Bridge E

User Manual

UM-ER-EB1000M-r26.03

ER-EB 1000M
ER-EB 1000M-2
r26.03

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Disclaimer

All directives, data and requirements mentioned in this document relate to CE certification and use in the EU. The sections of this document regarding the FCC certifications are still work in progress and will be updated in the near future. Conformity and approvals for US/CA are explained in a separate section marked with FCC (Section 3.1.3).

1 General Terms of Use of this Document

It is the user's responsibility to check and ensure they have downloaded the latest version of this manual regularly as R3 may edit, revise, or improve product documentation over time.
The user must ensure the product is used correctly according to this document's guidelines, in particular observing all relevant standards and regulations.

NOTE — To configure devices running release 26.03 or newer, please ensure the R3 Configuration Server version is also updated to at least 10.9.15.
Devices with older release versions require the previous R3 Configuration Server version for configuration. Note that the new Configuration Server can only be used with older release versions to update devices to the latest release and configuration of older versions is not supported in the new software version.

2 Please Observe the Following Notes

Please observe and obey the following note formats and instructions throughout the document:

TIP — Text in this format is information explaining the use of the product.

ATTENTION — Text in this format must be observed to prevent malfunctions and/or even damage, or safety risks.

EXAMPLE/NOTE — Text in this format provides examples or notes.

3 Product Information

3.1 General Information

3.1.1 Versions of this Product

- ER-EB 1000M / ER-EB 1000M-2 (EU Version)
- ER-EB 1000M / ER-EB 1000M-2 (US/CA Version)

3.1.2 Conformity/National Approvals – CE (EU)

The device complies with these essential EU directives, which include any modifications:

- 2011/65/EU Restriction of the use of certain hazardous substances (RoHS)
- 2014/53/EU Radio equipment (RED).

Additional information (e.g. declaration of conformity, documents, data sheets, certificates, etc.) can be found at www.r3.group.

3.1.3 Conformity/National Approvals – FCC (US/CA)

FCC 47 CFR 15 Compliance

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference;
2. This device must accept any interference, including interference that may cause undesired operation.

ATTENTION — Changes or modifications made to this equipment not expressly approved by R3 may void the FCC authorization to operate this equipment.

This equipment has been tested and found to comply with the limits for a class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user encouraged to try to correct the interference by one or more of the following measures:

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

ATTENTION — This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. Under normal use condition the user has to keep at least 20cm separation distance between radiator and body of the user.

ATTENTION — This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

ATTENTION — Professional Installation Notice: To comply with FCC Part 15 rules in the United States, the system must be professionally installed to ensure compliance with the Part 15 certification. It is the responsibility of the operator and professional installer to ensure that only certified systems are deployed in the United States. The use of the system in any other combination (such as co-located antennas transmitting the same information) is expressly forbidden.

RSS-247, Issue 2 of ISED

This device contains license-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's license-exempt RSS(s). Operation is subject to the following two conditions:

1. This device may not cause interference;
2. This device must accept any interference, including interference that may cause undesired operation of the device.

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

1. L'appareil ne doit pas produire de brouillage;
2. L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

ATTENTION — This device has been designed to operate with dipole antennas having a maximum gain of 8.5 dBi. Antennas having a gain greater than that are strictly prohibited for use with this device. The required antenna impedance is 50 ohms. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that permitted for successful communication. The device for operation in the band 5,150-5,250 MHz is only for indoor use to reduce the potential for harmful interference to co-channel mobile satellite systems.

Additional information (e.g. declaration of conformity, documents, data sheets, certificates, etc.) can be found at www.r3.group.

3.2 Intended Use of the Product

The Bridge E (device) provides a reliable, time-critical wireless link between Ethernet-based industrial protocol devices. It can be used to:

- Replace cable-based network infrastructure with a wireless connection in machinery, vehicles and devices, providing simplified infrastructure and flexible operations.
- Replace network cables between moving structures or components in machinery, vehicles and devices to reduce weight, size and use of installation space, as well as wear and tear on network infrastructure.

ATTENTION — Installation must only be performed by qualified specialist personnel.

ATTENTION — This radio device is designed to transmit wireless data. It is also intended to be used for low latency and/or high reliability data communications. When using the device, keep in mind the general behavior and physics of the wireless channel. Abrupt or predictable changes in the operational environment, such as movement of people or objects, and the presence of interfering devices, can result in reduced wireless signal quality and failed data transmissions. As a result, **intended operations cannot rely solely on this device when used in critical applications, where the result of poor wireless conditions can cause serious injury or economic damage**. A comprehensive system solution, such as an integrated wired fail-safe in the case of poor wireless connectivity, must be installed and tested to the level of intended application's importance.

ATTENTION — The device emits Radio Frequency (RF) energy in the Industrial, Scientific, Medical (ISM) bands. Make sure that all medical devices used in proximity to this device meet appropriate susceptibility specifications for this type of RF energy.

ATTENTION — The antennas used for this transmitter must be installed to provide a separation distance of at least 20cm from all persons and must not be colocated or operating in conjunction with any other antenna or transmitter.

ATTENTION — The device is recommended for use in industrial environments. It is mandatory to use a functional ground connection to comply with safety requirements.

ATTENTION — The device is certified with the enclosed antenna. Any other antenna can exceed the maximum permitted transmission power.

ATTENTION — The device must not be disassembled. Do not break the seal!

3.3 Equipment Required

ID	Item	Needed to		
		Deploy	Operate	Update
❶	Bridge E 	x	x	x
❷	Power Cable M12, 5-pin, A-coded 	x*	x*	x*
❸	Ethernet Cable M12/RJ45 	x	x	x
❹	Network Switch 	x		x
❺	Ethernet Cable RJ45/RJ45 	x		x

* Item not needed if Power over Ethernet (PoE) is used.

Requirements for the Equipment

ID	Item	Requirements
❸	Ethernet Cable M12/RJ45	The signal cable for digital input must be routed in the same cable as the power supply and functional ground if the line length exceeds 3 meters.
❹	Switch	Possibility to disable IGMP Snooping; at least as many ports as Bridge E devices should be connected + 1

TIP — Not all switches support IGMP Snooping, we recommend turning it off. For more information check the IGMP section in Troubleshooting.

3.4 Connectors

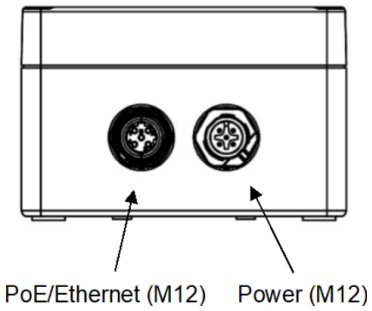


Figure 3-I: Connectors

TIP — The Ethernet connector is PoE and can also be used to supply power to the device (48 VDC, PoE 802.3at Type 1).

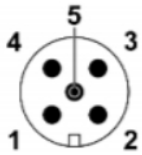
Figure	Pins	Function
	1	Power supply 24 VDC (+/- 10%)
	2	Ground for digital input
	3	Ground for power supply
	4	Digital input + (9 – 30 VDC)
	5	Functional ground

Table 3-i: Power connector (M12 socket, A coded)

Figure	Pins	Function	Color Mark (T568B)
	1	Send	Orange/white
	2	Receive	Green/white
	3	Send	Orange
	4	Receive	Green

Table 3-ii: PoE/Ethernet connector (M12 socket, D coded)

3.5 LED Indicators

LED	Color/pattern	Meaning
Power	Off	No power.
	● Green	Device is connected to power.
Ethernet	● Green	Ethernet physical layer was able to establish a connection to another device.
Config	Off	Device is in Deployment Mode.
	● Green	Device is in Configuration Mode and DHCP lease was obtained.
	● Green blinking (slow)	Device is updating its firmware.
Status	● Green	Device is in active deployment and EchoRing is reporting healthy state.
	● Green blinking (slow)	EchoRing offline.
	● Red	The main device manager task found an unrecoverable error. Device is not working.
	● Red blinking (slow)	EchoRing not in healthy state.
	● Red / ● Green switching (fast)	System initialization experienced a critical failure. The system is most likely offline on all interfaces.
	● Red / ● Green switching (medium)	Failed to start or stop EchoRing and/or the Bridge E or the initialization of the Bridge E failed during bootup.
Config+ Status	● Green flashing Config and Status (very slow)	System is initializing.
	● Green flashing Config and Status (very slow) with ● Orange Status for a short moment at the beginning of a cycle	Waiting to receive a DHCP lease.
	● Green flashing Config (slow) alternating with ● Green blinking Status (fast)	Update successful.
	● Green flashing Config (slow) alternating with ● Red blinking Status (fast)	Update failed.
	● Green flashing Config ● Green Status	The EchoRing network interface has been started or, in the case of a Mobile Device in Deployment Mode, the device is ready to be controlled via ERCI (see Section 8.2).
	● Green blinking Status and Config (slow) alternating with ● Red blinking Status (slow)	Factory resetting the device.
	● Green Config ● Red flashing Status	Failed to deploy the configuration to flash or failed to verify the written configuration.
All	Off	Inconclusive; a specific mode might have been exited (depending on context).

Table 3-iii: Explanation of LEDs

TIP — There are other LED labels on older versions of the Bridge E: PWR (Power), ETH (Ethernet), CFG (Config), HLT (Status).

Flashing speeds

- Very Slow: 1.6s on - 1.6s off
- Slow: 800ms on - 800ms off
- Medium: 200ms on - 400ms off
- Fast: 200ms on - 200ms off

4 Installation

4.1 Hardware Installation

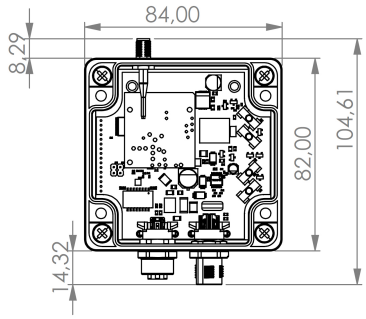


Figure 4-I: Dimensions are in millimeters (mm)

Screw the antenna(s) to the device's SMA connector(s). Note: antenna is not included in the diagram.

ATTENTION — Antennas should only be tightened by hand or with a torque wrench of maximum 0.3 Nm.

4.1.1 DIN Rail Mounting

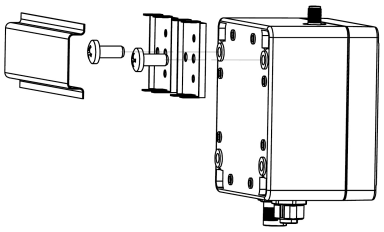


Figure 4-II: DIN rail mounting

Applies to both versions of the Bridge E.

1. Use the provided selftapping screws to attach the device to DIN rail. Place the selftapping screws through the small DIN-rail adapter-plates and screw them into their designated position in the device.
2. Place the device that is now attached to the adapter on the top edge of the DIN rail.
3. Push the device downwards so that it snaps into place.

TIP — To release device from DIN rail, push the device downwards while pulling outwards.

4.1.2 Wall or Mast Mounting

TIP — Attaching wall mounts to a device is irreversible.

1. Place the wall mounts in their desired positions on the device. They can be placed horizontally or vertically.
2. Use adequate force to drive the mount bolt in the device notch. If using a hammer, please ensure you do not accidentally hit and damage the device casing.
3. Repeat with the other mounts.

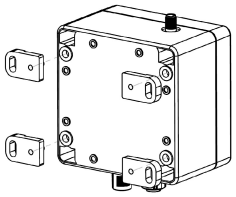


Figure 4-III: Wall or mast mounting

Applies to both versions of the Bridge E.

4.2 Set Up and Access Web User Interface

The web-based configuration interface is used for configuring, deploying and updating devices.

1. Set up and connect a PC running the R3 Configuration Server and the Bridge E devices ①, intended to be in the same network or subnetwork, to the switch ④, according to Figure 4-IV:

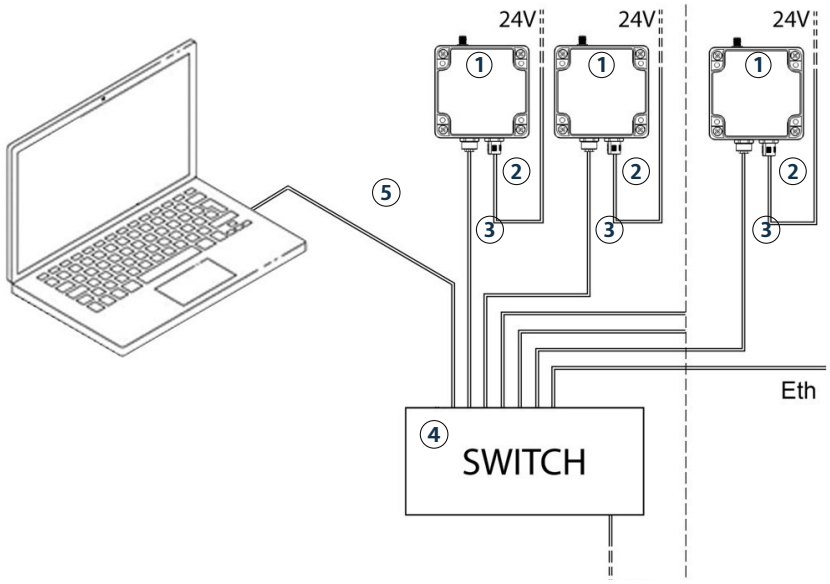


Figure 4-IV: Configuration set-up

2. Turn on the network switch.
3. Follow the steps to start the R3 Launcher application and start the Configuration Server as described in section 4.3. The Configuration Server needs an IP address on the EchoRing interface (either from ICS, a DHCP server, or assigned manually).
4. This will open a web browser with the URL `https://localhost:8443/`.

> **TIP** — The web-based user interface supports the web browsers Firefox and Chrome version 100 or newer. We recommend using version 144 for Firefox and version 141 for Chrome. Other browsers may not support full functions.

5. The R3 Configuration Server is protected by a password. For the first login, use the default password ”admin”.

> **NOTE** — It is recommended to change the password on the Settings page after the first login (see here). Note that the password is shared among all users.

6. Turn on the Bridge E devices.

> **NOTE** — During the initial configuration deployment, only one Bridge E device can be connected at a time, since all new Bridge E devices have the same default IP address (**192.168.0.183**).

> **NOTE** — All new devices have a password pre-set from the factory (EOL test). The default R3 password must be used as the ”Old password” to set a new device password later on (see 5.4.3).

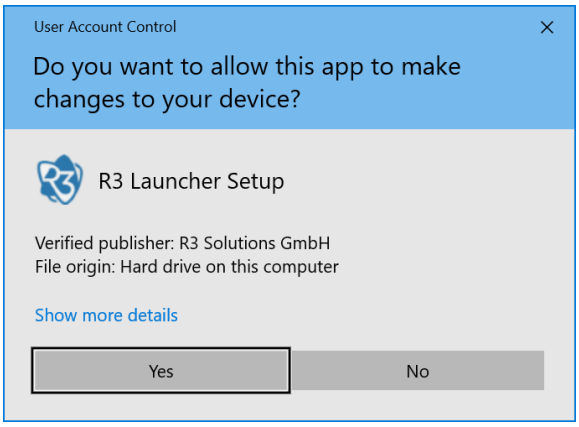
4.3 Software Installation

4.3.1 R3 Launcher Application

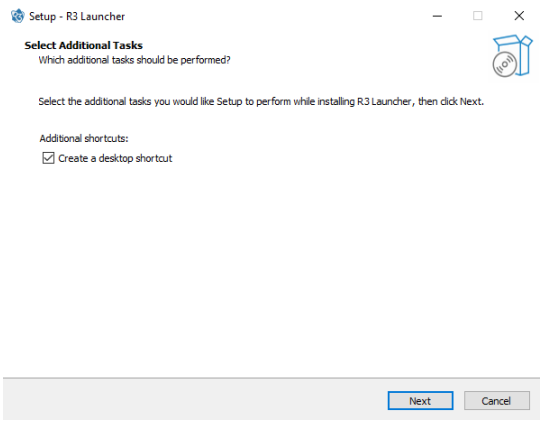
The R3 Launcher is an application provided as a single installer which can be found at www.r3.group/en/support-downloads/ under ”Software”.
The application allows you to launch the Configuration Server that can be accessed using your browser.
Optionally the application allows to enable ICS if run with administrative privileges.

NOTE — For using the installer and the application the computer needs to run on Windows 11.

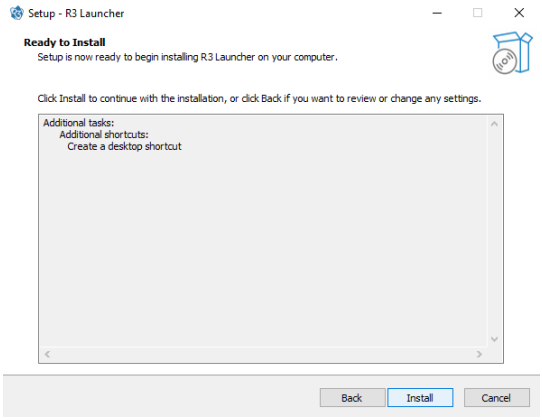
- To install, double-click the R3 Launcher application setup file.
- It will prompt confirmation to make changes to your system. Click on ”Yes”.



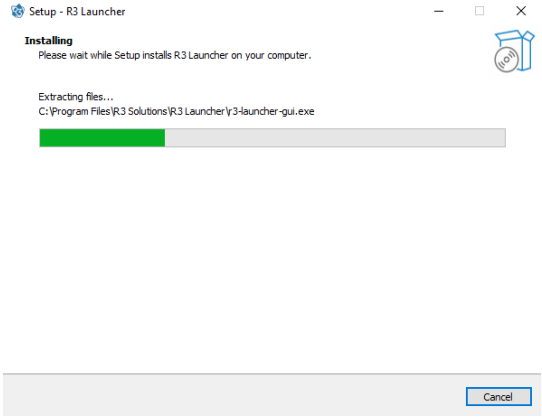
- When the screen below appears, select if you want to create a desktop shortcut and click on ”Next”.



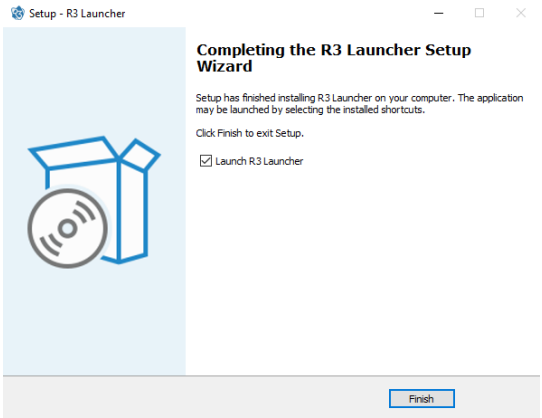
- Click on ”Install”. This will run the setup file and begin installing the R3 Launcher application on your computer.



- Wait for R3 Launcher to finish installing. The installation will be completed in a few seconds.



- Click on ”Finish” to complete the installation process. The R3 Launcher application is now successfully installed on the system and ready to use.

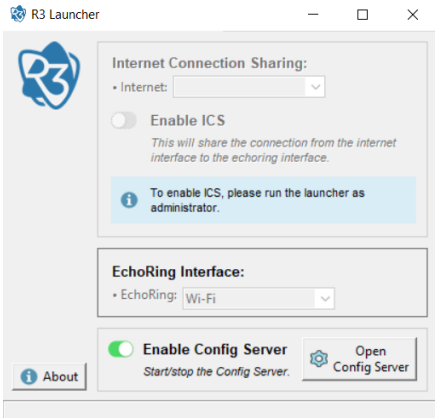


4.3.2 Configuration Server

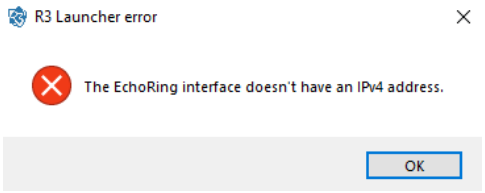
The Configuration Server is used to configure and update Bridge E. If the Configuration Server is started with administrative rights, ICS can be enabled.
To start the Configuration Server, select the network interface it should be running on (”EchoRing Interface”).

ATTENTION — Do not set-up multiple instances of the Configuration Server on the same physical Ethernet interface.

This interface needs an assigned IP address to run the Configuration Server. Start the server by clicking the toggle-switch ”Enable Config Server”.
Click the ”Open Config Server” button to access the web-based user interface.



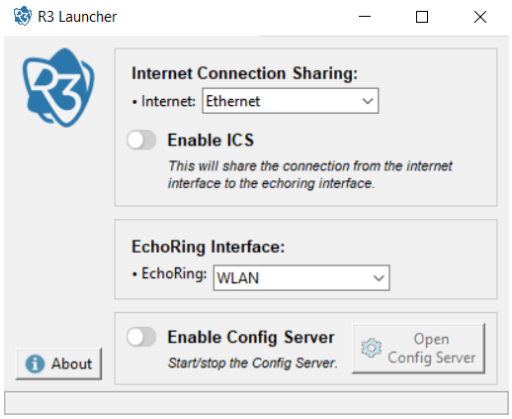
If no IP address is assigned, the following error prompt will appear:



NOTE — Alternatively to ICS an external DHCP server can also be used.

4.3.3 Launcher with administrative rights

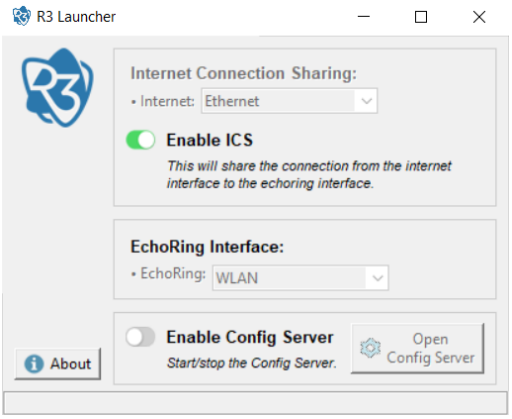
The Configuration Server can optionally be started with administrative rights. In this case, ICS can be enabled including DHCP server that can be used to assign IP-addresses to the Bridge E devices.



4.3.4 Internet Connection Sharing

An internet connection is required to update the Bridge E. When you operate the Bridge E in a separated network without internet connection, you can use ICS to share the connection from a second network interface (e.g. WiFi). When ICS is activated, it automatically includes a DHCP server. To enable ICS in the application, select the interface providing the internet connection (”Internet” interface). Then you can enable ICS using the toggle switch.

NOTE — Administrative rights are needed to enable ICS



4.4 Update Devices

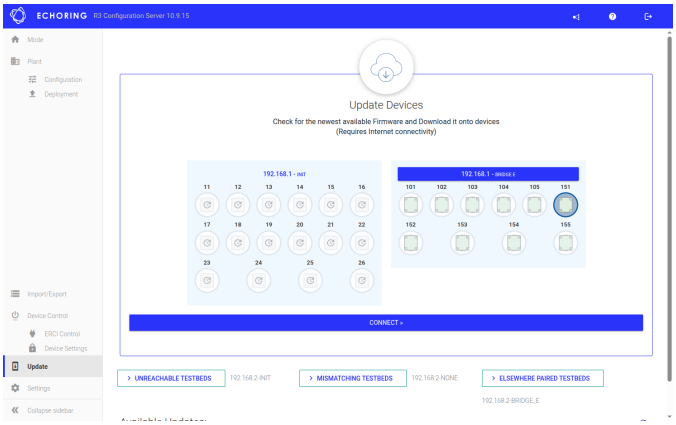
TIP — Updates are assigned on a per customer basis. Ask your sales representative about new software versions or write an email to support@r3.group.

NOTE — To successfully run updates, an internet connection is required.

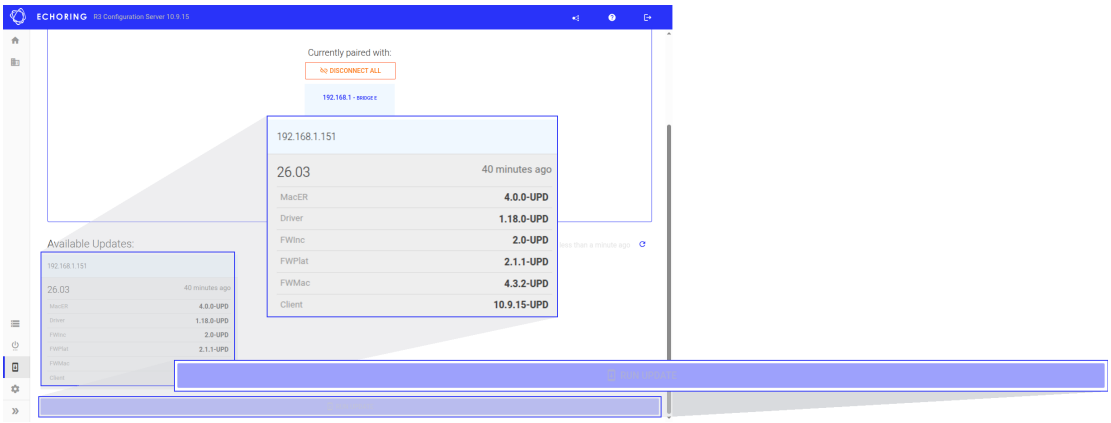
New devices are already initialized but might require an update before use. To update the device an internet connection is required. The network must provide a DHCP and Network Time Protocol (NTP) server to perform an update. If you are using ICS, the DHCP and NTP servers are provided by ICS.

NOTE — In order to update devices, device passwords must be set (see 5.4.3).

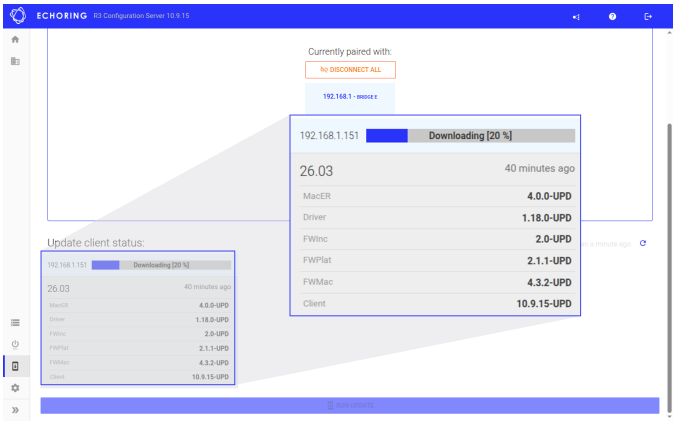
1. Switch power on and set up the devices as described in Section 4.2.
2. After a successful login, the home page of the R3 Configuration Server appears. Click the double-arrow icon on the left side of the screen to open the sidebar, if it is not already visible. In the sidebar, click ”Update” to open the Update Devices page.
3. Click the IP address to update all devices or click the devices that should be updated individually.
4. Click ”Connect”.



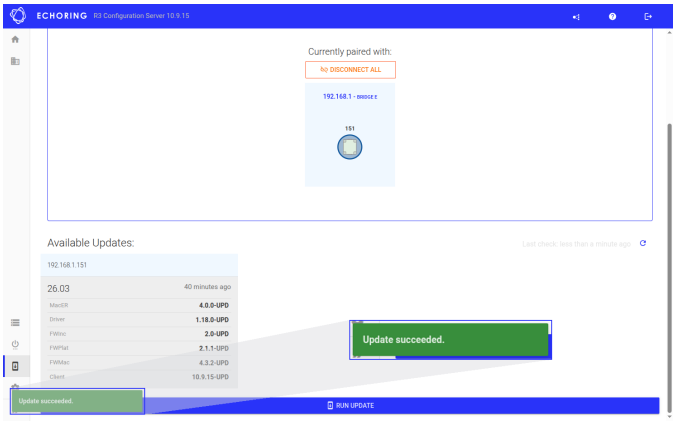
5. Click ”Run Update” to install the listed update on each device on the screen. In certain circumstances it might be the case that no version information is provided.



6. Downloading started and the update will be installed right afterwards.



7. The update is complete. Click the home icon to go back to the main page.

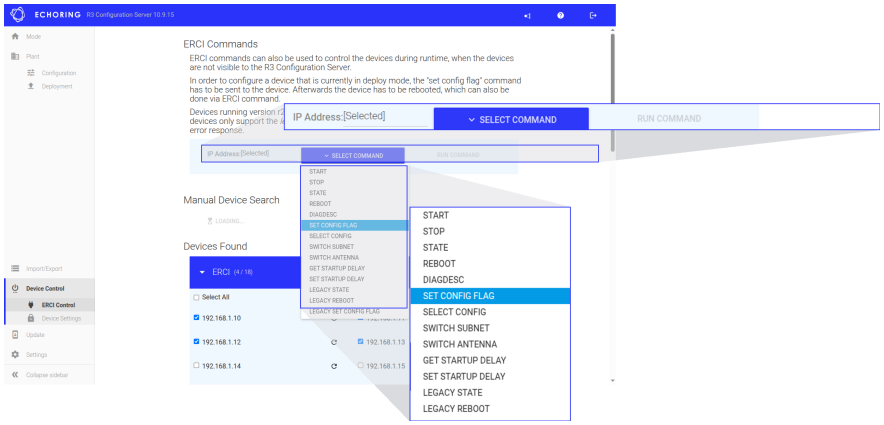


4.5 Configuration and Deployment

There are mainly two modes a device can operate in: Configuration Mode and Deployment Mode.
A device can be configured and updated in Configuration Mode. The device loads the deployed configuration in Deployment Mode.

New devices will boot in Configuration Mode initially. Once a configuration is successfully deployed, the device will go into Deployment Mode after the next reboot.
Devices can be reset to Configuration Mode using the Configuration Server. To do this, open the "ERCI Control" section. You can either enter the IP address of a single device or select one or multiple devices from the list below. Then click on "Select Command" and choose "Set Config Flag". Make sure that the IP configuration of the relevant interface(s) needs to be set properly.

TIP — New devices or devices that have been factory reset will use the default IP address **192.168.0.183**.



Once that command is sent to the selected devices via "Run Command", they will return to Configuration Mode after the next reboot.

The device will go into Fallback Mode if an error occurs during deployment or bootup. In Fallback Mode, the device can be returned to Configuration Mode using the Configuration Server as described above.

5 Using the Device

5.1 Basic Concepts

Subnetwork	A subnetwork is a network of multiple Bridge E devices where all participants can communicate directly with each other. Each subnetwork has its own channel assignment.
Network	A network consists of one or more subnetworks. All subnetworks within a network form a handover domain. If handover is enabled, devices can roam between subnetworks inside the network seamlessly.
Handover	The roaming of Mobile Devices between different subnetworks within one network is called Handover. Mobile Devices do not lose their connection during the Handover process.
Config Slot Selection	Mobile Devices can switch between networks (where each network has its own configuration). The Mobile Device is not able to communicate during the config slot selection.
Mobile Device	A Mobile Device can seemlessly roam between subnetworks within one network. Roaming to a new subnetwork needs to be triggered externally. Mobile Devices can be reconfigured to switch to another network.
Static Device	A Static Device is a stationary device in a subnetwork that can be connected to one or more client devices.
Anchor Device	An Anchor is a Static Device acting as the central station of a subnetwork for Mobile Devices using Handover. It requires a connection to a shared backbone network between all Anchor Devices of other subnetworks within the same network to support seamless handovers.
Relay Device	A Relay Device is not connected to a network or client device. It is introduced into a subnetwork to increase reliability without consuming any additional resources in the subnetwork. Currently only one Relay Device per subnetwork is supported. Note that typically other devices also perform relaying.

5.1.1 Introduction

The Bridge E devices can be used in multiple application scenarios, for example, in storage, logistics, production or tools.

Let's take lifting platforms as an example in production. Nowadays large workpieces in production lines, such as car chassis, are often carried between workstations by lifting platforms. Complex cable layouts ensure power and real-time data connectivity. Despite their speed and reliability, cables are constantly subject to wear and tear and are frequently prone to failure, resulting in expensive downtimes for diagnosis and repairs.
EchoRing revolutionizes M2M communications, combining speed and reliability with the flexibility of wireless networks. Fewer physical points of failure ensure durable, mobile setups with far fewer maintenance cycles.

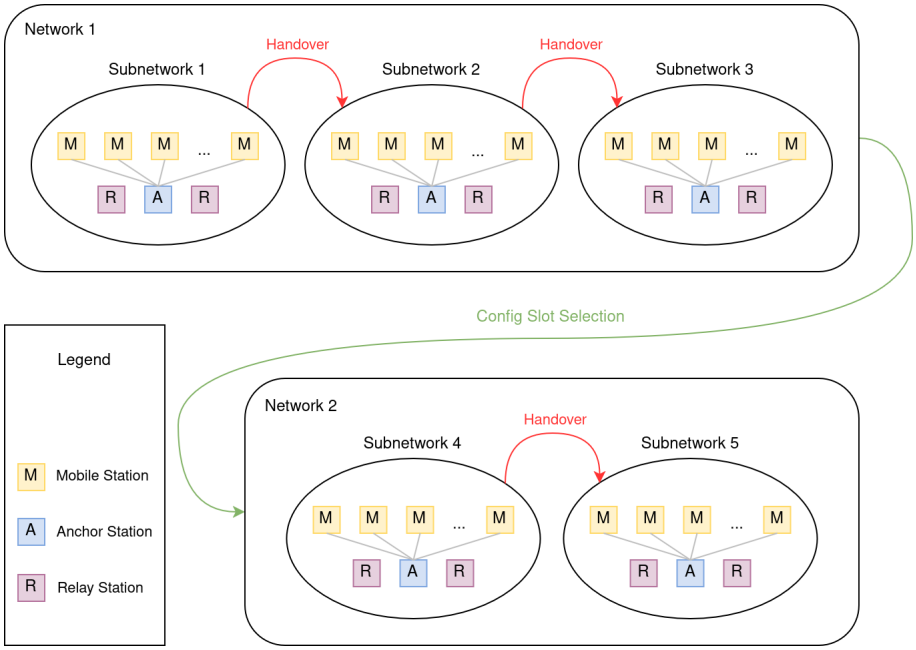
But how does this work?

Let's stay with the example of the lifting platforms that are used on a shopfloor.
Lifting platforms are stationary conveyor systems embedded in the floor. They are commonly used for final assembly of vehicles. In this context, lifting platforms are contiguous, similar to a chain, and move forwards in tandem at low speeds.

Let's assume there are Bridge E devices on each workstation and on each platform. For each safety-critical production section there is a separate "configuration zone", which corresponds to a network. A network can consist of several subnetworks.

The Anchor Device is the central device of a subnetwork. There must be one Anchor Device per subnetwork. It is connected to a shared network with all Anchor Devices of other subnetworks to allow signaling.
There can also be Relay Devices in a subnetwork. Relay Devices exist to increase reliability. They do not take part directly in the network, meaning they do not consume or block any (temporal) resources in the subnetwork but can be used as a "relay". Currently only one Relay Devices per subnetwork is supported.

If a platform runs through a production line, then the Bridge E on this platform is called a Mobile Device. Mobile Devices which move through the production line can switch between the subnetworks performing Handovers without interruption.
Each of the sections has its own subnetwork selection and its own channel assignments, which are loaded during downtime between the safety-critical sections. As a result, a new config slot will be selected on Bridge E at the start of each "configuration zone".



Each network has a defined maximum number of Static and Mobile Devices and a defined number of transmission slots. Aside from that the level of reliability, the maximum frame length, the latency and more parameters can be configured.
For each subnetwork it can be chosen on which channel and with which power the Bridge E devices should operate.
Per Bridge E transmission slots can be picked (which is limited by the overall network capacity) e.g. to configure asymmetric traffic. Furthermore each Bridge E can be used either as an Anchor or as a Relay Station or neither.
The MAC address of network components that should be connected to the Bridge E can be defined as well as if the device should obtain its IP from a DHCP server or use a static IP.

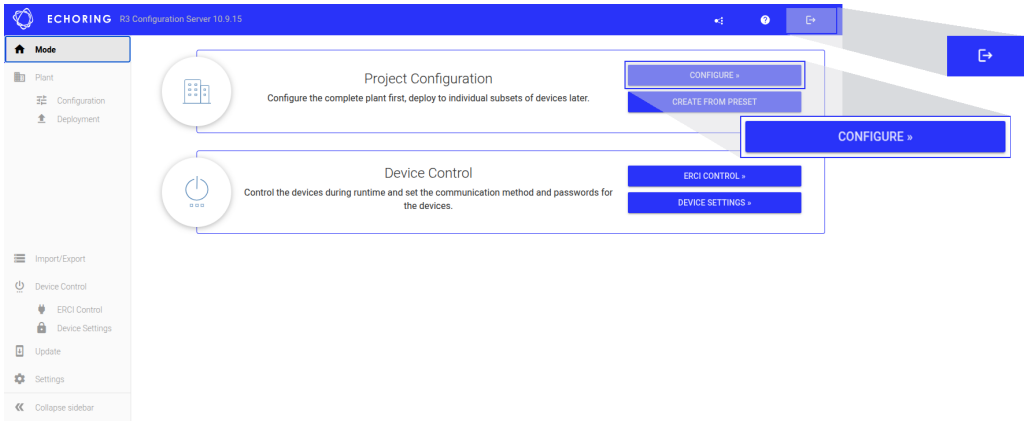
Further information about all parameters and how to configure them will follow in the next sections.

5.2 Configuration

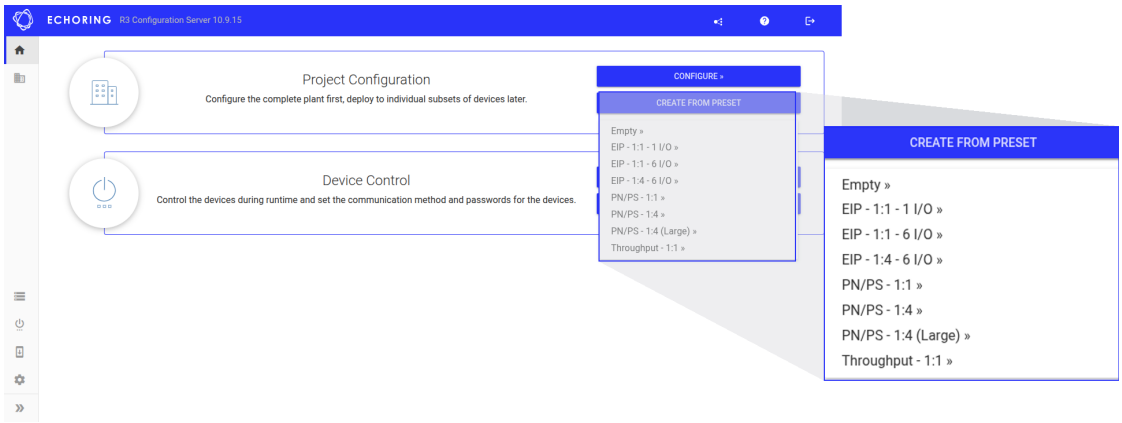
In order to configure devices, they must be set to Configuration Mode before they are booted. Configurations can be created without having actual Bridge E connected, but deploying a configuration to an existing device is only possible if that device is set to Configuration Mode.

> **NOTE** — If the configuration on a device has exactly one network and one subnetwork (i.e. Static Devices including Anchor and Relay Devices) then the device will start automatically. Otherwise they are Mobile Devices and need to be started using ERCI commands (see Section 8.2). The command to enable the Configuration Mode on future bootups of the Bridge E can be sent by the Configuration Server (see Section 4.5).

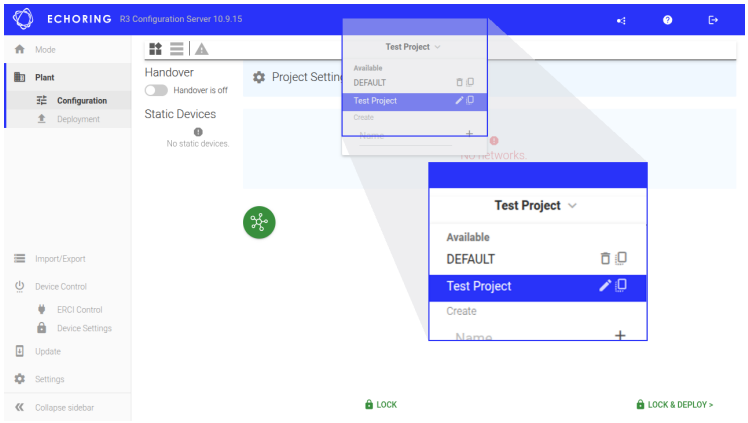
Logging out and ending the session is always possible via the button in the top-right corner.
To enter an empty Configuration, click on ”Configure”.



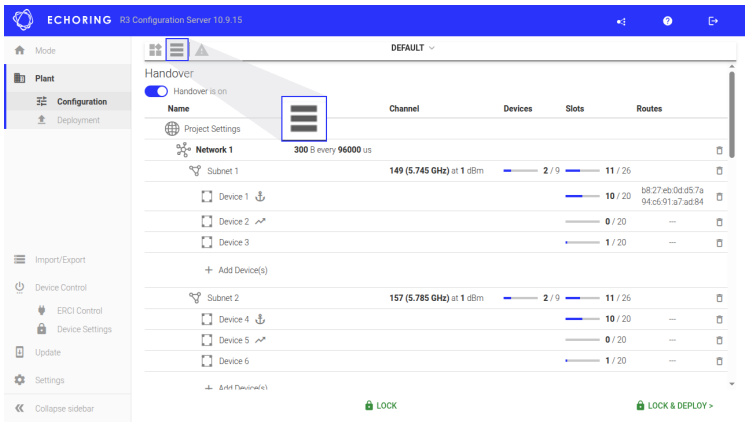
It is also possible to select a preset using the dropdown menu which opens after clicking on ”Create From Preset”. The selected preset will be copied and loaded from a database (the original preset remains unchanged). This copy can then be renamed and modified in the configuration space.



In the top middle you can see the name of the configuration which you are currently working on. Click on it to see the list of configurations. You can create new ones, rename existing ones and also copy an existing configuration.



To change the view, click on the ≡ symbol in the top bar. An overview of all networks, subnetworks, etc. is then displayed in a list. As before, you can click on networks, subnetworks or individual devices to change the settings.

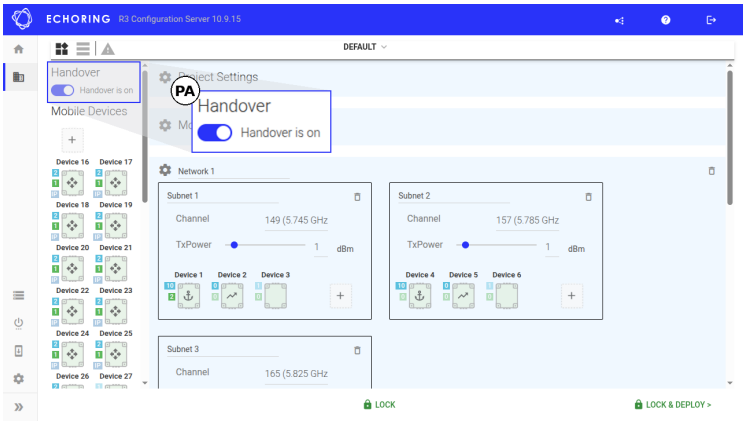


The configuration is split into Project, Mobile-wide, Network, Subnetwork and Device settings.

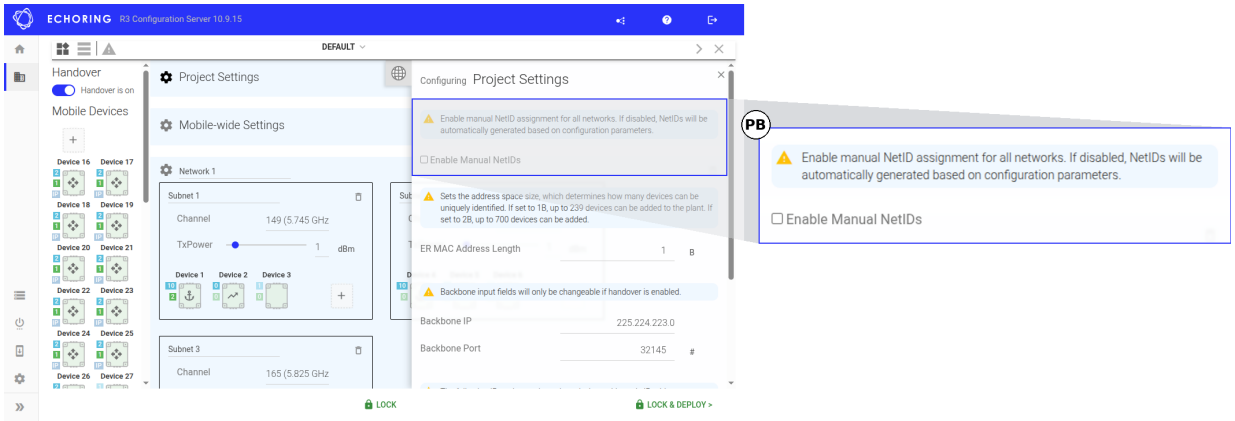
5.2.1 Project Settings

Project settings affect the entire configuration and are the highest level of settings.

PA Handover Toggle:
The handover functionality can be turned on/off explicitly for the whole configuration by toggling the button. Disabling handover deletes all mobile devices after confirming.



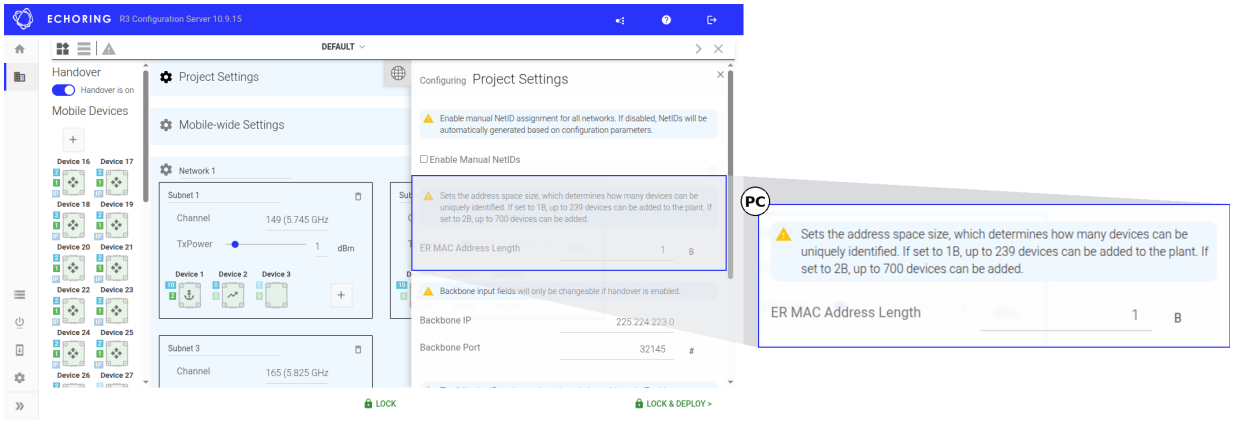
PB Enable Manual NetID:
EchoRing NetIDs ensure that each network has a unique and fixed identifier.
In case a device needs be replaced or added to an already deployed configuration, it is possible to do so by manually assigning the deployed NetID to that new device. After deploying the added device will be able to communicate within the network.
By default, NetIDs are automatically generated based on the configuration parameters. Enabling this option allows manual assignment of NetIDs. When enabled, each network must have a NetID set in the network settings (see here).



PC ER MAC Addr Length:

This setting defines the length of the EchoRing MAC addresses used in the whole configuration. By default, one-byte MAC addresses are used, allowing up to 239 devices. Switching to two-byte MAC addresses enables support for up to 700 devices.

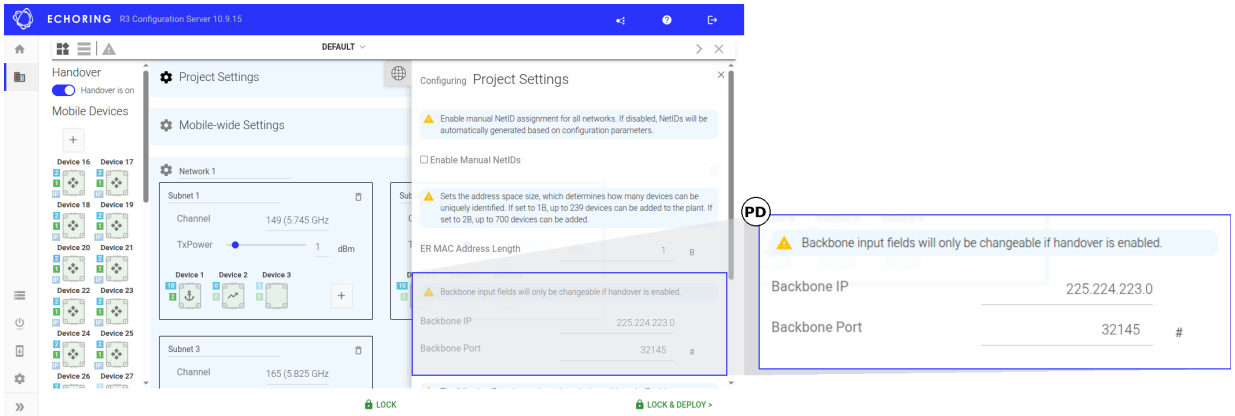
TIP — Use the two-byte ER MAC Addr Length option when planning large-scale deployments with more than 239 devices.



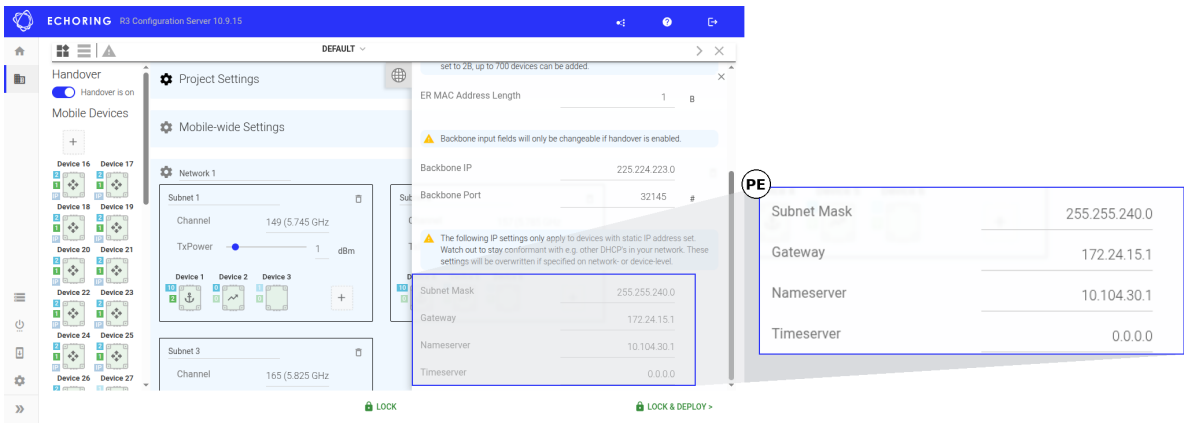
NOTE — The maximum number of all devices in a project is 239 for one-byte and 700 for two-byte addresses.

PD Backbone IP and Backbone Port:

Backbone IP is a multicast IP mask specifying the first 3 common bytes of the multicast IP that the Anchor Devices subscribe to. The range for valid IPs is 224.0.0.0 to 239.255.255.255. This information along with the Backbone Port is collectively used by Anchor Devices on the backbone to subscribe to a multicast address made up of a multicast port equal to the Backbone Port and a multicast IP equal to the Backbone IP appended with subnet ID. It enables Anchor Devices to communicate with each other using a multicast address formed by appending the Target subnet ID to Backbone IP. Multicast is needed for zero delay handover.



PE Subnet Mask, Gateway, Nameserver, Timeserver:
These settings are specified per project. If necessary, they can be overwritten on a network and device level or for all Mobile Devices. The most specific setting takes precedence.
An IP address needs to be entered to configure the Subnet Mask, Gateway, Nameserver or Timeserver. It is not possible to use an URL to configure it.



Networks and subnetworks can be added to a configuration by clicking on the corresponding green buttons.

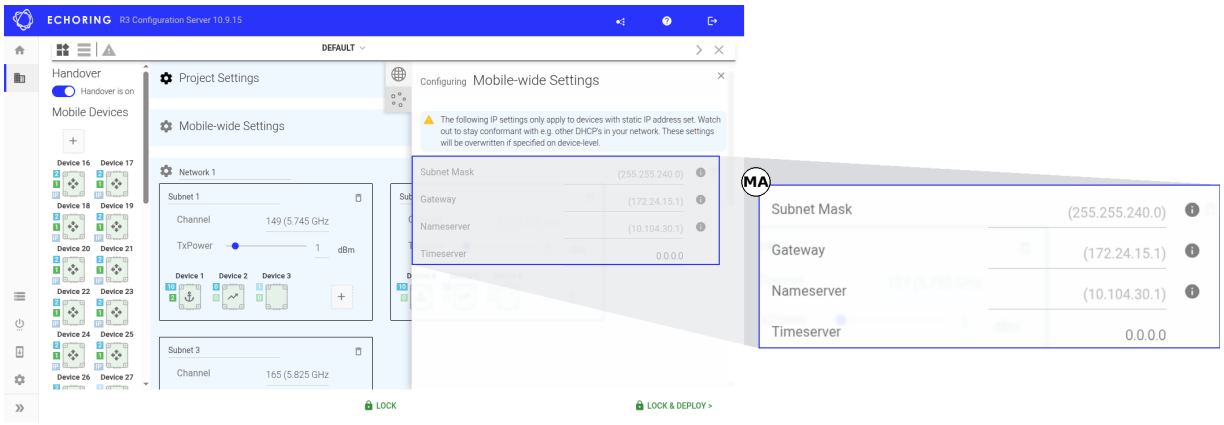
NOTE — The maximum number of networks is 20 with no more than 24 subnetworks per network.

5.2.2 Mobile-wide Settings

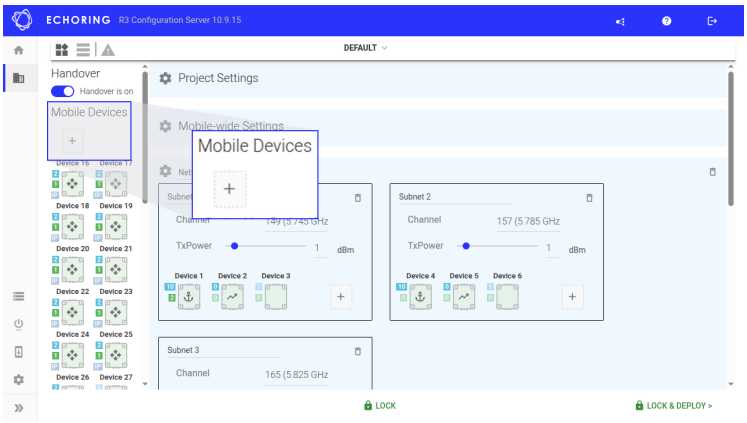
Mobile-wide setting only affect the Mobile Devices.

NOTE — When the (PA) Handover Setting (as described in Project Settings) is disabled, all mobile devices will be deleted and this section will not be shown.

(MA) Subnet Mask, Gateway, Nameserver, Timeserver:
If these settings are specified on mobile-wide level, they override those from project settings. If necessary, they can be overwritten on a network and device level. The most specific setting takes precedence. An IP address needs to be entered to configure the Subnet Mask, Gateway, Nameserver or Timeserver. It is not possible to use an URL to configure it.



Mobile Devices are listed on the left. To add more, click on the ”+”-symbol. Left-click to add one device, right-click to add several devices at once.

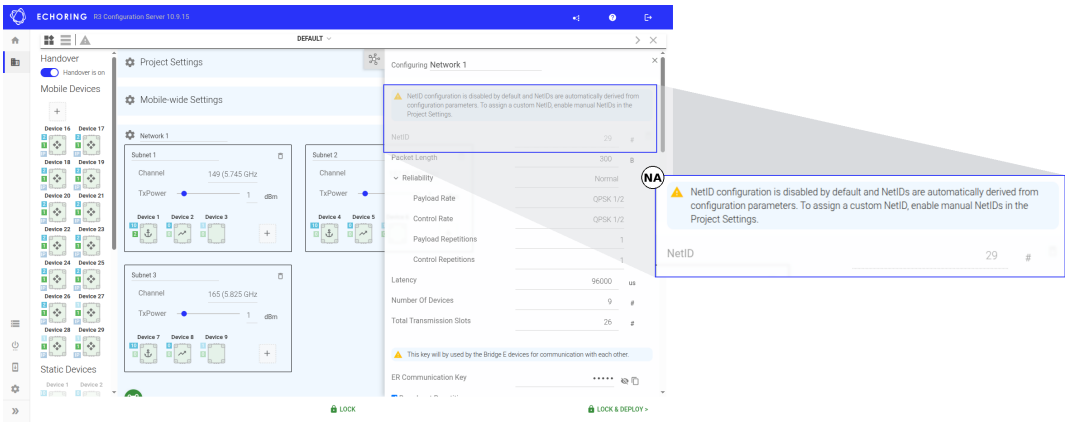


5.2.3 Network Settings

The networks can be renamed. The configuration for the different networks can be changed by clicking on the gear icon next to the name. All configurable parameters are defined as follows:

Basic Settings

(NA) NetID:
By default, NetIDs are generated automatically. To assign them manually, manual NetIDs must be activated project-wide in the Project Settings (see here). Once enabled, a unique NetID must be set in the Network Settings for each network. This ensures that the configuration remains valid and deployable. When configuring an empty project and enabling manual NetIDs, the input field is empty and a new ID needs to be entered. When enabling manual NetIDs inside an existing configuration, which was already deployed once, the NetID used during the last deployment will be set as the default.



(NB) Packet Length: the maximum length of priority packets to be conveyed over EchoRing (Ethernet frame size including headers). Only best effort traffic may be fragmented.

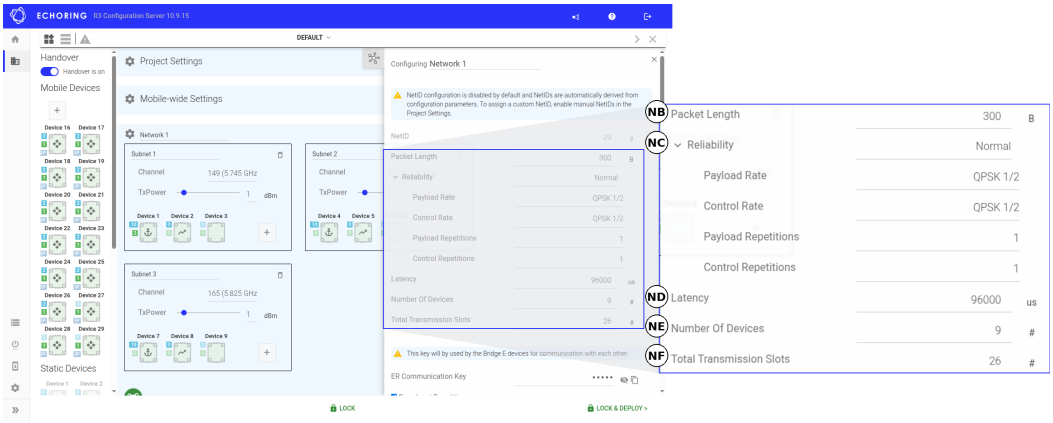
(NC) Reliability: defines the Modulation Coding Scheme and the number of scheduled frame repetitions for the EchoRing protocol. By clicking on the setting, more detailed options will be displayed. Reliability can be split into Payload Rate, Control Rate, Payload Repetitions, and Control Repetitions, all of which can be set individually. See Table.

- Payload Rate: Shows the current MCS for payload packets.
- Control Rate: Shows the current MCS for control packets.
- Payload Repetitions: Specifies the number of times a payload packet is retransmitted if the direct link fails. With n repetitions, there will be a total of up to n+1 transmissions.
- Control Repetitions: Specifies the number of times a control packet is retransmitted if the direct link fails. With n repetitions, there will be a total of n+1 transmissions.

(ND) Latency: the maximum time limit for a priority packet to be queued for transmission in EchoRing before it is dropped. An infeasible latency might cause the configuration not being accepted by the bridge.

(NE) Number of Devices: the maximum number of Static and Mobile Devices in each subnetwork in this network. Relay Devices do not count into the Number of Devices. Maximum is 20.

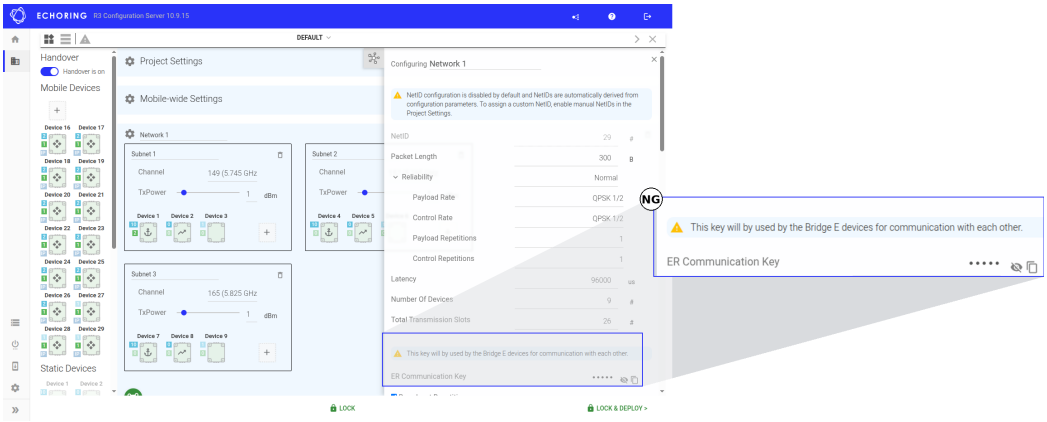
(NF) Total Transmission Slots: configures the number of available transmission slots available in each subnetwork, allowing for greater data throughput or asymmetric traffic per device in relation to overall network capacity. There will be up to 24 transmission slots.



NG ER Communication Key:

The ER Communication Key must be set for each network to enable secure communication between devices. This field cannot be left empty and must be configured manually. Without a valid key, deployment is not possible. The key can be copied to the clipboard by clicking the copy icon next to the field.

TIP — To simplify setup, the key can be copied to the clipboard by clicking the copy icon next to the field.



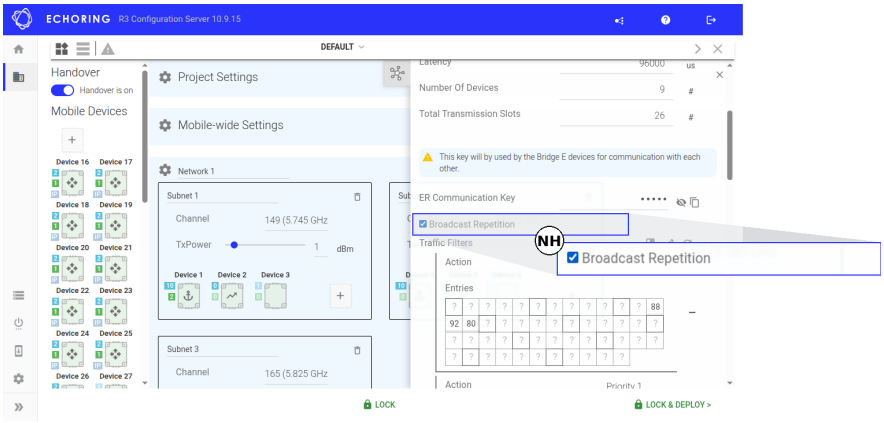
Advanced Settings

NH Broadcast Repetition:

EchoRing uses cooperative communication to increase reliability. A suitable Relay Device is selected for each frame to repeat the frame if the direct link fails.

Broadcast traffic is sent to all devices in the network, and thus has no clear destination, which makes it difficult to determine a single suitable Relay Device for all possible destinations. As a result, broadcast frames are only sent once by default.

The Broadcast Repetition setting enables repetition of broadcast frames to increase reliability. This setting only applies to Priority 1 frames. If enabled, all Priority 1 broadcast frames are repeated once. Deduplication in cases where both frames are received is performed on the receiving device. The Broadcast Repetition will only take place once all other Priority 1 frames not yet sent have been sent.



TIP — The repetition of the broadcast frame will take up a transmission slot. Please include this in your capacity calculation. All priority will be dropped after the configured maximum latency. This applies to broadcast repetitions as well.

NI Traffic Filters:

EchoRing allows you to distinguish five priority classes. Datatraffic can be assigned to a priority class using a bytemask. It is possible to assign different priorities to different filters. It is also possible to drop unwanted traffic using a drop rule. Click on the book icon on the right to load various presets.

Priority filters are evaluated in the listed order, starting from the top. Only the first match is applied, with one filter per packet. The filter transmission order can be rearranged via drag and drop.

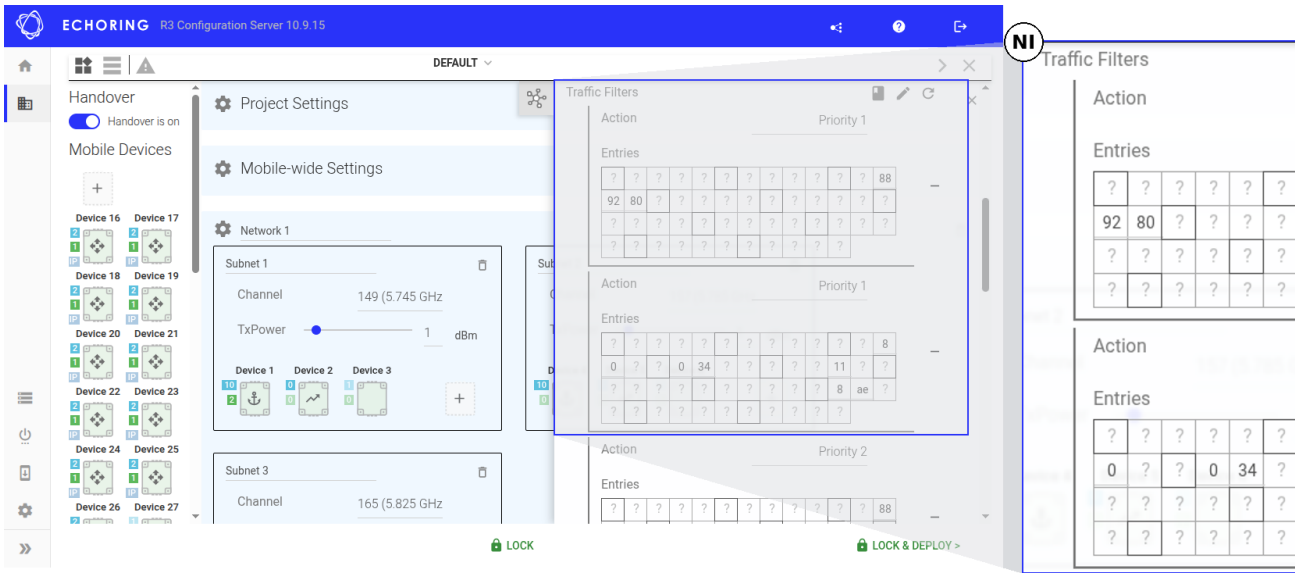
To enable prioritization, choose a priority action in the Traffic Filter section from the dropdown menu.

To select the bytes of the frames which should be filtered, type in the byte value in the box for the corresponding byte index.

All traffic that does not match the filter is treated as ”Best Effort” and thus will be sent after all priority traffic. The latency drop rule is not applied to ”Best Effort” traffic.

NOTE — Data to be transmitted is buffered in a queue and transmitted when its device’s transmission slot is available. If the application has multiple traffic types, such as critical control/safety frames or best-effort frames, the critical frames can be prioritized via a filter. Frames matching the filter will be buffered in the corresponding priority queue and sent prior to frames in the ”Best Effort” queue. If no prioritized traffic is set, all data is treated as ”Best Effort”.

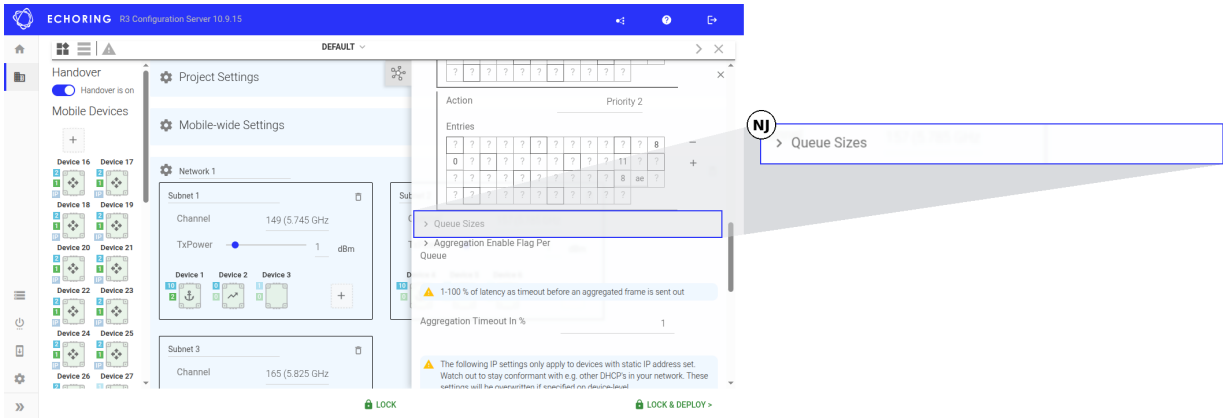
NOTE — If Handover is enabled, drop rule for anchor multicast traffic is automatically added (but not visible in the configuration) based on "Backbone IP" setting (see (PD)). This rule will not be added automatically if it is already manually entered.



(NJ) Queue Sizes:

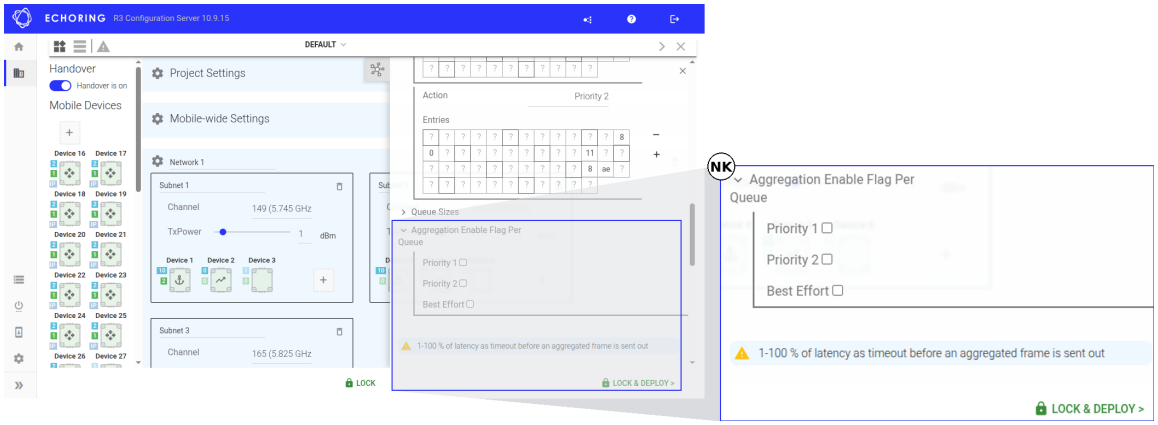
ATTENTION — This setting needs changes only in very specific scenarios. Proceed with caution!

The queues in EchoRing are equally sized by default. In special cases, e.g. with very high traffic load in one priority class compared to the others, it may be necessary to customize the queue sizes to ensure no frames are lost.
EchoRing will allocate the queue sizes automatically by default, or if the entries are not specified (all entries 0).
To customize queue sizes, queue sizes need to be configured for all priorities that have been assigned in the Traffic Filter section. If possible, the available buffers will be assigned as specified, any additional buffers will be distributed equally among all queues.



NK Aggregation:

The aggregation feature for a queue allows multiple smaller packets to be combined before transmission. Packets are aggregated without fragmentation until either the payload limit is reached or the specified timeout expires. This feature can be enabled or disabled individually for each queue by checking or unchecking the corresponding box. The aggregation timeout, adjustable as a percentage, has to correspond to the desired latency.



NL Subnet Mask, Gateway, Nameserver, Timeserver:

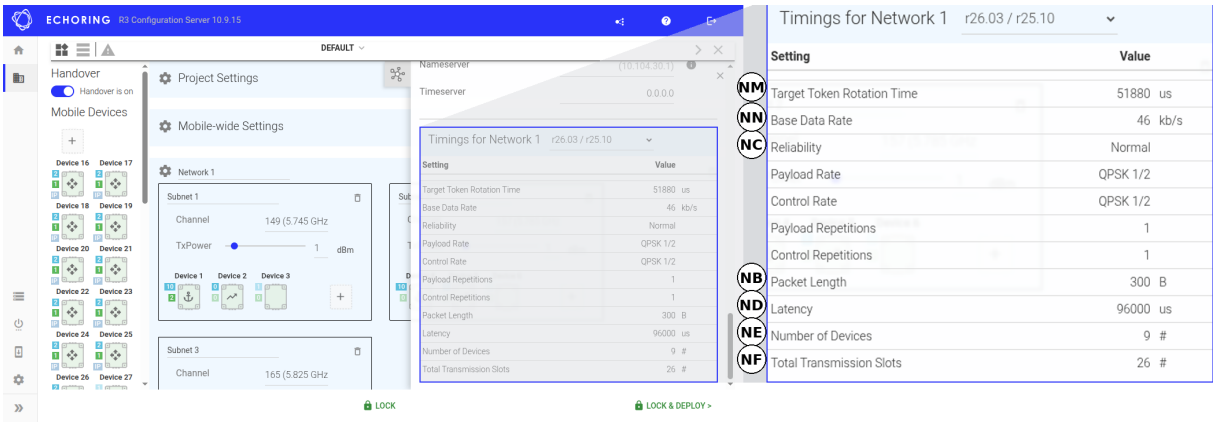
If these settings are specified on network level, they override those from project settings. If necessary, they can be overwritten on device level. The most specific setting takes precedence.

An IP address needs to be entered to configure the Subnet Mask, Gateway, Nameserver or Timeserver. It is not possible to use an URL to configure it.

Calculated Settings

Given the configured parameters in the network settings, the timings are calculated and the resulting Target Token Rotation Time and Data Rate are displayed. For explanations of the parameters check section Basic Settings.

NOTE — In case the parameters are not feasible, an error message will appear instead of the calculated values. This can be fixed, for example, by increasing the latency to ensure the calculation works and successful deployment can be guaranteed.



NM Target Token Rotation Time: the timespan for a device that has transmitted a packet to be allowed to transmit once more.

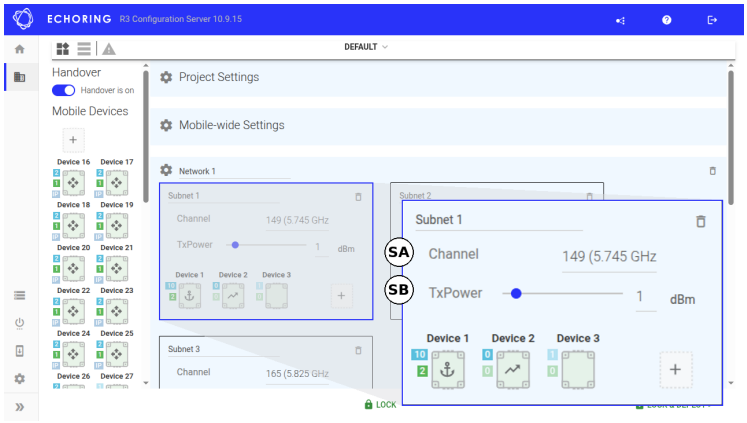
EXAMPLE — The system should ideally be configured with a Target Token Rotation Time slightly below the application cycle time, to allow for jitter leeway.

NOTE — For more background information on EchoRing, please email us.

NN Data Rate: shows the System Data Rate in kbit/s (provided above the MAC layer) per transmission slot achieved by the configuration. This is the minimum, deterministically assigned, guaranteed data rate at maximum utilization of the system.´

5.2.4 Subnetwork Settings

The different subnetworks can be configured.

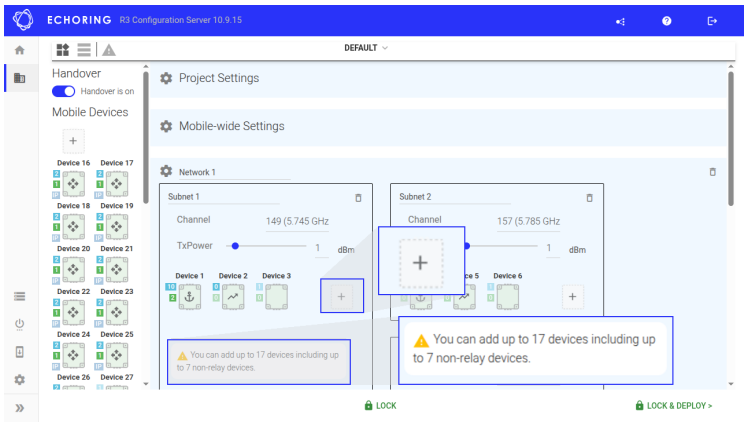


TIP — To prevent interference, please ensure that other/external radio transmitting devices in the vicinity of the network are not operating on the selected frequency.

SA Channel: the network's radio frequency to operate on.

SB TxPower: each device's transmitting power.

Static Devices can be added to a subnetwork by clicking on the "+"-symbol. Left-click to add one device, right-click to add several device at once.



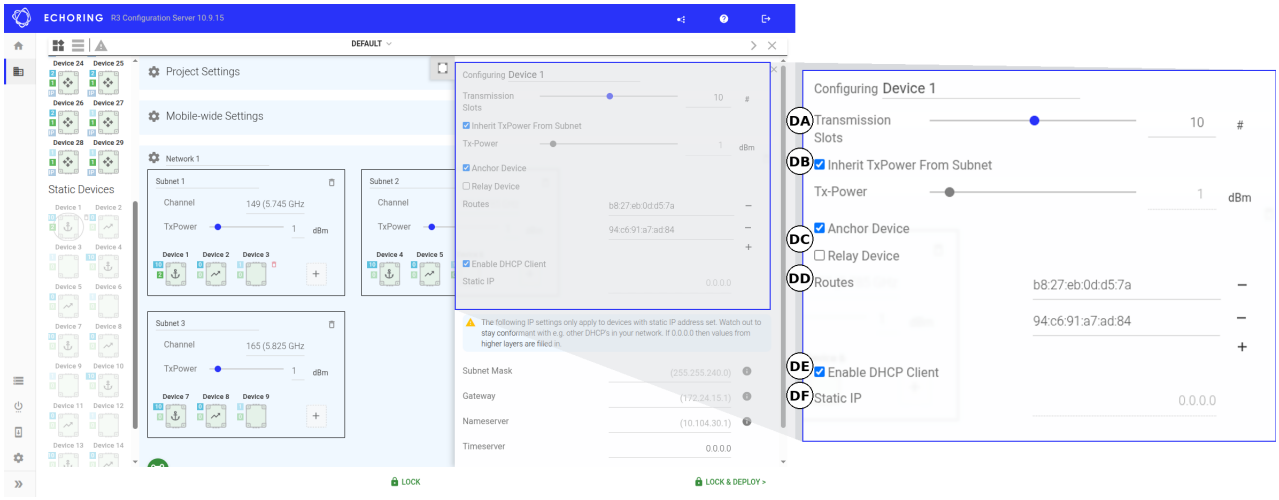
NOTE — The maximum number of Channels is 3 for all subnetworks in a network.
The maximum number of devices in a subnetwork is 20.

Added devices can be deleted by hovering over the device and clicking the trash bin twice. The trash bin will turn red after the first click. Same applies to deleting subnetworks and networks.

When a subnetwork containing devices is deleted, the outcome depends on the handover toggle. If handover is enabled, the devices are transferred to the Mobile Devices. If handover is disabled, the devices are permanently deleted after confirmation.

5.2.5 Device Settings

Click on a specific device to configure it individually.



DA Transmission Slots: configures the number of transmission slots used for the selected device, allowing for greater data throughput or asymmetric traffic per device. The sum for all devices in this subnetwork is limited by the overall subnetwork capacity (see **NF** Total Transmission Slots).

TIP — To determine the required transmission slots for each device, analyze the traffic and corresponding data rate that each device transmits, in relation to all devices in the subnetwork. Then distribute the transmission slots accordingly.

DB Inherit TxPower From Subnet: if checkbox is selected, TxPower is inherited from the subnetwork settings. If the box is deselected, the value initially remains that of the subnetwork, but can be changed individually for the respective device using the slider.

DC Anchor Device or Relay Device (or neither):

- An Anchor Device is the central device for a subnetwork. It is connected to a shared network with all Anchor Devices of other subnetworks within the network for signaling.
- Relay Devices increase the reliability. They do not consume or block (temporal) resources in the subnetwork, but support data exchange between other Bridge E devices. Thus they have a transmission slot of zero. Currently only one Relay Device per subnetwork is supported.

DD Routes: Allows to statically assign the MAC address of one or more customer network components that are to be connected to the Bridge E.
The introduction of the MAC learning feature in r24.05 enhances this process by dynamically learning and storing MAC addresses, thereby automating part of the routing management.
The system initially broadcasts the first few packets to discover the MAC addresses of connected devices. Once a MAC address is captured, it is stored in a table, enabling the system to directly route packets to these addresses in future communications.

NOTE — Be aware of the table's capacity, which can hold a maximum of 200 entries. This includes both manually set routes and dynamically learned addresses.

DE Enable DHCP Client: The device should obtain its IP from a DHCP server.

DF Static IP: If DHCP is disabled, this static IP will be the device's IP address.

> **TIP** — When using static IP, other settings such as Subnet Mask, Gateway, Nameserver and Timeserver should also be configured.

> **NOTE** — If (DE) DHCP is enabled, (DF) Static IP is automatically disabled and vice versa.

DG Subnet Mask, Gateway, Nameserver, Timeserver:
If these settings are specified on device level, they override those from network and -wide settings. If not, they are inherited from higher level(s).
An IP address needs to be entered to configure the Subnet Mask, Gateway, Nameserver or Timeserver. It is not possible to use an URL to configure it.

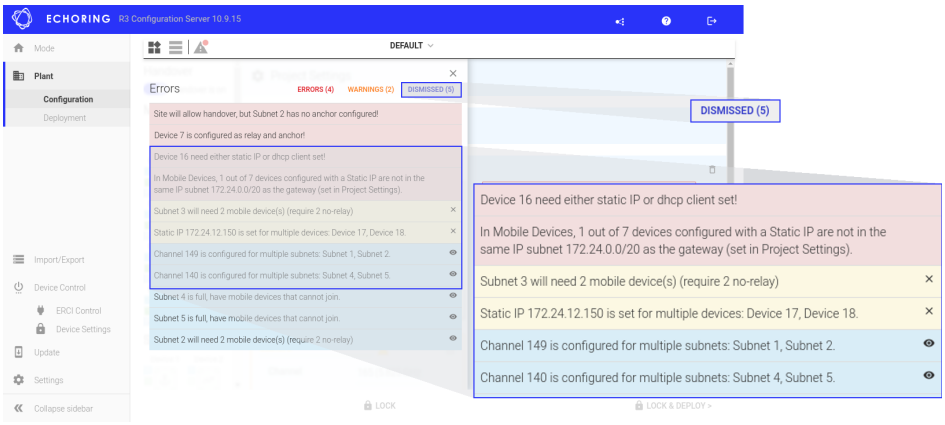
5.2.6 Make Configuration Deployable

NOTE — Applying a configuration with warnings is possible, but errors must be solved first.

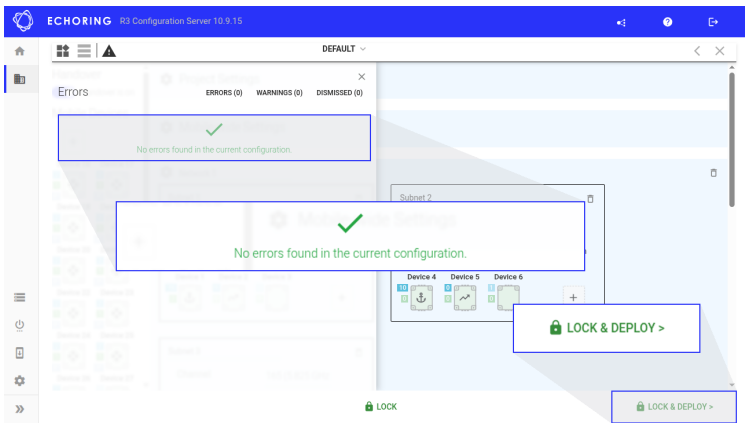
Click on the warning sign in the top bar to display warnings and errors. Click on a warning or error to open the settings where the warning originates.

When getting a warning, yet confident that the actions taken are correct and intentional, one may choose to dismiss the warning to prevent distraction. This can be accomplished by clicking on the ”x” icon next to the warning. Once dismissed, these warnings are relocated to the ”dismissed” tab. From there, they can be reinstated by clicking the eye icon causing them to reappear in the error/warning list.

TIP — How to avoid warnings:
If there is more than one subnetwork per network or Mobile Devices are required, Handover is needed.
In that case, there has to be an Anchor Device configured in each subnetwork!
The number of devices must be lower than configured in Step 5.2.3.



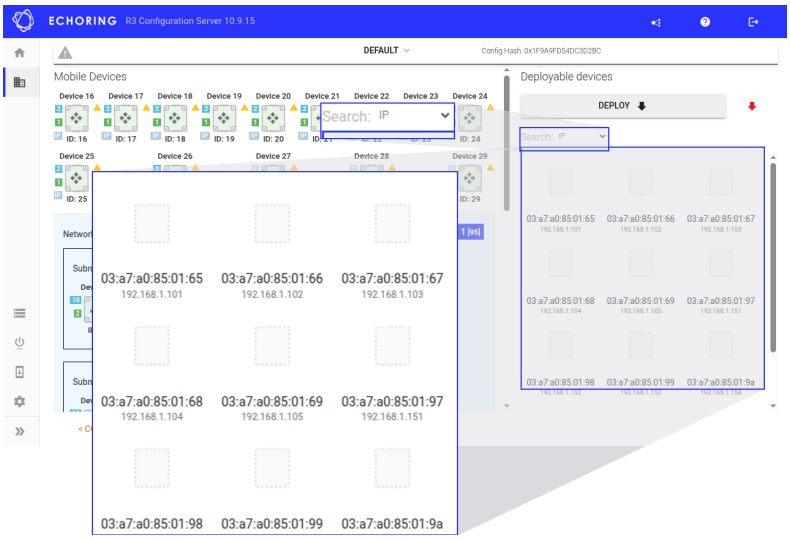
When there are no errors displayed, the ”Lock & Deploy” button on the bottom right will be green.



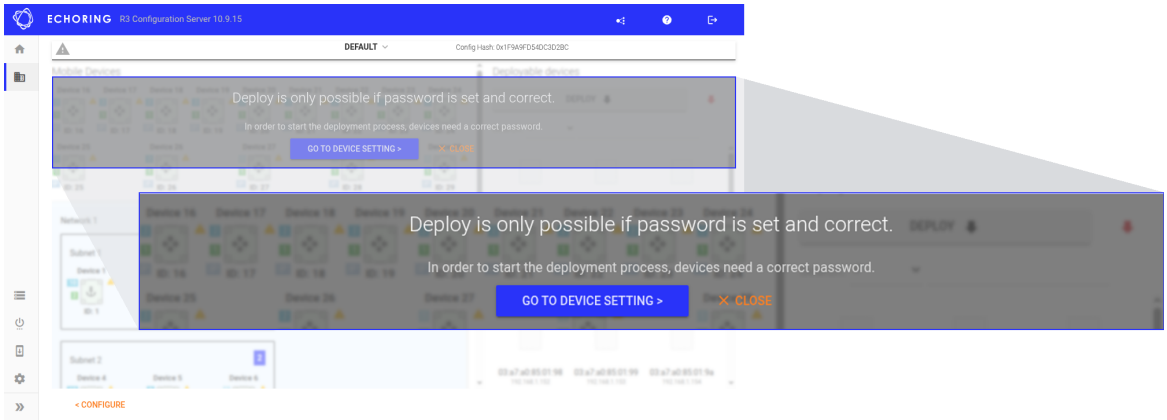
5.3 Deployment

NOTE — In order to deploy devices, device passwords must be set (see 5.4.3).

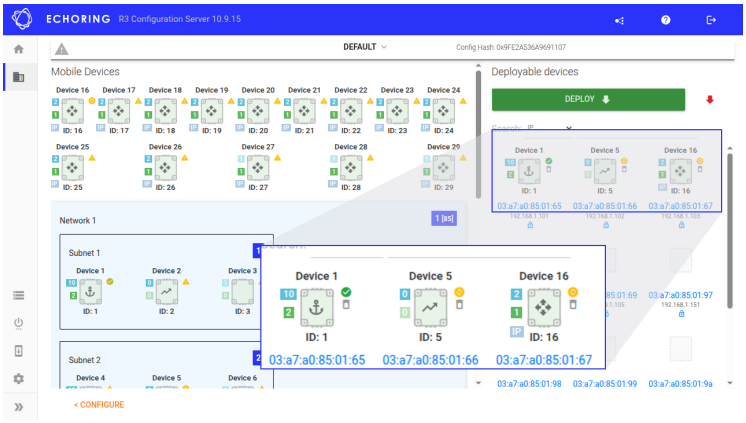
1. Click on ”Lock & Deploy” to access the ”Deployment” page.
   All the deployable devices are listed on the right. Use the dropdown menu to select a searching/sorting criteria (MAC/IP/Name).



2. Set device passwords first (see 5.4.3). Addresses of devices which have a password will be colored blue and have a small lock icon below the address. When trying to deploy a device for which there is either no password or an invalid password saved, an overlay will be shown which redirects you to ”Device Settings”.



3. When the configuration changed, outdated devices will have a yellow update symbol next to them. Click ”Deploy” or drag and drop the device to the MAC/IP on the right. The updated devices will have a green check mark.



TIP — When you click ”Deploy”, only devices with a yellow symbol will be updated. When you click the red arrow next to ”Deploy”, the configuration will be sent to all devices, including the ones that already have a green check mark.

4. Click on a device in the list of deployable devices to open its settings.

TIP — If the application’s data rate exceeds the maximum throughput limited by the other set configuration parameters, the system overloads and the packets risk being dropped, leading to packet losses. If application has combined traffic of both critical and best-effort, the setting Prioritized Traffic filter ((NH)) allows a type of traffic to be prioritized and the other to be transmitted secondly (bearing eventual packet losses).

5. The configuration is locked during deployment to prevent corruption of the configuration data set. Choose either to continue the deployment or to unlock the configuration.

NOTE — If you choose to unlock the configuration, the configuration deployment will stop.

6. The deployment process cannot be started while the configuration is unlocked, so finish modifying the configuration first. Then click on ”Lock” and (re)deploy the devices.
7. After deployment, the Bridge E should be disconnected from the common switch to avoid creating a bridging loop.

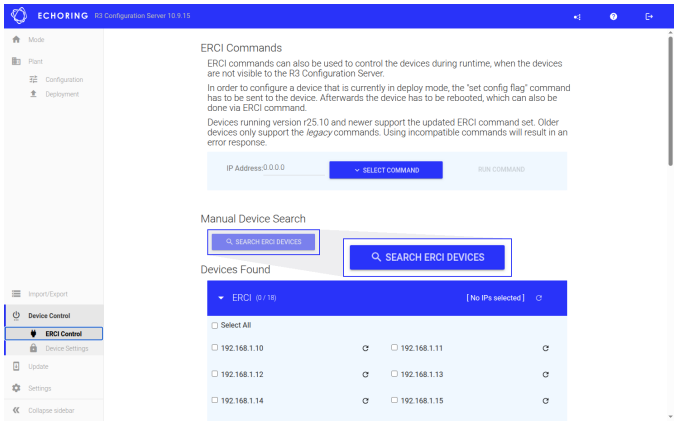
5.4 Device Control

5.4.1 Control Device during Runtime

To control the device during runtime, the ”ERCI Control” subpage under ”Device Control” offers a range of ERCI and BETI commands. A detailed description of those commands can be found in Section 8.2 and 8.3.
To find available ERCI devices, click the ”Search ERCI Devices” button. In the ”ERCI” section under ”Devices Found” all IPs of devices which can be controlled via ERCI/BETI are listed.

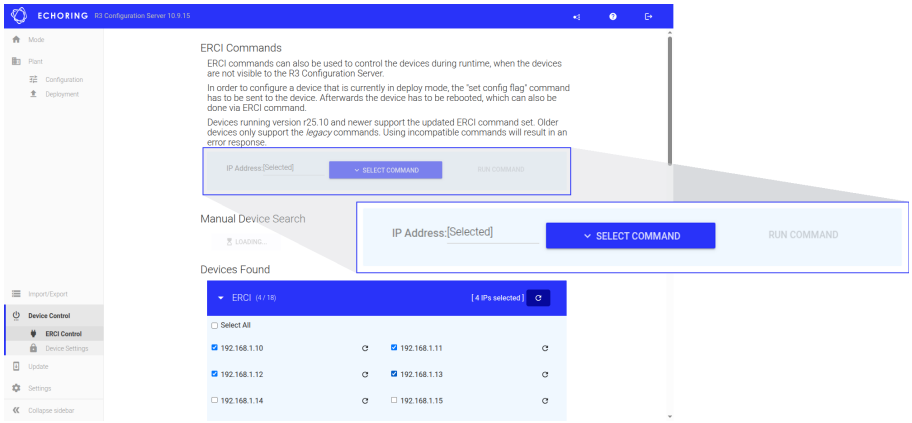
NOTE — In order to run ERCI commands on devices, device passwords must be set (see 5.4.3).

Next to each device’s IP address is a reload and a shutdown icon which reboots or shuts down the particular device. ERCI/BETI commands can be run on a single device by entering the corresponding IP address in the input field and clicking ”Run command”.



When clicking the ”Select All” checkbox, all devices inside the ERCI section will be selected. The number in the header shows the amount of devices selected. By clicking in the icons in the ERCI header, all previously selected devices will be rebooted/shut down.

Similarly, it is also possible to run a command, such as ”Set Config Flag”, for multiple devices. When multiple devices are selected, the IP input field will show ”[Selected]”, implicating that the command will be run for more than one device.

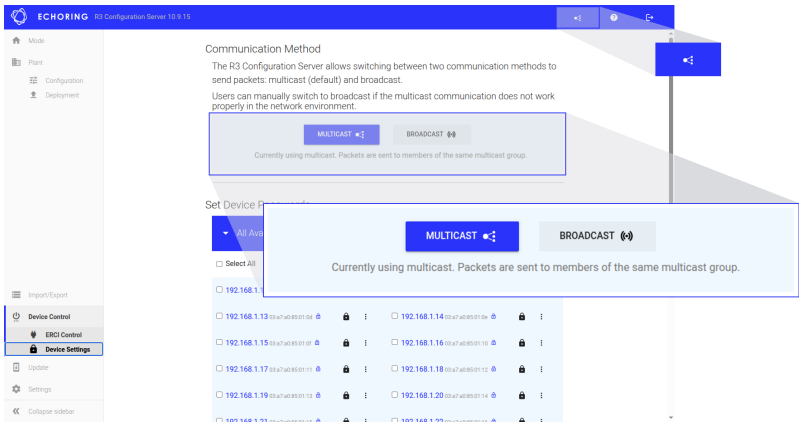


After selecting the target command and clicking ”Run command”, it will be applied to all selected devices. A success message for each device confirms that the command has been sent and received.

TIP — Devices running version r25.10 and newer support the updated ERCI/BETI command set. Older devices only support legacy commands. Using incompatible commands will result in an error response.

5.4.2 Communication Method

The communication method used for discovering devices can be manually configured in the ”Device Settings” subpage found under ”Device Control”, accessible via the left sidebar. By default, Multicast is used for device discovery. If unpaired devices are not detected, it may help to enable Broadcast.
This can improve discovery reliability in networks where multicast traffic is restricted, for example due to IGMP snooping problems on some switches. When broadcast is enabled, both multicast and broadcast packets are sent during the discovery process.

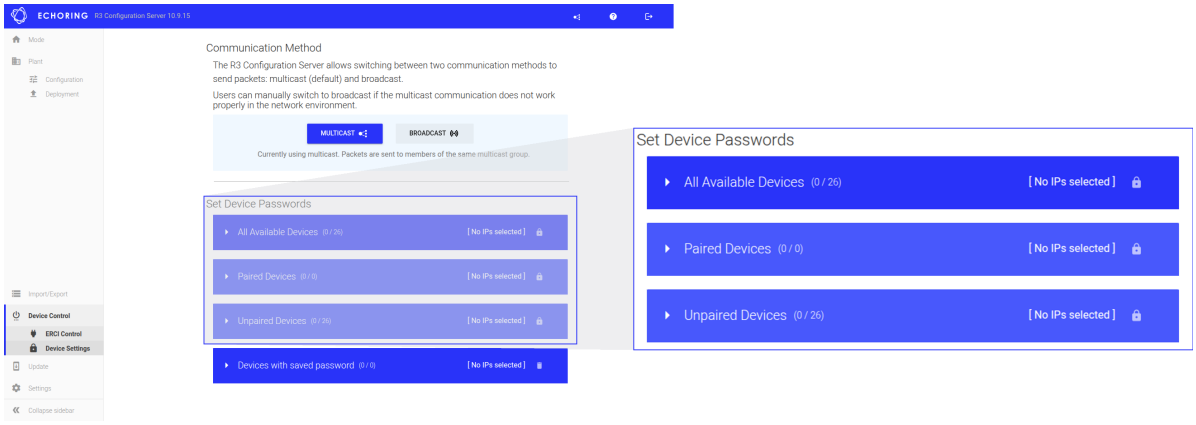


5.4.3 Set Device Password

1. Device Settings Overview:
   In the ”Device Settings” subpage, under Communication Method, each device must be assigned a password to allow access via the R3 Configuration Server. Without a password, deployment is not possible as well as running any ERCI command.

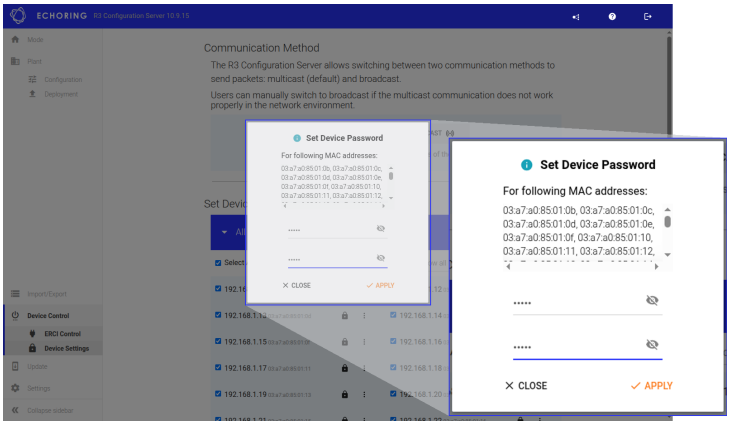
   The interface is divided into three sections: ”All Available Devices”, ”Paired Devices”, and ”Unpaired Devices”. Each section can be expanded or collapsed by clicking the arrow to the left of the section title.

   NOTE — ”All Available” includes both ”Paired” and ”Unpaired” devices.

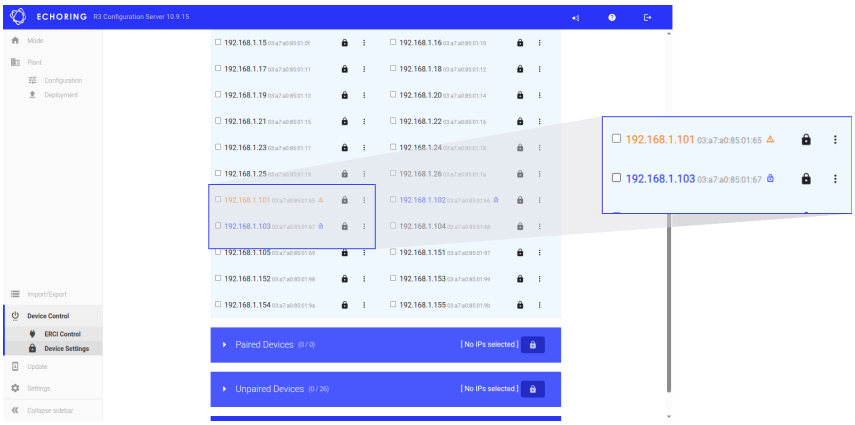


2. Set Device Password:
   It is highly recommended to use the same password for all devices. To do this efficiently, use the ”Select All” checkbox in the ”All Available Devices” tab to change the password for all devices. To set the same password for a specific amount of devices, select the desired devices in the relevant section (e.g. ”All Available”). Click the the lock icon on the right side of the section header to change the password.
   A dialog window will appear, showing which devices the password will be applied to.
   It is also possible to set a password for an individual device by clicking the lock icon next to its entry. However, this method is not recommended when managing multiple devices.

   For newly added devices, a password has already been set during the end-of-line (EOL) test. To change this password, the default R3 password must be entered as the ”Old password”. For devices that already have a password assigned and stored in the R3 Configuration Server, only the new password needs to be entered, as the old password is stored internally.



Devices with a configured password are marked in blue with a small lock icon next to their address.
If no password is saved for a device, but an action requiring authentication (e.g. deployment or ERCI command execution) was attempted, the device will be marked in yellow with a yellow warning sign.
Devices for which an invalid password is saved will be marked in red with a red warning sign.



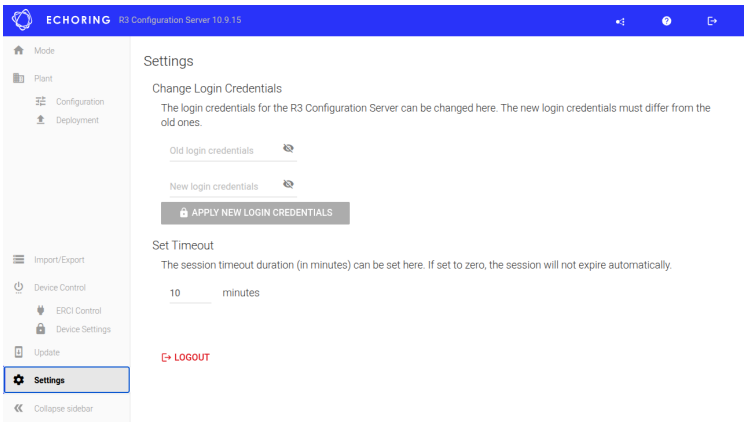
5.5 Save and Restore Database

The left-hand menu contains the ”Import/Export” section, where the database can be saved and restored. The database contains all adjustments made in the Project Configuration.
The current database can be downloaded using ”Export”.
A previously saved database can be uploaded using ”Import”.

ATTENTION — All previous settings will be **overwritten** when you import a database.

5.6 Settings

Click the double-arrow icon on the bottom-left side of the home screen to open the sidebar, if it is not already visible. In the sidebar, click Settings to open the Settings page.



1. Change Password:
   It is recommended to change the default password ”admin” to a secure one after the first login.
   To set a new password, first enter the current password, then enter the new one. The password fields can be revealed by clicking the eye icon next to them. To apply and confirm the change, click the ”Apply New Password” button.
2. Set Timeout:
   The session timeout defines the period of inactivity (in minutes) after which the user is logged out. Once this time has passed, the session ends automatically.
   To disable the automatic logout entirely, set the timeout to 0. This keeps the session active indefinitely.

> **Note** — An automatic logout due to timeout does not discard any configuration changes made during the session. All changes remain saved.

3. Logout:
   Clicking the ”LOGOUT” button ends the current session and logs the user out manually.

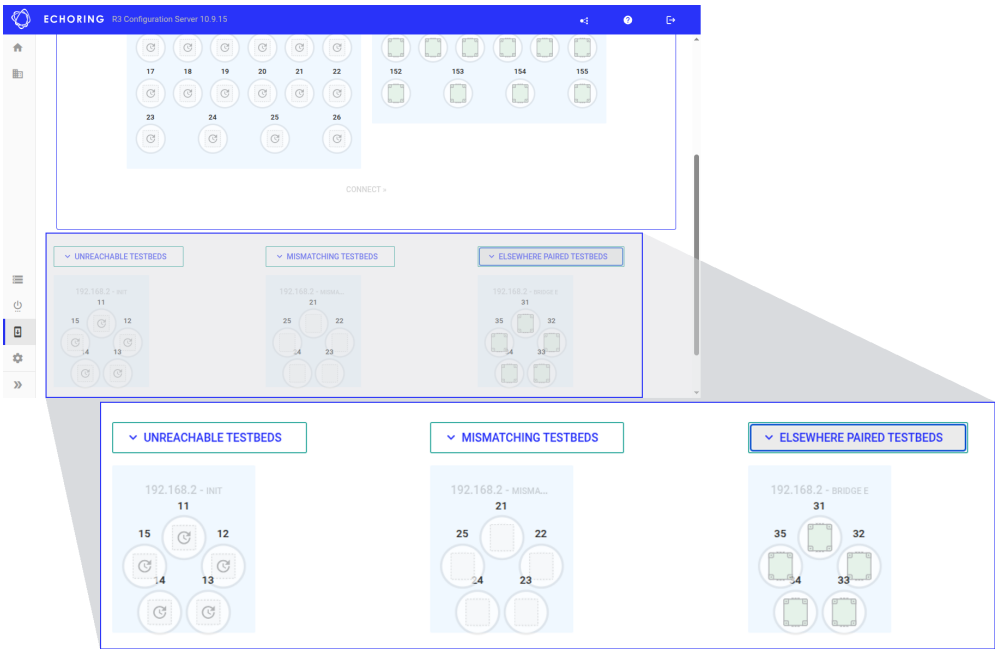
> **NOTE** — Before logging out, ensure that the password is available for the next login. Without it, you will not be able to access the R3 Configuration Server.

6 Troubleshooting

6.1 Device Not Showing Up

If the devices do not show up on the web user interface, one of the following messages may be displayed under the ”Update Devices” box on the ”Update” subpage:

- Unreachable Testbeds: These devices could not be discovered by the Configuration Server for roughly 20 seconds.
- Elsewhere Paired Testbeds: The devices shown in this section are reporting that they are already paired.
- Mismatching Testbeds: These devices are not compatible with the Configuration Server in any of the core functions (Configuration or Update).



TIP — If devices are not showing up, ensure your PC is in the same subnet as the Bridge E devices. By default, Bridge E devices use the IP address **192.168.0.183**.

IGMP Snooping Problem

If no devices are discovered and the network is working properly, try checking if multicast is working as intended. Not all switches support IGMP Snooping, so turning it off on all switches may solve the issue as well as switching to broadcast (see here).

TIP — We recommend to use the Netgear GS308E-100PES switch as it has been tested and works with it. The use of other switches is at your own risk.

6.2 Different Regularity Domains

The regulatory domain is used to indicate the area where Bridge E devices are used, and to enforce the regulatories for that domain because different laws apply in different parts of the world.
If you see the error message ”The used regulatory domain of the R3 Configuration Server and the database do not match”, this means that the Configuration Server and the database file are from different regulatory domains.
This problem can be solved by changing either the regulatory domain of the Configuration Server or of the database. Please contact your Application Engineering representative.

7 Customer Service and Addresses

Customer Service

For technical inquiries, our service is available.

R3 Customer Service
Contact form: www.r3.group/contact
Email: service@r3.group

R3 Solutions GmbH
Kurfürstendamm 194
D-10707 Berlin
Phone: +49 30 800 936 75
Email: contact@r3.group

Further addresses for sales and service locations can be found at:
www.r3.group

8 Appendix

8.1 Reliability/MCS Table

The reliability influences the chosen MCS as well as how many repetitions for data (Payload Repetitions) and token (Control Repetitions) are being used.

Reliability Level	Payload Rate	Control Rate	Payload Repetitions	Control Repetitions
None	QAM16 3/4	QAM16 3/4	1	1
Low	QAM16 1/2	QAM16 1/2	1	1
Moderate	QPSK 3/4	QPSK 3/4	1	1
Normal	QPSK 1/2	QPSK 1/2 1	1	1
Advanced	BPSK 3/4	BPSK 3/4	1	1
High	BPSK 1/2	BPSK 1/2	1	1
Critical	BPSK 1/2	BPSK 1/2	2	1
Extreme	BPSK 1/2	BPSK 1/2	2	2

8.2 External Runtime Control Interface (ERCI) Specification

ERCI is the control interface for the Bridge E during runtime.

INFO — The Application Engineering Team can provide 'function block' examples to integrate ERCI functionality to different automation environments. See here for the contact information.

Mode of Operation

The devices communicate using a Transport Layer Security (TLS) encrypted Transmission Control Protocol (TCP) connection and exchange messages in a command and response pattern.
All configuration data will be pre-deployed using the Configuration Server.

Initialization

NOTE — ERCI is only available once the device password in was updated via the Configuration Server!

By default, the Bridge E has the IP address **192.168.0.183**. This IP address can be modified during the configuration process (via DHCP or by assigning a different static IP).
If the configuration of a Bridge E only consists of a single network with a single subnetwork, the configuration is auto deployed and the MAC started for Static Devices. This is not the case for Mobile Devices.
Otherwise the Bridge E waits for input via ERCI to select the active configuration and another ERCI command to start the MAC.
Until EchoRing is started, all "Switch Ring" and "Switch Antenna" commands are invalid and an error will be returned.

Protocol

- TLS on TCP port 12300
- Network Byte Order
- All commands are synchronous and there is only one active command

INFO — Value 0 is invalid for any ID.

Message Header

Field	Size (B)	Comment
-	1	[Reserved] Value: 0
Protocol Version	1	Value: 4
Type	1	
Sequence number	1	
Message Length	2	Length of the full message, including the header
Auth Mode *	1	Enum specifying what kind of authentication data comes in the next field
Auth Data *	hash_len	The authentication data matching the Auth Mode
Payload	n	

* Only included in Request Commands.

Messages

Type	Req (Q)/ Resp (A)	Message Type	Payload	Response	Command Result Code	Comment
0		Invalid				
1	Q	Select Configuration	1B Config ID, 1B Ring ID, 1B Antenna ID	Command Result	Success → Config applied Invalid Message Received → Wrong format Wrong ERCI State → Not in READY or CONFIGURED No Config Available → No configs at all are stored Invalid Data Received → Invalid Config, Ring and/or Antenna ID Generic Error → Error in processing request	Only in READY or CONFIGURED ERCI state. If provided config is invalid or unknown, (Config ID and/or Ring ID and/or Antenna ID) will reset any loaded config (if present) and go to READY
2	Q	Switch Ring	1B Ring ID, 1B Antenna ID	Command Result	Success → Switch ring executed Invalid Message Received → Wrong format Wrong ERCI State → Not in RUNNING Invalid Data Received → Invalid Ring and/or Antenna ID Generic Error → Error in processing request	Only in RUNNING ERCI state
3	Q	Start	1B Ring ID	Command Result	Success → Start executed Invalid Message Received → Wrong format Wrong ERCI State → Not in CONFIGURED Generic Error → Error in processing request	Only in CONFIGURED ERCI state
4	Q	Stop		Command Result	Success → Stop executed Invalid Message Received → Wrong format Wrong ERCI State → Not in RUNNING Generic Error → Error in processing request	Only in RUNNING ERCI state, resets Config ID, Ring ID and Antenna ID to 0 (=invalid)
5	A	Command Result	1B Command Result Code, NULL terminated result description	-		
6	Q	ERCI State Query		ERCI State Response		Allowed in any ERCI state
7	A	ERCI State Response	1B ERCI State, 1B Config ID, 1B Ring ID, 1B Antenna ID	-		Returns ERCI State, Configuration ID, and Ring ID
8		Reserved				
9		Reserved				

Value	Req (Q)/ Resp (A)	Message Type	Payload	Response	Command Result Code	Comment
10	Q	Switch Antenna	1B Antenna ID	Command Result	Success → Switch antenna executed Invalid Message Received → Wrong format Wrong ERCI State → Not in RUNNING Invalid Data Received → Invalid Antenna ID Generic Error → Error in processing request	Only in RUNNING ERCI state
11	Q	Set Config Mode	1B 0: disabled 1: enabled other: invalid	Command Result	Success → Config flag set or cleared Invalid Message Received → Wrong format Generic Error → Error in processing request	Allowed in any ERCI state. May not be executed properly in FAULT ERCI state.
12	Q	Query Passport	6B assumed MAC of device, 26B assumed Serial Number (SN) of device	Query Passport Response		Allowed in any ERCI state
13	A	Query Passport Response	1B Command Result, 6B MAC address stored in passport (PP), 26B Serial Number stored in passport		Success → Provided SN & PP MAC matches stored information in bootloader, query was successful Invalid Data Received → Provided SN and/or PP MAC do NOT match stored information in bootloader Invalid Msg Received → “Query Passport” message wrong size → Failed to parse “Query Passport” message Generic Error → Provided SN & PP MAC matches stored information in bootloader, query was NOT successful	
14	Q	Set Autodeploy Delay	2B Delay in ms	Command Result	Success → The value was configured	Sets the startup delay factor in ms. The delay factor will be multiplied with the EchoRing StationID.
15	A	Get Autodeploy Delay Query		Get Autodeploy Delay Response		Retrieves the startup delay factor in ms.
16	A	Get Autodeploy Delay Response	2B Delay in ms			

Value	Req (Q)/ Resp (A)	Message Type	Payload	Response	Command Result Code	Comment
17..127		Not used yet				
128	Q	Reboot		Command Result		Immediately reboots the device.
129..255		Reserved				

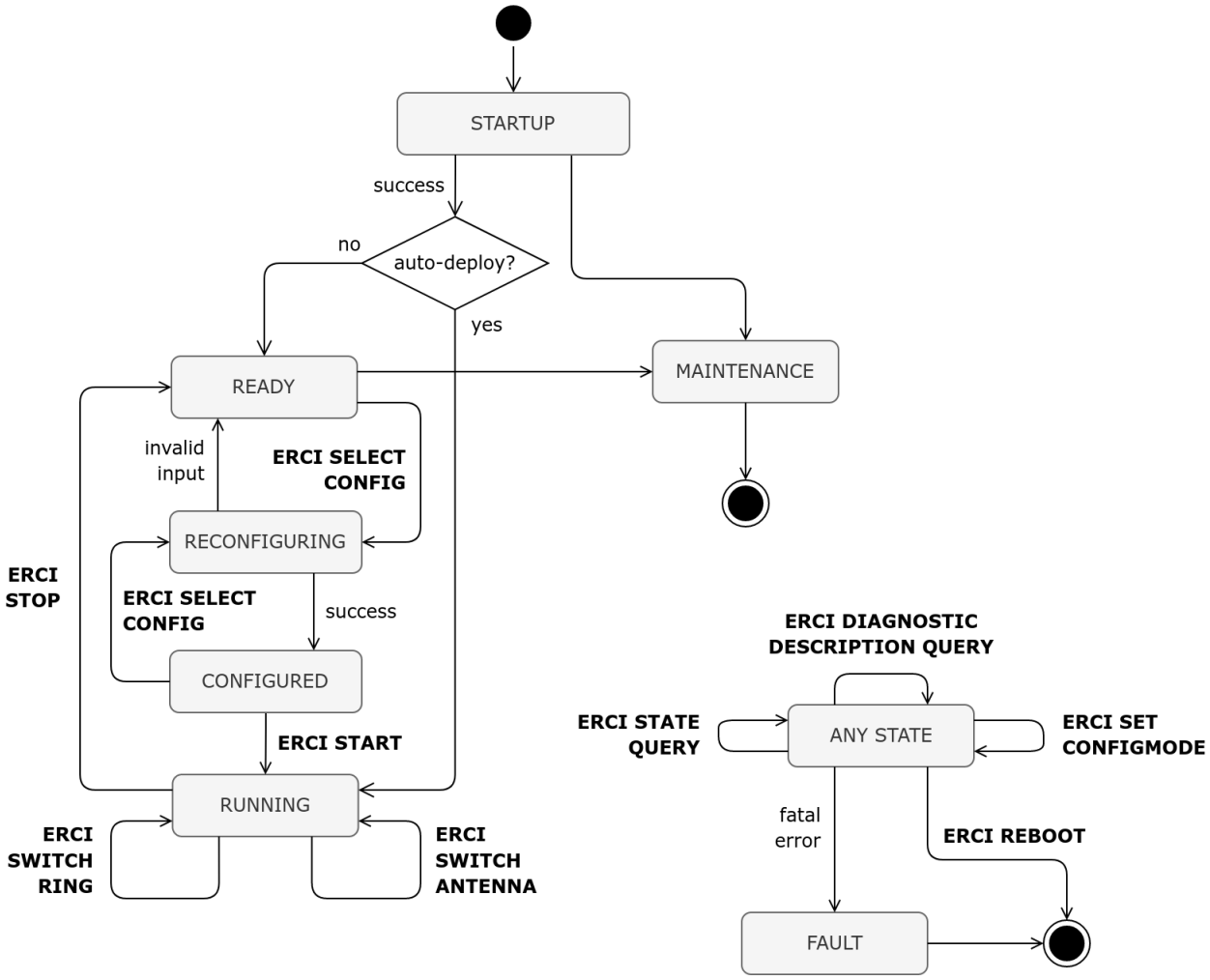
Command Result Codes

Value	Result
0..64	[Reserved]
65	Success
66..69	[Reserved]
70	Generic Error
71	Wrong ERCI State
72	Invalid Message Received
73	Invalid Data Received
74	No Configuration Available
75	Access Denied

ERCI State Machine

ERCI State	Value	Description
INVALID	0	Values of zero are invalid.
STARTUP	1	The device is still booting up.
READY	2	The device is ready to be configured.
RUNNING	3	Bridging over EchoRing is operational.
RECONFIGURING	4	The device is reconfiguring.
FAULT	5	The device is in an unrecoverable fault state and needs to be reset.
MAINTENANCE	6	The device is busy with other activities (i.e. updating, Configuration Mode, ...).
CONFIGURED	7	The device has been configured and is ready to be started (or reconfigured).

ERCI State Diagram



INFO — Transition from STARTUP to RUNNING to support auto-deploy in case of a single configuration. Transition from RECONFIGURING to READY will happen on any invalid input (Config ID, Ring ID, Antenna ID).

8.3 Bridge E Telemetry Interface (BETI) Specification

BETI provides low-overhead access to Bridge E telemetry data.

Mode of Operation

The devices communicate using User Datagram Protocol (UDP) over Ethernet with application-level ACKs (as part of the Command Result message).
All configuration messages will be handled by the Configuration Server or via the ERCI interface.

Initialization

No explicit initialization is required to use BETI.
The Bridge E has a default IP address (192.168.0.183). The IP can be modified during configuration (DHCP or different static IP).

Protocol

- Port 12400
- Network Byte Order
- All commands are synchronous and there is only one active command

INFO — Value 0 is invalid for any ID.

Message Header

Field	Size (B)	Comment
-	1	[Reserved] Value: 0
Protocol Version	1	Value: 1
Type	1	
Sequence number	1	
Payload	n	

Messages

Value	Req (Q)/ Resp (A)	Message Type	Payload	Response	Comment
0		Invalid			
1	Q	ERCI State Query		ERCI State Response	Allowed in any ERCI state
2	A	ERCI State Response	1B ERCI State, 1B Config ID, 1B Ring ID, 1B Antenna ID, 1B MACSTATE, 3B <Reserved>	-	
3		Link State Query		Link State Response	Allowed in state RUNNING

Value	Req (Q)/ Resp (A)	Message Type	Payload	Response	Comment
4		Link State Response	160B link state information 20 * (Addr, Len, SNR) 6B Addr 1B Addr Length 1B SNR 1B MACSTATE		Addr padded from the front: ID 0xAABB → 00:00:00:00:AA:BB The first link state entry is the MAC address of device being queried (its SNR is 0) R3_MAC_STATE_OFFLINE: Station is in OFFLINE state, i.e. stopped and not connected to a ring, or the station lost connection to the ring and did not attempt to reconnect yet (non-HO only) R3_MAC_STATE_HEALTHY: Station is in HEALTHY state, i.e. started and connected to a ring R3_MAC_STATE_INITIALIZED: Station is started, but not yet connected to a ring
5..128		Reserved			These should provide machine-readable low-overhead telemetry data
129	Q	Diagnostic Description Query		Diagnostic Description Response	Allowed in any ERCI state Request ASCII system diagnostics
130	A	Diagnostic Description Response	NULL terminated diagnostic description		ASCII text representation of system diagnostics
131..254		Reserved			
255		Invalid			

Command Result Codes

Value	Result
0..64	[Reserved]
65	Success
66..69	[Reserved]
70	Generic Error
71	Wrong ERCI State
72	Invalid Message Received
73	Invalid Data Received
74	No Telemetry Data Available

8.4 Product Change Notification

Product Change Notification Form 1

PN #: PCN-E-001	**Rev:** 1.0	**Issue Date:** 18-Aug-2022

Type of Change

☒ minor ☐ major

Detailed description of change

Product name changes to Bridge E.

Resulting changes in code marking and changes in its face plate label are documented in Exhibit 1.

Exhibit 2 summarizes all code marketings for this product that are still valid.

Quality Impact

☐ minor ☐ major ☒ none

Reliability Impact

☐ minor ☐ major ☒ none

Reason for change

As the product portfolio of R3 Solutions grows, new product names are necessary to differentiate product families better.

Implementation date

18-AUG-2022

Contact details

R3 Customer Service

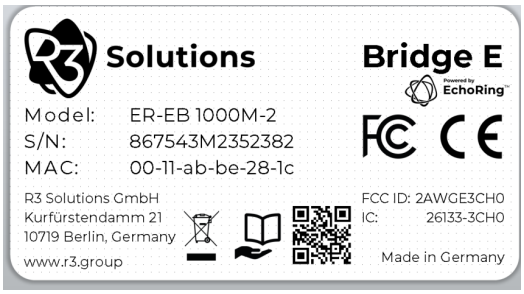
service@r3.group

Affected part number(s)

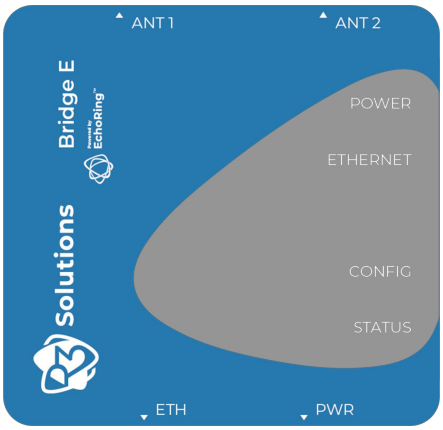
ER-EB 1000M

PCN-E-001 Exhibit 1

New Code Marking (Label)



Face Plant Print



PCN-E-001 Exhibit 2

Existing Code Marking 1

Existing Code Marking 2

Existing Code Marking 3

Existing Code Marking 4

Product Change Notification Form 2

PN #: PCN-E-002	**Rev:** 1.0	**Issue Date:** 20-Aug-2022

Type of Change

☒ minor ☐ major

Detailed description of change

The product is now equipped with an additional antenna port. The product uses only one of the two ports at any given time and can be operated either with only one antenna connected or two antennas connected.

The product package now includes one Bridge E device, one antenna, and one IP65-compatible lid to seal an antenna port if not in use.

Code marking and label changes are documented in the appendix.

Quality Impact

☒ minor ☐ major ☐ none

Reliability Impact

☒ minor ☐ major ☐ none

Reason for change

The extra antenna port on the product now supports roaming between different channels.

Implementation date

20-AUG-2022

Contact details

R3 Customer Service

service@r3.group

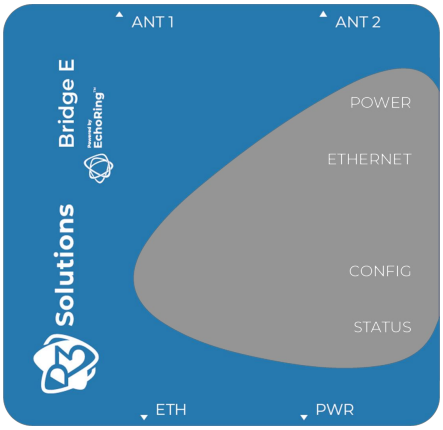
Affected part number(s)

ER-EB 1000M-2 (formerly ER-EB 1000M)

PCN-E-002 Exhibit 1

New Code Marking (Label)

Face Plant Print



List of Acronyms

ACK Acknowledgment 54
BETI Bridge E Telemetry Interface 39, 54
DHCP Dynamic Host Configuration Protocol . . . . . 11, 14 ff., 20, 35, 49, 54
ERCI External Runtime Control Interface . . . . . 18, 21, 39, 41 f., 49, 54
ICS Internet Connection Sharing . . . . . 11 f., 14 ff.
IGMP Internet Group Management Protocol 6, 40, 45
ISM Industrial, Scientific, Medical 5
MAC Medium Access Control . . . . . 20, 24, 32, 34, 37 f., 49
MCS Modulation Coding Scheme 27, 48
NTP Network Time Protocol 16
PoE Power over Ethernet . . . . . 6 f.
RF Radio Frequency 5
SMA Sub-Miniature Version A 10
TCP Transmission Control Protocol 49
TLS Transport Layer Security 49
UDP User Datagram Protocol 54

UM-ER-EB1000M-r26.03