness	6 mm
Net weight	840 g
Weight including accessories	971 g
Gross weight	1434 g
Environmental conditions	
Operating temperature	0 °C to 50 °C
Storage temperature	-20 °C to 70 °C
Certifications	
UL certification	yes
KC certification	-

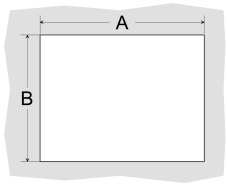
3 Deployment

3.1 Installation

Overview

The cloudPanel is suitable for the installation in operating tables and control cabinet fronts. The installation happens via the backside. The cloudPanel is provided with a fixing technique that allows an easy connection with a crosstip screwdriver. A fast and easy device change is possible.

Installation cutting



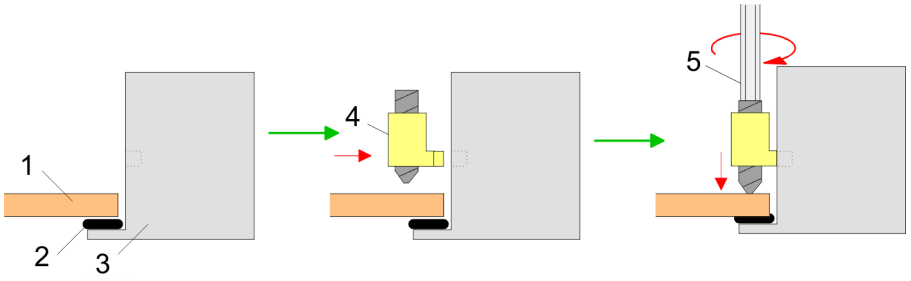
For the installation into a operating tableau and control cabinet fronts, the cloudPanel requires the following front plate cutting:

cloudPanel	A x B in mm
HA1-L1A41-0	271 x 186 mm

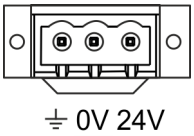
Installation

To fix the cloudPanel mounting clips are included. For the installation a small crosstip screwdriver is required.

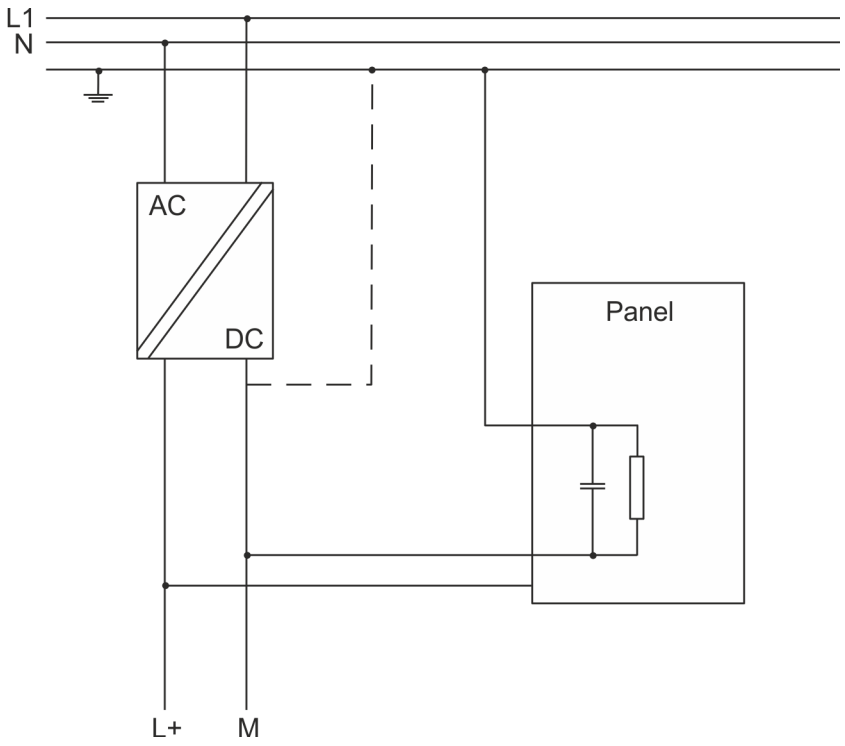
1. Push the cloudPanel [3] from the front side into the front panel cutting [1] until it touches the panel with the seal [2].
2. Put the mounting clips [4] on all four sides of the cloudPanel into the openings. The screws should point in the direction of the front panel.
3. Screw the screws from the other side with the crosstip screwdriver [5].



Connect power supply



- For the cabling of the DC 24V power supply (18 ... 32 VDC) a black plug is included. The connector is a plug with screw contacts. The associated label is located on the back of the cloudPanel.
- The cloudPanel must always be grounded to earth. Grounding helps limit the effects of noise due to electromagnetic interference.
- Use the power supply terminal marked with ⏚ for grounding.
- The power supply circuit may be floating or grounded. In the latter case, connect to the ground the power supply as shown in figure with a dashed line.
- When using the floating power scheme, note that the cloudPanel internally connects the power to the ground with a 1MΩ resistor in parallel with a 4.7nF capacitor.



3.2 Commissioning

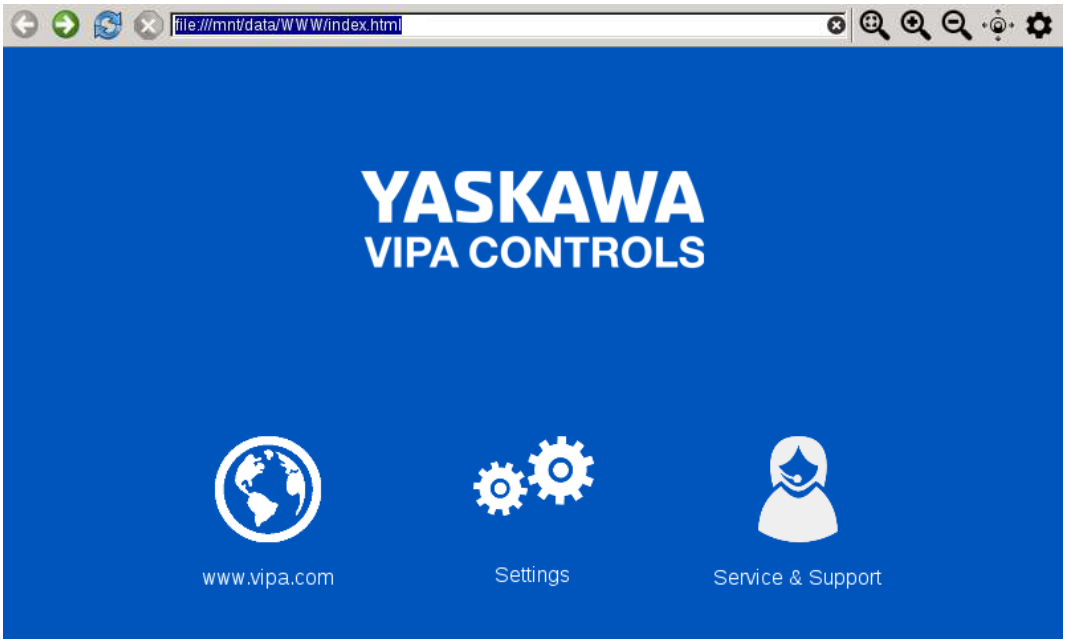
CAUTION!

- Before commissioning the device must be brought to room temperature.
- At condensation the device must be absolutely dry before connected to power.
- To avoid overheat during operation the device must not be laid open to direct sun light.
- After opening the control cabinet or desk, there are parts with possible dangerous voltage available.
- For all signal connections only screened cables are permitted.
- Signal cables must not be let within the same cable shaft as high voltage cables.

3.2.1 Web browser

Splash screen

As soon as the cloudPanel is provided by power supply, the VIPA splash screen of the implemented Web browser will be loaded.



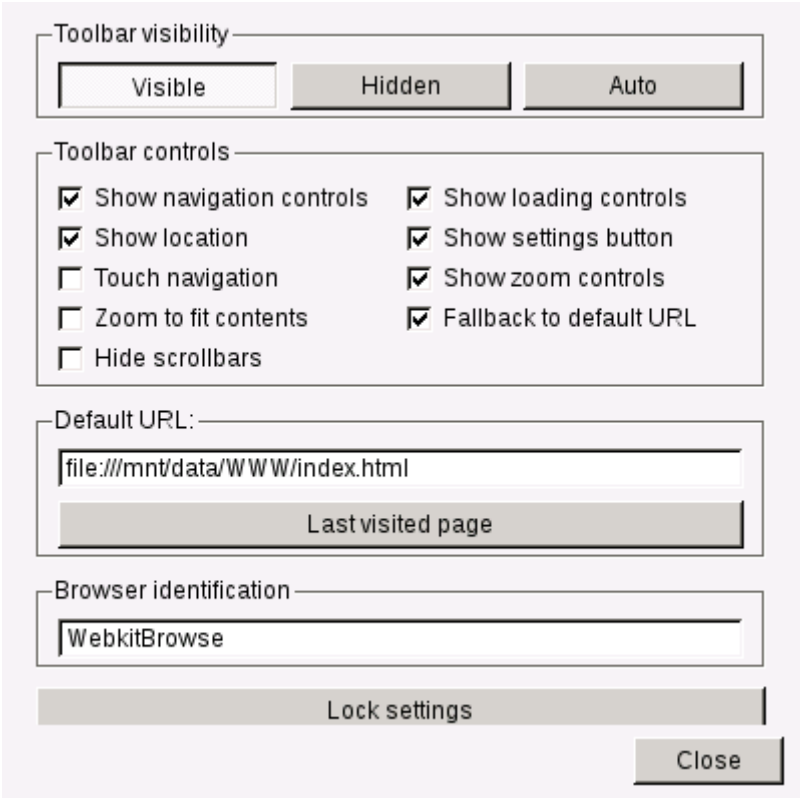
www.vipa.com - With active internet connection, this button opens the VIPA home-page *www.vipa.com*.

Settings - Use the [Settings] button to open the "System Settings" interface of the cloudPanel.

Service & Support - With active internet connection, this button takes you directly to VIPA "Service & Support".

Browser settings

Use the ⚙ button in the upper right corner of the browser window to open the browser settings.



'Toolbar visibility'

[Visible] - Toolbar visible

[Hidden] / [Auto] - Toolbar hidden

'Toolbar controls'

'Show navigation controls' - Display of the buttons

'Show location' - Display of the address bar

'Touch navigation' - Display of the button

'Zoom to fit contents' - Display of the button

'Hide scrollbars' - Hide the scrollbars

'Show loading controls' - Display of the button

'Show settings button' - Display of the button

'Show zoom controls' - Display of the buttons

'Fallback to default URL' - Fallback to default URL

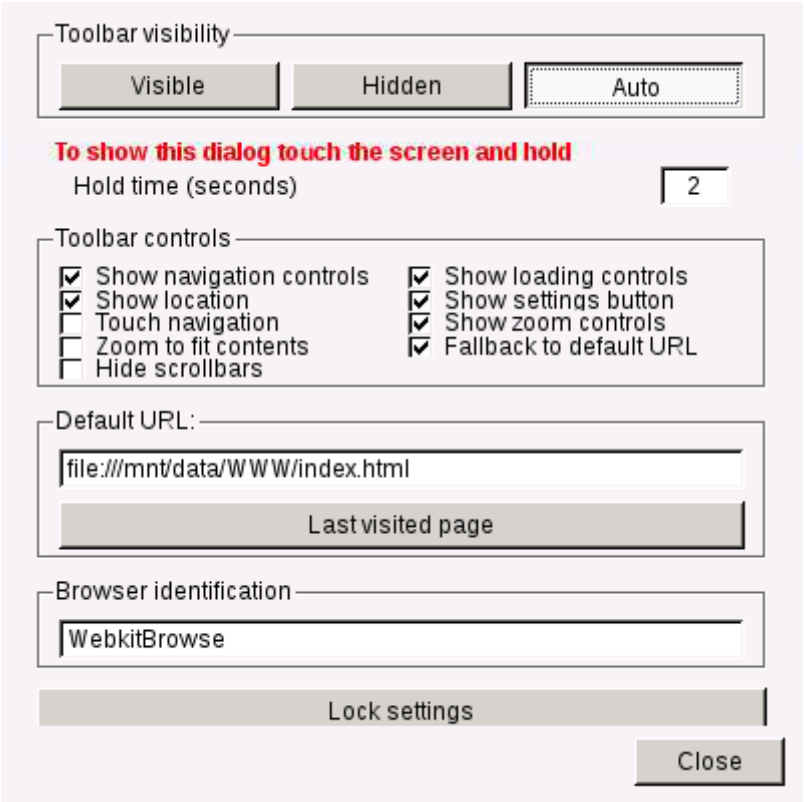
'Default URL'

'Default URL' - Setting the address of the homepage (default: VIPA splash screen: *file:///mnt/data/WWW/index.html*)

[Last visited Page] - Activate / deactivate the display of the last visited page when restart the cloudPanel (default: activate)

[Lock Settings] - Set a password for the browser settings

Additional setting under [Hidden] / [Auto]



'Hold time (seconds)' - Setting the time that must be pressed and held on the touch screen for the browser settings window to appear (default 2 seconds).

3.2.2 System Settings

3.2.2.1 Interface

The cloudPanel has a "System Settings" interface to allow configuration of system options. The "System Settings" are accessible locally on cloudPanel or in remote using a current Web browser on port 443 (*https://IP/machine_config*).

- Username: admin
- Password: admin

3.2.2.2 Menu

Use navigation menu on the left side of the screen to browse through the available options. With the following menu items:

Language

Here you can select a language for the "System Settings" menu. The following languages are available:

- English (default)
- Italiano
- German
- Chinese
- French

System

See *System* for information about the operating system, serial and article number and available memory (RAM) of the cloudPanel.

Logs

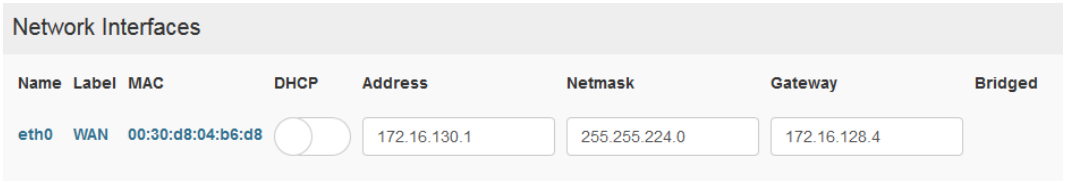
Here you can enable the persistent log for BSP and have the possibility to export it under [Save].

Date & Time

Here you can change the date and time of the cloudPanel including the time zone and the NTP server. Go to [Edit].

Network

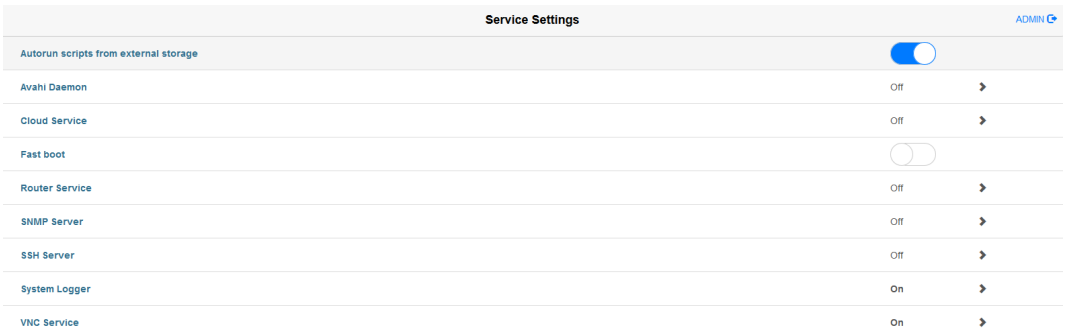
Configure the network settings of the cloudPanel here such as IP address of the Ethernet interface, Network mask and gateway. You have to disable DHCP. Go to [Edit].



In the cloudPanel you have to set an IP address that is in the same IP range as the web server.

Services

Here you can activate / deactivate the following services:



In order to perform a firmware update 'Autorun scripts from external storage' has to be activated!

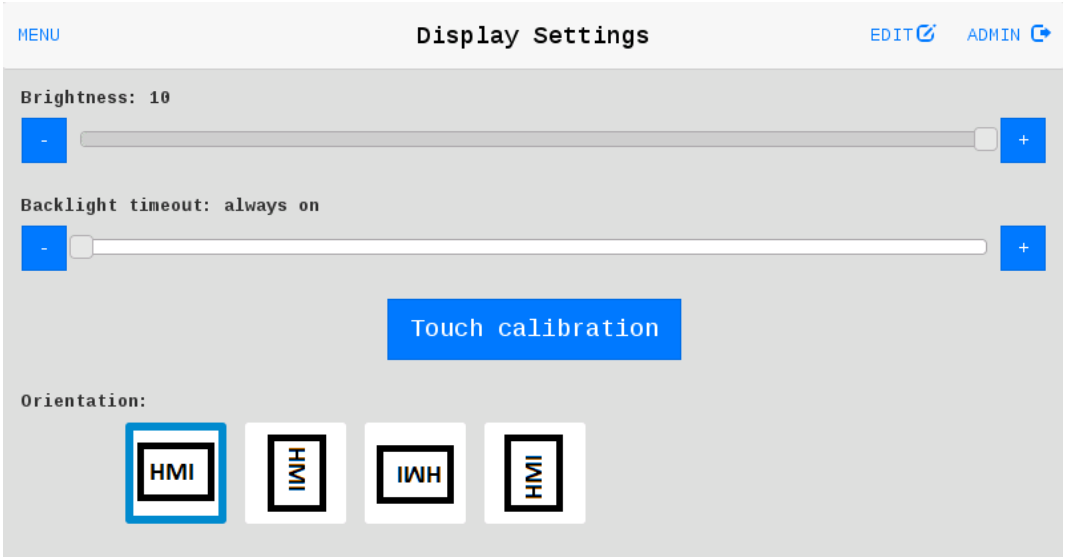
Management

Under *Management* the update of BSP components (Main OS, Config OS, Bootloader, XLoader) and the splash screen takes place. You will also receive information about the use and size of stored data here.

> *The update of Main OS is available only in System Mode, the update of Config OS is only in User Mode.*
>
> *The complete firmware update of cloudPanel can be found in Chapter Firmware update.* *Chapter 3.2.3 'Firmware update' on page 29*

Display

Here you can use a slider to adjust the brightness of the display, set the time of the automatic backlight timeout and select panel orientation (90°, 180°, 270° and 360°). You can also calibrate the Touch Display here.



Restart

- Here you can restart the cloudPanel in *User Mode* or in *System Mode*.
- *Main OS* option restarts as per default in *User Mode*.
- *Config OS* option restart cloudPanel directly into "System Settings" in *System Mode*.

Authentication

Change here the password for administrator (admin) and configure the password for the standard user (user). The Administrator has full access to "System Settings". The standard user has some limitations.

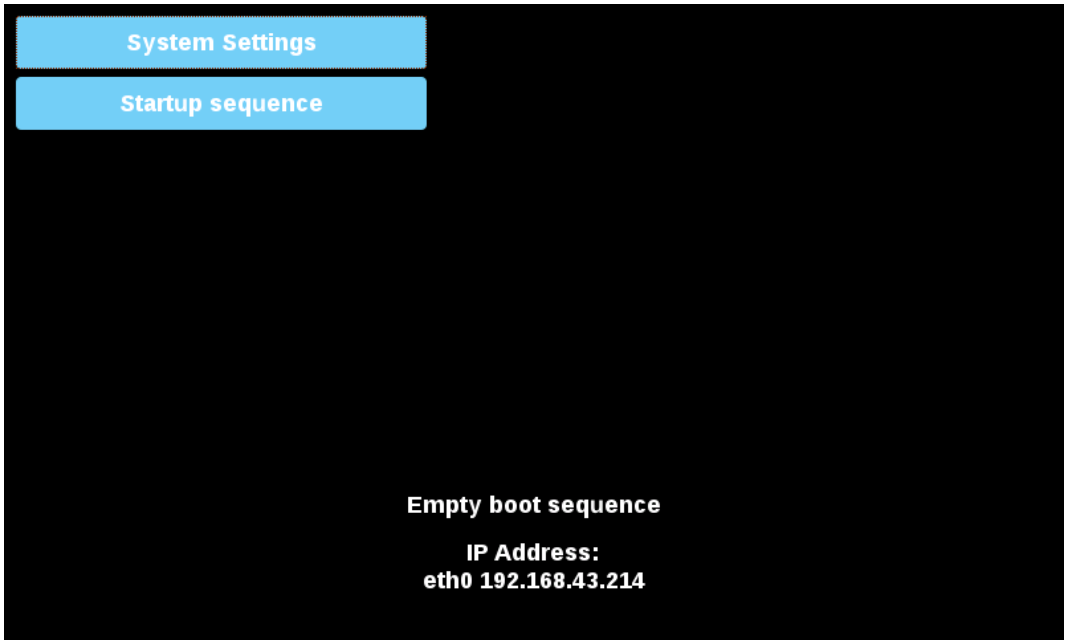
3.2.2.3 Operation modes

The "System Settings" have different operating modes:

- *User Mode (Main OS Mode)*
  - The cloudPanel is in factory default status, der Web browser is installed.
  - The *User Mode* allows to configure system parameters and update *Config OS* area.
- *System Mode (Config OS Mode)*
  - The cloudPanel has a software failure or the Web browser is not installed.
  - *System Mode* includes all options available in *User Mode* and offers in additions commands dedicated to system upgrade and recovery not available when running in *User Mode*.
- *Default Mode*
  - The *Default Mode* allows Restore Factory Settings.
- *Calibration Mode*
  - The *Calibration Mode* allows to calibrate the touch screen.

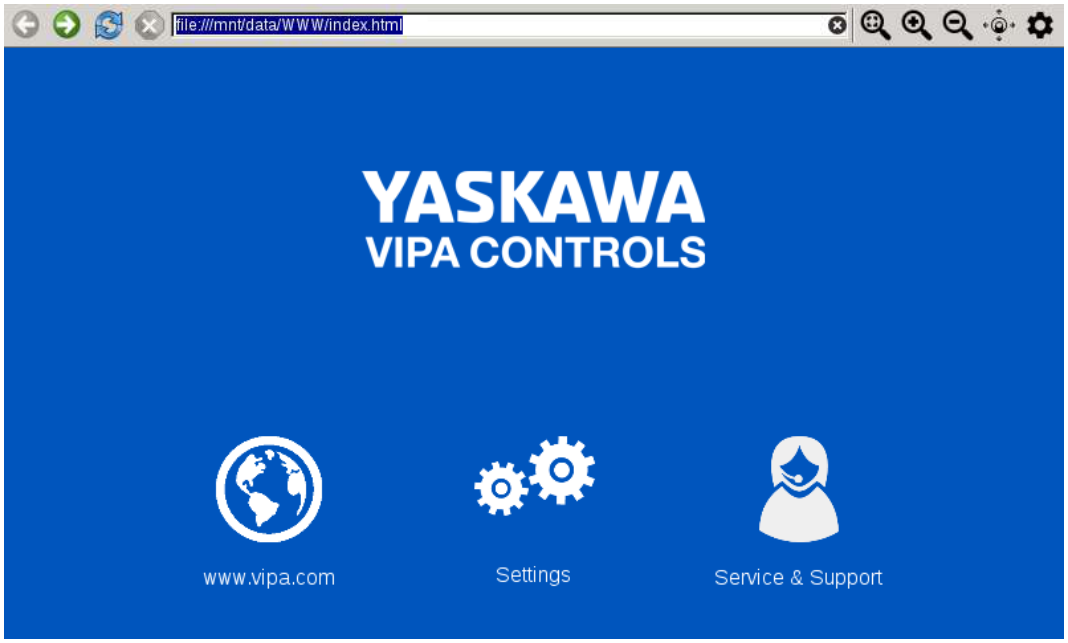
User Mode (Main OS Mode)

- *Web browser is not running*



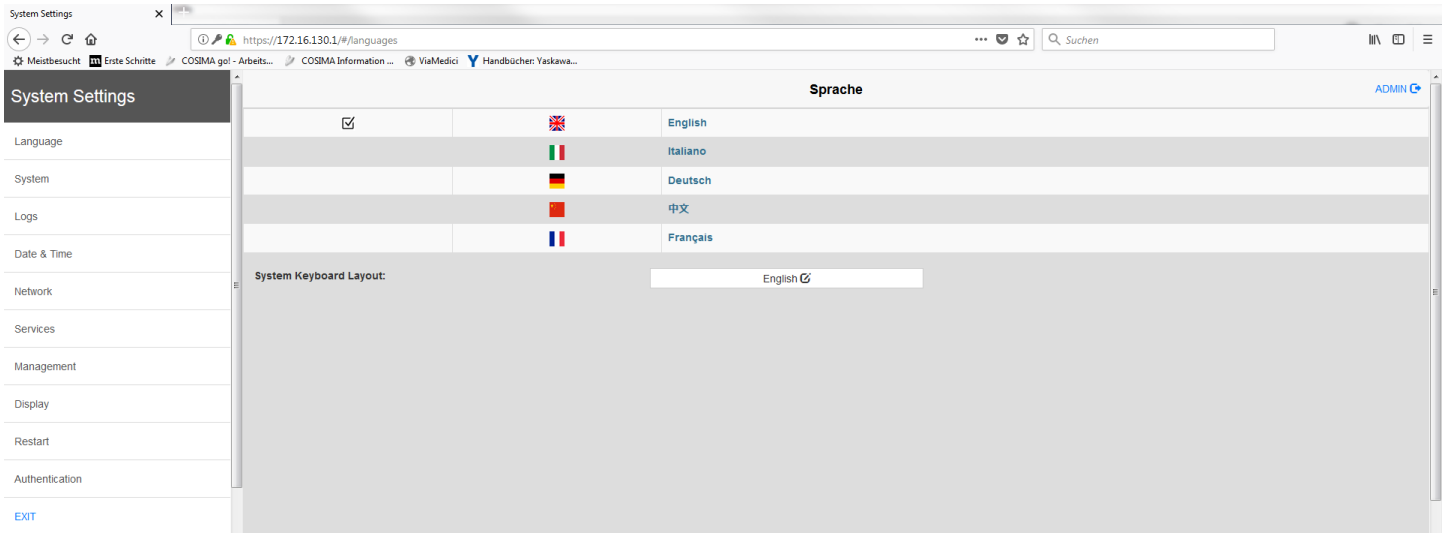
→ To enter the "System Settings" in *User Mode* of cloudPanel, click [System Settings] on the black settings screen.

- *Web browser is running*



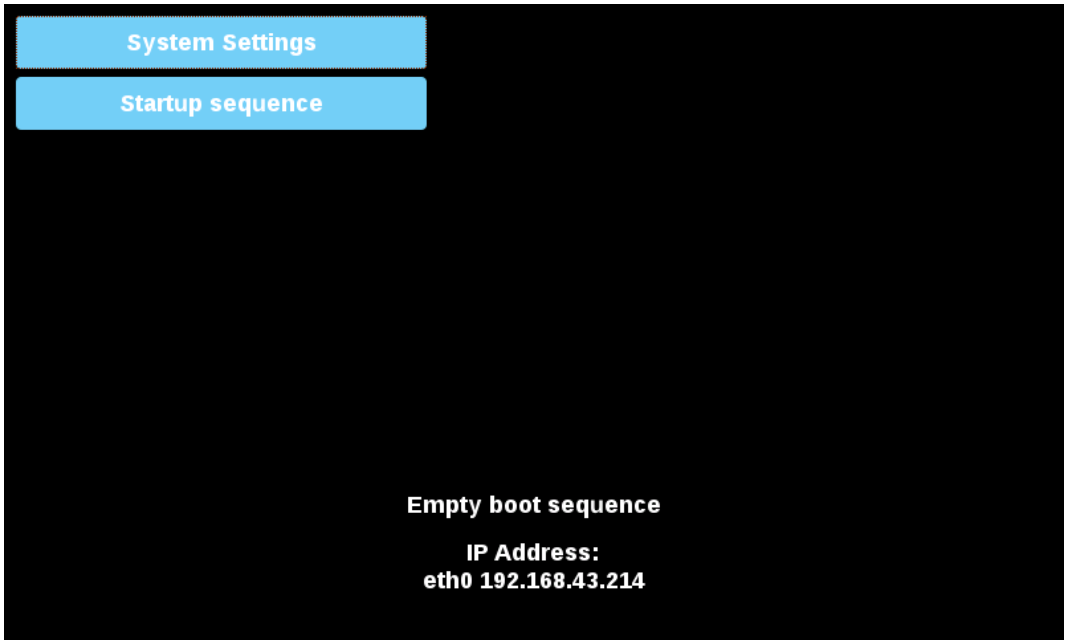
→ Click [Settings] on the blue splash screen, then enter the user name "admin" and the password "admin".

- The "System Settings" in *User Mode* is accessible remotely via web browser of the PC, enter *https://<HMI_IP_address>*.



System Mode (Config OS Mode)

- *Normal operation - Web browser is not running*



1. Click on [System Settings] on the black settings screen to enter in "System Settings" in *User Mode*.
2. Select *'Restart ➔ Config OS'* to reboot in *System Mode*.

- *Normal operation - Web-Browser is running*

1. Click on [Settings] on the blue splash screen to start "System Settings" in *User Mode*.
2. Select *'Restart ➔ Config OS'* to reboot in *System Mode*.

- *Recovery operation*
  The "System Settings" are available in *System Mode* via a "Tap-Tap procedure" and can be accessed also when cloudPanel is facing a software failure. "Tap-Tap" consists in a sequence of several touch activations by simple means of the finger tapping the touch screen performed during the power-up phase and started immediately after the cloudPanel is powered on.

When `TAP-TAP DETECTED` message appears on the top of the screen, touch and hold few seconds and select `RESTART: CONFIG OS`.

```
** TAP-TAP DETECTED  2 **
>> RESTART: CONFIG OS
   SYSTEM SETTINGS
```

⇨ The cloudPanel starts with the "System Settings" in *System Mode*.

Default mode

"System Settings" in *Default mode* allows Restore Factory Settings, this mode is available via "Tap-Tap sequence" and can be accessed also when cloudPanel is facing a software failure. "Tap-Tap" consists in a sequence of several touch activations by simple means of the finger tapping the touch screen performed during the power-up phase and started immediately after the cloudPanel is powered on.

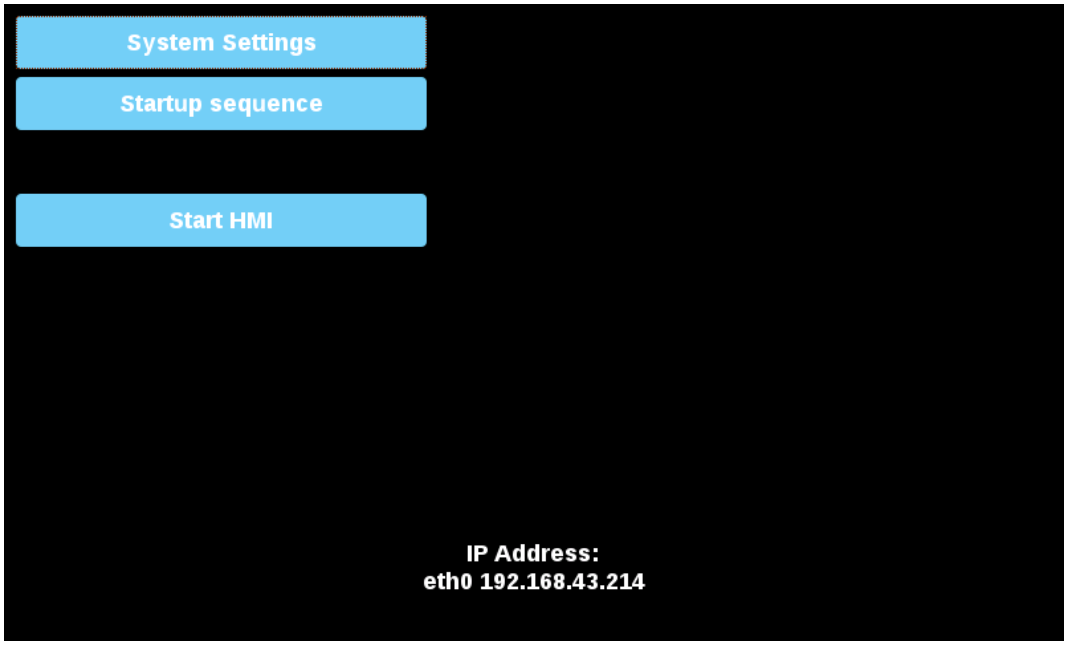
1. When `TAP-TAP DETECTED` message appears on the top of the screen, wait for 5 seconds (without touching the screen) to enter `SYSTEM SETTINGS`.

```
** TAP-TAP DETECTED  2 **
   RESTART: CONFIG OS
>> SYSTEM SETTINGS
```

2. Wait for 5 more seconds (without touching the screen) to enter `Default Mode`.

```
** ENTERING SYSTEM SETTINGS ...  2 **
>> DEFAULT MODE
   TOUCHSCREEN CALIBRATION
```

Uninstall the Web browser



1. To uninstall the Web browser in *Default mode* select [Startup Sequence].

2. Select the Web browser and click [Uninstall].
   ⇨ Uninstall process will be performed.

Calibration mode

Calibration mode allows to calibrate touch screen, can be accessed by "Tap-Tap" procedure. "Tap-Tap" consists in a sequence of several touch activations by simple means of the finger tapping the touch screen performed during the power-up phase and started immediately after the cloudPanel is powered on.

1. When `TAP-TAP DETECTED` message appears on the top of the screen, wait for 5 seconds (without touching the screen) to enter `SYSTEM SETTINGS`.

2. Press on touch screen, `TOUCHSCREEN CALIBRATION` will be highlighted in yellow, hold pressed for few seconds until touchscreen calibration procedure starts.

3. Follow the instructions on screen to complete the calibration procedure, system will prompt to touch specific points to calibrate the touchscreen device.

"Tap-Tap"summary

Perform "Tap-Tap" sequence, then:

- touch and hold for 5 seconds > Go to *System mode (Config OS mode)*
- or wait (without touching) for 5 seconds then:
  - touch and hold for 5 seconds > Go to *Calibration mode*
  - wait without touching for 5 seconds > Go to *Default mode*

3.2.3 Firmware update

Requirement

To execute the firmware update an empty USB stick (at least 1GB) in FAT32 format is necessary.

Current firmware on www.vipa.com

The latest firmware versions can be found in the service area at *www.vipa.com*.

CAUTION!
When installing a new firmware you have to be extremely careful. Under certain circumstances you can destroy the cloudPanel, for example if the voltage supply is interrupted during transfer or if the firmware file is defective. In this case, please call our hotline!

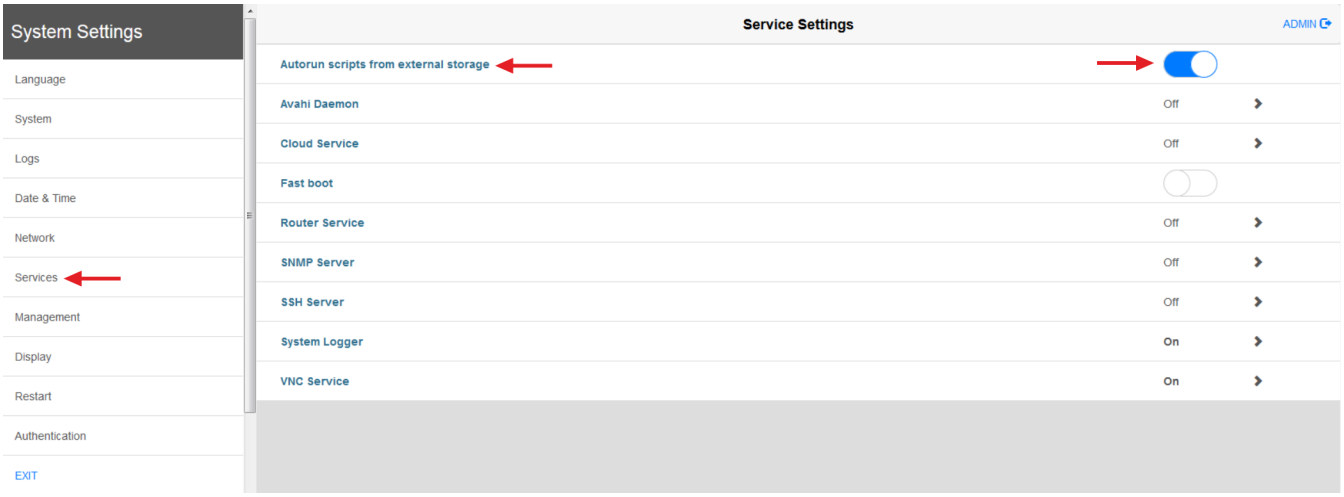
Please regard that the version of the update firmware has to be different from the existing firmware otherwise no update is executed.

Load firmware on USB stick

1. Go to *www.vipa.com*.
2. Click on *'Service / Support ➔ Downloads ➔ Firmware'*.
3. Via *'HMI'* navigate to your cloudPanel, download the ZIP file for the update process and unzip the content in the root directory of the USB stick.

Prepare the cloudPanel

1. Connect the cloudPanel to the power supply.
   ⇨ The cloudPanel starts with the VIPA splash screen.
2. Open the "System Settings" interface of the cloudPanel via the [Settings] button.
3. Activate *'Autorun scripts from external storage'* under *'Services'* by moving the button to the right.



Transfer firmware from USB stick into cloudPanel

1. Insert the prepared USB stick into the USB port of the cloudPanel.
   ⇨ The update process starts automatically and can take several minutes.

   After successful update the message "Process completed successfully" appears.

   A log file "lastupdate.log" is generated and saved in the root directory of the USB stick.
2. Remove the USB-Stick and reboot the cloudPanel.

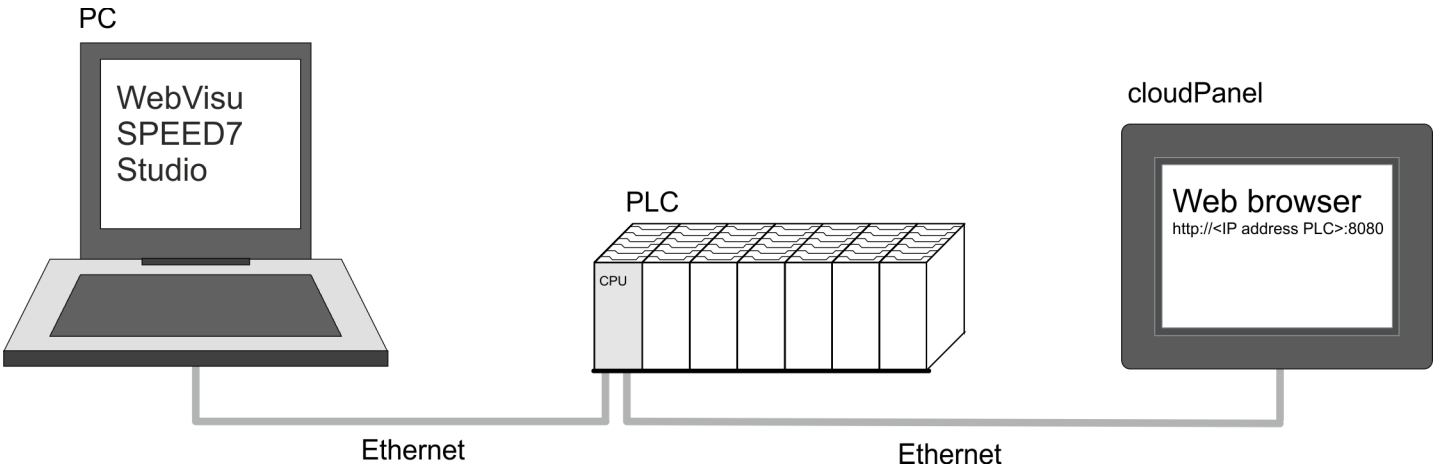
3.3 Connection to a PLC system

Overview

- It is assumed that a WebVisu project has been created for your PLC. The feature for creating a WebVisu is integrated in the VIPA SPEED7 Studio.

> *For more information on the VIPA SPEED7 Studio and how to create a web visualization, refer to the manual of your CPU or the online help of the SPEED7 Studio.*

- The web visualization runs on the Web server within the respective PLC and is called up via a Web browser in cloudPanel. Access is via the previously configured IP address of the Ethernet channel and is called by entering this IP address in the address bar of the Web browser. Per default, port 8080 is used for http: *http://<IP address PLC>:8080*.
- The cloudPanel is connected to your PLC via Ethernet. In the cloudPanel you have to set an IP address that is in the same IP range as the Web server.
- During operation your operating device communicates with the according PLC and reacts to the application courses in the PLC according to the configured processes. Via dialogues configured before, process values may be monitored graphically, altered and evaluated.



4 Installation Guidelines

4.1 Basic rules for the EMC-equitable assembly of installations

General

The installation guidelines contain information about the interference free deployment of a PLC system. There is the description of the ways, interference may occur in your PLC, how you can make sure the electromagnetic compatibility (EMC), and how you manage the isolation.

What does EMC mean?

Electromagnetic compatibility (EMC) means the ability of an electrical device, to function error free in an electromagnetic environment without being interfered respectively without interfering the environment.

The components of VIPA are developed for the deployment in industrial environments and meets high demands on the EMC. Nevertheless you should project an EMC planning before installing the components and take conceivable interference causes into account.

Possible interference causes

Electromagnetic interferences may interfere your control via different ways:

- Electromagnetic fields (RF coupling)
- Magnetic fields with power frequency
- Bus system
- Power supply
- Protected earth conductor

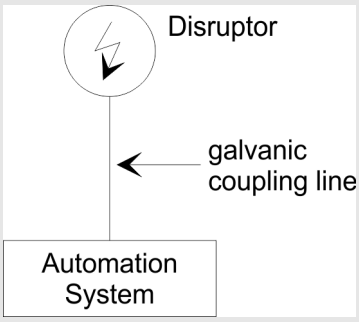
Depending on the spreading medium (lead bound or lead free) and the distance to the interference cause, interferences to your control occur by means of different coupling mechanisms.

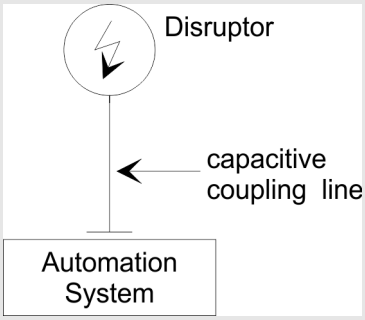
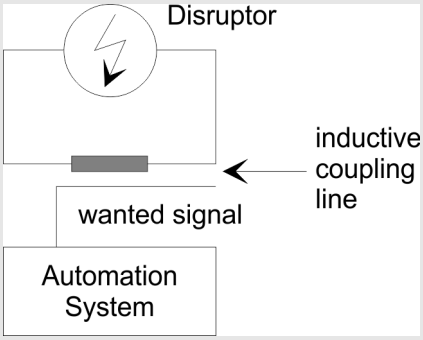
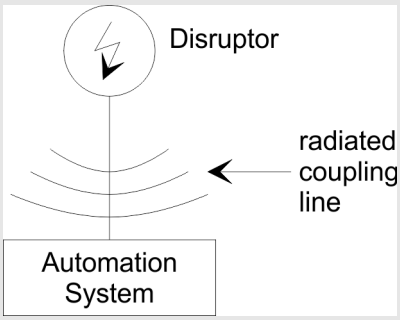
There are:

- galvanic coupling
- capacitive coupling
- inductive coupling
- radiant coupling

Coupling mechanisms and interference sources

The following table shows the four different coupling mechanisms, their causes and possible interference sources.

Coupling mechanism	Cause	Typical source
Galvanic coupling 	Galvanic or metallic coupling always occurs, when two current circuits have a common line.	■ Pulsed devices (Net influence from transducers and foreign net devices) ■ Starting motors ■ Different potential of component cubicles with common current supply ■ Static discharges

Coupling mechanism	Cause	Typical source
Capacitate coupling 	Capacitate or electric coupling occurs between conductors with different potential. The coupling is proportionate to the temporal change of the voltage.	■ Interference through parallel signal lines ■ Static discharge of the personnel ■ Contactors
Inductive coupling 	Inductive or magnetic coupling occurs between two current active line loops. The magnetic flows associated with the currents induct interference voltages. The coupling is proportional to the time related change of the current.	■ Transducers, motors, electric welding devices ■ Parallel net cables ■ Cables with toggled currents ■ Signal cable with high frequency ■ Unused coils
Radiate power coupling 	One talks of radiate power coupling, when an electromagnetic wave meets a line circuit. The hit of the wave inducts currents and voltages.	■ Sender in the neighbourhood (e.g. walkie-talkie) ■ Sparking lines (sparking plugs, collector of electric motors, welding devices)

Basic rules for EMC

In the most times it is enough to take care of some elementary rules to guarantee the EMC. Please regard the following basic rules when installing your PLC.

- Take care of a correct area-wide grounding of the inactive metal parts when installing your components.
  - Install a central connection between the ground and the protected earth conductor system.
  - Connect all inactive metal extensive and impedance-low.
  - Please try not to use aluminium parts. Aluminium is easily oxidizing and is therefore less suitable for grounding.
- When cabling, take care of the correct line routing.
  - Organize your cabling in line groups (high voltage, current supply, signal and data lines).
  - Always lay your high voltage lines and signal respectively data lines in separate channels or bundles.
  - Route the signal and data lines as near as possible beside ground areas (e.g. suspension bars, metal rails, tin cabinet).

- Proof the correct fixing of the lead isolation.
  - Data lines must be laid isolated.
  - Analog lines must be laid isolated. When transmitting signals with small amplitudes the one sided laying of the isolation may be favourable.
  - Lay the line isolation extensively on an isolation/protected earth conductor rail directly after the cabinet entry and fix the isolation with cable clamps.
  - Make sure that the isolation/protected earth conductor rail is connected impedance-low with the cabinet.
  - Use metallic or metallised plug cases for isolated data lines.
- In special use cases you should appoint special EMC actions.
  - Consider to wire all inductivities with erase links.
  - Please consider luminescent lamps can influence signal lines.
- Create a homogeneous reference potential and ground all electrical operating supplies when possible.
  - Please take care for the targeted employment of the grounding actions. The grounding of the PLC serves for protection and functionality activity.
  - Connect installation parts and cabinets with your PLC in star topology with the isolation/protected earth conductor system. So you avoid ground loops.
  - If there are potential differences between installation parts and cabinets, lay sufficiently dimensioned potential compensation lines.

4.2 EMC-equitable assembly

Mostly, measures for suppressing interference voltages are only taken, when the control is already in commission and the perfect receive of a wanted signal is disturbed. Causes for such interference's are in the most cases inadequate reference potentials, coming from mistakes at the device assembly and installation.

Guidelines for assembling and grounding of inactive metal parts

When assembling the devices, you have to ensure the large-surface grounding of the inactive metal parts. A correctly done grounding supports an unambiguous reference potential for the control and reduces the impact of coupled interferences.

Grounding means the conducting connection of all inactive metal parts. The sum of all interconnected inactive parts is called ground.

Inactive parts are all conductive parts electrically separated from all active parts by means of a basic isolation and that may only get voltage in case of an error.

The ground must not adopt dangerous contact voltage even in case of an error. Thus you have to connect the ground with the protected earth conductor. To avoid ground loops, local distant ground constructions (cubicles, construction and machine parts) have to be connected with the protected earth conductor system in star-topology.

Please regard at grounding:

- Connect the inactive metal parts as carefully as the active ones.
- Take care of impedance-low metal-metal-connections, e.g. with large-surface and well conductive contacts.
- If you include coated or anodized metal parts in the grounding, you have to come through the isolating protection layers. For this you may use special contact washers or remove the isolation layer.
- Protect the connection points from corrosion, e.g. with grease.
- Moveable grounding parts (e.g. cubicle doors) have to be connected via flexible ground strips. The ground strips should be short and have a large surface, because the surface is decisive for the diversion of high frequency interferences.

4.3 EMC-equitable cabling

Line routing

Content of this section is the line routing of bus, signal and supply lines. Object of the line routing is to suppress the "slurring" at parallel lines.

Line routing inside and outside of cubicles

For an EMC-equitable routing of the lines it is convenient to divide the cables in different groups and install each group itself:

Group A

- screened bus and data lines
- screened analog lines
- unshielded lines for direct voltage ≤60V
- unshielded lines for alternating voltage ≤25V
- Coaxial cables for monitors

Group B

- unshielded lines for direct voltage >60V and ≤400V
- unshielded lines for alternating voltage >25V and ≤400V

Group C

- unshielded lines for direct and alternating voltage >400V

Group D

- Lines for H1 respectively TCP/IP

Combination of groups

Following the table you may see the conditions for the cabling of the line groups by combining the single groups:

	Group A	Group B	Group C	Group D
Group A	[1]	[2]	[3]	[4]
Group B	[2]	[1]	[3]	[4]
Group C	[3]	[3]	[1]	[4]
Group D	[4]	[4]	[4]	[1]

[1]	The lines may be installed in common bundles or cable trusses.
[2]	The lines have to be installed in different bundles or cable trusses (without min. distance).
[3]	The lines have to be installed in different bundles or cable trusses inside of cubicles and outside of the cubicle but inside the building in separated cable trusses with a min. distance of 10cm.
[4]	The lines have to be installed in different bundles or cable trusses with a min. distance of 50cm.

Line routing outside of buildings

Wherever possible, exterior cabling should be installed on metallic cable trays. A galvanic connection must be provided for joints between cable trays. You must abide by the applicable lightning protection and grounding regulations when installing exterior cables.

Lightning protection

CAUTION!
Where cables and signal lines for PLC equipment are installed outside of buildings, the conditions for internal and external lightning protection must be satisfied.

- Exterior lines should either be installed in metallic conduit pipes that is grounded on both ends or in steel-reinforced concrete cable trunks with continuously connected reinforcing.
- Signal lines should be protected against overvoltage by varistors or by lightning arrester filled with rare gas.
- Install these protective elements at the location where the cables enter the building.

Any lightning protection system must be based on an individual assessment of the entire plant. For questions please contact VIPA GmbH.

Equipotential bonding

Potential differences can occur between different sections when controllers and peripheral equipment are connected by means of non-isolated connections or the screens of screened cables are connected at both ends and grounded on different sections of the plant. One reason for a potential difference can be that different sections of the plant are powered from different power sources. These potential differences must be reduced by means of equipotential bonding conductors to ensure that the electronic equipment employed on the plant operates properly.

Rules for equipotential bonding

- The lower the impedance of the equipotential bonding conductor, the higher the effectiveness of potential equalization.
- The impedance of the equipotential bonding conductor must not exceed 10% of the impedance of the screen where screened signal lines are connected between the different sections of the plant and the screening is connected to ground/neutral on both sides.
- The cross-sectional area of the equipotential bonding conductor must be calculated to carry the maximum equalization current. The following cross-sections have been successfully employed:
  - 16mm^2 Cu for equipotential bonding conductors up to 200m
  - 25mm^2 Cu equipotential bonding conductors exceeding 200m.
- Use copper or galvanized steel for equipotential bonding conductors. These must be connected to ground/neutral by means of large-surface connections that are protected from corrosion.
- The equipotential bonding conductor should be installed in such a manner that it includes the smallest surface between the bonding conductor and the signal lines.

Screening of lines and cables

Screening is one method commonly used to reduce (attenuate) the interference pick-up from magnetic, electrical or electromagnetic fields.

- Interference on screens is conducted to ground by the conductive connection between the screen and the screening rain/enclosure. To avoid interference from these currents it is very important that the neutral connection is a low-impedance connection.
- You should only use cables that are provided with a braided screen. The degree of screening should be more than 80%.

- Avoid cables with foil-type screens as the foil can be easily damaged by tension and pressure at the point of attachment; this can result in reduced effectiveness of the screening action.
- As a rule you should always ground the screens of cables on both ends. This is the only way in which you can ensure that high frequency interference is attenuated properly.

One-sided grounding of screens

In exceptional cases it may be necessary to ground the screen on one side only. However, this will only attenuate the lowest frequencies. The one-sided grounding of screens may provide advantages when:

- It is not possible to install an equipotential bonding conductor
- Analogue signals (a few mV or mA) must be transmitted
- Foil-type screening (static screening) is employed.

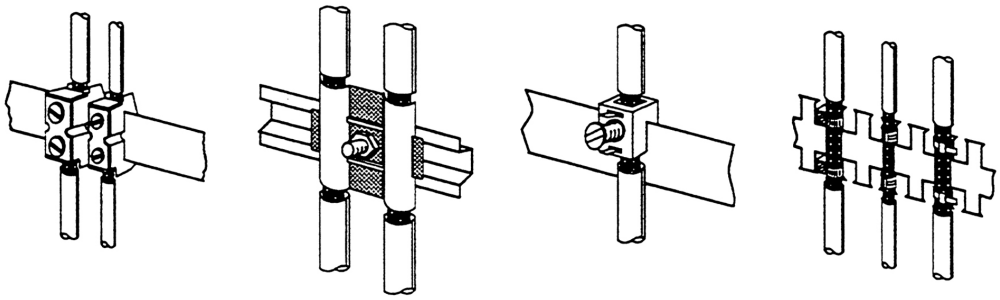
You should always use metallic or metallised covers for serial data lines. Connect the screen of the data line to the cover. Do **not** connect the screen to PIN 1 of the connector! In case of stationary operations it is recommended that the remove the insulation from the screened cable without cutting the screen and to attach this point to the screening/ neutral rail.

Potential differences can give rise to an equalization current via the screen connected between the two ground connections. In this case you must install an additional equipotential bonding conductor.

Connecting the screen

Please observe the following points when you handle the screens:

- Use only metallic cable clamps when connecting the screening of cables. These clamps must provide a good electrical contact and a large-surface connection to the screen.
- Attach the screens to the screening rail directly at the point where the cables enter the enclosure. The screening conductor must be continued to the module without interruption, however, it must not be connected to the module!



4.4 Special precautions providing high noise immunity

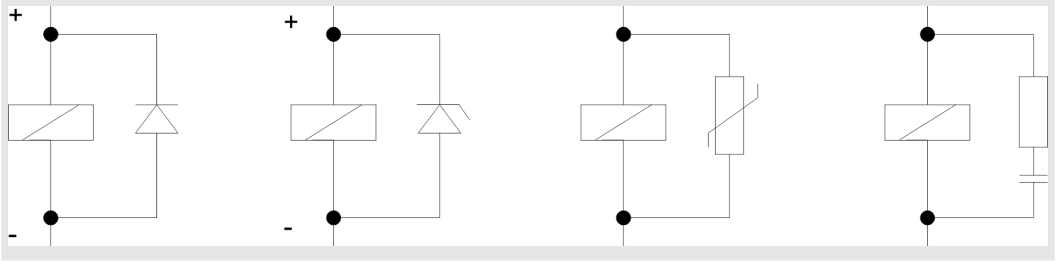
Inductors require snubber networks

Inductors controlled by your programmable controller (e.g. contactors and relays) do not normally require additional snubber networks or suppressors as the respective modules have been provided with the required components.

Equipotential bonding

Snubber networks must only be connected to inductors when output circuits can be disabled by means of additional contacts (e.g. relay contacts). In this case the integrated suppressors on the module are also disabled. You can connect diodes to suppress back-emc, varistors or RC-networks to the inductors.

Connections of DC-activated inductors		Connections of AC-activated inductors	
using a diode	using a Z-diode	using a varistor	using RC-network



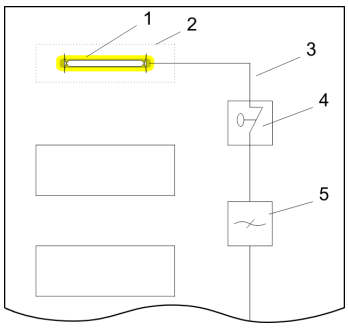
Power outlet for PGs

Every cubicle must be provided with a power outlet for the PU. These outlets must be wired to the distribution system, which is also used to connect the neutral conductor for the cubicle.

Cubicle illumination

The cubicle illumination should consist of incandescent lights, e.g. LINESTRA-lamps. Avoid using fluorescent lamps as these lamps can cause interference. If you can not avoid using fluorescent lamps you should implement the steps outlined in the following figure.

Suppression of fluorescent lamps in cubicles



1 Fluorescent lamp
2 Screen above the lamp
3 Screened cable
4 Switch with metallic cover
5 Line filter or screened power cable

4.5 Checklist for the EMC-compliant installation of controllers

EMC-measures	Space for Notes
Connection of the inactive parts	
You should take special care to check the connections of: ■ Module racks ■ Frames ■ Screen and protected earth conductor	
Are all the inactive metal parts interconnected by means of large-surface and low-impedance connections?	
Has a proper connection been installed with respect to the ground/protected earth conductor system?	
Has the isolation been removed from varnished and anodized surfaces or have these connections been fitted with special contact washer?	
Have the connection been protected from corrosion, e.g. by means of grease?	
Have doors been grounded by means of grounding straps connected to the body of the cubicle?	
Cable routing	
Cabling divided into groups?	
Power cables (230 ... 400V) and signal lines installed in separate channels or bunches?	
Potential compensating	
When installing the equipment at separate locations, check the installation of the potential compensating line.	
Cable screen	
All covers of plugs are metallic?	
All analog and data lines installed screened?	
Line screens attached to the screening or the protected earth conductor?	
Have the screens been connected by means of large-surface and low-impedance cable clamps?	
Cable screens grounded both-sided where possible?	
Inductors	
Have the coils of contactors controlled by means of contacts been connected to snubber networks?	