CEREC Radio Device

Operating Manual

This document contains a functional and operational manual for the CEREC Radio Device which implements a wireless network to be used for the communication between acquisition units and milling units in the CEREC system.

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1. Introduction

Thank you for choosing Sirona CEREC Radio Device.

CEREC Radio Device (part no. 6543891 D3492) is a powerful 100 Base-T Ethernet wireless transmission system that allows peripheral devices to build up a wireless network or to access a wired network. The CEREC Radio Device operates in the 2.4 GHz ISM band and complies with FCC, IC and EC regulations.

CEREC Radio Device is easy to install and does not require specific drivers. It can be used with most computers and operating systems.

This manual includes the device's technical data and operating instructions.

In case of problems during the installation or during the operation that cannot be solved with the information given in this manual, please contact the service department of your local dealer or contact:

Sirona Dental Systems GmbH
Fabrikstrasse 31
D-64625 Bensheim
Germany
www.sirona.com

In the USA:
Sirona Dental Systems LLC
4835 Sirona Drive, Suite 100
Charlotte, NC 28273
USA

1.1 Important User Information

CEREC Radio Device (part no. 6543891 D3492) does not require maintenance work or special attendance except for the following instructions outlined below.

CAUTION:

Do not operate the device within the range of strong electromagnetic fields.

Comply with the temperature range for operation mentioned in chapter Technical Data. Avoid overheating.

Protect device against humidity and dust.

Clean device only with a soft cloth and mild cleaning agent. Do not apply water or wet cleaner.

Do not insert any objects into device openings unless specifically mentioned otherwise in this document. This may damage the device.

Do not open the CEREC Radio Device.

The CEREC Radio Device does not contain parts which could be maintained, exchanged or repaired by the customer or non-authorized maintenance personnel.

Opening the device can damage the electric components. A correctly functioning device is no longer guaranteed!

1.2 FCC and IC Declarations

Compliance statement

This device complies with part 15 of the FCC Rules and to Industry Canada's license-exempt RSSs.

Operation is subject to the following two conditions:

(1) this device may not cause harmful interference, and

(2) this device must accept any interference received, including interference that may cause undesired operation.

Le présent appareil est conforme aux CNR d'Industrie 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, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Warning

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This in particular is applicable for the antenna which has been delivered with the CEREC Radio Device.

RF Exposure

To comply with FCC RF exposure requirements for mobile transmitting devices, this transmitter should only be used or installed at locations where there is at least 20cm separation distance between the antenna and all persons.

Information to the User

Note: 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 is 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.

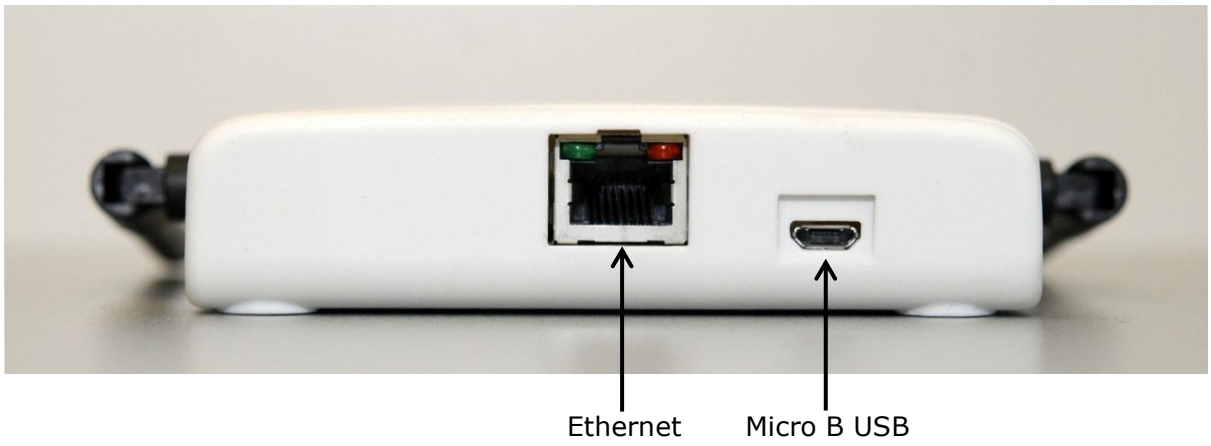
--Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

--Consult the dealer or an experienced radio/TV technician for help.

This device complies with Industry Canada ICES-003: CAN ICES-3 (B)/NMB-3(B).

2. Product Description

2.1 Operational Elements



Ethernet	RJ45 connector for Ethernet 100 Base-T with red and green LED
DC Input	Micro B USB connector for 5V DC power supply

Reset	Opening to press reset button. Use small object to press.

LED Indications

Two LEDs are used to indicate the device's state. Each LED can have the following states:

1. Off
2. Slow blinking
3. Fast blinking
4. On

The following table shows potential states for the device:

State	Orange	Green	Comment
Booting	**Off**	**Off**	Both LEDs are not yet functional.
Networking	**Slow**	**Slow**	Typically only seen when setting up a new network.
Connecting	Off	**Slow**	
Disconnected	**On**	**Slow**	Should preferably not occur since the network unit should be connected.
Connected	Off	**On**	Device is functioning properly.
Transmitting	Off	**Fast**	Fast blinking for data transfer.
Error	**Fast**	**Fast**	Failure in data communication.

3. Specifications

Dimensions:	Approx. 104 x 75 x 24 mm³
Weight:	Approx. 100 g
Operating Temperature:	0...40 °C
Storage Temperature:	-25..80 °C
Power Supply:	5.0 V DC (1.4 W max.)
Data Interface:	100 Base-T Ethernet
Radio Band:	2402 .. 2480 MHz
Transmit Power:	Max. 10 mW (+10dBm)
Standards:	EN60950-1:2006+A12:2011 EN301489-1/-3 EN300440-02 V 1.4.1 AS/NZS4268:2008 FCC: 47 CFR part 15 RSS-210
Conformity:	R&TTE, FCC and IC
Modulation:	GFSK
Multiplexing:	None
Air Data Rate:	1.0 Mbit/s
Payload Data Rate:	Up to 300 Kbit/s
Antennas:	2 x omni-directional, integrated reverse SMA (Male), vertical polarization, ¼ dipole, 2.0 dB gain. At each time one antenna is used for transmitting (Tx) and the other one for receiving (Rx).
Range:	Line-of-sight; up to 60 m inside buildings, up to 300 m in open field.
Operating Elements:	Push Button on backside Two LEDs
Housing:	Plastic housing
Installation:	Desktop or wall mount installation
Accessory:	AC/DC adapter Type FW7662/05 Input 100-240VAC / 50-60Hz / 150mA Output 5V DC / 1.1 A

4. System Description

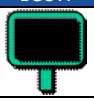
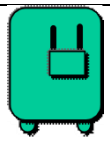
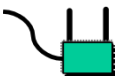
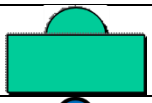
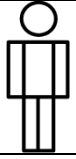
This chapter describes the context of the CEREC Radio Device by describing the main function and identifying the system components.

4.1 CEREC System

Mobile acquisition unit and a stationary milling unit.
The acquisition unit generates the restoration data which is to be transmitted to the milling unit.
The acquisition unit completes this by setting up a TCP/IP connection to the milling unit.
An Ethernet infrastructure is required to facilitate this.
This can be implemented by a standard wired LAN infrastructure, Wi-Fi or the CEREC Radio Device system as described in this document.

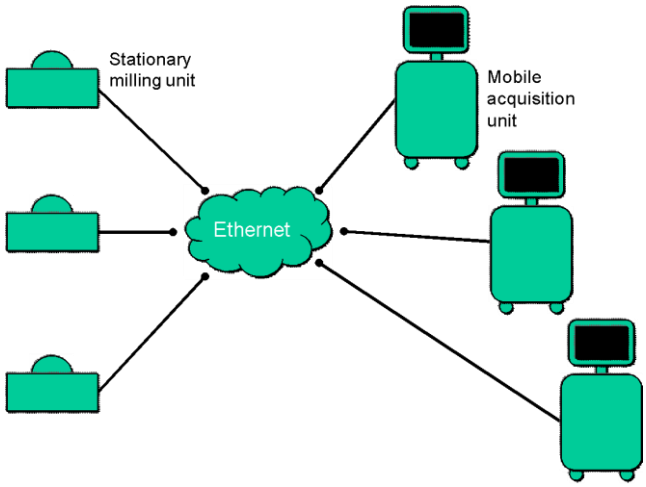
4.2 System Components

The identifiable components and their role in the CEREC system are listed below:

Actor	Description	Role	Icon
Acquisition unit	The PC platform that is used to acquire the dental data.	Data source. Initiates the transmission to a milling unit.	
Network unit	A wireless transceiver that has an Ethernet connector. The Ethernet socket also has LEDs to indicate the status.	Wireless node in the network.	
Mobile network unit	A network unit which is installed inside an acquisition unit.	The network unit for the acquisition unit.	
Stationary network unit	A network unit is either attached to the milling unit directly or connected to a LAN.	Wireless end-point for the data communication to the milling unit.	
Milling unit	Receives the data and processes it to mill a restoration.	Data receiver.	
Operator	Person possessing technical knowledge (either by experience, instruction or education) about the operational details of the network.	Performs all infrastructural changes to the network using technical knowledge.	
Dentist	User who does not possess any technical knowledge about the working of the network.	Uses the network to transmit data.	

4.3 Main Function

The objective of the CEREC Radio Device is to obtain a reliable wireless data connection between a stationary milling unit and a mobile acquisition unit. The wireless network that is created can then be used to transmit time constraint data.



For the acquisition units and milling units there is no difference between the CEREC Radio Device and a wired LAN; the connection is completely transparent.

4.4 Network Unit

The CEREC Radio Device comprises a number of wireless *network units* that together create a wireless network. These network units implement a proprietary Sirona protocol specially developed to comply with time constraint transmission requirements that followed from the CEREC Radio Device use cases.

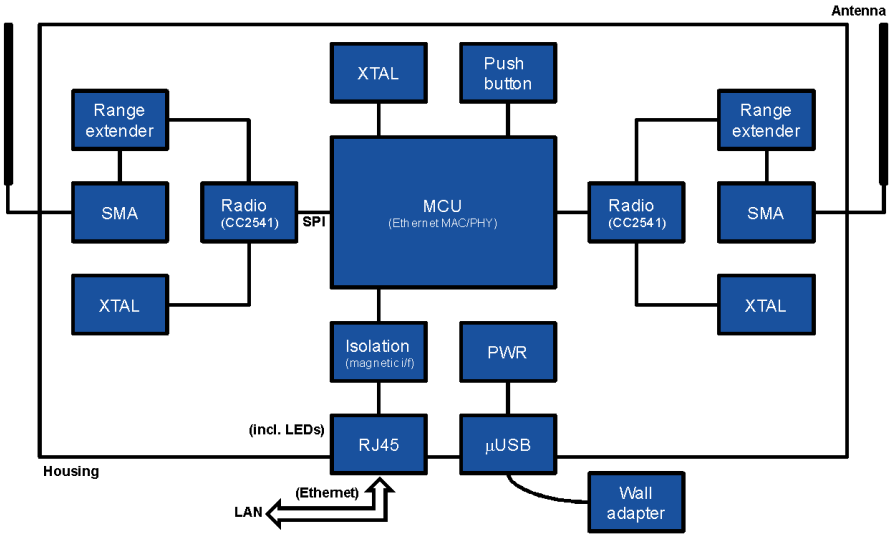
The basic functionality of a network unit is to convert incoming Ethernet data into a number of wireless packages and forward these to one or more selected neighboring network units and vice versa. This functionality is comparable to an Ethernet network switch. As such, this network can be used as a wireless LAN and is completely transparent for any Ethernet communication.

Using this functionality, a link between two network units can support the data communication of an acquisition unit and milling unit.

A network unit can appear in four roles:

- Directly connected to a milling unit using a LAN cable and powered by the supplied wall adapter.
- Built into an acquisition unit where it is directly connected to the internal PC via a LAN cable and powered via the USB 3.0 connection of the PC.
- Connected to another network unit via a LAN cable and powered by the wall adapter.
- Connected to a LAN infrastructure, i.e. to a hub or switch and powered by the wall adapter.

The schematic representation of a network unit is shown below.



As illustrated, the network unit has four connectors:

- ***Antenna***
  The network unit has two antennas that are screwed on during production. Do not remove these antennas or use different antennas.
- ***Micro B USB***
  For power the network unit has a standard micro B USB connector. A standard supplied 5V power adapter can be plugged into this connection. However, any standard USB 3.0 connection can be used to power the network unit. The network unit integrated in the CEREC mobile acquisition unit is powered in this way.
- ***RJ-45***
  A network unit has a RJ45 socket to which a standard LAN cable (CAT5) can be connected. As such the network unit can be connected to any other Ethernet communication device or to a Ethernet interconnecting device such as a hub or switch, i.e. connected to the LAN infrastructure. This is explained further in "Connecting to LAN infrastructure".

5. Networking

This section describes the networking functionality of the CEREC Radio Device. The following lists the chapters:

- CEREC Radio Device network overview
- Creating a network
- Network creation failures
- Extending the network
- Increasing network coverage
- Reset to factory defaults
- Network unit states
- Radio characteristics

5.1 CEREC Radio Device Network Overview

The network units in the CEREC Radio Device network create a so called peer-to-peer mesh network. This means that there is not a master or slave as with Bluetooth or a central controlling access point as with Wi-Fi.

As such there is no distinction between a network unit connected to a milling unit, one that is built into an acquisition unit or one that is connected to a LAN infrastructure: any network unit belonging to the same network (see "Create a network") can communicate which each other as soon as they are in each other's range. This is also applicable when they are out of range of all other network units making the network connections very flexible.

This wireless network operates in the 2.4GHz band which is available worldwide for license-free operation. It therefore needs to be able to operate in coexistence with other wireless networks such as Wi-Fi or Bluetooth. The network accomplishes this by avoiding congested channels when possible. However, the network is not immune to interferences caused by these other wireless technologies. The result of these interferences can be a reduced range or lower performance. The network technology therefore offers several easy mechanisms by which a network can be extended to achieve better coverage (see "Extending the network").

The network can also easily be extended and the coverage increased, using LAN cables or even an existing LAN infrastructure (see "Increasing network coverage").

5.2 Creating a Network

Network units that come out of the box have never been part of a network. To allow for several networks of different owners to operate side-by-side or in the same area, new network units must first create a network. This is described in the following section.

5.2.1 Creation

To create a new network with a number of new network units the following steps must be completed:

1. Bring all network units together in one room.
2. Power-up all network units within 1 minute of each other.
3. Wait approximately one minute after the last network unit was powered-up.
4. Check that all the network units are connected, indicated by the green LED (see "LED indications").

When completed, all network units will belong to a single network and can operate as an independent network as well as communicate with each other. The created network is unique worldwide.

See "Network creation failures" should a problem arise.

5.2.2 Isolated Network Unit

A unique network is only created when two or more network units are present. In case of an isolated network unit, no network is created until another network unit is within range.

5.2.3 Persistent Network

When a network unit has been added to a network, the network ID is stored permanently. When network units are power cycled, they will rejoin the network.

5.2.4 Installation

After the network is created, the network units can be switched-off and placed at their designated locations e.g. connected to milling units.

Since the network creation is permanent, when powered cycled the network units will remain part of the network. This applies even if they are placed outside of range of other network units, for example in case of an isolated milling unit in a separate room.

5.2.5 Maximum Size

There can be a maximum of 10 network units in one network. Larger networks are not possible.

5.3 Network Creation Failures

The following chapter describes potential issues which could arise when creating a new network and offers solutions for each scenario.

5.3.1 Isolated Network Unit

When a single network unit is powered-up too late it may not be part of the network. This can be identified if the LED does not turn green.

This situation is the same as when a new network unit is added to an existing network. This is described in "Extending the network".

5.3.2 Multiple Networks Created

When more than one network unit is powered-up too late, these network units could form their own network.

Initially this will not be clear because all network units will indicate that they have connections to other network units showing a green LED (see "LED indications").

Networking	**Slow**	**Slow**	In most cases only seen by the operator when setting up a new network.
Connecting	Off	**Slow**	
Disconnected	**On**	**Slow**	Should preferably not happen since you want the network unit to be connected.
Connected	Off	**On**	All's fine. Should be the normal situation.

One way of checking this is to connect a PC with fixed IP address to each network unit and try to ping the PCs from another PC. Another way is to switch-off all but one network unit. Then complete the following steps for each additional network unit:

1. Turn-on a network unit.
2. Wait until the orange LED turns off.
3. LED turns green, the network unit belongs to the network.
4. Go to the next network unit.

When a network unit is not connected, the orange LED is continuously on. When this occurs the network unit must be reset to factory defaults (see "Reset to factory defaults") and then added to the network by power-cycling one of the other network units (see "Extending the network").

5.4 Extending the Network

Additional new network units can be added to an existing network. This section explains how this is done.

5.4.1 Add New Network Unit

New network units can be added to an existing network. However, to prevent any network unit from becoming part of the network, the user must complete four simple but specific steps:

1. Place the new network units next to a network unit belonging to the network.
2. Switch-on the new network units.
3. Within one minute, power-cycle the existing network unit.
4. After one minute the new network units will become part of the network.

5.4.2 Reduce Network

In some cases it may be necessary to remove one or more network units from an existing network.

Sequence:

1. Network unit C is switched-off.
2. After approximately 5 seconds both network units A and B detect the lost connection to network unit C.

Notes:

- There is not a difference if the network unit C would be moved out of the range of the network other than having a transition period.
- It does not matter whether the connection between the network units is wireless or via LAN.

The network units by themselves cannot distinguish the difference between a network unit that is switched off and is to be removed from the network and a situation in which the network unit is moved out of range. The removed network unit will still occupy an entry in the network information administration. Normally this does not affect the performance of the network at all.

However, since the number of network units in the network information administration is limited, this can be a problem if a network unit is removed a number of times.
To clear the list of detected network units the network units can be power-cycled.

5.5 Increasing Network Coverage

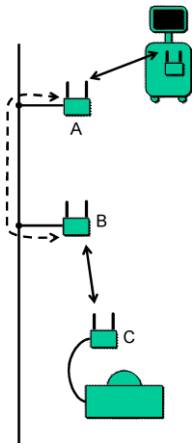
This chapter describes how the network coverage can be increased in case the network suffers from severe interference or needs to cover long distances.

5.5.1 LAN Cable Extension

Normally, a network unit is either connected to a milling unit or to the PC inside the acquisition unit. With this configuration the communication always goes from the PC to the connected network unit, then to the neighboring network unit which is connected to the milling unit and finally to the connected milling unit: AC PC → network unit → network unit → milling unit

For a network unit it does not matter where the Ethernet data is coming from. It simply will forward the data.

Should the network suffer from severe interference or needs to cover distances longer than the transmission range, additional network units can be added and interconnected using a LAN cable.



1. In the communication the mobile network unit in the acquisition unit sends the packet to stationary network unit A.
2. Stationary network unit A forwards the packets onto the LAN.
3. Stationary network unit B receives the packet and forwards it to the wireless network, i.e. to stationary network unit C.
4. Stationary network unit C forwards this packet to the connected milling unit.

Note that the basic functionality of a network unit is to relay data from the Ethernet connection onto the wireless network and vice versa. Extending the network is always done using LAN cables. Simply placing an extra network unit in between two network units that are out-of-range does not work since this would mean relaying data from wireless to wireless. This is not implemented in the CEREC Radio Device because this would quickly lead to unsatisfactory performance in most cases.

5.5.2 Connecting to Ethernet Infrastructure

The network units can also be connected to an existing LAN infrastructure.

In this way, the flexibility of increasing the coverage is very straightforward.

5.6 Reset to Factory Defaults

A network unit that was previously part of a network can be removed from this network.

This is completed by holding the reset button for five seconds.

This will reset the network unit to factory defaults.

5.7 Network Unit

The proper behavior of a network unit can be identified by its state. This chapter describes the states that can be identified for a network unit. To provide feedback on the proper operation of the network unit to the user, these states are also mapped onto LED indications.

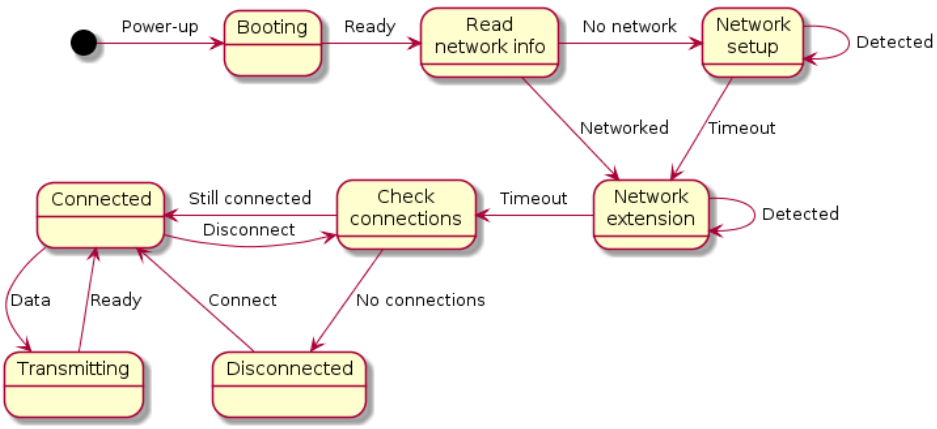
5.7.1 State Definitions

The following states can be identified for a network unit:

State	Description
Booting	The firmware is starting up the network unit.
Read network info	Network information is read from persistent memory.
Network setup	The network unit was not previously part of a network and is trying to detect other network units to create a new network.
Network extension	The network is created, but still new network units can be added to extend the network.
Check connections	Checking whether the network unit is still in range of (has a connection to) one or more neighboring network units.
Disconnected	Part of a network, but not in range of other network units.
Connected	Connected to one or more network units.
Transmitting	Relaying Ethernet packets from wireless to the LAN and vice versa.
Error	Hardware fault.

5.7.2 State Transitions

The transitions between these states are given in the following figure:



The transitions are described in the following table:

State	Transition	Description
Initial	Power-up	Boot program starts-up after reboot or power on.
Booting	Ready	The firmware is started.
Read network info	No network	The network unit was not previously part of a network. A network setup timer of **1 minute** is started.
Read network info	Networked	The network unit was part of a network before, i.e. the network unit is power-cycled.
Network setup	Detected	A new network unit was detected and will be added to the network. The timer is restarted.
Network setup	Timeout	The network is created and stored persistently in the network unit. A network extension timer of **1 minute** is started.
Network extension	Detected	A new network unit was detected and will be added to the network. The timer is restarted.
Network extension	Timeout	The network set-up finished.
Check connections	Still connected	The network unit has connections (i.e. is still in range), to one or more of its neighboring network units.
Check connections	No connection	There are still no connections.
Connected	Disconnect	The network unit lost the connection to its last neighbor and is effectively isolated.
Connected	Data	The network unit received an Ethernet frame which is to be forwarded to one of its neighbors.
Transmitting	Ready	Ready transmitting data.
Disconnected	Connect	A connection was established with another network.

5.7.3 LED Indications

1. Two LEDs are used to indicate the device's state. Each LED can have the following states: Off
2. Slow blinking
3. Fast blinking
4. On

The following table shows potential states for the device:

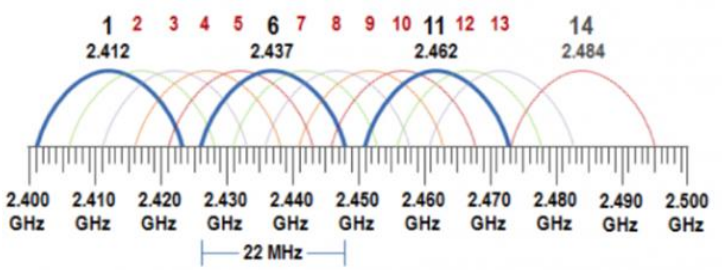
State	Orange	Green	Comment
Booting	**Off**	**Off**	Both LEDs are still not functional.
Networking	**Slow**	**Slow**	In most cases only seen by the operator when setting up a new network.
Connecting	Off	**Slow**	
Disconnected	**On**	**Slow**	Should preferably not happen since you want the network unit to be connected.
Connected	Off	**On**	All's fine. Should be the normal situation.
Transmitting	Off	**Fast**	Fast blinking is data transfer.
Error	**Fast**	**Fast**	Failure in data communication.

5.8 Radio Characteristics

This chapter describes some technical details about the radio which might be required for more advanced setups when the system must operate and coexist in an environment with several wireless systems.

5.8.1 Frequency Spectrum

The CEREC Radio Device network units each receive a 2 MHz channel assigned in the 2.4 GHz band. The Wi-Fi channels in this band are illustrated in the figure below.



5.8.2 Channel Control

Each network unit uses a specific channel on which it can receive data.

5.8.3 Channel Switching

When the network unit is idle i.e. not supporting ongoing data stream between an acquisition unit and a milling unit, it monitors the received signal strength on its channel.

Whenever it detects signal strength above a certain threshold for more than a few seconds the network unit will switch to a channel.

6.Use Cases

To further explain the functionality as implemented in the CEREC Radio Device, this section describes the scenarios of some use cases in more detail.

The following use cases are described:

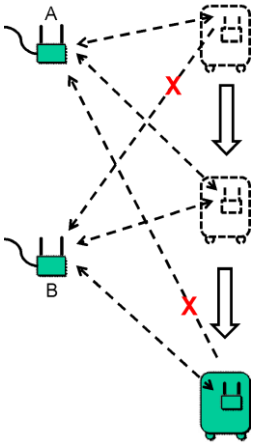
- Moving around
- Transmit data wirelessly
- Transmit data using LAN
- Interrupted transmission

6.1 Moving Around

One of the obvious benefits of having a wireless network is that the acquisition units can be moved to different locations. When moved the acquisition unit can be moved in and outof the range of other network units. This chapter describes some typical scenarios.

6.1.1 Moving Within Network

While being moved, the mobile network unit always stays within one or more network units.



Preconditions:

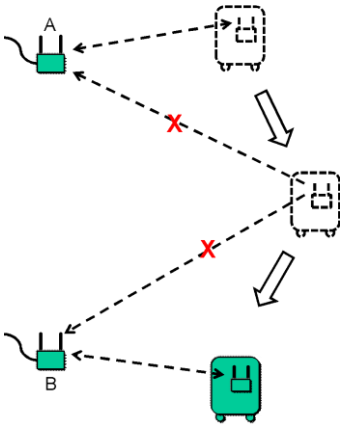
- All network units belong to the same network.
- The mobile network unit is in range of stationary network unit A.
- The mobile network unit is out of the range of stationary network unit B.

Sequence:

1. The mobile network unit is pushed into range of stationary network unit B.
2. The mobile network unit establishes the connection with stationary network unit B.
3. The mobile network unit is pushed out of the range of stationary network unit A.
4. The mobile network unit loses the connection to stationary network unit A.

6.1.2 Temporarily Disconnected

While being moved, the mobile network unit temporarily moves outside the network clusters and has no more connection.



Preconditions:

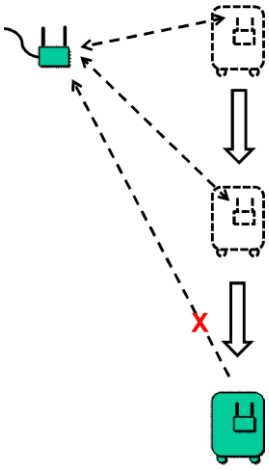
- The mobile network unit is in range of stationary network unit A.
- The mobile network unit is out ofthe range of stationary network unit B.

Sequence:

1. The mobile network unit is pushed out of the range of stationary network unit A.
2. The mobile network unit has no connection to other network units.
3. The mobile network unit is pushed in range of stationary network unit B.
4. The mobile network unit (re)establishes a connection stationary network unit B.

6.1.3 Disconnected

While being moved, the mobile network unit moves outside the clusters and loses the connection to the network.



Preconditions:

- The mobile network unit is in range of the stationary network unit.

Sequence:

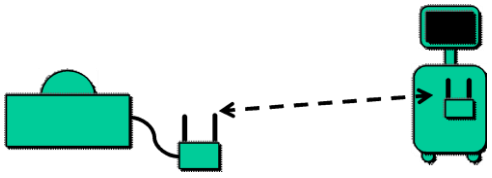
1. The mobile network unit is pushed away from the stationary network unit.
2. The mobile network unit detects that the connection to the stationary network worsens.
3. The mobile network unit is pushed out of the range of the stationary network unit and loses the connection.

6.2 Transmit Data Wirelessly

This chapter describes the scenarios of the use cases in which the system does not use LAN infrastructure to communicate, but only the peer-to-peer mesh network.

6.2.1 Stationary Data Transmission

The mobile network unit stays connected to the same stationary network unit while transferring the data.



Preconditions:

- The acquisition unit is in range of the stationary network unit.
- The stationary network unit is connected to a milling unit.
- The acquisition unit wants to start transmitting data to the milling unit.

Sequence:

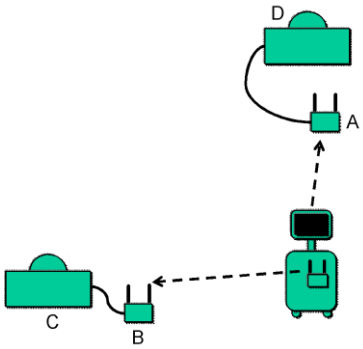
1. The acquisition unit sends a packet to the connected mobile network unit.
2. The mobile network unit forwards the packet to the stationary network unit.
3. The stationary network unit forwards the packet to its connected milling unit.
4. The milling unit receives the packet.
5. The milling unit sends an acknowledgement.
6. This acknowledgement is received and forwarded by the connected stationary network unit.
7. The mobile network unit forwards the acknowledgement to the acquisition unit.

Notes:

- The data that is contained in the packet as was filled by the acquisition unit or milling unit is not important.

6.2.2 Network Routing

The mobile network unit has a connection to several stationary network units that each are connected to a milling unit. Therefore the mobile network unit has to determine which stationary network unit to use.



Preconditions:

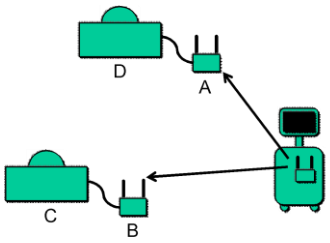
- The acquisition unit is in range of two stationary network units A and B.
- Each stationary network unit is connected to a milling unit.
- An acquisition unit wants to start transmitting data to a milling unit C.

Sequence:

1. The acquisition unit sends the first data to the connected mobile network unit.
2. The mobile network unit forwards the data to both stationary network units.
3. Both stationary network units forward the data to their connected milling unit.
4. Only milling unit C will process the data.
5. Milling unit C sends the confirmation.
6. The confirmation is received and forwarded by the connected stationary network unit B.
7. The mobile network unit forwards the data to the acquisition unit.
8. The steps are repeated until the mobile network unit is confident that the link to stationary network unit B is the one to use.
9. After this, the data is only transmitted to stationary network unit B.

6.2.3 Multiple Streams

The mobile network unit has a connection to several stationary network units that each are connected to a milling unit. The acquisition unit is transmitting data to all milling units.



Preconditions:

- The acquisition unit is in range of two stationary network units A and B.
- Each stationary network unit is connected to a milling unit.
- An acquisition unit is transmitting data to a milling unit D using stationary network unit A.

Sequence:

1. At one point in time, while the transmission to milling unit D is still ongoing, the acquisition unit starts a transmission to milling unit C using another stationary network unit B.
2. Because the mobile network unit in the acquisition unit now has to support two data streams, the effective data rate available for both data streams will be lower.
3. When one of the data streams is stopped, the effective data rate for the remaining data stream will again be at its maximal level.

Notes:

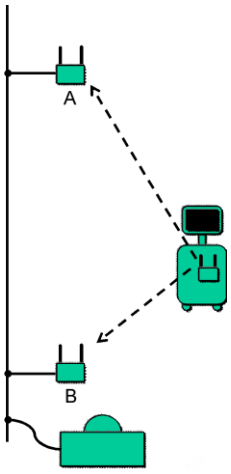
- There is only a practical limit to the number of data streams since at a certain number the effective data rate will no longer be acceptable.

6.3 Transmit Data Using LAN

As described in "Increasing network coverage", data can also be transmitted by using LAN as a means of increasing the coverage of the network. The main scenarios associated with this functionality are described in this chapter.

6.3.1 LAN Routing

In the example below the mobile network unit has a connection with two stationary network units which are connected to the same the LAN infrastructure as the milling unit.



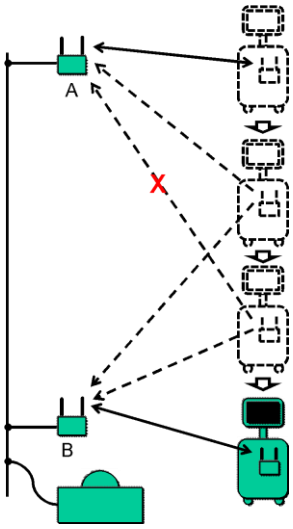
When the acquisition unit wants to send data to the milling unit for the first time, the network unit inside the acquisition unit must determine which connected stationary network unit to use. The following sequence describes the steps taking place on the LAN:

1. The mobile network unit forwards the data to both stationary network units.
2. Both stationary network units forward the data onto the LAN.
3. The data sent on the LAN by one stationary network unit is received by the other, but is discarded.
4. The milling unit receives the data from both stationary network units, but discards the second copy as per the TCP/IP functionality.
5. As a result of the received data, the milling unit sends data which could, for example, contain a confirmation.
6. This data is received by both stationary network units.
7. Both stationary network units forward this data to the mobile network unit connected to the acquisition unit.
8. The mobile network unit only forwards both copies to the acquisition unit, but uses the second copy to determine which stationary network unit, to use for the subsequent communication to the milling unit. This decision is based on the signal strength.

The resulting functionality is similar to that of a network switch. The resulting situation will be that only stationary network unit B will forward the data that it receives over the LAN meant for the acquisition unit. Stationary network unit A discards these.

6.3.2 Handover

The mobile network unit moves out of the range of the stationary network unit that it uses for data transmission to the milling unit and consequently loses the connection. When it is in range of another stationary unit, the mobile network unit will switch to that one.



Sequence:

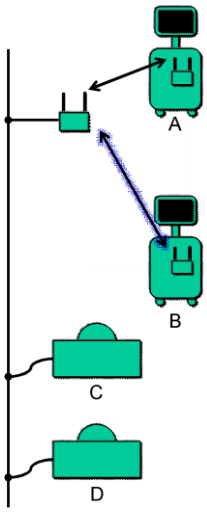
1. The acquisition unit is pushed into range of stationary network unit B.
2. The mobile network unit will connect with stationary network unit B.
3. The acquisition unit is pushed out of the range of stationary network unit A.
4. Data transmission will be temporarily interrupted.
5. The mobile network unit will eventually detect that the connection to stationary network unit A is lost.
6. The data transmission will continue using the connection to stationary network unit B.

Notes:

- This is a hard handover in which no decision process is implemented whether or not the data transmission could better use the connection to stationary network unit B when this connection comes available.

6.3.3 Simultaneous Access

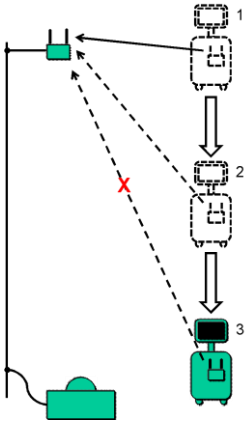
Several acquisition units are transmitting their data via the same stationary network unit.



For acquisition unit B the effective data rate is lower than compared to the situation if the stationary network unit was not shared.

6.4 Interrupted Transmission

The acquisition unit is pushed out of the range of the stationary network unit and no alternative path to the milling unit is available.



Sequence:

1. The acquisition unit is pushed out of the range of the stationary network unit.
2. After a while, both the mobile network unit and stationary network units will detect that no packets are exchanged anymore.

The mobile network unit will try but fail to reconnect with other network units.