Installation- and Operating instructions for

CU8890-0000

WLAN Controller with USB Input

Preliminary - Int

Preliminary - Internal Only

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BECKHOFF

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Foreword

Notes on the Documentation

This description is only intended for the use of trained specialists in control and automation engineering who are familiar with the applicable national standards. It is essential that the following notes and explanations are followed when installing and commissioning these components.
The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

Liability Conditions

The documentation has been prepared with care. The products described are, however, constantly under development. For that reason the documentation is not in every case checked for consistency with performance data, standards or other characteristics. In the event that it contains technical or editorial errors, we retain the right to make alterations at any time and without warning. No claims for the modification of products that have already been supplied may be made on the basis of the data, diagrams and descriptions in this documentation.

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State at Delivery

All the components are supplied in particular hardware and software configurations appropriate for the application. Modifications to hardware or software configurations other than those described in the documentation are not permitted, and nullify the liability of Beckhoff Automation GmbH.

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Description of safety symbols

The following safety symbols are used in this operating manual. They are intended to alert the reader to the associated safety instructions.

DANGER	**Acute risk of injury!!** If you **do not** adhere the safety advise adjoining this symbol, there is immediate danger to life and health of individuals!

WARNING	**Risk of injury!** If you **do not** adhere the safety advise adjoining this symbol, there is danger to life and health of individuals!

CAUTION	**Hazard to individuals!** If you **do not** adhere the safety advise adjoining this symbol, there is obvious hazard to individuals!

Attention	**Hazard to devices and environment** If you **do not** adhere the notice adjoining this symbol, there is obvious hazard to materials and environment.

Note	**Note or pointer** This symbol indicates information that contributes to better understanding.

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Product Description

Product Overview

View of the CU8890-0000 WLAN Controller

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The CU8890 WLAN controller is an industrial grade data exchange unit for radio technology. The CU8890 is based on the standard IEEE 802.11 b/g and is designed for control cabinet installation. Connected to a Beckhoff Industrial PC the CU8890 can be used either as access-point or as client. Client drivers are available for Windows XP, XP Embedded as well as Windows CE, thus for each Beckhoff IPC as well as the CX-series. These support also adhoc modus.

With the drivers for Windows XP and XP Embedded, the CU8890 can also operate as an access-point.

The encryption methods are possible from AES-128 bit up to WPA2, the module is compatible to Cisco CCX and supports PEAP and LEAP. The data rate is adapted dynamically up to 54 Mbit/s.

The CU8890 has a reverse SMA plug for connection of various radio antennas. The free choice of antenna enables adaptation to the respective environment. Beckhoff offers a complete accessories program of antennas and cables.

The outdoor range between two modules depends on the environment and can be up to 300 m.

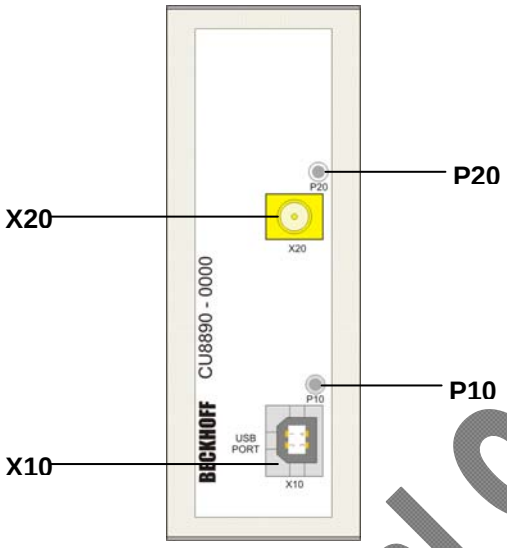
It is possible to choice between 11 channels in the 2.4 GHz-band while following the country specific rules. The status and the data transfer are indicated by LEDs, so providing quick and simply diagnostic.

Other outstanding features are:

- user-friendly installation via integrated top hat rail adapter
- power supply via USB - no supply voltage necessary
- IEEE 802.11 b/g and TCP/ UDP IP standard
- maximum 54 Mbit/s data range
- compact industrial design
- clear quick diagnosis by separate LEDs.

Connectors and LED Diagnostics

View of the connectors and LED diagnostics



Power Supply

Power supply

The power supply is realized by the USB connector.

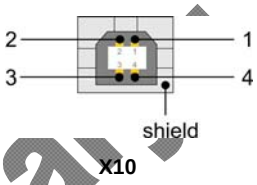
Data Connector

Data connector

The WLAN-Controller CU8890 is connected to the Industrial PC via the USB Port type B **(X10)**. The pins are described below:

USB Type B Port (X10) (Standard-Cable)

USB Type B Port



Pin	Signal
1	VCC
2	Data -
3	Data +
4	GND
Shield	shield

Antenna Terminal

Antenna terminal

The CU8890 has a reverse SMA plug **(X20)** for connection of various radio antennas. The free choice of antenna enables adaptation to the respective environment.

LED-Diagnostic

States for the LEDs

The following table shows the possible states for the LEDs:

LED	Assignment	Status	Meaning
P10	Power LED	off	No power supply connected
		lights	Power supply via USB Port
P20	WLAN active	off	WLAN not active
		lights	WLAN active

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Installation Instructions

Please also refer to chapter ***Foreword***.

Transport and Unpacking

The specified storage conditions must be observed (see chapter *Technical data*).

Transport

Despite the robust design of the unit, the components are sensitive to strong vibrations and impacts. During transport, the unit should therefore be protected from excessive mechanical stress. Therefore, please use the original packaging.

Attention	**Danger of damage to the unit** If the device is transported in cold weather or is exposed to extreme variations in temperature, make sure that moisture (condensation) does not form on or inside the device. Prior to operation, the unit must be allowed to slowly adjust to room temperature. Should condensation occur, a delay time of approximately 12 hours must be allowed before the unit is switched on.

Unpacking

Proceed as follows to unpack the unit:

1. Remove packaging.
2. Do not discard the original packaging. Keep it for future relocation.
3. Check the delivery for completeness by comparing it with your order.
4. Please keep the associated paperwork. It contains important information for handling the unit.
5. Check the contents for visible shipping damage.
6. If you notice any shipping damage or inconsistencies between the contents and your order, you should notify Beckhoff Service.

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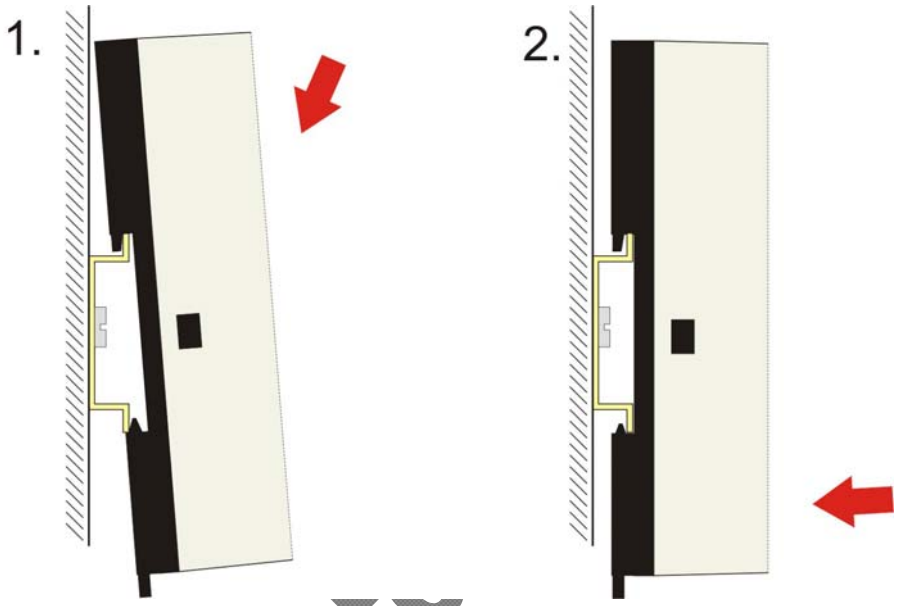
Mounting / Unmounting

The CU8890 can be snapped onto a 35 mm mounting rail conforms to EN 50022.

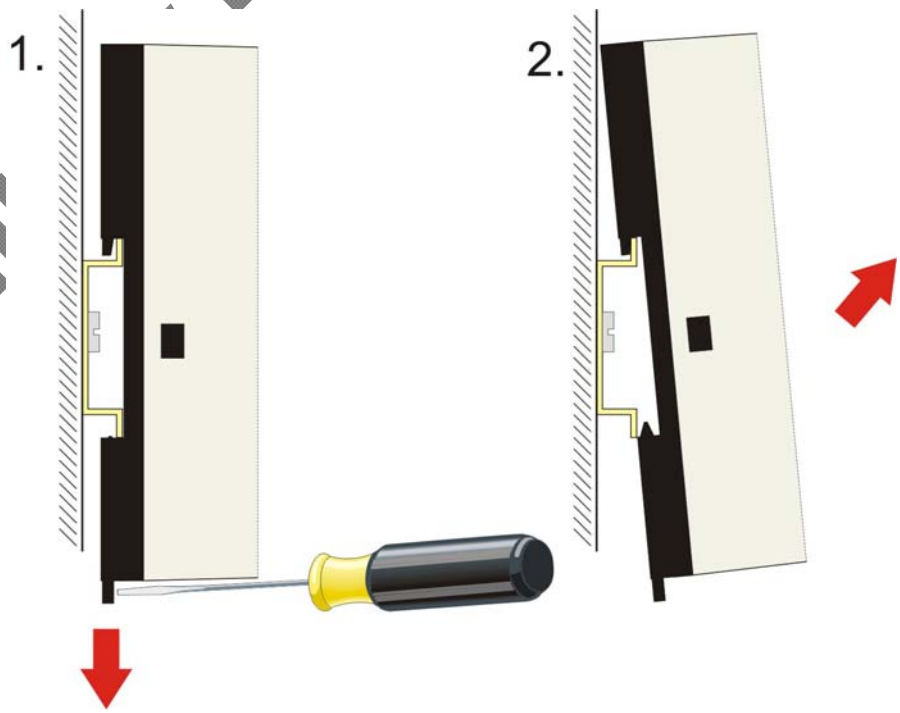
Mounting the WLAN-Controller

Just push the unit on the upper side under the rail **(figure 1)** and snap in the lower side as shown below **(figure 2)**:



Unmounting the WLAN-Controller

To release the CU8890 from the mounting rail pull down the locking clip with a screwdriver **(figure 1)** and pull off the device from the rail **(figure 2)**:



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Connecting devices

Attention	**The power supply plug must be withdrawn** Please read the documentation for the external devices prior to connecting them. During thunderstorms, plug connector must neither be inserted nor removed. When disconnecting a plug connector, always handle it at the plug. Do not pull the cable!

Connecting cables

The connections are documented in the section *Product Description*.

When connecting the cables to the CU8880, proceed according to the following sequence:

- Switch off all the devices that are to be connected.
- Disconnect all the devices that are to be connected from the power supply.
- Connect all the cables between the CU8880 and to the devices that are to be connected.
- Reconnect all devices to the power supply.

Connecting Power Supply

The power supply is realized by the USB connector.

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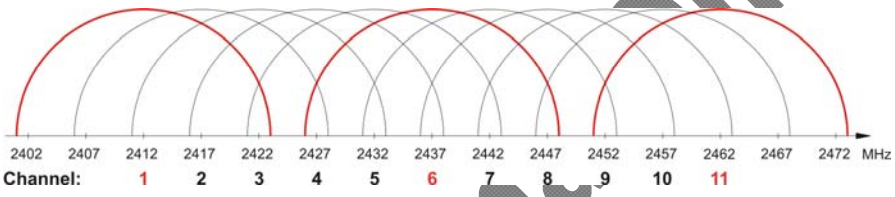
Operating Instructions

IEEE 802.11 Standard

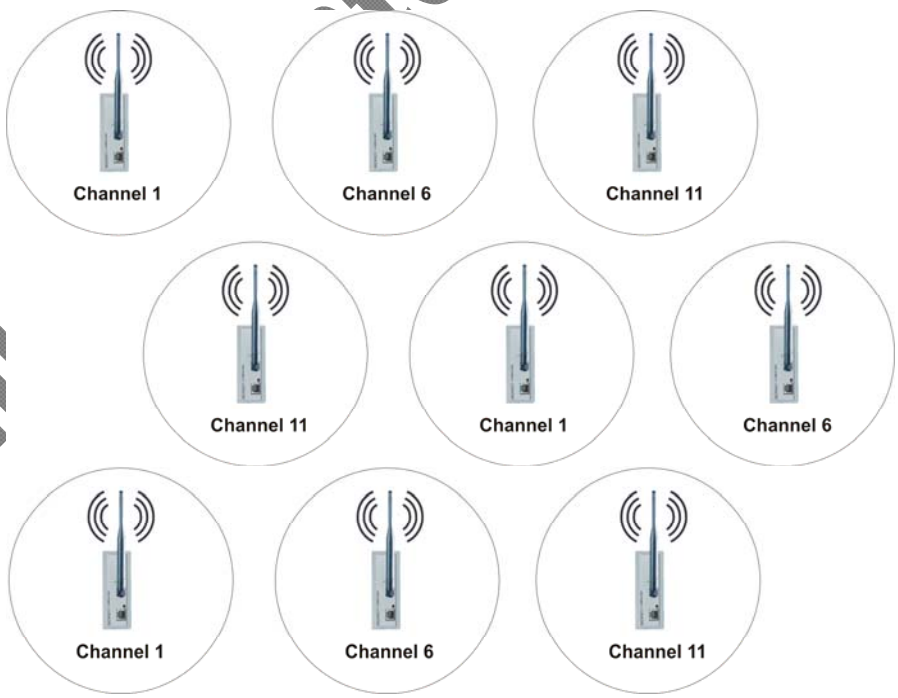
Wireless LANs (WLANs) are local radio networks with main reference to wireless computer networks. The IEEE 802.11 standard was first published in 1997.
Basically the standard allows either the wireless connection of two (or more) PCs (or laptops) with each other directly (adhoc) or to expand an existing wired computer network with an infrastructure (access points) for wireless users.
The most popular standard is the IEEE 802.11 b/g that provides a data transfer rate up to 54 MBit/s for the 2.4 GHz band. The data rate is adjusted dynamically.
The standard provides 11 channels worldwide, but only 3 can be used without overlapping:

Channel overlapping



When using the network in a confined area (e.g. in a factory building) notice the following comb-shaped structure with a channel difference of 5 channels to each neighbor cell:

Comb-shaped



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Antennas

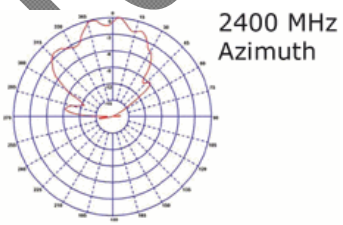
The use of the CU8890-0000 is permitted with the following antennas:

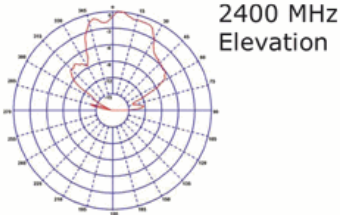
Designation	Description
ZS6100-0900	Directional antenna (gain 9 dBi), without cable
ZS6200-0400	Omni directional antenna (gain 4 dBi), without cable
ZS6201-0410	Rod antenna (gain 4 dBi), with cable (1 m)
ZS6201-0500	Rod antenna (gain 5 dBi), without cable

Note	**Use original Beckhoff accessories** The CE conformity of the CU8890-0000 is only guaranteed if it is operated with original Beckhoff accessories (antennas, coaxial cable)!

ZS6100-0900

ZS6100-0900





Technical data	ZS6100-0900
Frequency range	2400...2485 MHz
Transmission factor	9 dBi
3 dB bandwidth, horizontal	65°
3 dB bandwidth, vertical	65°
Connection	SMA socket
Dimensions (W x H x D)	93 mm x 93 mm x 25 mm
Weight (incl. accessories and packaging)	Approx. 190 g
Operating temperature	-40°C ... + 80°C
Relative humidity	95%, no condensation
Protection class	IP20
Installation position	variable
Approval	CE
Mounting	Bracket mounting, included in scope of supply
Suitable coaxial cable	ZS6000-0102-0020, ZS6000-0102-0040

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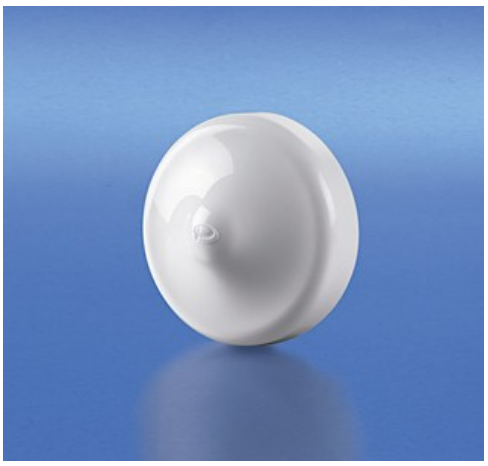
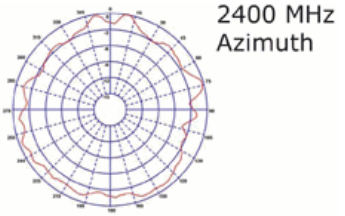
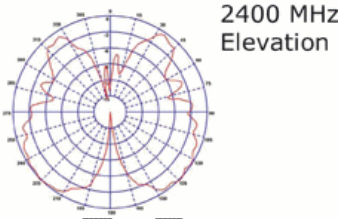
ZS6200-0400

ZS6200-0400







Technical data	ZS6200-0400
Frequency range	2400...2485 MHz
Transmission factor	4 dBi
3 dB bandwidth, horizontal	360°
3 dB bandwidth, vertical	70°
Connection	SMA socket
Dimensions	Diameter 110 mm, height 45 mm
Weight (incl. accessories and packaging)	approx. 210 g
Operating temperature	-40°C ... + 80°C
Relative humidity	95%, no condensation
Protection class	IP20
Installation position	variable, predestined for mounting below the ceiling
Approval	CE
Suitable coaxial cable	ZS6000-0102-0020, ZS6000-0102-0040

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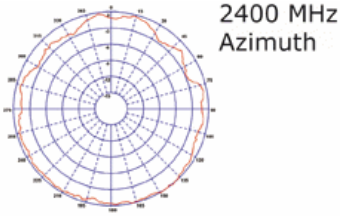
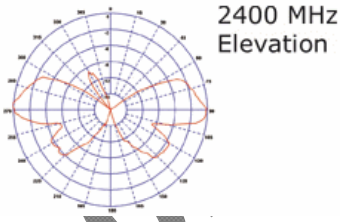
ZS6201-0410

ZS6201-0410



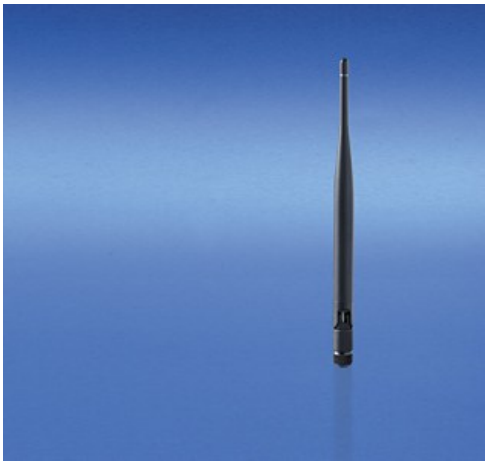


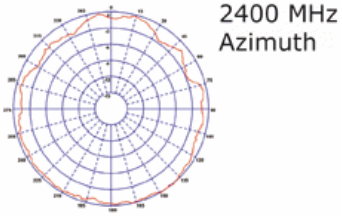
Technical data	ZS6201-0410
Frequency range	2400...2485 MHz
Transmission factor	4 dBi
3 dB bandwidth, horizontal	360°
3 dB bandwidth, vertical	70°
Connection	Reverse SMA socket (with 1 m cable, permanently connected to antenna)
Dimensions	Height 202 mm, foot diameter 35 mm
Weight (incl. cable, accessories and packaging)	approx. 220 g
Operating temperature	-40°C ... + 80°C
Relative humidity	95%, no condensation
Mounting	Cap nut M14
Protection class	IP20
Installation position	variable
Approval	CE
Coaxial cable	1 m, included in scope of supply

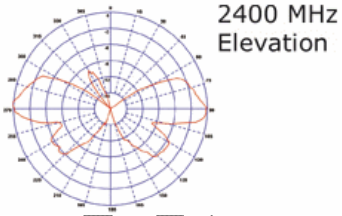
Preliminary - Internal C

ZS6201-0500

ZS6201-0500







Technical data	ZS6201-0500
Frequency range	2400...2485 MHz
Transmission factor	5 dBi
3 dB bandwidth, horizontal	360°
3 dB bandwidth, vertical	70°
Connection	reverse SMA socket
Dimensions	Height 195 mm, foot diameter 12 mm
Weight (incl. packaging)	approx. 40 g
Operating temperature	-40°C ... + 80°C
Relative humidity	95%, no condensation
Mounting	Direct connection with hinged joint
Protection class	IP20
Installation position	variable
Approval	CE
Suitable coaxial cable	Not required, direct connection

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Coaxial Cable

Coaxial cables

The following coaxial cables are available:

Designation	Description
ZK6000-0102-0020	Coaxial cable, characteristic impedance 50 Ω, preassembled plug connectors (SMA plug and reverse SMA socket), black, 2 m
ZK6000-0102-0040	Coaxial cable, characteristic impedance 50 Ω, preassembled plug connectors (SMA plug and reverse SMA socket), black, 4 m

Antenna alignment

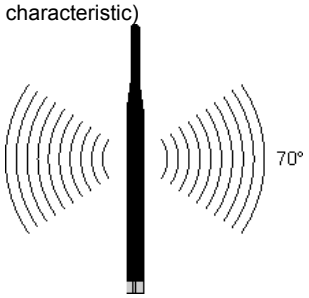
Please pay attention to the directional characteristics and polarization of the antennas in order to mount and align them to each another optimally!

Directional characteristic Omni directional antennas

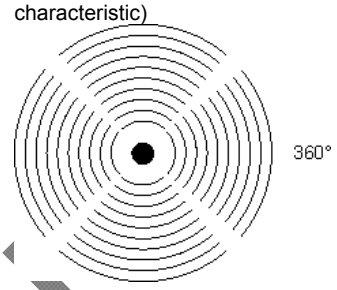
ZS6201-0410, ZS6201-0500

Design form

Side view (vertical directional characteristic)



Top view (horizontal directional characteristic)

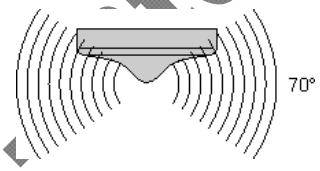


ZS6200-0400

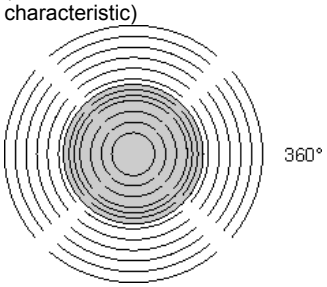
Predestined for mounting below the ceiling.

Design form

Side view (vertical directional characteristic)



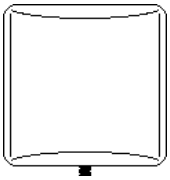
Top view (horizontal directional characteristic)



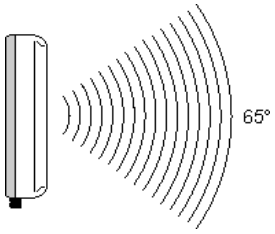
Directional characteristic directional antennas

ZS6100-0900

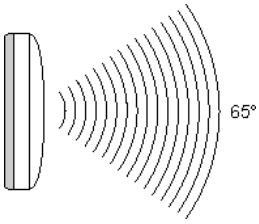
Design form



Side view (vertical directional characteristic)



Top view (horizontal directional characteristic)



Preliminary - external

Alignment examples

Align the antennas so that each lies within the radiation cone of the opposite antenna.

Omni directional antennas

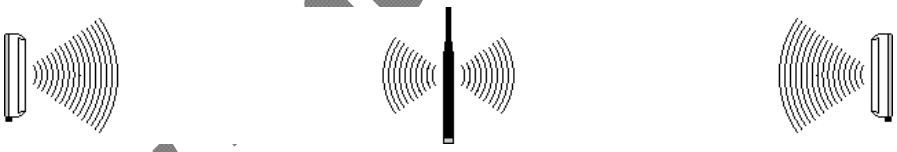
Two ZS6201-0410 or ZS6201-0500

Directional antennas

Two ZS6100-0900

Mixed operation

e.g. one ZS6201-0410 and two ZS6100-0900



Polarization

For optimum transmission, all antennas used must have the same polarization.

Omni directional antennas

Care must also be taken when using omni directional antennas that the antennas used have the same polarization.

Omni directional antennas such as the ZS6201-0410, ZS6201-0500 or ZS6200-0400 are mostly mounted for vertical polarization.

Directional antennas

Arrows marked with the letters H and V are located on the rear side of the housing of the ZS6100-0900 directional antenna in order to identify the polarization

Mount the directional antennas such that the marked arrows of all the antennas used correspond to one another.

Placement of the antennas

Mount the antennas such that they can radiate freely!

There must be no obstructions in the direct vicinity of the antenna that could hinder the development of the Fresnel zone. Metal obstacles such as control cabinets, machine parts, pipelines, iron beams etc. particularly hinder the development of the Fresnel zone!

The connection of the antennas to the CU8890 via the RSMA plug and coaxial cable enables the antenna to be mounted remotely, so that you can position the antenna optimally.

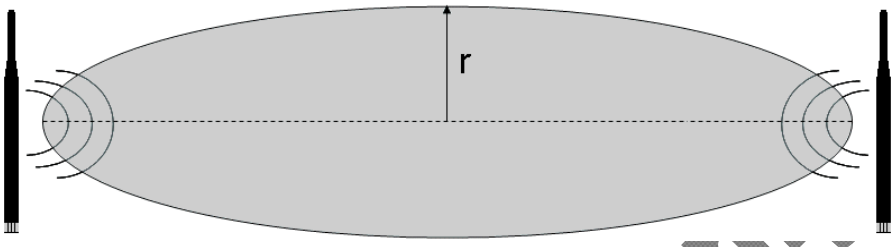
Preliminary Only

Attenuation and range

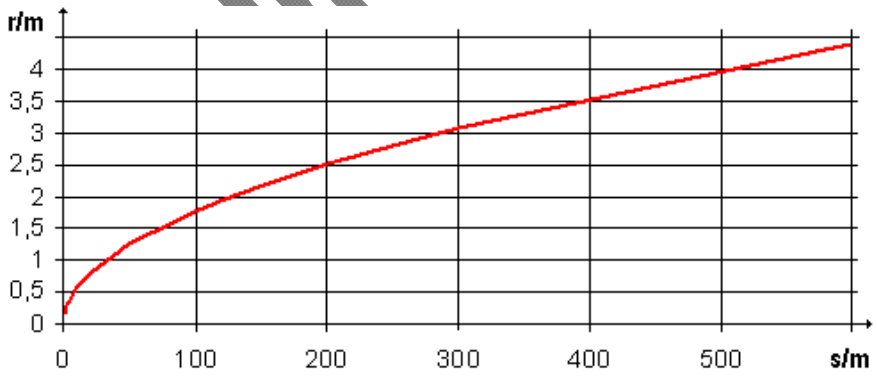
Fresnel Zone

Fresnel Zone

In radio transmission, the space between the transmitting and receiving antennas is known as the Fresnel zone. The Fresnel zone is a notional spheroid between the antennas.



The main portion of the energy is transmitted in the area of the Fresnel zone.
This zone should be free of obstructions (e.g. objects, houses, trees etc.). Metal obstacles such as control cabinets, machine parts, pipelines, iron beams etc. particularly hinder the development of the Fresnel zone!
Each hindrance of the Fresnel zone attenuates the transmission. If the Fresnel zone is half obscured, for example, the additional attenuation is 6 dB, i.e. the field strength is reduced to half of the free field value. Reception may then be disturbed or completely interrupted under certain circumstances.
If the Fresnel zone is free from obstructions, the propagating wave is only attenuated by the free field attenuation.



Radius r of the Fresnel zone in relationship to the distance s.

Attenuation in practice

Attenuation

With an attenuation of 6 dB the range is shortened to half of the value for an unobstructed connection, with 12 dB it is shortened to a quarter.

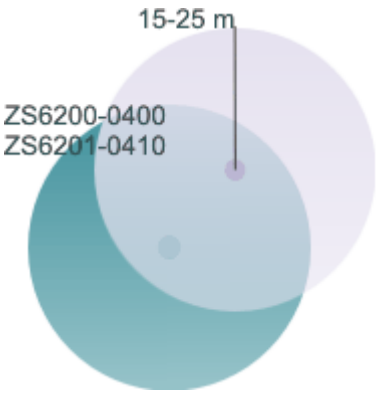
Material	Attenuation	Range approx.	Example for an unobstructed range of 280 m
Thin wall	2-5 dB	(free field range)/1.5 - (free field range)/2	180 m - 140 m
Wooden wall	5 dB	(free field range)/2	140 m
Masonry wall	6-12 dB	(free field range)/2 - (free field range)/4	140 m - 70 m
Concrete wall	10-20 dB	(free field range)/4 - (free field range)/8	70 m - 5 m
Concrete ceiling	20 dB	(free field range)/8	< 35 m

Preliminary – Internal Only

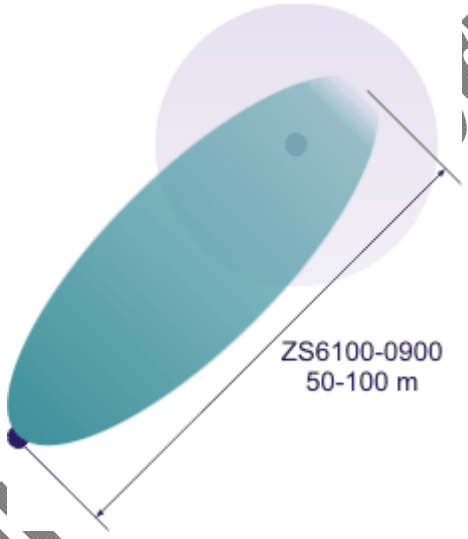
Ranges for a selection of the following antenna combinations

The given ranges are based on an unobstructed view and adherence to the Fresnel zone.

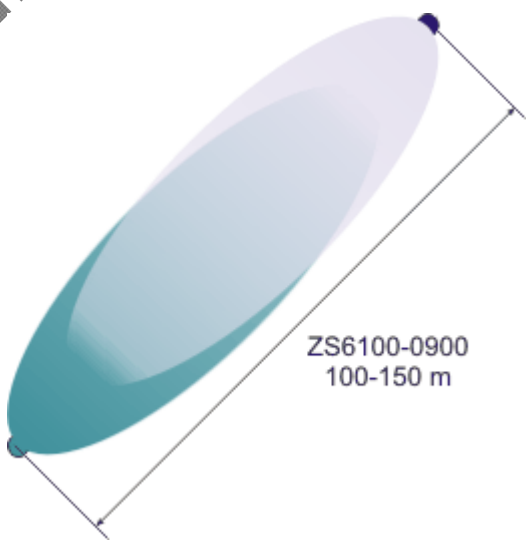
Two omni directional antennas



Omni directional antennas combined with a directional antenna



Two directional antennas

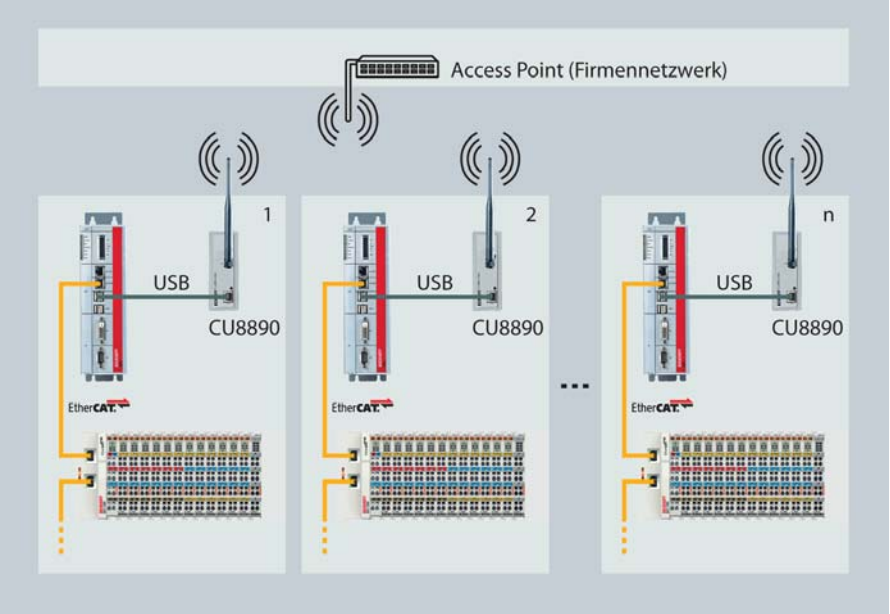


Preliminary Documentation Only

Examples of Use

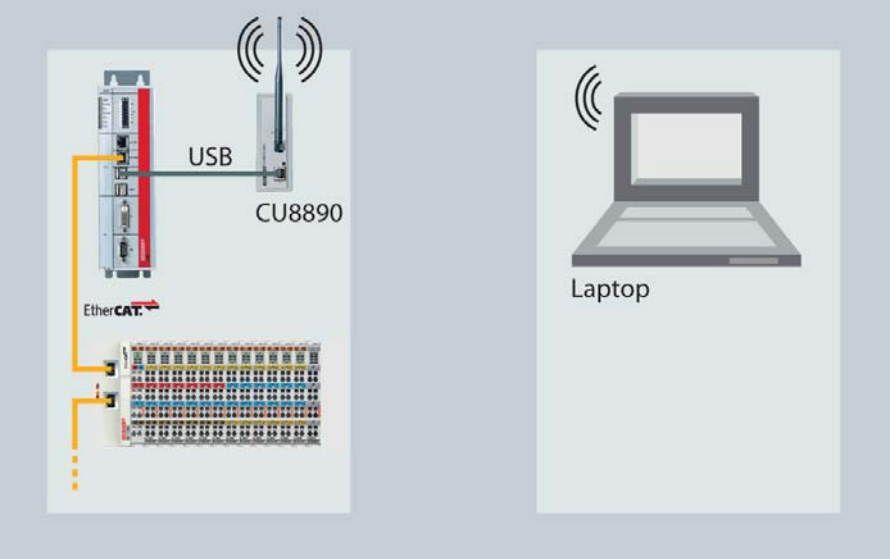
Operating mode: CU8890 as Client

Client Modus



Operating mode: CU8890 as Access Point

Access Point Modus



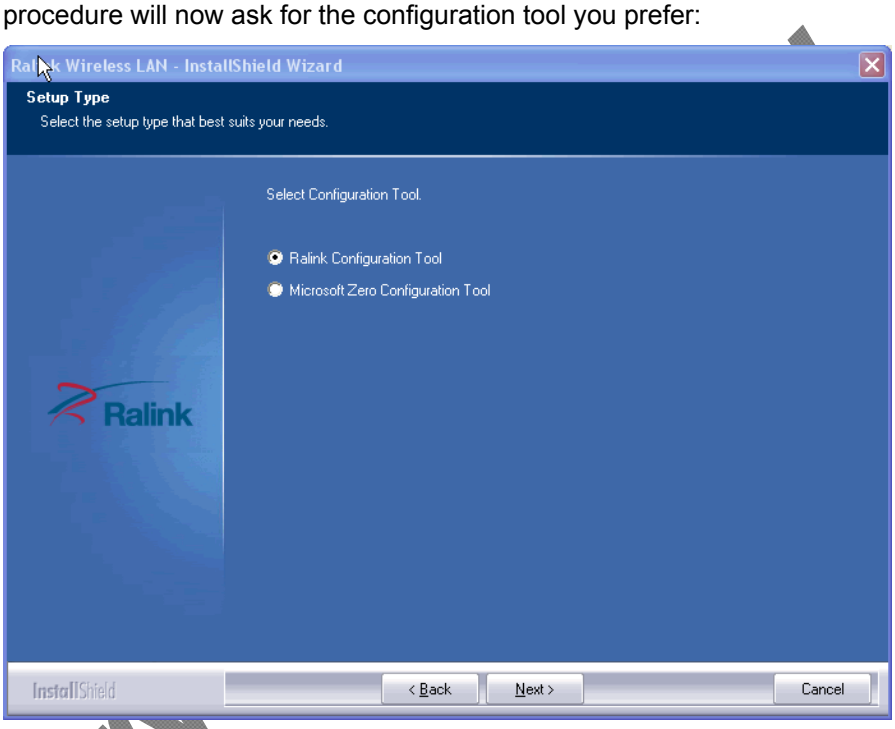
Prelimi

Software installation

Installation under Windows XP

Note	**Installation** Install the software before connecting the CU8890 WLAN-Controller!

Accept the terms of the license agreement and click *Next*. The installation procedure will now ask for the configuration tool you prefer:

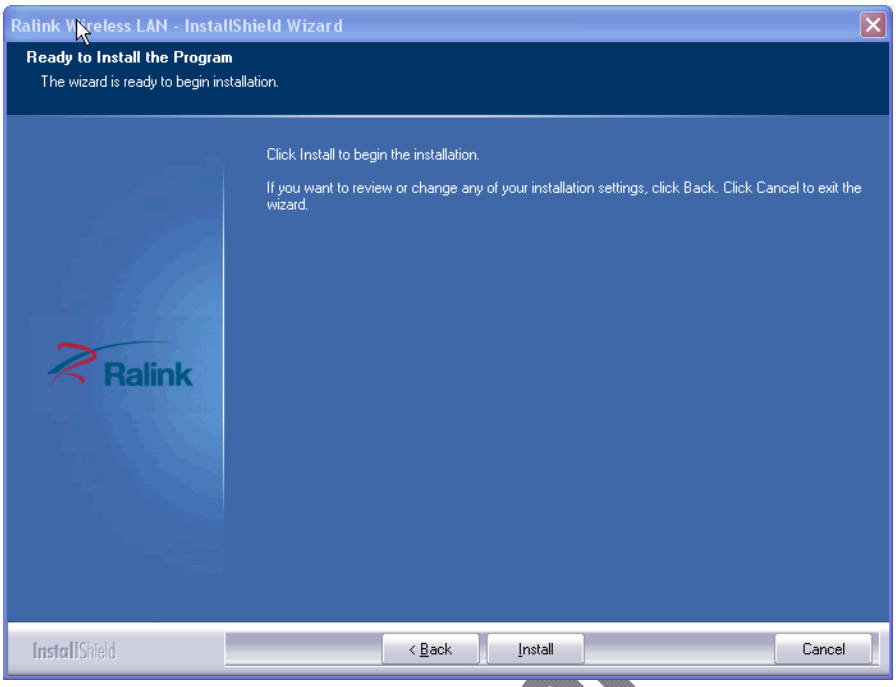


Select *Ralink Configuration Tool* and click *Next* to continue.

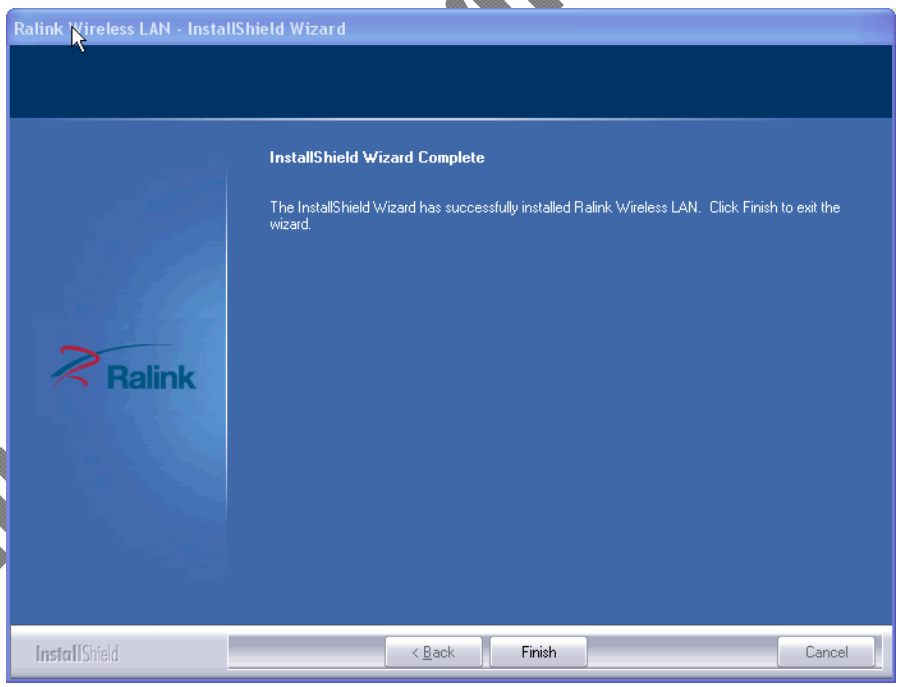
Note	**Select Configuration Tool** After the installation has finished you can always change to the *Microsoft Zero Configuration Tool*.

Click *Install* to start the installation procedure. The required data will now be copied to the hard disk.

Preliminary



Click *Finish* and the installation is completed:



In the task bar of your computer you now see the crossed Ralink symbol that indicates an inactive USB connection.

Connecting USB cable

Connect now the CU8890 WLAN controller with your computer via the USB cable.

When the USB connection is active you see the following symbol in the task bar:

The installation of the Ralink driver is completed successfully.

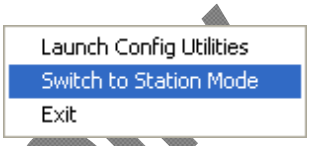
Prelimi

Note	**Default mode** After successfully installation under Windows XP the Ralink module is generally in client modus.

Operating the CU8890 as Client

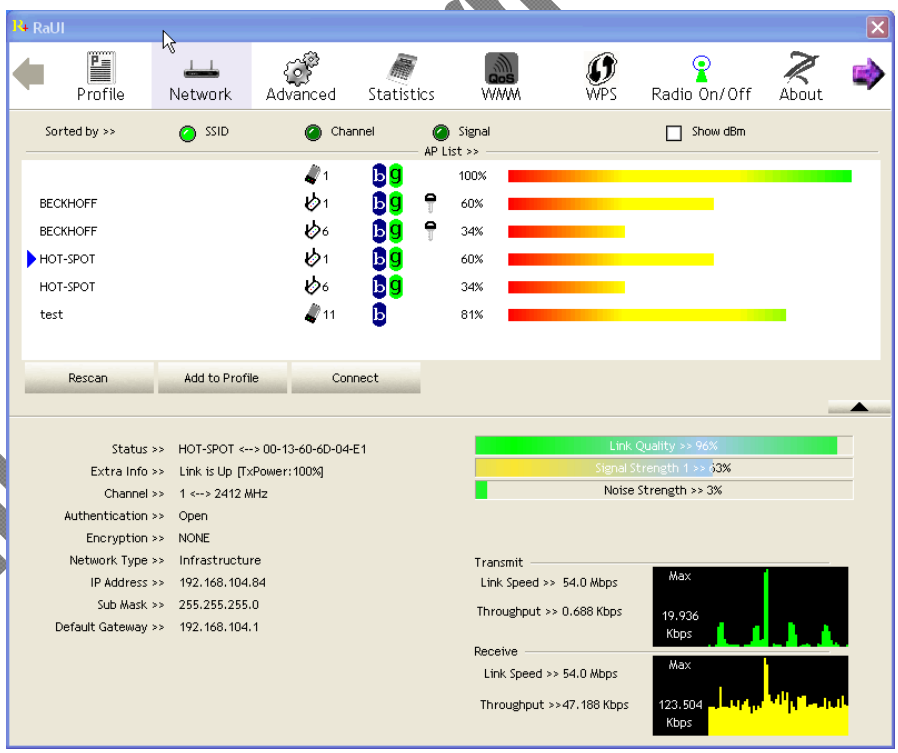
Generally the CU8890 WLAN controller is in client modus.

Note	**CU8890 should as access point** When the CU8890 should be operated as access point you can change the mode by right mouse click on the Ralink symbol in the task bar:

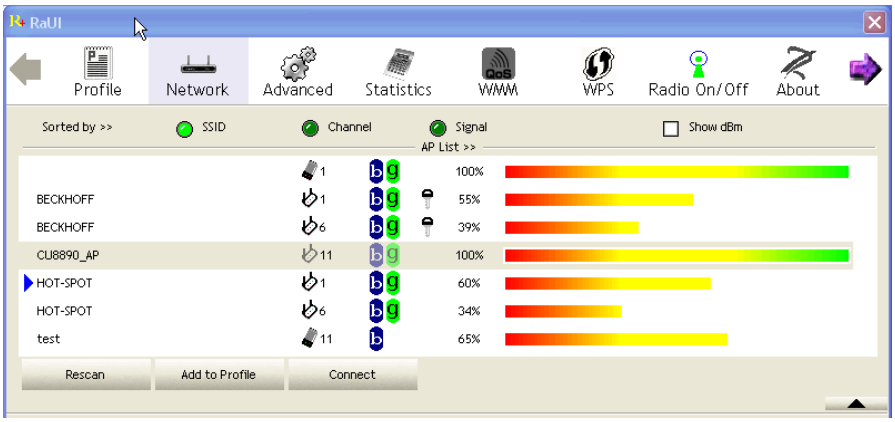


Double click on the Ralink symbol in the task bar starts the *RaUI-Client configuration tool*.

To connect to an existing network select the register *Network* in the RaUI-Client configuration tool. A list of the available WLANs is shown:



Click *Rescan* to refresh the list:



Preliminary

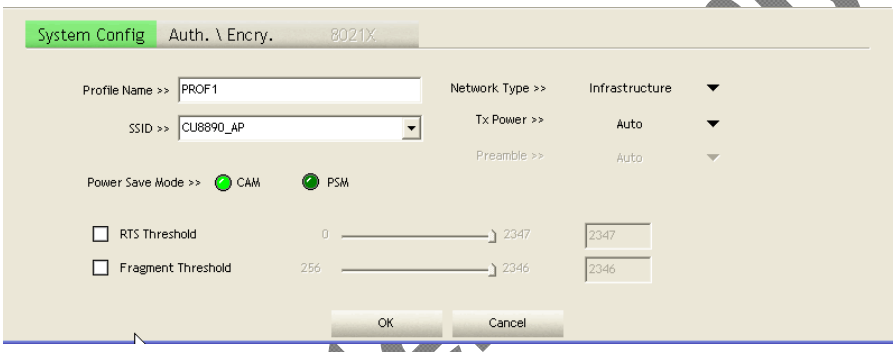
Click on the button *Channel* to get a list of the networks sorted by channels.

Note	**Multiple networks** If multiple networks are on one channel, a bad performance can be possible and you should change the channel!

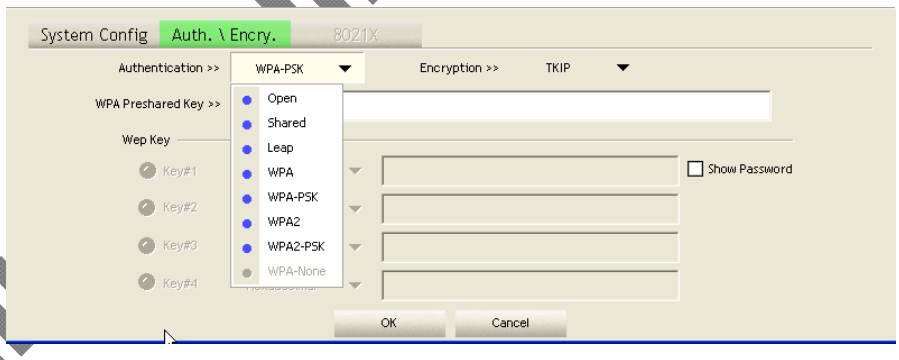
Connecting the WLAN-Controller

The blue arrow in the network window symbolize the active connection. Click on the network to select it.

Now the *System Config* window appears and you can give a profile name to the selected network:

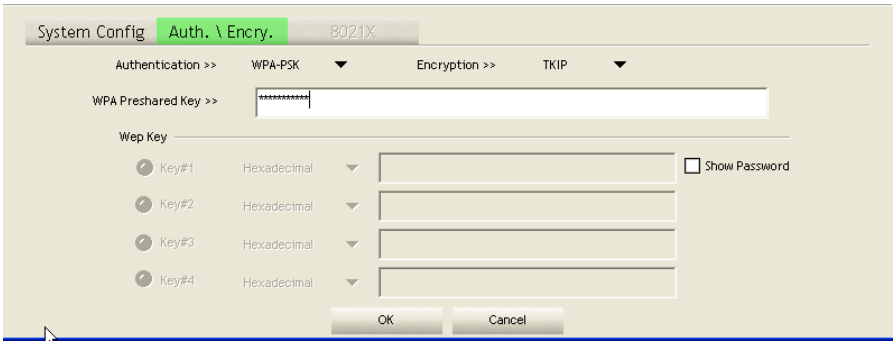


In the next window you can select the encryption method. Therefore click on the register *Auth.\Encr.*:



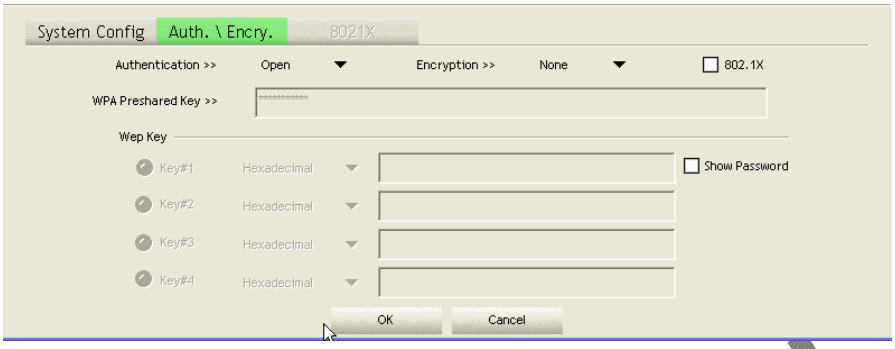
You now see a list of the selectable encryption methods. On top of the list the method *Open* is shown, that means no encryption.

If there is an encryption in the actual network, it now can be selected. In our example it is *WPA-PSK* (WPA2-PSK recommended).

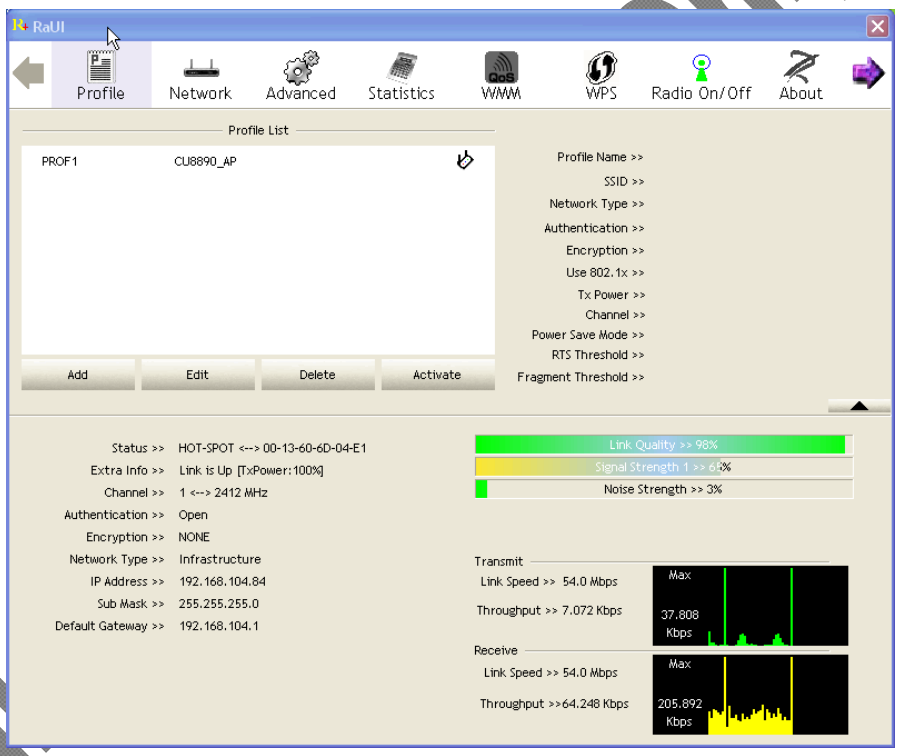


Preliminary

Type the *WPA preshared key* and confirm with *OK*.



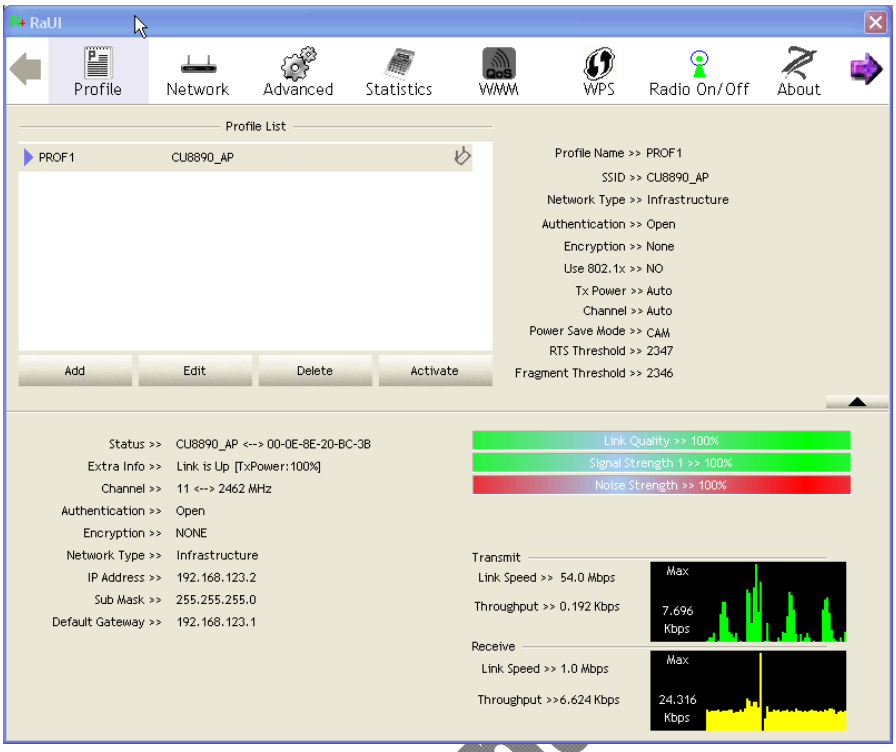
Now the view changes to the *Profile* window and you can see the new profile:



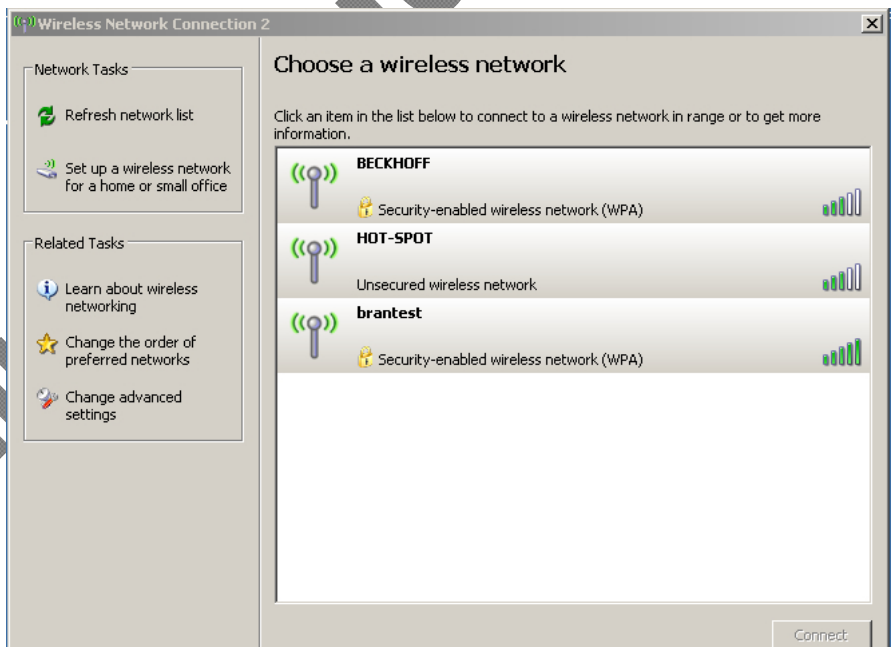
Click on you profile and the *Activate* button to activate the network.

The WLAN-Controller now has a network IP-Address shown in the status messages:

Preliminary



Now the network connection is also shown in the standard Windows network diagram:

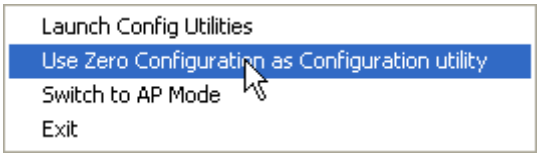


Preliminary

Note

Zero Configuration Tool

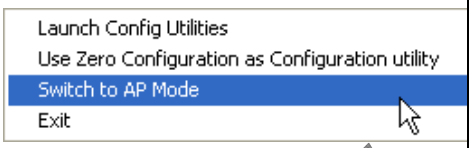
Alternatively you can configurate the connection of the WLAN controller in the Zero Configuration Tool (Standard Wireless Configuration Tool). Open the tool with a right mouse click on the Ralink symbol in the task bar:



Operating the CU8890 as Access Point

By default the CU8890 WLAN-Controller is in client modus. Access point operation is only possible under XP/ Xpe.

Note	**CU8890 should as access point** When the CU8890 should be operated as access point you can change the mode by right mouse click on the Ralink symbol in the task bar:



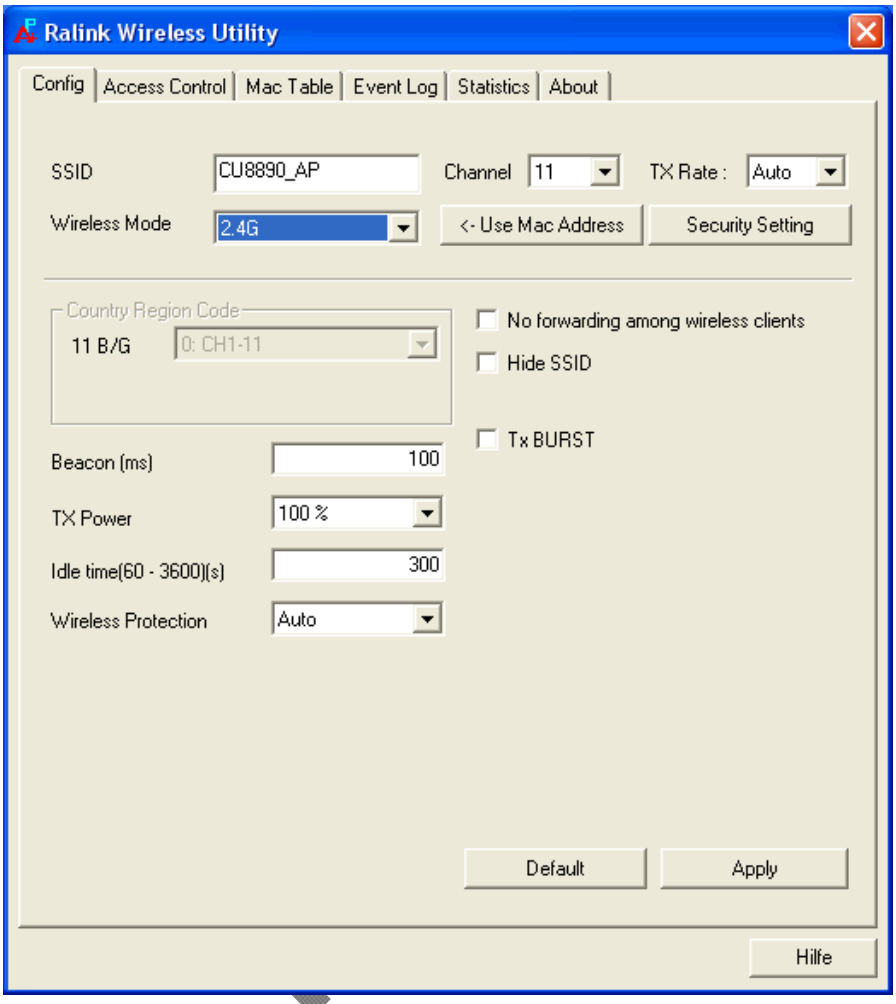
The symbol in the task bar has now be changed into *AP*:

The window *Internet Connection Sharing (ICS)* appears:

Select the WAN adapter and click *OK*. The *Ralink Wireless Utility* window appears and you can type the network name *(SSID)* and the channel.

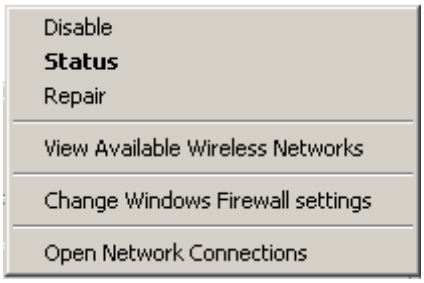
Click *Apply* and the alignments will be saved.

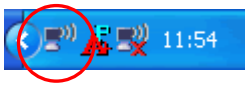
Preliminary - Internal Only



Note	**Modification of the network name (SSID)** The modification of the network name (SSID) is not applied until the WLAN adapter is deactivated and then activated again **after** changing the name. Changing the channel without deactivating/ activating is not possible.

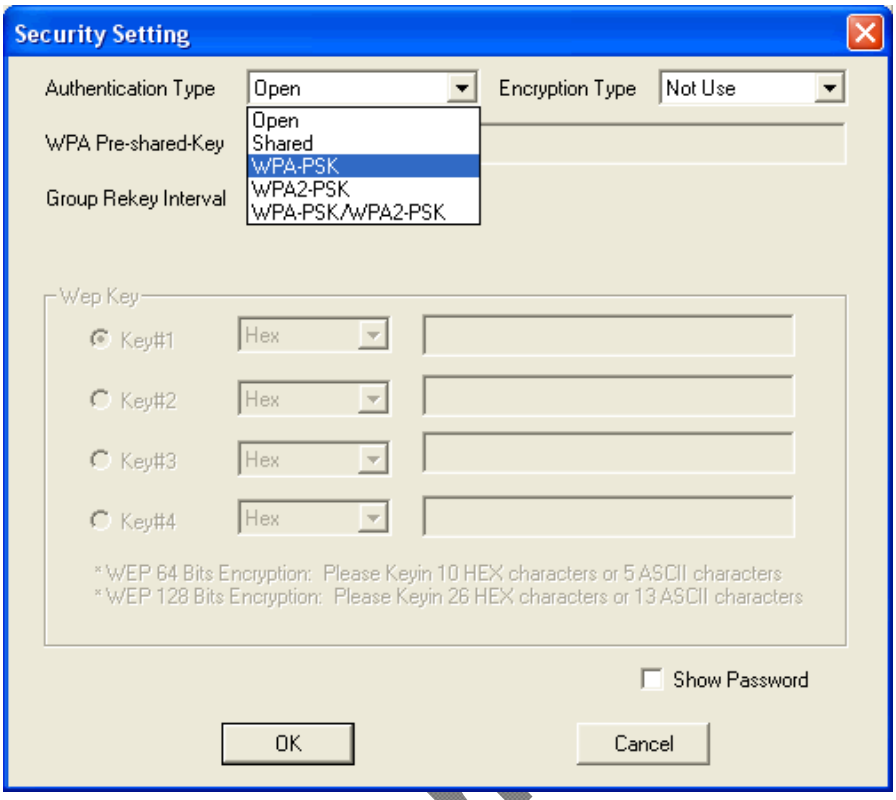
Preliminary - 1





Click the button *Security Settings* to open the security settings window. Here you can select the designated encryption mode (e.g. WPA-PSK, suggested) and assign the according key.

The network is not encrypted if you select *Open*.



The CU8890 WLAN-Controller now provides the network with the network name (SSID) on the selected channel. WLAN clients can now connect to the network. If a network key was assigned under data encryption options it must be published to the clients.

Preliminary - Intern

General Installation Instructions

TwinCAT Real-Time-System

TwinCAT

With the CU8890, TwinCAT network variable swapping is possible on base of UDP/IP (Publisher/ Subscriber Variables).

For installation the CU8890 ethernet adapter for TwinCAT, run the manual installation via the *windows network settings*, do not use the system manager.

Proceed as follows:

1. Select *Windows Network Settings*
2. Select *Wireless LAN*
3. Right mouse click for *Properties*
4. Click *Install*
5. *Add Service*
6. Select the manufacturer: *Beckhoff*
7. Network protocol *TwinCAT RT-Ethernet Intermediate Driver*
8. Click *OK* to finish.

In the TwinCAT system manager the wireless network interface is listed under the category *installed devices (system manager -> options -> list real-time ethernet compatible devices)*.

Then TwinCAT network variable swapping is possible on base of UDP/IP. It is not possible to run RT-EtherNet protocol or EtherCAT!

Operation with Windows Firewall

Windows Firewall

When operating the wireless network while Windows firewall is activated the access point mode can be blocked. In that case deactivate the firewall.

Windows CE

Windows CE

Under Windows CE the operation of the CU8890 WLAN-Controller is only possible in client mode.

The Windows CE driver is available for CE 6. You can download the driver for Beckhoff x86- and ARM based devices under:

ftp://ftp.beckhoff.com/Software/embPC-Control/CE/Solutions/CUxxxx_Driver/CU8890_CE60.zip

For operating the CU8890 WLAN-Controller you need the CE driver as well as the Microsoft Zero tool for configuration the WLAN. On x86 based devices this is already integrated in the CE 6 image. On ARM based devices the installation has to be started later on.

Proceed as follows:

Driver Installation on ARM based Devices

ARM based devices

Proceed as follows to install the drivers:

1. Download and unpack file *CU8890_CE60.zip.*
   There are two sub-folders for the particular systems *x86* or *ARM.*
2. Copy the files of the selected system (x86 or ARM) to the CE device (via USB stick, public folder or FTP folder)

Preliminary - Internal Only

3. Copy the files to the correct folders:
   \Hard Disk\System:
   xcopy all files to device under \hard disk\System
   \Hard Disk\RegFiles:
   xcopy all files to device under \hard disk\Regfiles
4. Double click on all new *Registry Files*
5. Finally reboot the system.

After rebooting the system, the driver is installed, as well the Microsoft Zero Tool at ARM based devices.

Connecting with the network

Connecting with the network

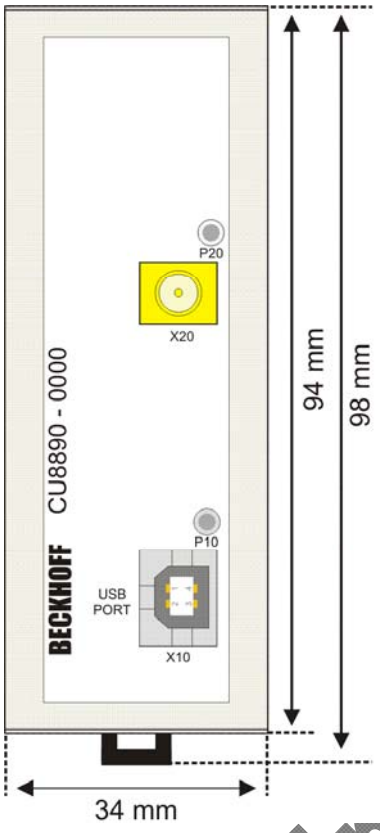
In the graphical user interface you can select a network. Click *connect* to connect with the network:

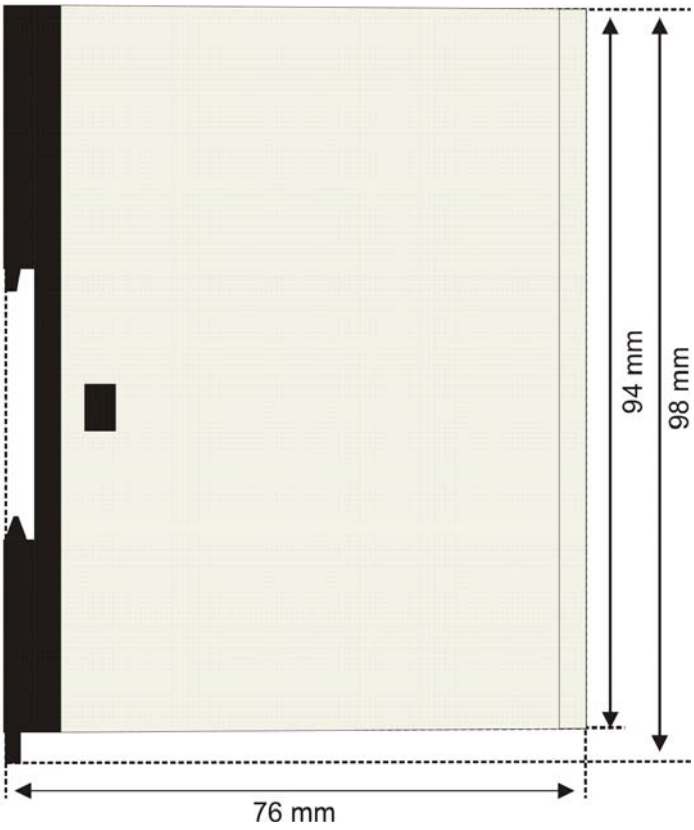
Preliminary

Appendix

Assembly dimensions

The product is characterized by small overall installed size. With a height of approx. 100 mm, the module dimensions exactly match those of the Beckhoff Bus Terminals. Together with the lowered connector surfaces, this means that it can be used in a standard terminal box with a height of 120 mm.





Prelimin

Technical data

Input	USB-2.0 input with USB-B connector
Antenna terminal	Connection via a reverse SMA plug (RP-SMA)
Standard	IEEE 802.11 b/g and TCP/ UDP IP
Data transfer rate	max. 54 Mbit/s
Data transmission band	2,4 GHz
Channels	11
Channel separation	5 MHz
Channel width	22 MHz
Available	Worldwide
Data rate adjustment	Dynamic data rate adjustment at mode b: 1, 5, 11 Mbit/s; at mode g: 6, 9, 12, 18, 24, 36, 48, 54 Mbit/s. Not usable for Realtime Ethernet or EtherCAT!
Encryption	64-/128-Bit-encryption, WEP, WPA, WPA2 Cisco-compatible extension CCX, porviding PEAP and LEAP
Power supply	Power supply via USB input connector (5 V_{DC})
	The following conditions must be observed during operation:
Environmental conditions	Ambient temperature: 0 to 55°C (operation) -25°C to +70°C (transport/ storage) Atmospheric humidity: Maximum 95%, non-condensing
Vibration/ Shock resistance	EN 60068-2-6 / EN 60068-2-27, EN 60068-2-29
EMC resistance burst/ ESD	EN 60000-6-2 Burst: EN 60000-6-4, EN 300328 V1.7.1 Safety of persons in electromagnetic fields: EN 50371:2002
Protection class	IP20
Do not use the CU8890 in areas of explosive hazard	**The WLAN Controller may not be used in areas of explosive hazard.**
Dimensions (W x H x D)	app. 35 mm x 98 mm x 77 mm (with mounting for DIN rail)
Weight	app. 90 g
Assembly	on 35 mm mounting rail conforms to EN 50022
Installation position	any
Approvals	CE, FCC

Note	**Use original Beckhoff accessories** The CE conformity of the CU8890-0000 is only warranted when operated with original Beckhoff accessories (see chapter *Antennas*)

The CU8890-0000 meets demands of the EN 300328 V1.7.1 and is approvable in all countries of the EU as well as Liechtenstein, Switzerland, Ireland and Iceland.

The CU8890-0000 meets also demands of FCC Part 15.4 and Canada IC.

More countries on request.

Preliminary - Internal Only

CE Declaration of Conformity

BECKHOFF New Automation Technology

EG-Konformitätserklärung, EC Declaration of Conformity

Hersteller *Manufacturer*	**Beckhoff Automation** GmbH
Anschrift *Address*	Eiserstr. 5 33415 Verl Bundesrepublik Deutschland
Produktbezeichnung *Product description*	**CU8890 WLAN-Controller mit USB-Eingang** *CU8890 WLAN controller with USB input*

Die hier genannten Baugruppen sind entwickelt, konstruiert und gefertigt in Übereinstimmung mit den EG-Richtlinien 1999/5/EG R&TTE-Richtlinie, 2004/108/EG EMV-Richtlinie und 2006/95/EG Niederspannungsrichtlinie.
Folgende Normen wurden angewandt:
The components mentioned herein have been developed, designed and manufactured in accordance with the EC Guideline 1999/5/EG, 2004/108/EC and 2006/95/EC. The following standards have been used:

Generic Standard: EN 61000-6-2:2006 *Generic Standard: EN 61000-6-2:2006*	**Störfestigkeit für Industriebereich** *immunity for industrial environments*
Generic Standard: EN 61000-6-4:2007 *Generic Standard: EN 61000-6-4:2007*	**Störaussendung für Industriebereich** *emission standard for industrial environments*
Standard: EN 300 328 V1.7.1:2006 *Standard: EN 300 328 V1.7.1:2006*	**Datenübertragungsgeräte, die im 2,4 GHz-ISM-Band arbeiten und Breitband-Modulationstechniken verwenden** *Data transmission equipment operating in the 2,4 GHz ISM band and using wide band modulation techniques*
Standard: EN 301 489-1 V1.6.1:2005 *Standard: EN 301 489-1 V1.6.1:2005*	**EMV und Funkspektrumangelegenheiten (ERM) – EMV für Funkeinrichtungen und –dienste - Teil 1: Gemeinsame technische Anforderungen** *EMC and Radio spectrum Matters (ERM)- EMC for radio equipment and services - Part 1: Common technical requirements*
Standard: EN 301 489-17 V1.2.1:2002 *Standard: EN 301 489-17 V1.2.1:2002*	**Teil 17: Spezifische Bedingungen für Breitband-übertragungssysteme im 2,4 GHz Band** *Part 17:specific conditions for 2,4 GHz wideband transmission systems*
Generic Standard: EN 50371:2002 *Generic Standard: EN 50371:2002*	**Sicherheit von Personen in elektromagnetischen Feldern** *human exposure to radio frequency electromagnetic fields*

Verl, den / *the* **19.06.2009**

Unterschrift, *signature*
Name, *name* **Hans Beckhoff**
Funktion, *function* **Geschäftsführer**, *Executive Director*

1 / 1

Operation Notes for USA/Canada

Note	**Beware of unapproved and unauthorized modifications** Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment. The manufacturer is not responsible for any radio or TV interference caused by unauthorized modifications to this equipment. Such modifications could void the user's authority to operate the equipment.

CAUTION	**Consider Health Canada limits for the general population!** The installer of this equipment must ensure that the antenna is located or pointed such that it does not emit RF field in excess of Health Canada limits for the general population; consult Safety Code 6, obtainable from Health Canada's website http://www.hc-sc.gc.ca/rpb.

FCC ID and IC ID

FCC ID: XS3 – FC9891-0000
IC ID: 8573A – FC98910000

FCC: Federal Communications Commission Radio Frequency Interference Statement

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

Preliminary – Internal Only

Calculating with decibels

In communication technology power is expressed in decibels (dB), a tenth of the unit Bel. It is the logarithmic ratio between two quantities with the same unit.

A reference variable (P1), e.g. a milliwatt (mW) is compared with the measured variable (P2). The logarithmic correlation was discovered by Alexander Graham Bell, in whose honor the unit Bel was named.

Since the number values would be too unwieldy if the Bel was used, it was agreed to use 1/10 of the value, i.e. the decibel.

Definition of the level difference: Level difference [dB] = 10 log ([P1] / [P2]).

Definition of a power ratio: power ratio = $10^{\text{level difference}/10}$

The advantage of expressing the powers and losses (attenuations) in dB is that the calculation method for power ratios can be replaced by a lower calculation method for the dB calculation.

Power ratio	dB calculation
Multiplication or Division	Addition or subtraction
Exponent	Factor

Examples of power ratios:

Factor	Amplification [dB]
x 1	+0 dB
x 1,25	+1 dB
x 2	+3 dB
x 4	+6 dB
x 10	+10 dB
x 16	+12 dB
x 100	+20 dB
x 1000	+30 dB

Factor	Attenuation [dB]
x 1	-0 dB
x 0,8	-1 dB
x 0,5	-3 dB
x 0,25	-6 dB
x 0,1	-10 dB
x 0,6	-12 dB
x 0,01	-20 dB
x 0,001	-30 dB

Examples of calculations with decibels:

Change	in dB
10 / 2 = 5	10 – 3 = 7
2 x 2 x 2 = 8	3 + 3 + 3 = 9
2 x 100 = 200	3 + 20 = 23
1000 / 2 = 500	30 – 3 = 27

Preliminary - Internal Only

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You will also find further documentation for Beckhoff components there.

Beckhoff Headquarters

Beckhoff Automation GmbH
Eiserstraße 5
33415 Verl
Germany

Phone:	+49(0)5246/963-0
Fax:	+49(0)5246/963-198
e-mail:	info@beckhoff.com

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Quote the project number

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