caemax
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Manual

D^X Telemetry System

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Due to the continuous developement of the product, CAEMAX Technologie GmbH reserves the right to modify it and thus diverge from the description and technical points if it does not decrease its value.

1 Introduction

We compliment you on the purchase of your new digital multi-channel telemetry system D^x. The D^x is a state-of-the-art telemetry system for measurement technology.
We recommend you to acquaint yourself with the basics of the system before installing it or putting it into operation.

1.1 Abbreviations

RCI	=	Receiver Control Interface
SCT	=	Signal Conditioning Transmitter
RSU	=	Receiver Satellite Unit
SD-Card	=	Memory Card

1.2 System Overview

The D^X telemetry system consists of one receiver unit (RCI) and up to four multi-channel transmitters (SCTs). Up to 6 data channels per transmitter can be recorded. Measurement data are digitalized at the transmitter and serially radio-transmitted to the receiver. A 200 Hz sync signal of the RCI ensures synchrony of transmitters.

Data rate of radio channel is – depending on configuration – up to 100kbit/s.

Radio signals are received in diversity mode. Measurement values are displayed as analog signals and CAN messages.

Energy supply of transmitters is very flexible: The SCTs can either be supplied inductively (by stator head or ring stator), by commercial 9V batteries or by rechargeable batteries.

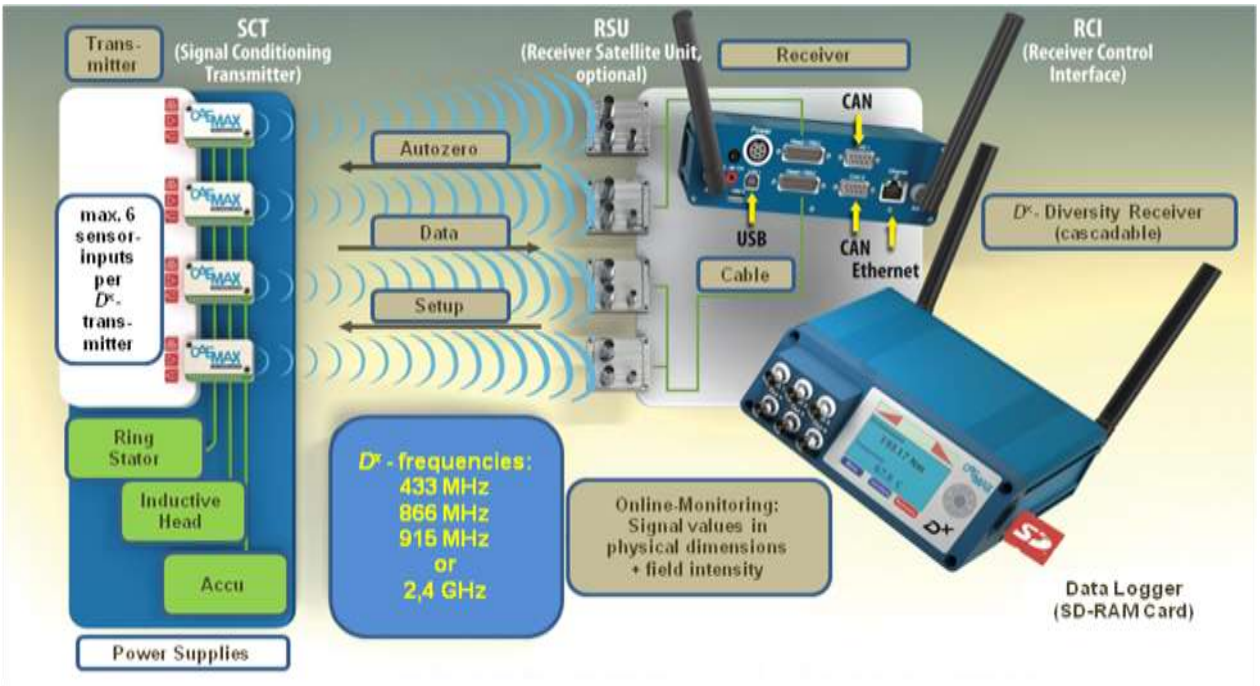


Figure 1: System Overview

1.3 Application

The telemetry system Dˣ can be used to receive, transfer and process electronically measured variables. No liability will be accepted by the manufacturer when the system is not used as intended.

The system is designed for the signal processing of strain gauges, thermo couples (-200…+1000°C) and analog voltage inputs (0...± 22V) (e.g. suitable for pressure sensors, displacement transducers and accelerometers).

1.4 Packing

The complete system will be delivered in one case.

Contents:

1. Receiver Control Interface (RCI)
2. Signal Conditioning Transmitter (SCT)
3. Ethernet cable
4. Rod antennas
5. Power supply
6. Manual
7. Optional: planar antennas
8. Optional: ring stator
9. Optional: assembly material for rotor application

Figure 2: Case Contents

2 Technical Components

2.1 Signal Conditioning Transmitter (D^x-SCT)

Figure 3: Rotor Electronics (SCT)

RF- transmitter:	Freely programmable channel in the 868 MHz ISM band (optionally 2.4GHz)
Transmission power:	Max. + 10dBm, will be adjusted as required and according to the national restrictions (LBT procedures included)
Data transfer:	Package transfer with error detection
Power supply:	Contactless power supply by an inductive head with stator winding or DC power supply 7.5V – 39V
Temperature range:	-40°C … +85°C
Dimensions:	Approx. 45mm x 25mm x 10mm
Weight:	<14g

2.1.1 Voltage Inputs for Small Level Signal (Strain Gauges, Thermo couple, etc.)

Either two differential voltage inputs to connect up to two full bridges or thermocouples, or to connect four half-bridge inputs with internal half-bridge completion.

Input ranges:	± 2mV to ± 2V individually adjustable via RCT (no external resistors or jumpers required)
Resolution:	16 bit
Accuracy:	±0.01% - ±0.025%
Sampling rate:	max. 4.6 kHz sampling rate (excluding additional channels)
Anti-aliasing filter:	6-pole Butterworth with cutoff frequency at 1/5 of the sampling rate
Bridge excitation:	+ 4.096 V (max. 40mA short-circuit proof)
Bridge balance:	> double measurement range, can be adjusted via RCT
Shunt test:	330 kΩ resistor, remote-controlled (as test signal to verify bridge resistance or for detection of broken thermocouples)

2.1.2 Inputs for high-level signal (voltage measurement)

One differential input and one single-ended input

Input range:	± 0.2V to ± 22.5V individually adjustable via RCT
Resolution:	16 bit
Accuracy:	±0.01%
Sampling rate:	max. 4.6 kHz sampling rate (excluding additional channels)
Anti-aliasing filter:	6-pole Butterworth with cutoff frequency at 1/5 of the sampling rate

2.1.3 Additional Channels for SCT Temperature and Supply Voltage

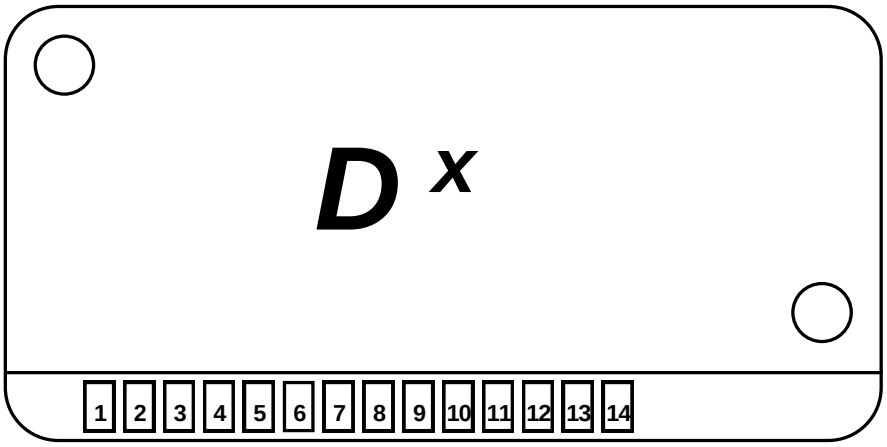
The extra channel of the SCT for temperature is also used as a reference for thermo couple sensors.

Measurement range:	-30°C – +100°C
Resolution:	12 bit
Sampling rate:	25 Hz

The internal measurement of supply voltage can be used to monitor the battery voltage or to check the quality of inductive power supply.

Measurement range:	- 41.5 V – + 41.5 V
Resolution:	12 bit
Sampling rate:	25 Hz

2.2 Terminal assignment SCT



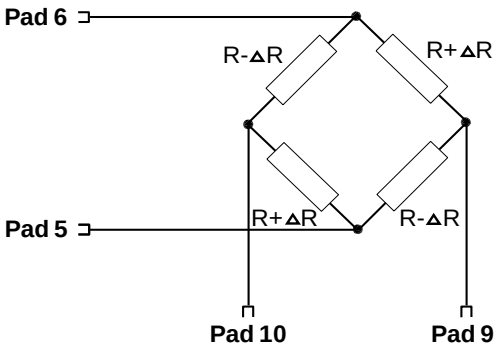
pad	label	function
1	IP1	Inductive-Power 1
2	DC+	DC-Power Plus
3	IP2	Inductive-Power 2
4	DC-	DC-Power Ground
5	EX-	Excitation -
6	EX+	Excitation +
7	I4	Ch2 Bridge Input -

pad	label	function
8	I3	Ch2 Bridge Input +
9	I2	Ch1 Bridge Input -
10	I1	Ch1 Bridge Input +
11	I6	Ch 4 High Level SE+
12	GND	Analog-Ground
13	I5-	Ch3 High Level -
14	I5+	Ch3 High Level +

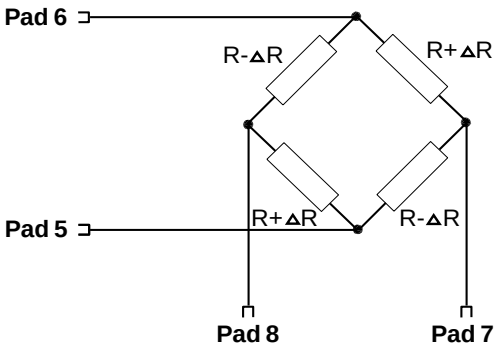
Caution: EX- and GND must not be connected (short circuit)

2.2.1 Strain Gauge: Full Bridge

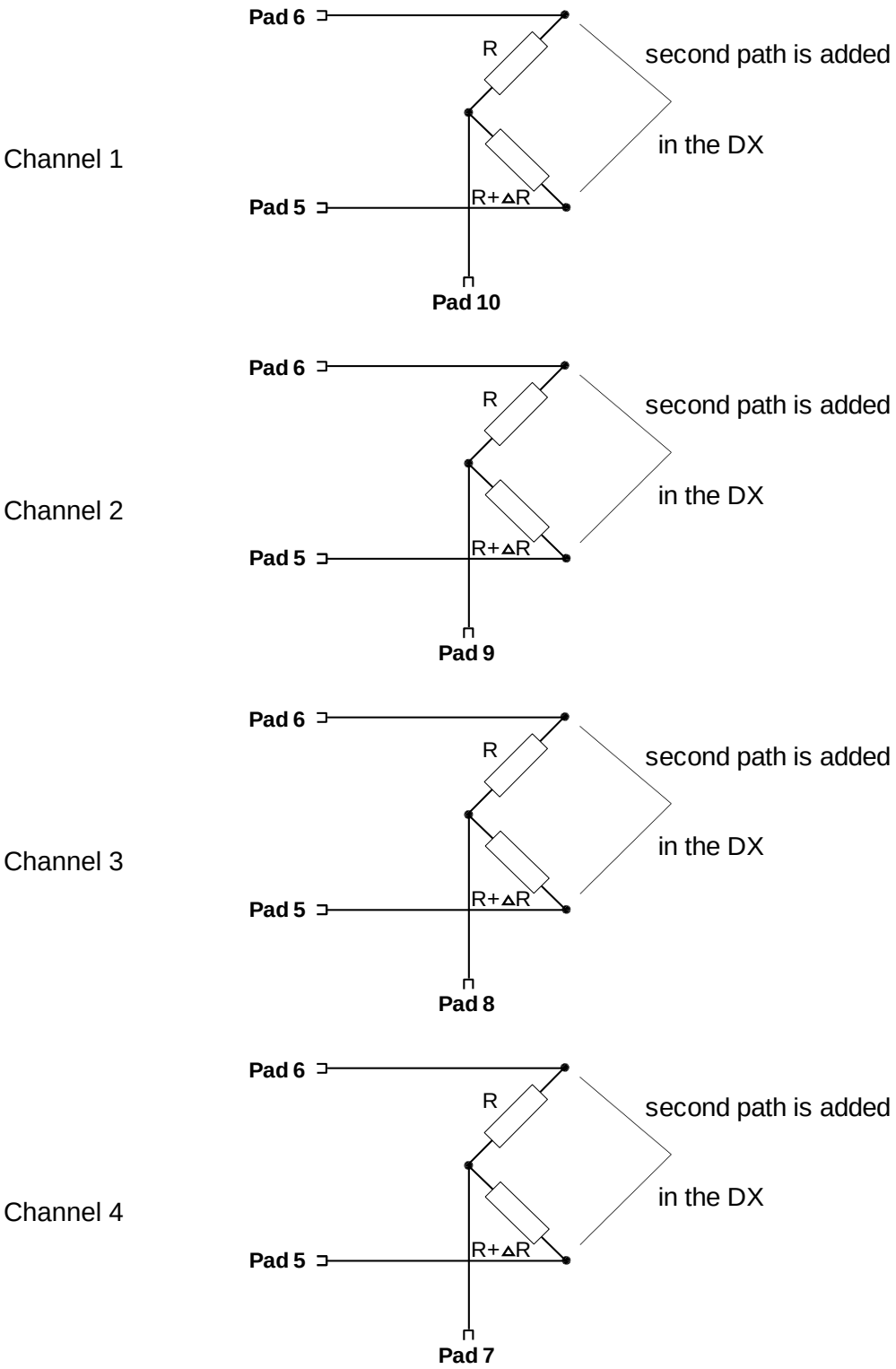
Channel 1



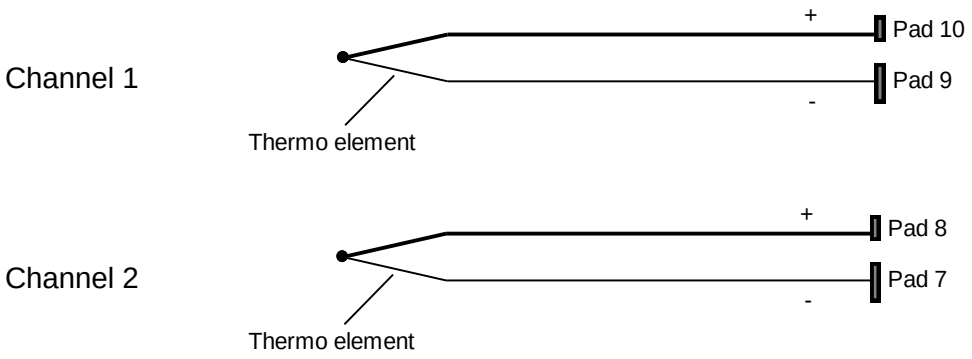
Channel 3



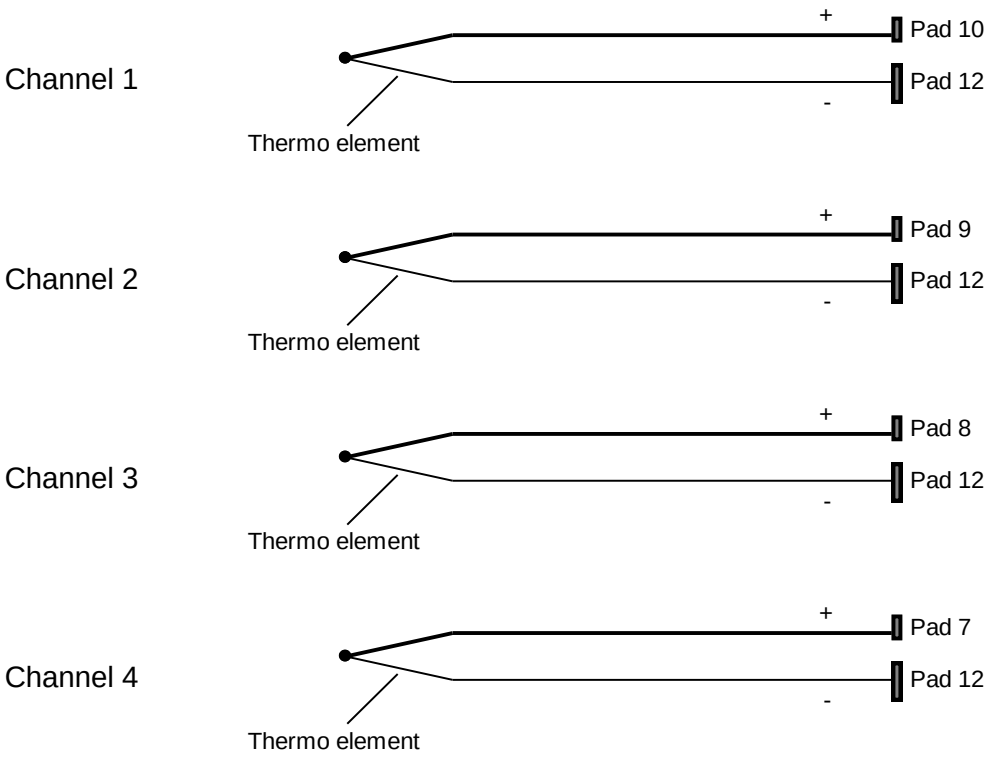
2.2.2 Strain Gauge: Half Bridge



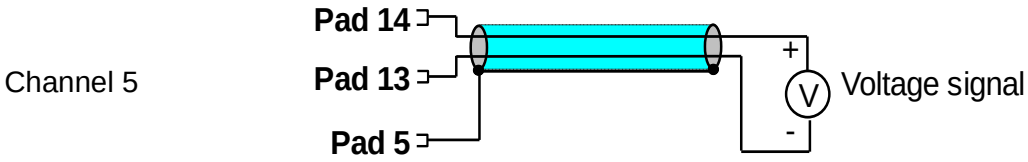
2.2.3 Thermo couples Differential



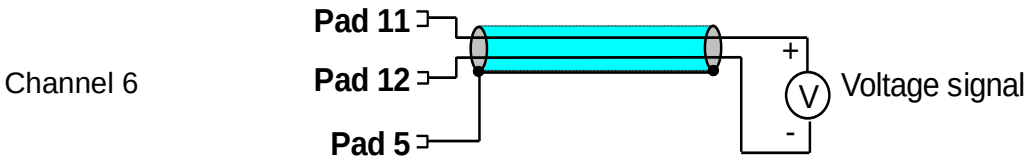
2.2.4 Thermo couples Single Ended



2.2.5 High Level Voltage Differential



2.2.6 High Level Voltage Single Ended



2.3 Receiver Control Interface (RCI)

Figure 4: RCI front

2.3.1 Technical data

Display:	2,83 inches IPS-display (In-Plane Switching)
Resolution:	320 x 240 px
Contrast:	10000:1 (TFT max. 400:1)
Perspective:	±85° no preferred view angle (TFT approx. ±70°)
Input interface:	Rotary multi-selector with five keys
Analog outputs:	6 BNC jacks, freely assignable
Output range:	±10 V with fixed frequency lowpass filter
Resolution:	16 bit
Accuracy:	±0.01% full scale
High-frequency receiver:	Channel freely programmable in the 868 MHz ISM band (optionally 2.4GHz)
Transceiver:	2 independent systems operated in diversity mode

Synchronization:	synchronized sampling and adjusted transmission frequencies of up to four D^x-SCT units, resulting in a synchronous data stream
Voltage supply:	9 – 36 volts DC
Input power	< 5W (without inductive energy supply of the transmitters)
Temperature range:	-20°C - +65°C
Dimensions:	approx. 170mm x 130mm x 53mm
Weight:	approx. 0.8kg

2.3.2 Connections

Figure 5: RCI back

SMA jack:	antenna plug
Banana jacks:	For DC power supply of RCI (9V-36V) **Please note:** These connectors are **not** designed to supply a ring stator or stator head!
Power jack:	External power supply connector
USB jacks:	USB 2.0 Full Speed/12 Mbit for Plug and Play-configuration
Head/RSU:	D-SUB 15 receptacle to plug in an optional satellite receiver
CAN:	CAN 2.0b, standard and extended identifier, freely programmable max. 1 Mbaud connection according to ISO 11898, galvanic isolation
Ethernet:	10/100 Mbit network connection with web server for the configuration
SD-Card (side):	Standard SD slot to save the configuration. Optionally: self-sufficient data storage, currently up to 4 GB.
BNC jacks (front):	6 analog outputs, assignable as required

2.3.2.1 Pin Assignment of D-Sub CAN Connector (9 pol)

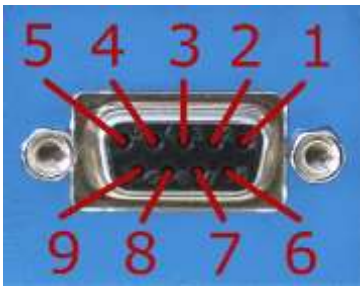


Figure 6: pin assignment of D-Sub CAN connector

pin	CiA name	function
1	--	not used
2	CAN_L	CAN_L, dominant low
3	CAN_GND	GND
4	--	not used
5	--	not used
6	--	not used
7	CAN_H	CAN_H, dominant high
8	--	not used
9	--	not used

3 Quickstart

3.1 Connect the D^X RCI

- Connect the D^X RCI to a power source. Therefore, use the DC-Inputs (9-36V DC) or connect the included power cable to the mains voltage.
- To configure the D^X via PC, connect the PC and D^X with the included Ethernet cable.
- For data transmission via CAN-Bus, connect a CAN cable (CAN1: CAN-Output; CAN2: CAN-Input)

  Please note: The D^X has no built-in CAN terminating resistor. In case the D^X is placed at the end point of a CAN bus chain, you **have to** place a 120 Ω termination resistor between connector and CAN jack.

- Plug BNC cables to the analog outputs of the RCI to tap measurement data. Analog outputs are freely programmable to all data channels (for configuration, see section 3.8).

3.2 Connect the D^X SCT

Connect the D^X SCT to a power source. The SCT can either be supplied by battery/rechargeable battery or inductively by a ring or fix stator. As soon as supplied with power, the SCT is transmitting measurement data. Please refer to Section 2.2 for more information on power input connection.

Note: To check whether voltage application to drive the SCT is sufficient, measure the strain gauge supply voltage (see section 2.2). Its voltage level is 4.096 ± 0.1 V when the device is sufficiently supplied.

3.3 Turn the D^X RCI on and off

To turn the D^X RCI on or off, press the button in the center of the scroll wheel for about 5 seconds.

3.4 Configure the D^X with a PC

With this function, configuration can be done conveniently with your PC instead of using the scroll wheel.

To configure the D^x using a Web browser, a local network connection between D^x and measuring computer must be set up. Connect the Ethernet interface of the D^x to your computer with an Ethernet cable.

Please note: Your computer must be assigned with an IP address (IPv4 protocol) from the same network segment (i.e, the first three digits has to match with the D^X IP address). Factory setting of the D^x IP-address is 192.168.000.212.
In this case, assign for example the IP address 192.168.000.100 to your computer. Furthermore, deactivate your computer's dynamic address assignment (DHCP).

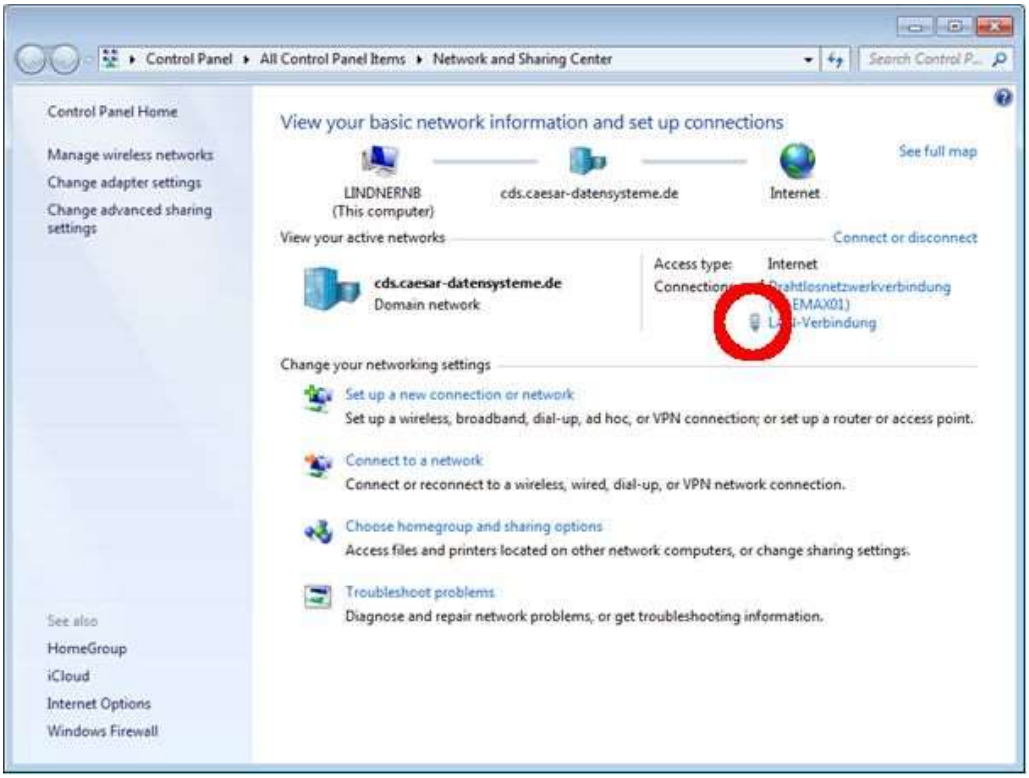


Figure 7: Network and Sharing Center

To do this with Windows 7, open the Network and Sharing Center and click on *LAN-Connection.* In the LAN connection dialog, select *Properties* (Administrator privileges required!).

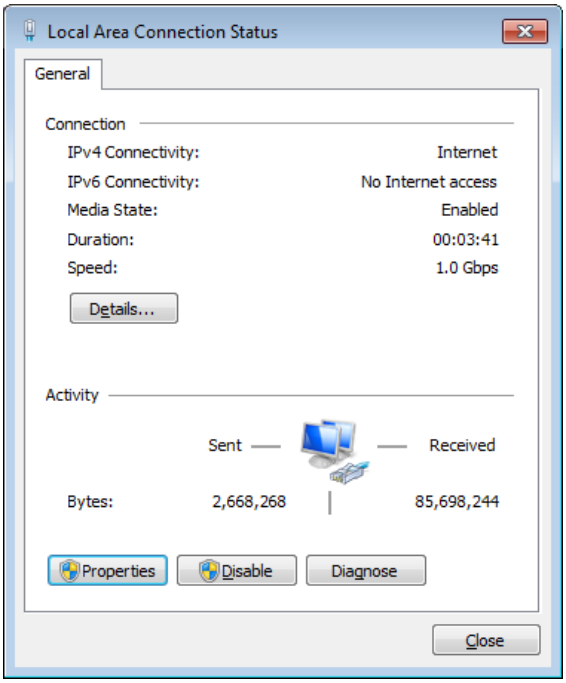


Figure 8: LAN connection status

Select *Internet protocol Version 4 (TCP/IPv4)* and click on *Properties*.

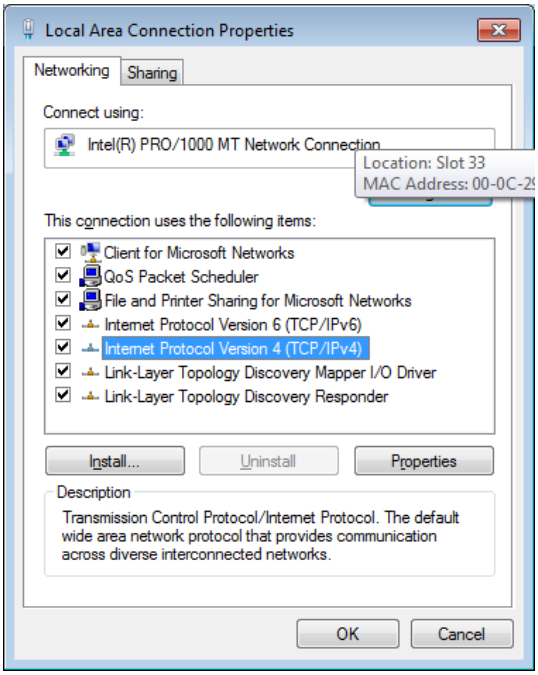


Figure 9: LAN connection properties

Now select *Use the following IP address*, type in the desired IP address and confirm with *OK*.

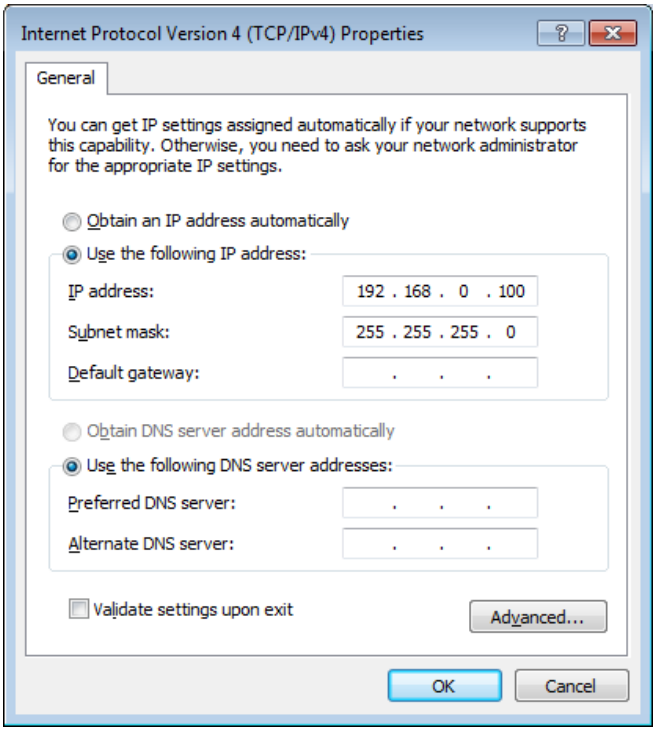


Figure 10: IP address

If you don't succeed in connecting to the D^{X}, please check your firewall settings. In this case, you may also ask your system administrator.

Now open any web browser and type in the D^{X} network address (factory settings: 192.168.0.212).

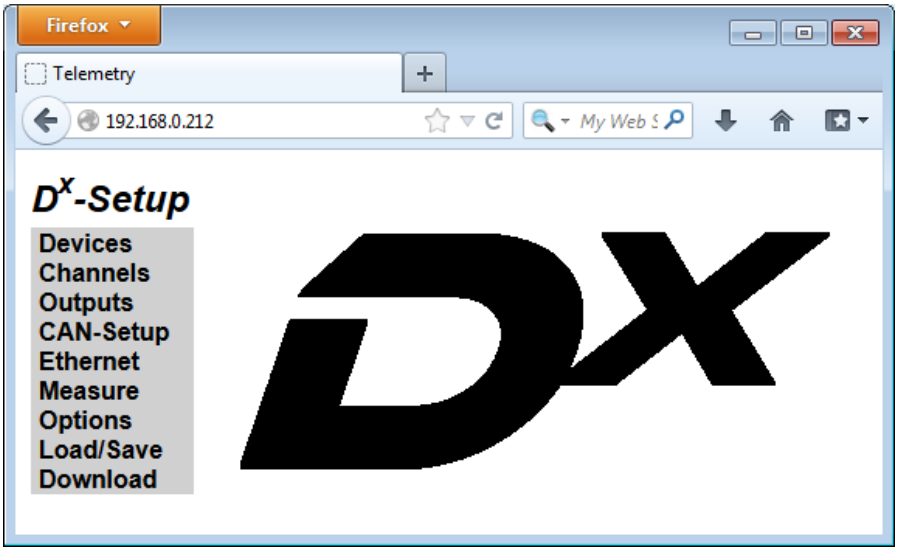


Figure 11: D^{X} menu

You are now able to conveniently configure the D^{X} using your PC.

Please note: The following steps (3.5 to 3.10) can be done either with the RCI scroll wheel or with your web browser. When configuring with a web browser, do not forget to confirm your input with the *Set* button to store it on the D^{X}.

3.5 Add a New SCT

3.5.1 Create a New Device

Switch on the SCT to be added to the RCI. All other SCTs must be switched off. Select *Devices →New Device* in the DX menu. You have now created a new object *Device X.*

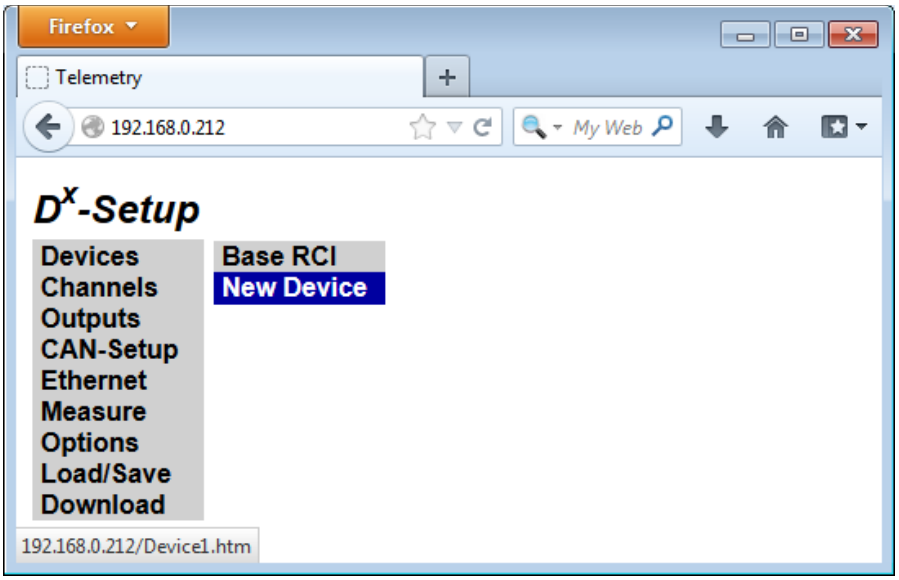


Figure 12: Add a new SCT

Please note: For more than one SCT to be added, create multiple new devices by selecting *Devices →New Device* multiple times. After having created all devices to be added, program the SCTs one after the other (see the following section).

3.5.2 Search for a SCT

Now make sure all other SCTs except the one to be added are switched off. Select *Devices → Device X.*

Please note: When searching for or programming a new SCT, this device has to be the only one to be active. Therefore, turn off **all** other SCTs in the vicinity.

You need to type in the last three digits of the SCT's serial number in the required field. The serial number can be found on the device's label.
E.g., if the serial number is *Dx-SCT-13-225*, type in *225*.

When configuring your DX with a web browser, click on *Set* to resume input to the DX.

Click *Search.*

Please note: If you have no access to the SCT's serial numbers, use the SCT search function: Type a three digit start value in the *Serial Number* field and click on *Search*. Starting from this value, the DX will search for the next 100 serial numbers in ascending order. E.g., if you type in 101 as starting value, the DX will search for SCTs with a serial number from 101 to 200.

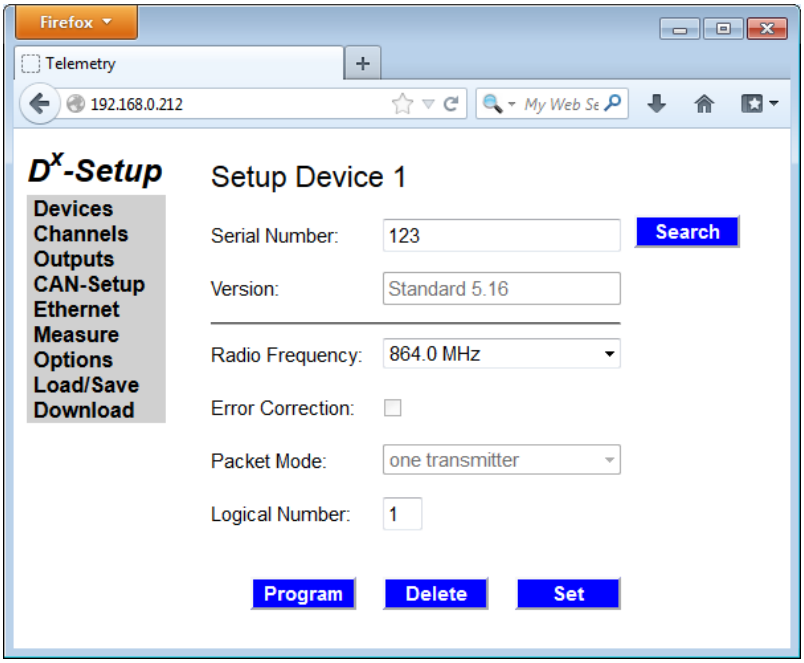


Figure 13: SCT setup

In case the search has been successful, confirm the *Device found!* message with *OK.*

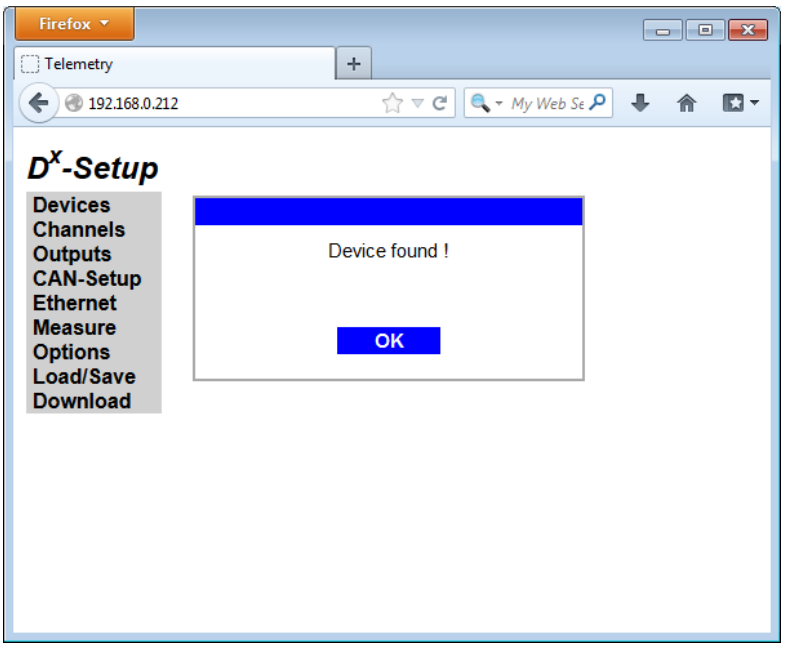


Figure 14: Message 'Device found!'

Now assign a *Logical Number* from 1-4 to the device**, with each SCT being assigned a different number**.

Please note: Serial Radio transmission signals with the D^X are transmitted within a window consisting of four sections. Each section is assigned to a fraction of time in the transmission window. The starting time of data transmission of the corresponding SCT is determined by its logical number.

When operating only one SCT, assign it to *Logical Number* 1. The SCT may now use the whole transmission window (sections 1-4).

When operating two SCTs, assign the first SCT to *Logical Number* 1, the second to *Logical Number* 3. Through this configuration, each SCT uses 2/4 of transmission time.

When operating 3 or 4 SCTs, any logical number can be assigned.

When configuring with a web browser, keep in mind to confirm your input with the *Set* button to resume it to the D^{X}.

Now click on the *Program* button.
Confirm the *Program done! Repower transmitter!* message with *OK.*

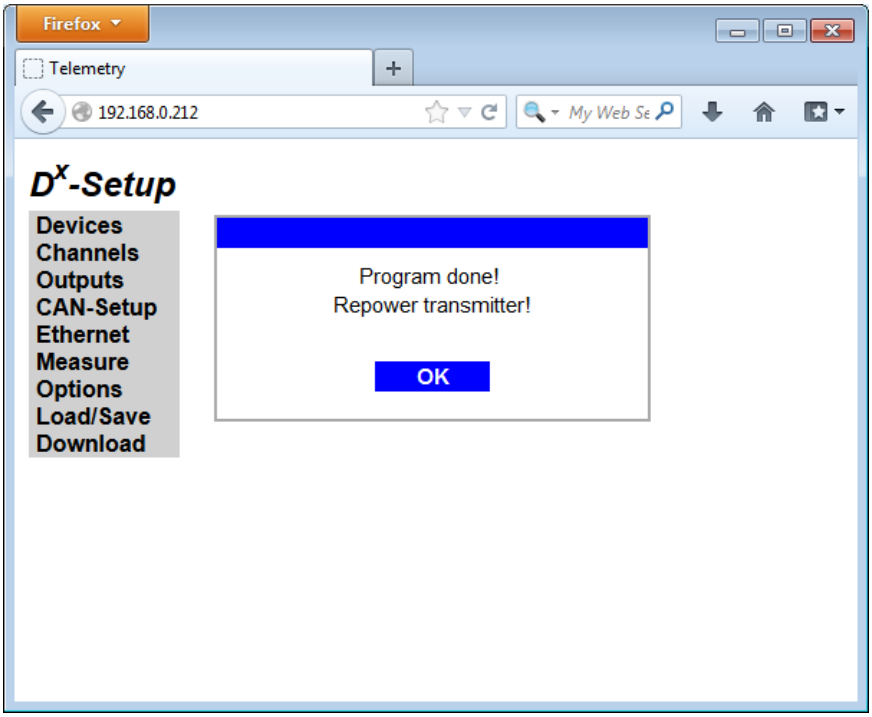


Figure 15: Message Program done!

Please note: The message *Program done!* only indicates that the configuration data has been transmitted. For successful programming, make sure the SCT is switched on and the RCI's radio signal can be received by the device (ideal RCI-SCT distance for programming: < 0.5m).

Disconnect the SCT from power supply for approx. 5 seconds, and then repower the device.

With *Devices →Device X,* open the SCT you have just programmed. Click *Search*.

If the SCT settings are found within the *Logical Number* you have recently programmed, the configuration has been successful.

Please note: After adding a new SCT, the channels of each SCT in the system have to be reprogrammed (*Channels → Device X → Channel_X_Y*, see section 3.6.2).

3.6 Channel Configuration

After you have added one or more SCTs to your telemetry system, the corresponding channels have to be created and programmed.

3.6.1 Generate a New Channel

Connect the sensors to the D^X (see connecting diagram in section 2.2).
Open *Channels → Modes.* Now select the measuring mode for the corresponding channel with the following options:

- Full bridge (strain gauges)
- Half bridge (strain gauges) with integrated bridge completion
- DC differential
- DC single ended
- Thermo differential
- Thermo single ended

Channels 7 and 8 detect reference temperature and supply voltage. These are sampled at a rate of 25 Hz and do not charge the bandwidth.

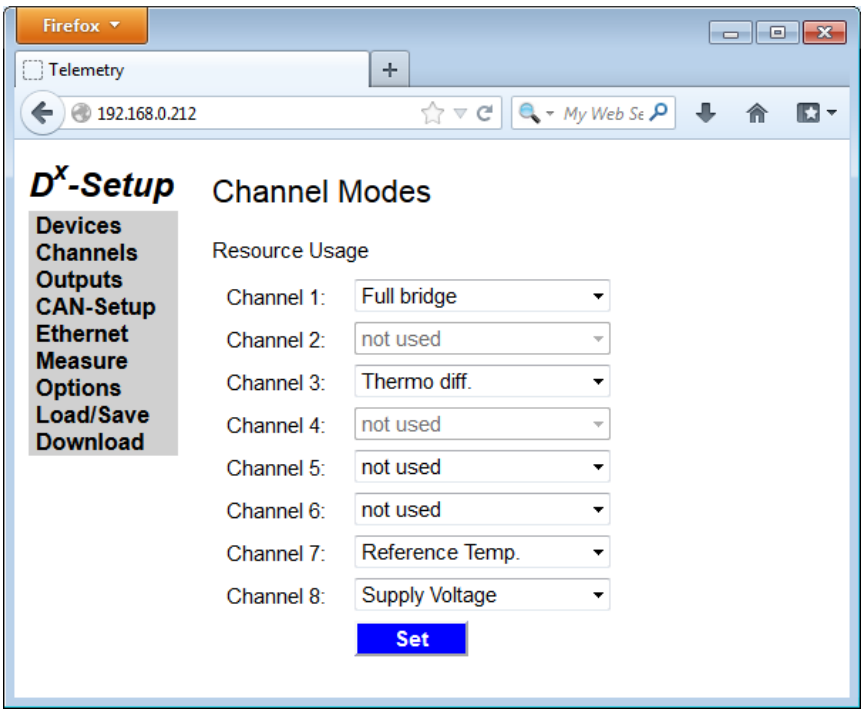


Figure 16: Channel modes

Please note: Due to technical restrictions, it is not possible to assign all measuring modes to any channel. Particularly, when using one channel as full bridge or in differential mode, the following channel is automatically blocked as sensor input. For further information, please see section 2.2.

Confirm with *OK* or *Set.*

3.6.2 Programming of Channels

After you have added one or more SCTs to your telemetry system, you proceed with programming at least one corresponding channel. To create a new channel, follow the instructions in section 3.6.1.

Select the menu item *Channels* → *Device X* → *Channel X_Y*, with *Device X* being the recently added SCT. *Channel X_Y* may be an arbitrary channel of *Device X* (except additional channels *Reference_Temp* and *Supply_Voltage*).

Activate the button *Program*.

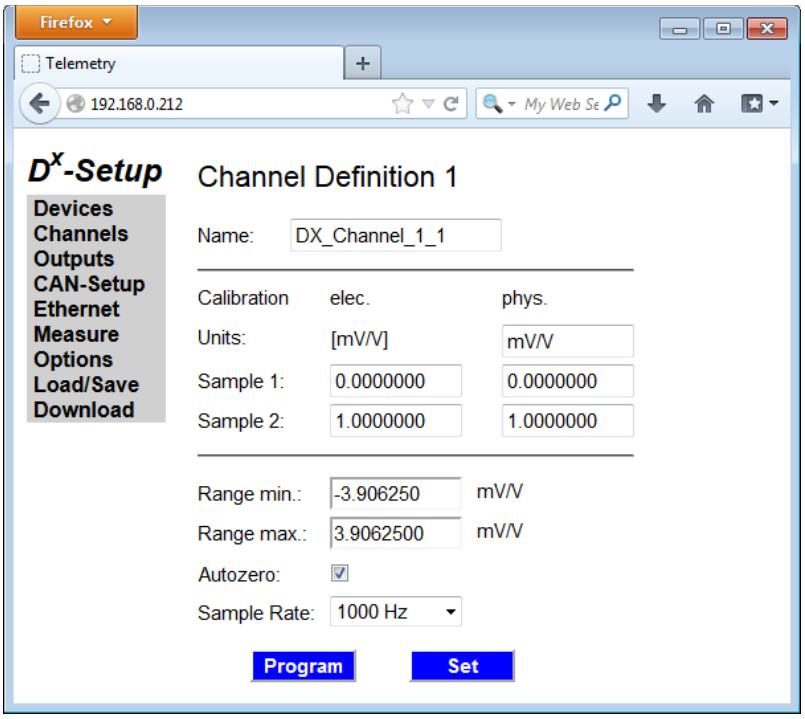


Figure 17: channel programming

Confirm the message.

Figure 18: Message 'Program done!'

3.6.3 Define a Sample Rate

Each channel of one D^{X} system is assigned the same sample rate (except additional channels *Reference Temp.* and *Supply Voltage*).

If you intend to change the sample rate of the D^{X} telemetry system, each SCT has to be reprogrammed individually. To do this, follow the steps described below for an arbitrary channel of each SCT. When programming a new sample rate, make sure that all SCTs are ready-to-receive.

Select the menu item *Channels→Device 1 →Channel 1_*Y, with Channel *1_Y* being an arbitrary channel of *Device 1* (except additional channels *Reference Temp.* and *Supply Voltage).*

With *Sample Rate,* select the desired sample rate. If the sample rate of one channel has been defined, the value selected is automatically assigned to all other channels of this SCT unit.

Please note: Bandwidth of the D^{X} telemetry system is split among all SCTs. Therefore, the maximum sample rate depends on the total number of channels and SCTs The cutoff frequency of the 6 pole anti-aliasing filter with Butterworth characteristics is automatically set to 1/5th of sample rate (-3dBs). The additional channels 7 and 8 for reference temperature and supply voltage are sampled at a rate of 25 Hz. They do not charge bandwidth of the channels 1-6.

Number of SCTs	max. n. of channels/SCT	max. sample rate [Hz]
1	1	4600
	2	2200
	3	1400
	4	1000
	5	800
	6	600
2	1	3600
	2	1800
	3	1200
	4	800
	5	600
	6	600
3 or 4	1	1000
	2	400
	3	200
	4	200
	5	200

For example: when configuring 2 SCTs and the first SCT has 3 channels in use while the second only has 1. The max sample rate should be 1200 Hz.

When configuring with a web browser, confirm your input with the *Set* button to resume it to the D^X.

Now select *Program*.

The High Temperature version of the system has slightly different sample rates
D^x-HT (2.4 GHz)

Number of SCTs	max. n. of channels/SCT	max. sample rate [Hz]
1	1	5000
	2	2400
	3	1600
	4	1200
	5	800
	6	800
2	1	4000
	2	2000
	3	1200
	4	1000
	5	800
	6	600
3 or 4	1	1200
	2	600
	3	400
	4	200
	5	200
	6	200

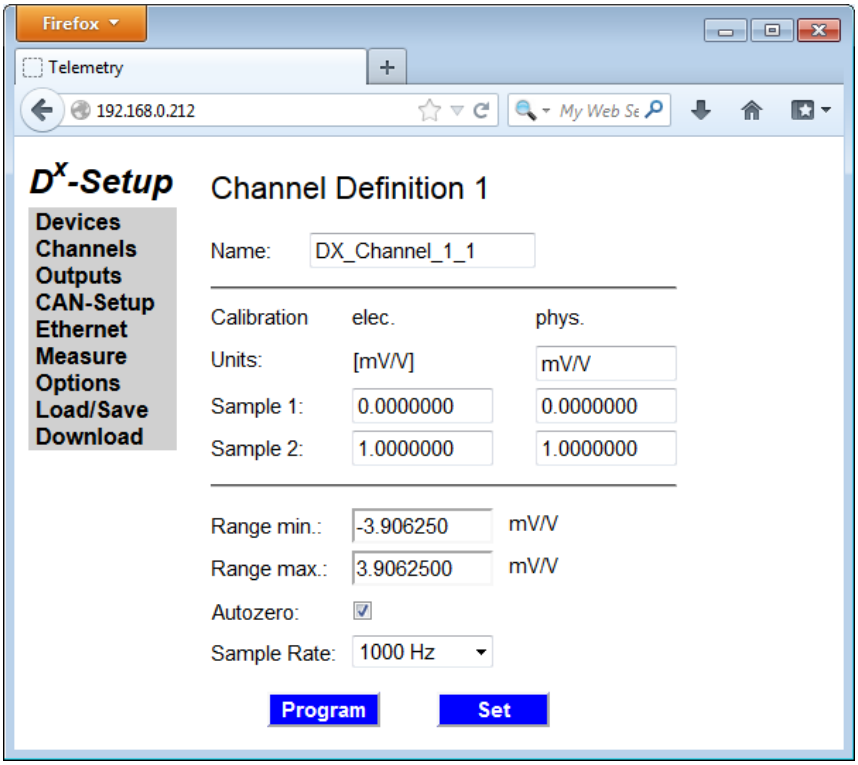


Figure 19: Programming of sample rate

Please note: Make sure the SCT is switched on (i.e. supplied with power) and radio transmission from RCI to SCT is undisturbed. Otherwise, the SCT can't be programmed successfully.

Confirm the message *Program done!* with *OK.*

Now continue with programming one corresponding channel of each SCT in the system (refer to section 3.6.2). The sample rate selected for *Device 1* is already entered.

3.6.4 Configure Full Bridges / Half Bridges

Make sure the desired channel has been assigned the correct signal mode (see section 3.6.1).
Open the desired channel by selecting *Channels→Channel X.*

3.6.4.1 Calibration

In the *Calibration* section, enter a two-point calibration line in the fields *Sample 1* and *Sample 2.* Define physical unit of output in the *Units* field.

When configuring with a web browser, confirm your input with the *Set* button to resume it to the D^{X}.

3.6.4.2 Autozero

Check the *Autozero* box to select the channel for zero adjustment in measuring mode.

When configuring with a web browser, confirm your input with the *Set* button to resume it to the D^{X}.

Please note: Zero adjustment is permanently stored in the D^{X} and is reloaded when the system is restarted.

3.6.4.3 Measurement Range

Enter upper and lower bound of desired measurement range in the fields *Range min:* and *Range max.* The measurement range resolution is 16 bits.

Please note: The measurement range can be increased/decreased by powers of two and is centered on zero.

When configuring with a web browser, confirm your input with the *Set* button to resume it to the D^{X}.

Select *Program*.

Please note: Make sure the SCT is switched on (i.e. supplied with power) and radio transmission from RCI to SCT is undisturbed. Otherwise, the SCT can’t be programmed successfully.

Confirm the message.

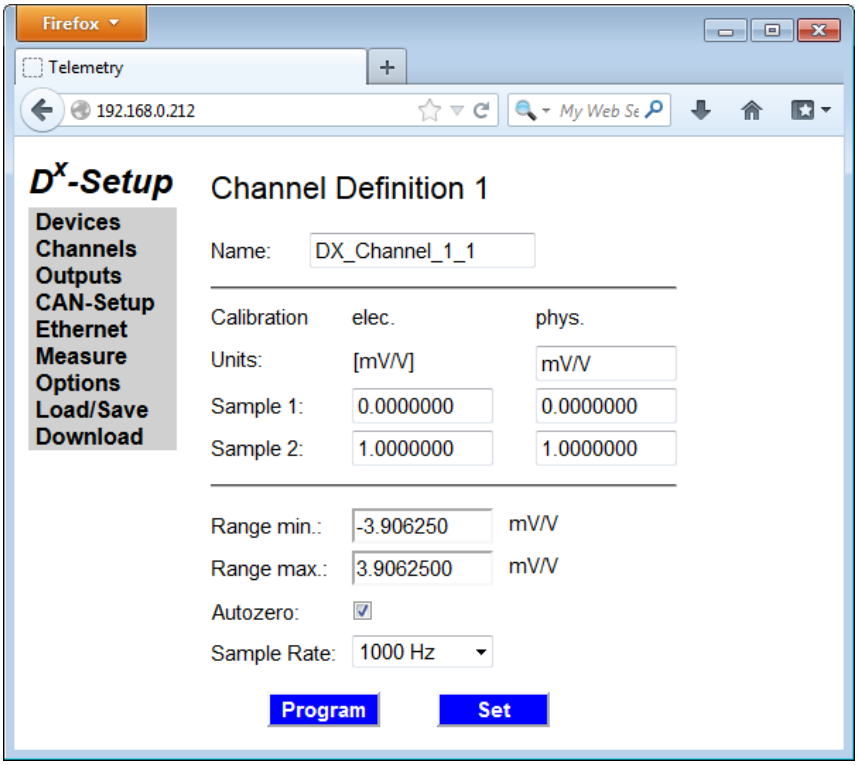


Figure 20: Strain gauge channel configuration

3.6.5 Configure Thermocouples (differential or single ended)

Open the desired channel by selecting *Channels → Channel X.*

3.6.5.1 Calibration

In the *Calibration* section, enter a two-point calibration line in the *Sample 1* and *Sample 2* fields*.* Define physical unit of output in the *Units* field.

3.6.5.2 Measurement Range

Enter upper and lower bound of desired measurement range in the fields *Range min:* and *Range max.* The measurement range resolution is 16 bits.

Please note: The measurement range can be increased/decreased by powers of two and is centered on zero.

3.6.5.3 Thermo mode

Select type of thermocouple (type J or type K).

When configuring with a web browser, confirm your input with the *Set* button to resume it to the D^X.

Select *Program*.

Please note: Make sure the SCT is switched on (i.e. supplied with power) and radio transmission from RCI to SCT is undisturbed. Otherwise, the SCT can't be programmed successfully.

Confirm the message*.*

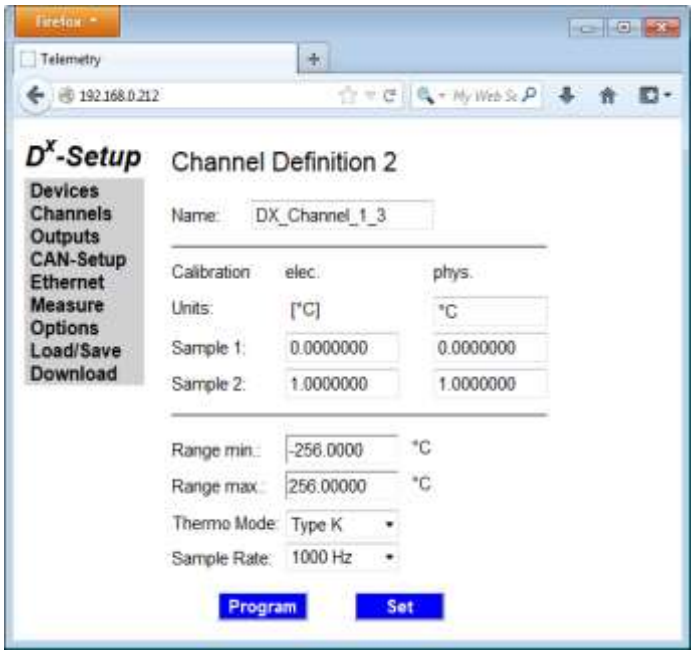


Figure 21: Temperature channel configuration

3.6.6 Configure High Level Voltage Inputs

Open the desired channel by selecting *Channels → Channel X.*

3.6.6.1 Calibration

In the *Calibration* section, enter a two-point calibration line in the *Sample 1* and *Sample 2* fields*.* Define physical unit of output in the field *Units*.

3.6.6.2 Autozero

Check the *Autozero* box if you do not want to adjust selected channel. If the adjustment is to be permanently stored in the SCT, the corresponding channel must be programmed after the autozero adjustment (*Channels→Channel X → Program*).

3.6.6.3 Measurement Range

Enter upper and lower bound of desired measurement range in the fields *Range min:* and *Range max.* The measurement range resolution is 16 bits.

Please note: The measurement range can be increased/decreased by powers of two and is centered on zero.

When configuring with a web browser, confirm your input with the *Set* button to resume it to the D^X.

Select *Program*.

Please note: Make sure the SCT is switched on (i.e. supplied with power) and radio transmission from RCI to SCT is undisturbed. Otherwise, the SCT can't be programmed successfully.

Confirm the message*.*

Figure 22: Voltage channel configuration

3.7 Configure CAN Output

For each measurement timepoint, one or several CAN messages are transmitted, with each message containing up to four 16-bit measurement values.

3.7.1 Create/Delete CAN Message

Select *CAN-Setup → New Msg.* in the menu.
Select the *active* checkbox for this message to be transmitted in measuring mode. In the field *Data*, select the channels to be transmitted (max. 4 for a message of 8 bytes). Define the desired data format (unchecked = INTEL / checked = MOTOROLA) and its sign mode in the field *Sign* (unchecked = unsigned / checked = signed).
The *Bit-Offset* between two successive channels has to be 16 bits.

Select *Set* / *OK* to resume the configuration. To delete this CAN message, select *Delete*.

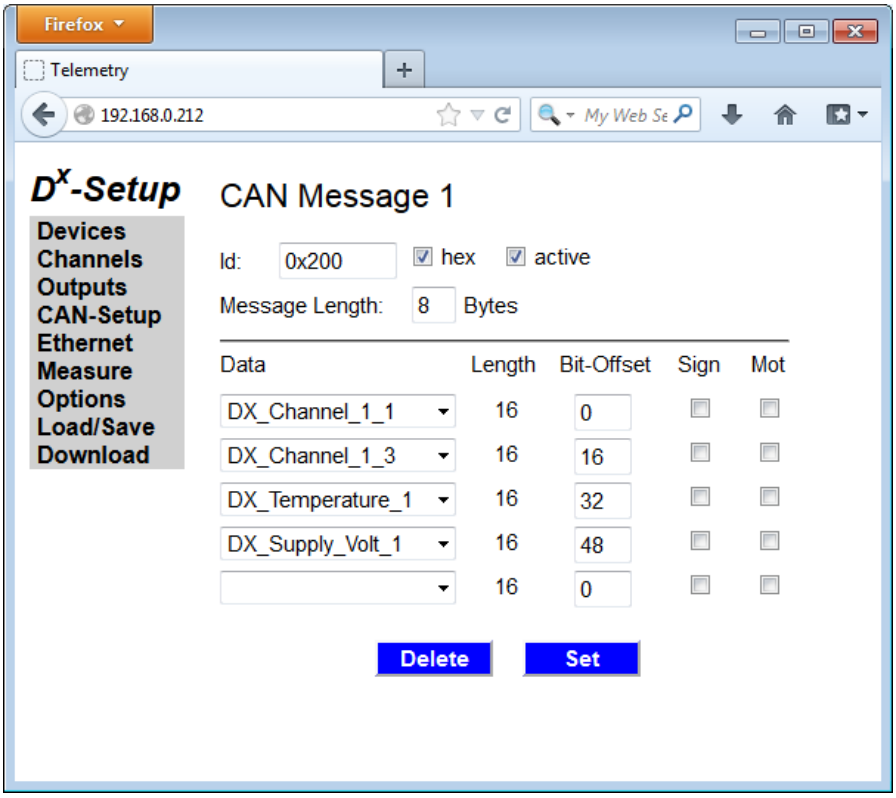


Figure 23: CAN message configuration

3.7.2 Edit/Save CAN Preferences

3.7.2.1 CAN-Bus Preferences

Select *CAN-Setup → General*.
In the *Bitrate* field, select bit rate of CAN bus (standard: 500 kBaud).
Check the *Ignore Acknowledge* box to deactivate the CAN acknowledge function. If desired, type in a data compression factor in the field *Send Rate: Sample Rate.*

When configuring with a web browser, confirm your input with the *Set* button to resume it to the D^X.

3.7.2.2 Create .dbc File

With a .dbc file, data configuration of CAN messages can be conveniently imported to your data acquisition software.

Click on the *Write* button to create a .dbc file with the current configuration. Confirm the message.

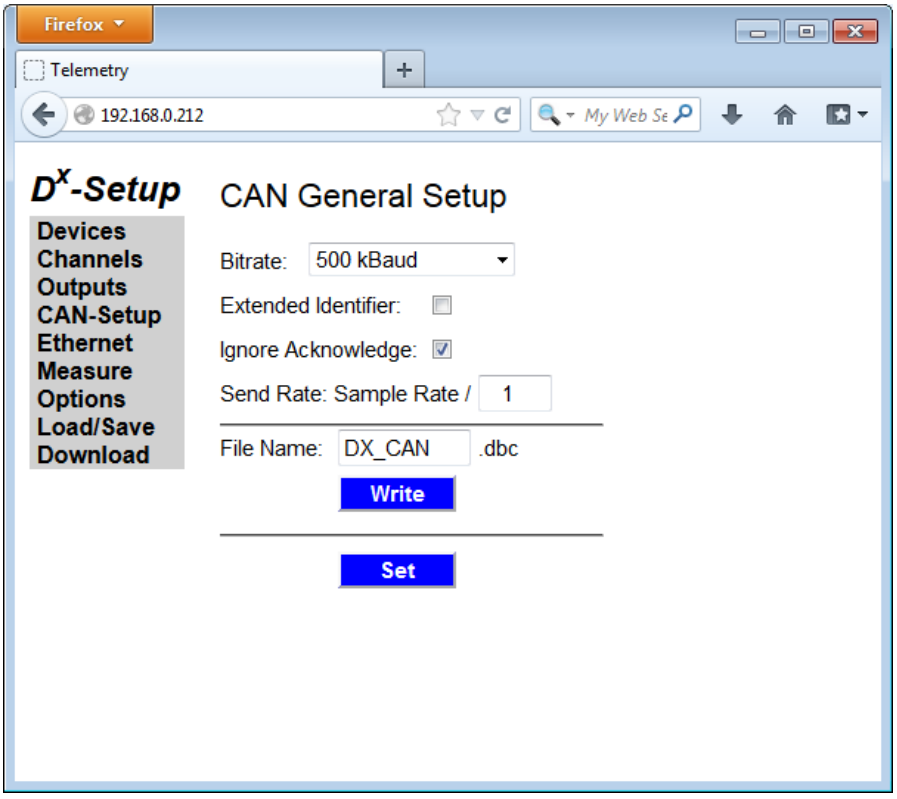


Figure 24: CAN setup

3.7.2.3 Download .dbc File

To download the .dbc file via Ethernet, select the menu item *Download*.

Please note: This menu item is only displayed in your browser, not in the RCI.

Select the .dbc file from the file list (default name: *DX_CAN.dbc*).

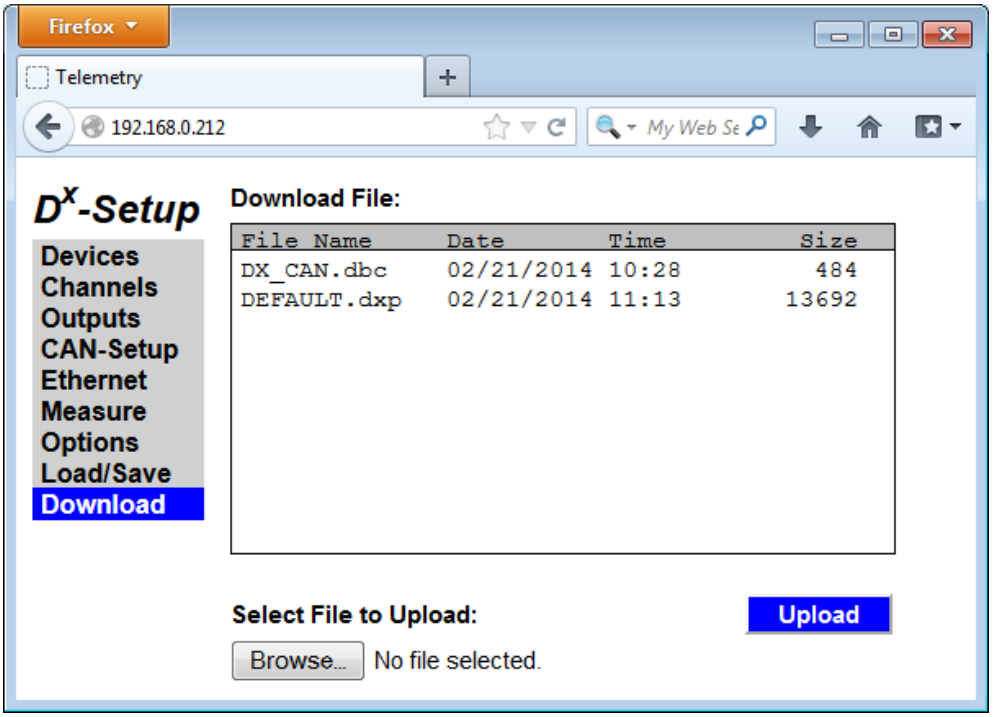


Figure 25: Download .dbc file

If there is no network connection established, remove the SD card of the D^{X} and insert it to the card reader of your computer. The .dbc file (default name: *DX_CAN.dbc*) is stored in the root directory.

3.8 Configure Analog Output

Any measurement data channel of the D^{X} can be assigned to one of the 6 analog outputs.

Select *Output* → *Output X*.

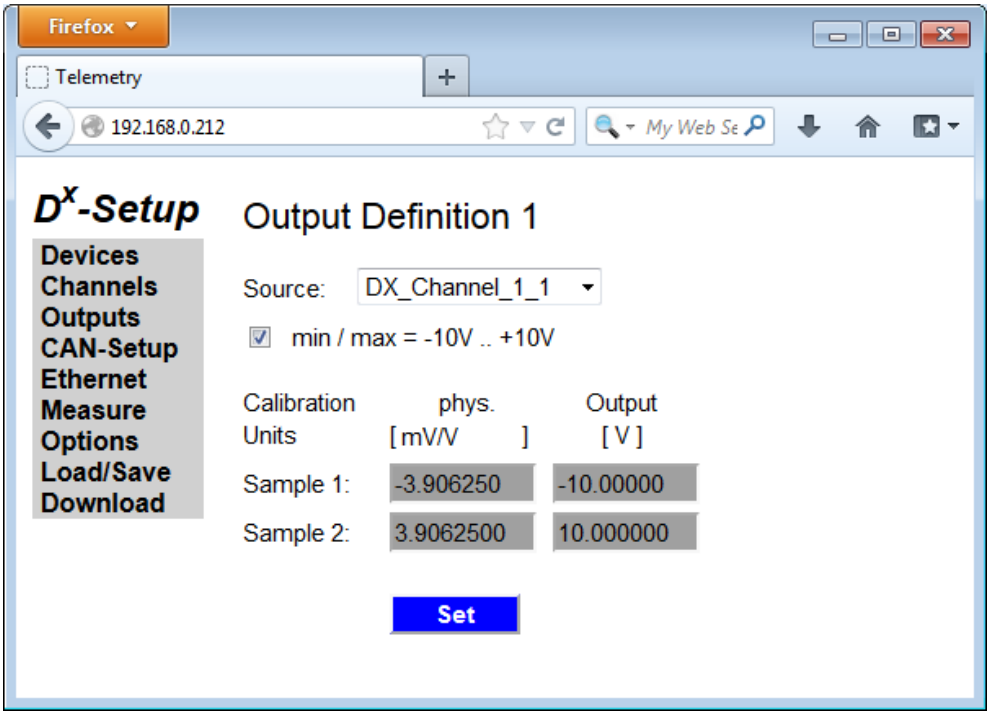


Figure 26: Analog output configuration

With *Source*, select the data channel to be displayed.

Check the *min/max = -10 V/+10 V* box to set the upper/lower bounds of the measurement range (see 3.6.4.3) to -10 V/+10 Volts. If the box is unchecked, the measurement range can be defined by a two-point calibration.

Please note: Maximum/minimum analog output is ± 10 Volts.

When configuring through a web browser, confirm your input with the *Set* button to resume it to the D^{X}.

3.9 Save and Export Settings

The current configuration can be saved as a .dxp file. When loading the file, the configuration you have saved is restored.

When booting the D^X, the DEFAULT.dxp configuration file is automatically loaded. If you save a configuration with *DEFAULT.dxp* as file name, it is immediately loaded when restarting the D^X.

3.9.1 Save Configuration (create .dxp File)

Select *Load/Save*. With *File Name,* type in the desired file name.

Please note: When choosing DEFAULT.dxp as file name, this file is automatically loaded at restart.

Select *Save* and confirm the message.

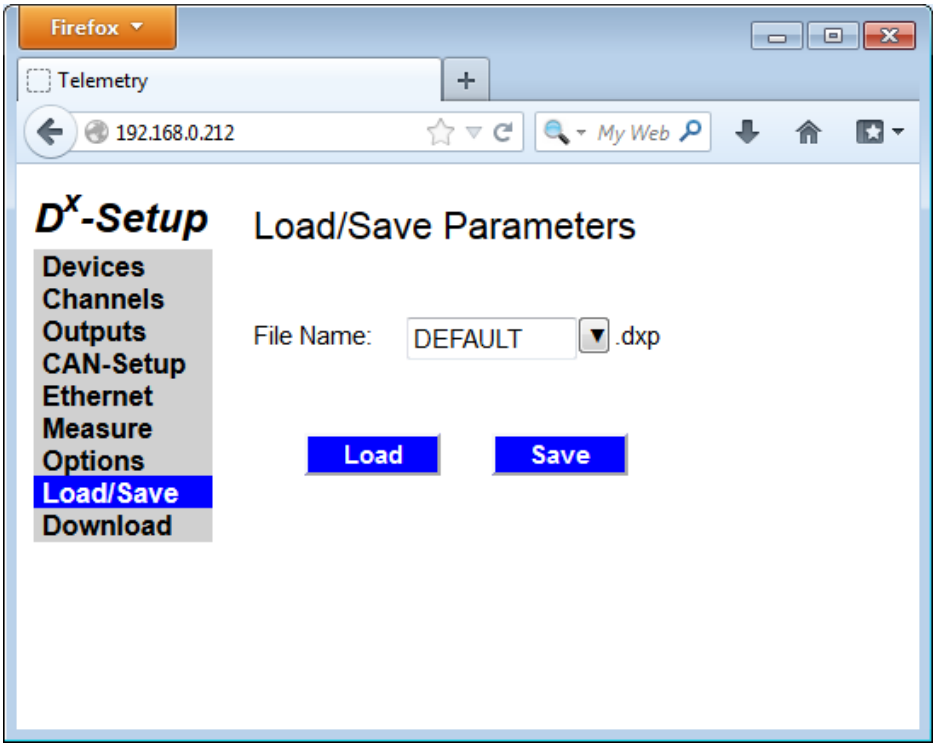


Figure 27: Save Configuration in .dxp file

3.9.2 Load Configuration

Select *Load/Save*. With *File Name*, enter the file name of the .dxp file to be loaded.

Select the *Load* button.

Confirm the message.

3.9.3 Download .DXP File

To download the .dxp file via Ethernet, select the menu item *Download* in your browser.

Please note: This menu item is only displayed in your browser and not in the RCI.

Click on the file to be downloaded from the file list to import it. (Default: *DEFAULT.dxp)*

If there is no network connection to the computer, remove the SD card of the D^{X} and insert it into your computer's card reader. The .dxp files are saved in the root directory.

3.9.4 Automatically load Configuration File when booting

When booting, the D^{X} automatically imports the configuration file DEFAULT.dxp. If you save your current configuration under this file name, it is automatically imported when rebooting.

Select *Load/Save* and type in *DEFAULT* as File Name.

Select the *Save* button.

Confirm the message.

The configuration selected is now automatically loaded at restart.

3.10 Start Measurement

3.10.1 Measurement Mode and Configuration Mode

When the D^{X} RCI is switched on, it is always in one of the following modes:

- In measurement mode, data is recorded and transmitted.
- In configuration mode, the SCTs and the RCI can be programmed. Here, no measurement data is transmitted.

To ensure consistent data, you immediately exit measurement mode when leaving the menu page *Measure → Start* (input by scroll wheel or Ethernet)

Please note: If you call the D^{X} configuration menu in a new browser session, you are automatically redirected to the D^{X} main page. The system then interrupts data transmission and switches to configuration mode.
To prevent any access to the D^{X} Ethernet interface during measurements, you may unplug the Ethernet cable.

3.10.2 Configure Online Display

In measurement mode, the current measurement values are displayed on the screen. For this purpose, up to six display windows can be configured.

Select the sub-item *Display X* from the *Measure* item.

Select which channels you want to be displayed, from the dropdown menu. Type in the number of digits to be displayed in the *Decimal* section (including its sign). In the *Places* field, type in the number of decimals showed after the comma.

When configuring with a web browser, confirm your input with the *Set* button to store it to the D^{X}.

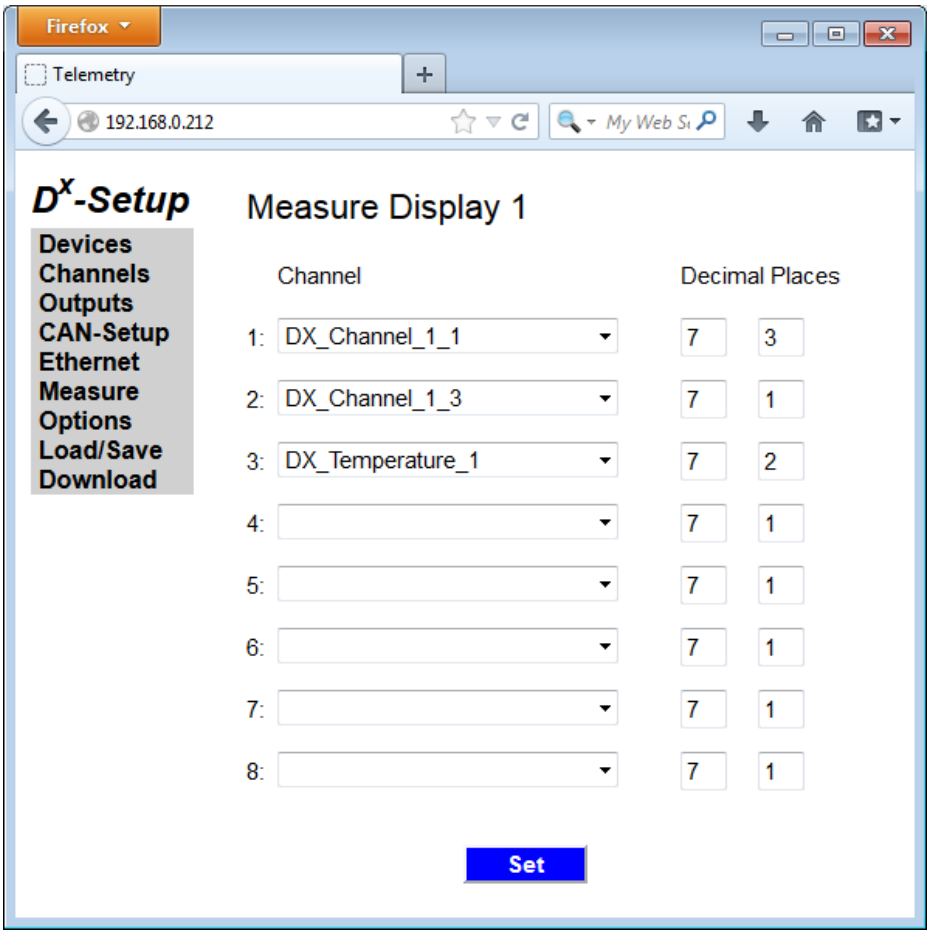


Figure 28: Online display configuration

3.10.3 Start and Stop Measurement

Select the sub-item *Start* in the menu item *Measure*. The D^X now switches to measurement mode.

3.10.3.1 Switch between Online Displays

In your web browser, you may click on *Page* to switch between the six online displays. On the RCI, press the 'up' and 'down' buttons on the scroll wheel to switch between the online views.

3.10.3.2 Online Zeroing

Click on the *Autozero* button to trigger zero balancing for all selected channels (see section 0).

3.10.3.3 Switch Shunt Resistance On and Off

To connect the shunt resistance for testing purposes, click on "*Sh. On"*. Now, an internal shunt resistance of 330 kΩ is set between positive signal input and positive bridge voltage input, the resulting amplitude is in the positive direction. The button label is now *Shunt Off*. Click on *Shunt Off* to disconnect the shunt resistance.

3.10.3.4 End Measurement

To exit the measurement mode, press the *Cancel* button on the RCI. You can cancel the measurement by clicking on any menu item via the web browser.

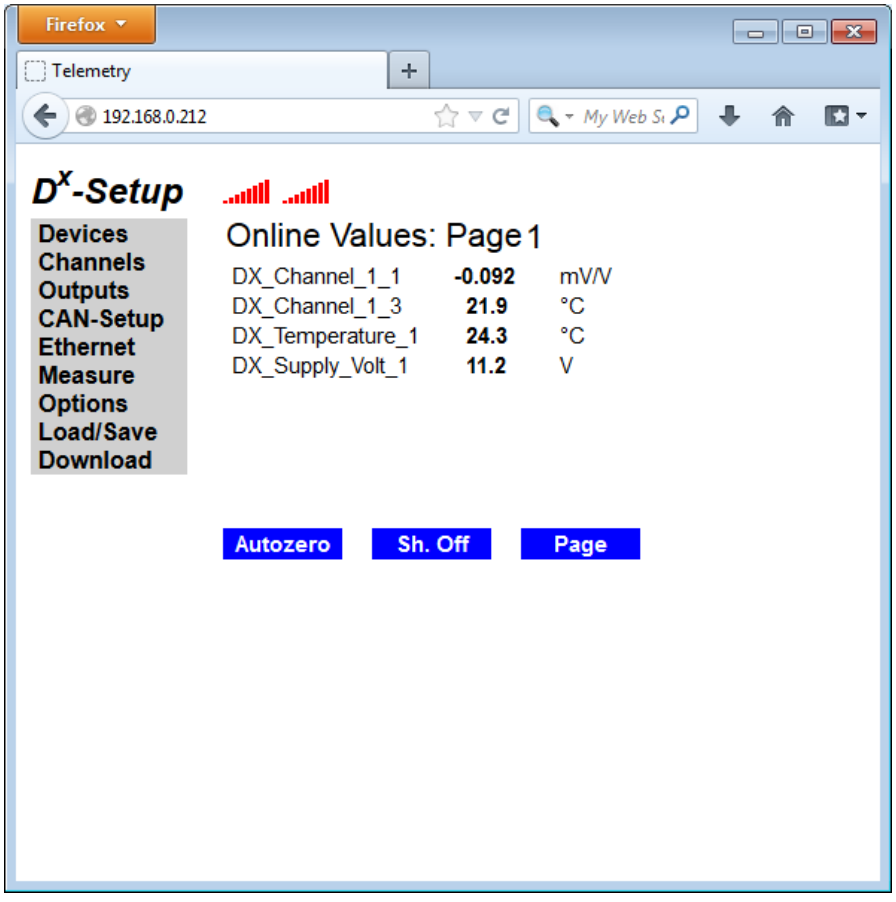


Figure 29: Measurement mode

3.10.4 Start Measurement Automatically (Auto Measure Start)

With these functions, the D^{X} automatically switches to measurement mode after booting. It is not necessary to start the measurement manually with *Measure* → *Start*.

Select *Options*.

Activate the *Auto Measure Start* checkbox.

When configuring with a web browser, confirm your input with the *Set* button to resume it to the D^{X}.

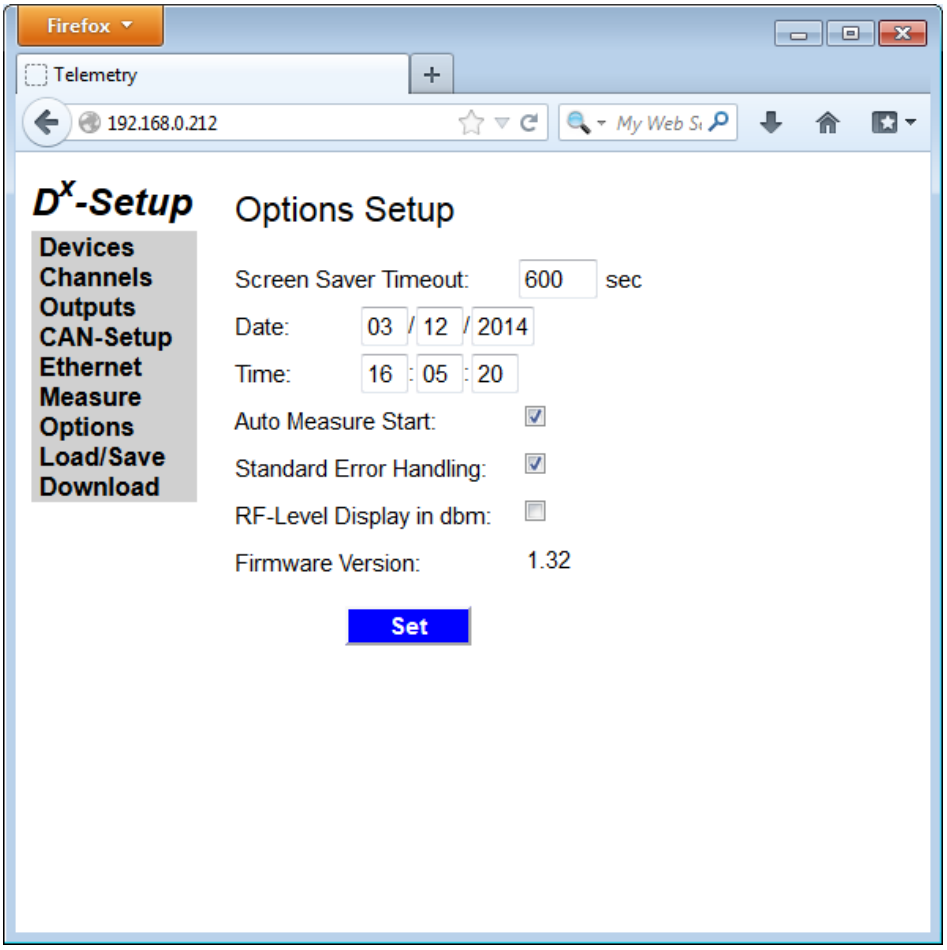
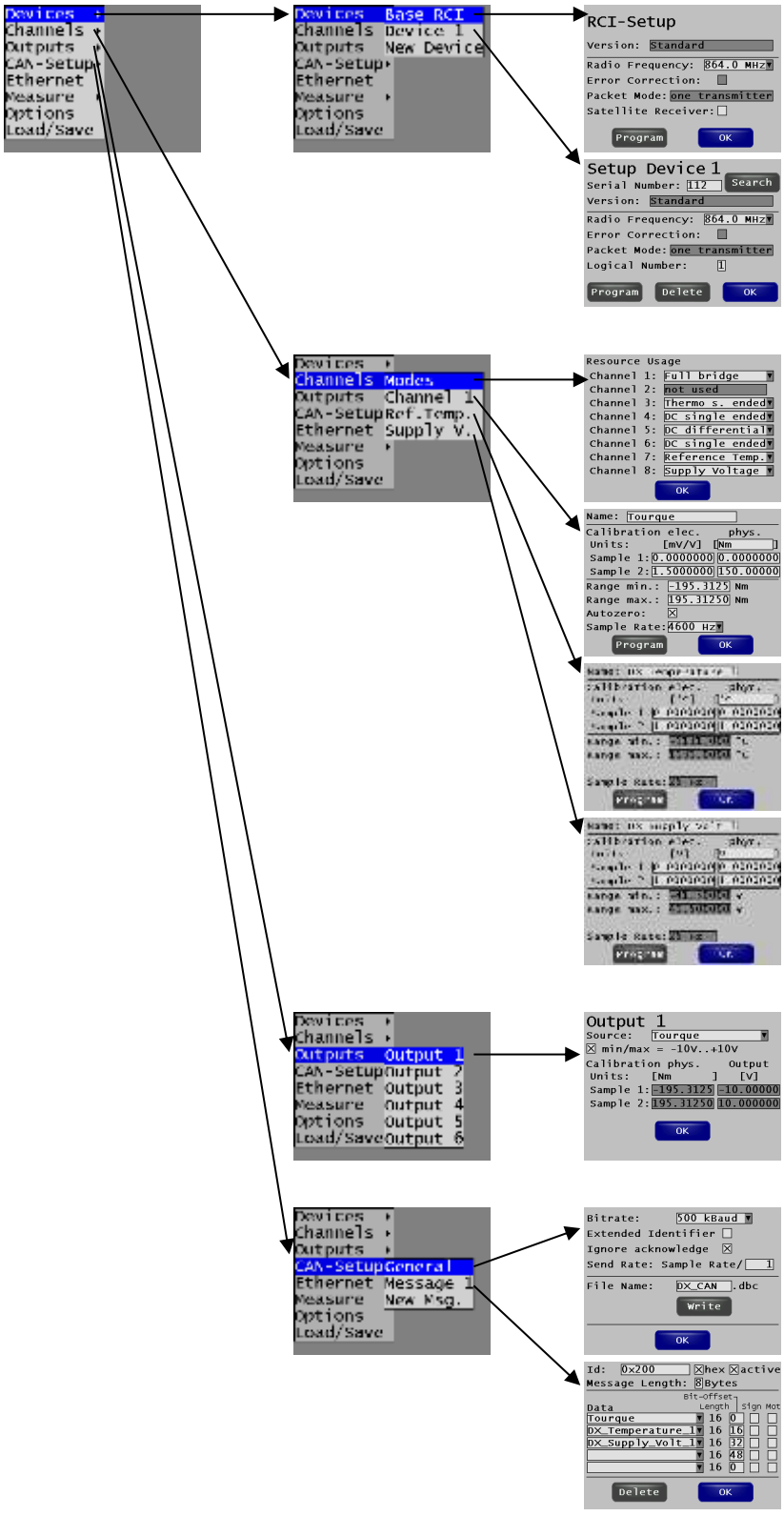


Figure 30: D^{X} options setup / Auto measure start

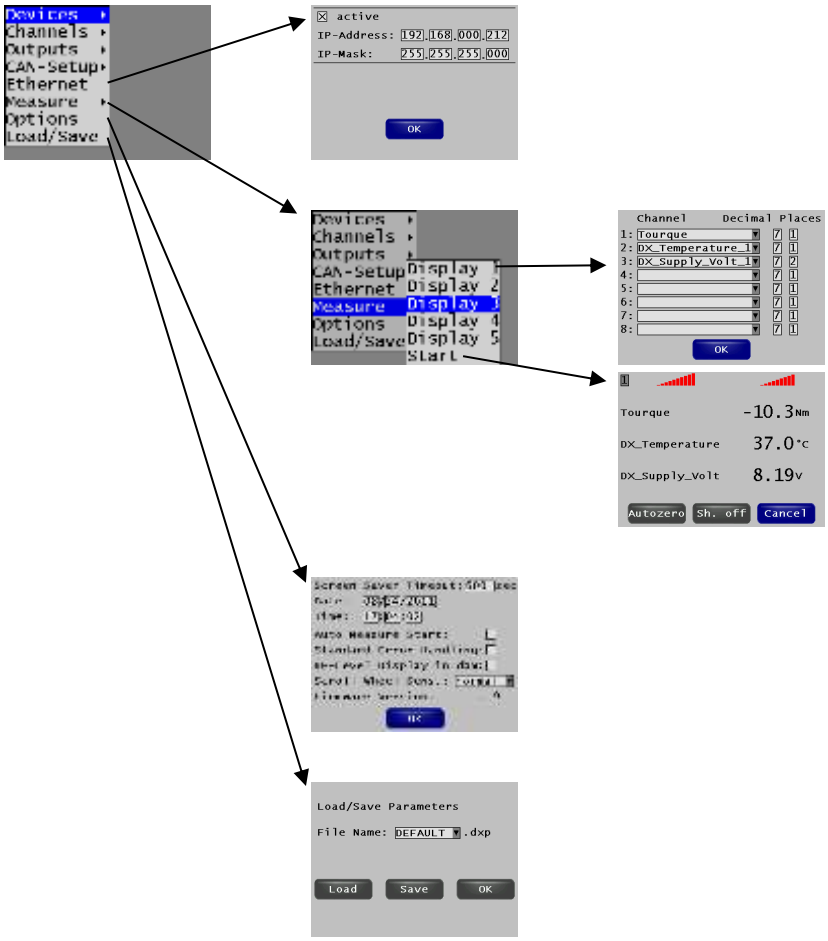
4 D^{X} Configuration Menu

In this section, all functions of the D^{X} configuration menu are described in detail.

4.1 Menu tree

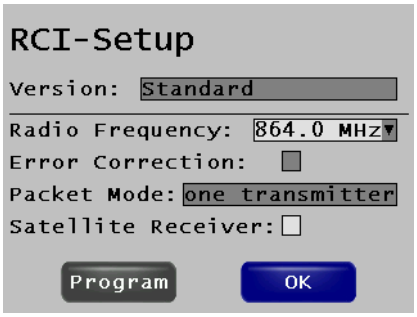


Menu tree (continued)



4.2 Settings

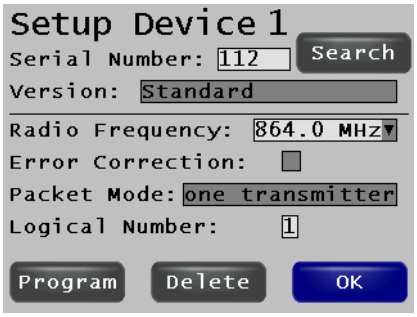
4.2.1 Menu: Device → Base RCI



Version:	Information about the RCI version
Radio frequency:	You can set the required radio frequency through a drop-down menu. If you use several RCIs within a transmission area, they must be programmed with different frequencies. IMPORTANT: Always set the SCTs to the desired frequency first. Otherwise you will “lock you self out”.
Error correction:	An additional hardware error correction can be activated when using the 2.4 GHz version. This feature will reduce the signal bandwidth.
Packet mode:	Reserved for future settings
Satellite receiver:	With this function, the two internal transceivers in the RCI are turned off. By doing so, the external transceivers (RSU) can be connected and used.
Program:	Store the configured parameters.
OK:	Exit menu.

Please note: In order to change settings permanently, you have to record your current configuration with the *Save* button in the menu → *Load/Save*

4.2.2 Menu: Device → Device1



Serial number:	This number is used for addressing the SCT. Only this device is addressed when programming.
Search:	This function is used to search for the respective frequency according to the SCT. The “serial number” and the "logical number" are determined and entered into the field. IMPORTANT: When searching, make sure that only one SCT is turned on to provide a unique identification.
Version:	Information about the SCT version. **Please note:** Current firmware version is displayed after pressing *Search.*
Radio frequency:	You can set the desired radio frequency through a drop-down menu. The SCTs can only communicate with RCIs of the same frequency. Up to 4 SCTs of the same frequency can be operated via one RCI. Each carrier frequency offers a bandwidth of approx. 6 kS/s. The modification of this setting is only activated after programming and rebooting the SCT. IMPORTANT: Always set the SCTs to the desired frequency first. Otherwise you will “lock yourself out”.
Error correction:	An additional hardware error correction can be activated when using the 2.4 GHz version. This feature will reduce the signal bandwidth.
Packet mode:	Reserved for future settings.
Logical number:	This number defines the starting point for the data transmission of the respective SCT in the corresponding timeslot. This time domain is subdivided into 4 sections (“logical number” 1-4). If you only use one SCT, set the “logical number” to “1”. By doing so, you are able to use the whole timeslot (1 - 4). If you operate with two SCTs use numbers 1 and 3; by doing so, each SCT has 2/4 of the timeslots available. When using 3 or 4 SCTs the numbers can be allocated as you like. IMPORTANT: At any given frequency, the "Logical Number" can only be assigned once.

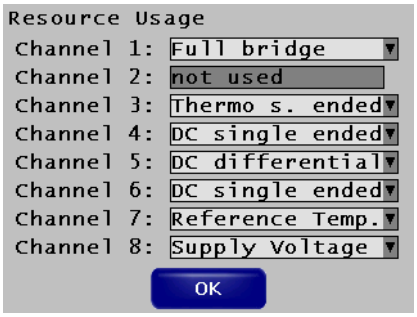
Program:	The settings (“radio frequency” and “logical number”) are transmitted to the SCT with the serial number registered under “serial number”. Then a reset of the transmitter module is required. To do this, please disconnect the SCT power supply for at least 5 seconds. IMPORTANT: Make sure that the SCT is sufficiently supplied while programming and that no other SCT operates with the same frequency.
Delete:	Delete this SCT from the configuration.
OK:	Exit menu.

IMPORTANT: In order to change settings permanently, you have to record your current configuration with the *Save* button in the menu → *Load/Save*

4.2.3 Menu: Device → New Device

If you would like to use more SCTs you can easily add a new device with this menu entry. Up to 4 SCTs of the same frequency can be operated via one RCI

4.2.4 Menu: Channels → Modes



Channel 1: Select the measuring mode for each respective channel. The following settings are available:

- Full bridge (strain gauges)
- Half bridge (strain gauges) with integrated bridge completion
- DC differential
- DC single ended
- Thermo differential
- Thermo single ended

When a channel is used as a full bridge or in differential mode, the following channel is automatically used and is no longer available to a sensor input!

IMPORTANT: Channels 1 to 6 share the max. sampling rate of 4.6kS/s.

Channel 2: Select measurement mode for respective channel. The settings are only available if they are not blocked by “Channel 1”. In this case the following settings are available:

- Half bridge (strain gauges) with integrated bridge completion
- DC single ended
- Thermo single ended

Channel 3: see “Channel 1”

Channel 4: see “Channel 2”

Channel 5: Choose whether “Channel 5” “DC differential” is to be activated

Channel 6: Choose whether “Channel 6” “DC single ended” is to be activated

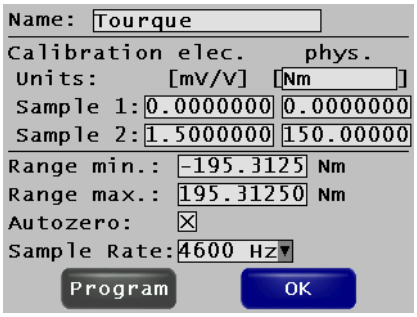
Channel 7: Choose whether “Channel 7” Internal reference temperature (“Reference Temp.”) is to be activated. This channel is scanned with 25Hz and does not affect the total bandwidth.

Channel 8: Choose whether “Channel 8” “Supply Voltage” is to be activated. This channel is scanned with 25Hz and does not affect the total bandwidth.

OK: Exit menu.

IMPORTANT: In order to change settings permanently, you have to record your current configuration with the *Save* button in the menu → *Load/Save*

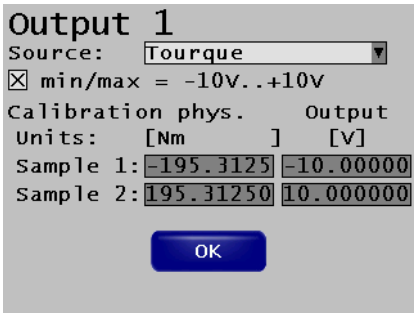
4.2.5 Menu: Channels → Channel x



Name:	Enter a channel name with a maximum of 16 characters
Units phys.:	Enter the desired measuring unit
Sample 1, Sample 2:	Two-point calibration line for conversion of electrical signal (e.g. mV/V with bridges) to physical magnitude. The linear equation is determined by these two reference points.
Range min., Range max.:	This input value marks the lower/upper limit of the measurement range in the given measuring unit. Measurement range is resolved with 16 bits.
Autozero:	If this box is ticked, it is possible to carry out a zero adjustment for this channel. If the adjustment is to be permanently stored in the SCT, the corresponding channel must be programmed afterwards ("Channels → Channel x → Program").
Sample Rate:	Here, the desired sampling rate is set. This has to be the same for all adjustable channels operated on one RCI. The 6-pole Butterworth filter is set to 1/5 of the sampling rate (-3dB).
Program:	By means of this button the settings made above are sent to the respective SCT. In case the Autozero box is ticked, the current zero adjustment is permanently saved in the SCT. IMPORTANT: Make sure that the SCT is sufficiently supplied while programming.
OK:	Exit menu.

Please note: In order to change settings permanently, you have to record your current configuration with the *Save* button in the menu → *Load/Save*

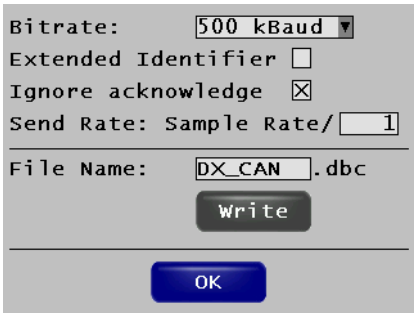
4.2.6 Menu: Outputs → Output x



Source:	Choose the channel to be output.
min/max:	If this box is ticked the detected maximum signal range of this channel is converted into an analog signal. The output range is +/-10 Volt. If it is not ticked the conversion can be freely programmed (see Sample 1 + 2)
Sample 1, Sample 2:	A calibration line is defined via Sample 1 and Sample 2, which determines the conversion of a physical signal (e.g. Nm) into an electrical voltage. The linear equation is determined by these two reference points.
OK:	Exit menu.

Please note: In order to change settings permanently, you have to record your current configuration with the *Save* button in the menu → *Load/Save*

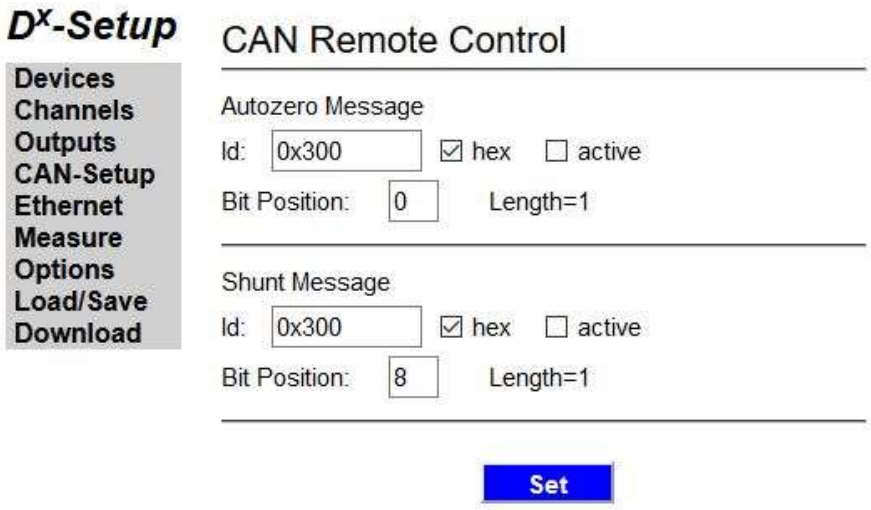
4.2.7 Menu: CAN-Setup → General



Bitrate:	Select the transmission rate for the CAN-Bus.
Extended Identifier:	When ticked a 29-bit extended identifier is used, otherwise an 11-bit identifer is used.
Ignore acknowledge:	The RCI transmits data without the sender's acknowledgement of receipt.
Send Rate:	Specifies the sample rate to be transferred by the CAN-output. Only one in x value is transferred to the CAN-bus.
File Name:	Enter the file name of the DBC-file
Write:	Writes the settings edited in the menu "CAN-Setup → Message x" into the DBC-file.
OK:	Exit menu.

Please note: In order to change settings permanently, you have to record your current configuration with the *Save* button in the menu → *Load/Save*

4.2.8 Menu: CAN Setup → Rem. Ctrl

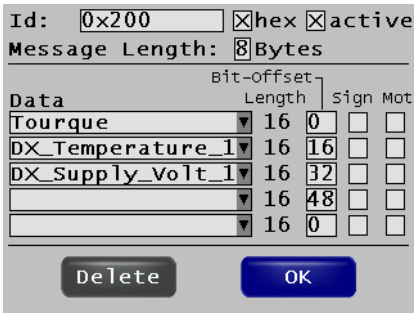


This function allows other devices to remotely activate “Autozero” or “Shunt test” on your D^X system.

Id: (Autozero Message)	Enter the desired CAN-Id for the "Autozero Message" in decimal or hexadecimal.
Id: (Shunt Message)	Enter the desired CAN-Id for the "Shunt Message" in decimal or hexadecimal.
hex:	Switch the CAN-Id between decimal and hexadecimal.
active:	Activate the message. The message will be received via the CAN only if this box has been ticked.
Bit Position:	Indicates the Bit position for the remote-controlled messages (Autozero and Shunt).

Please note: In order to change settings permanently, you have to record your current configuration with the *Save* button in the menu → *Load/Save*

4.2.9 Menu: CAN-Setup → Message x



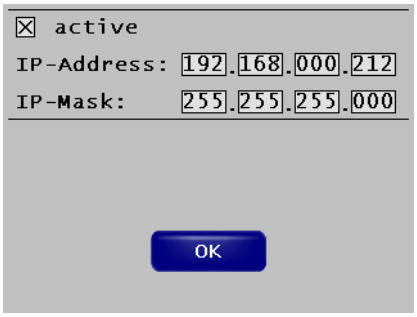
Id:	Enter the desired CAN-ID of the message in decimal or hexadecimal.
hex:	Switch the CAN-Id between decimal and hexadecimal.
active:	Activate the message. The message will be sent via the CAN only if this box has been ticked. It will also be stored in the DBC-file even if it was not activated.
Message Length: Data:	A message has a maximum of 8 bytes, but it can be reduced if, for example, only two channels should be transmitted. The setting is 4 bytes. Note: For four channels, it is more convenient to transmit these in an 8-byte CAN message since this causes less data load on the CAN bus.
Bit-Offset:	Indicated the starting point of the 16 data bits of the respective channel.
Sign:	Specifies whether the data should be transmitted with or without plus/minus sign (disabled = without / active = with sign).
Mot:	Specifies the data format (unchecked = INTEL / checked = MOTOROLA).
Delete:	Delete this message.
OK:	Exit menu.

Please note: In order to change settings permanently, you have to record your current configuration with the *Save* button in the menu → *Load/Save*

4.2.10 Menu: CAN-Setup → New Msg.

If you want to use more than one CAN message, with 4 channels each, further messages can be created. With the menu command "CAN-Setup → New Msg." You can simply add a new message.

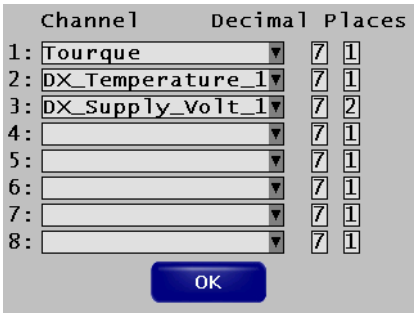
4.2.11 Menu: Ethernet



activate:	Ethernet-connection is set to “active”
	IMPORTANT: As soon as the Ethernet-connection is set to “active” on the RCI, anyone having access to the network can configure the RCI.
IP-Address:	Set the IP address. The computer must be in the same segment. In this case (see figure above): 192.168.000.xxx.
IP-Mask:	Enter the netmask
OK:	Exit menu.

Please note: In order to change settings permanently, you have to record your current configuration with the *Save* button in the menu → *Load/Save*

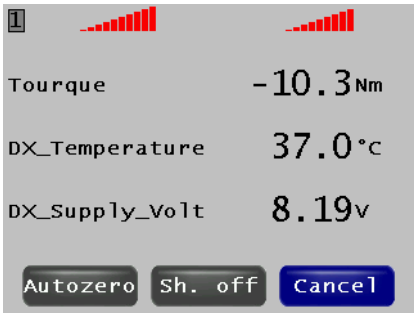
4.2.12 Menu: Measure → Display x



1-8:	Choose the channel to be shown on this display. You can also specify the maximum number of characters (including the sign, comma, and decimal figures) as well as the decimal places.
	Up to five displays can be defined, which can be switched through in the measuring mode.
OK:	Exit menu.

Please note: In order to change settings permanently, you have to record your current configuration with the *Save* button in the menu → *Load/Save*

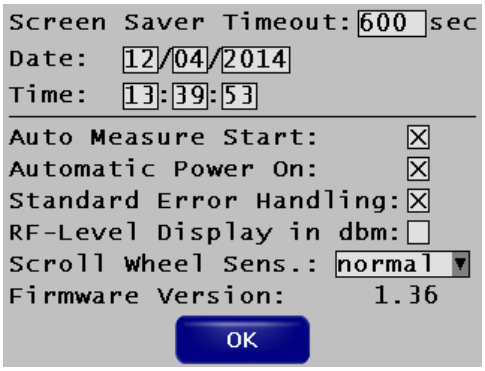
4.2.13 Menu: Measure → Start



1:	Indicates which display you are using. You can switch between displays by pressing up and down on the scrollwheel.
dbm display:	An indicator shows the signal strength as decimal or bar graph. Display type can be chosen in “Options → RF-Level Display in dbm”.
Autozero:	When this button is pressed, all channels for which "Autozero" has been selected are set to zero. If the adjustment is to be permanently stored in the SCT, the corresponding channel must be programmed afterwards (“Channels → Channel x → Program”).
Sh. off / Sh. on	By pressing this button, the internal shunt resistor will be connected between “signal-plus” and “bridge supply-plus”. This results in a positive oscillation of the signal. If the shunt is activated this is indicated by the changed button label to “Sh. on”. The shunt resistance is 330 kΩ.
Cancel:	Exit measurement mode.

IMPORTANT: The CAN-output is only active in measurement mode.

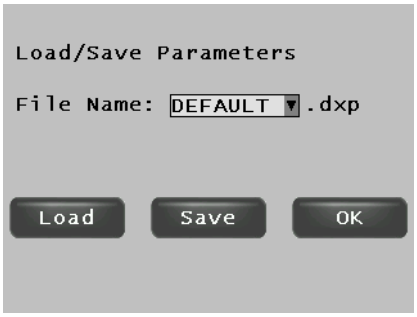
4.2.14 Menu: Options



Screen Saver Timeout:	Time in seconds after which the screen saver is switched on.
Date:	Enter date in mm/dd/yyyy format.
Time:	Enter time in hh:mm:ss format
Auto Measure Start:	When ticked, the D^{X} RCI automatically switches to measurement mode after booting.
Automatic Power On:	When ticked, the RCI boots automatically as soon as supplied with power.
Standard Error Handling:	When a transmission error occurs, the last displayed value is retained. When unchecked, the negative full-scale value will be output.
RF-Level Display in dbm:	Switches the signal strength display in the measuring mode. When checked, the display is numeric otherwise it's a bar graph.
Scroll Wheel Sens.:	Adjust the sensitivity of the scroll wheel. Choose between: "lowest, low, normal, high"
Firmware Version:	Displays firmware version.
OK:	Exit menu.

Please note: In order to change settings permanently, you have to record your current configuration with the *Save* button in the menu → *Load/Save*

4.2.15 Menu: Load/Save



File Name:	Select the file name to be loaded or saved. The parameter file “DEFAULT.dxp” is loaded automatically when the system is booting. You can select existing filenames or enter a new file name.
Load:	Load the selected parameter file.
Save:	Save the current configuration to the selected file.
OK:	Exit menu.

5 Energy Supply of SCTs

As telemetry transmitters are often placed on rotating devices, energy supply of transmitters is a challenging task. With the D^X telemetry system, there are several possibilities to solve this problem:

- supply by battery/rechargeable battery
- inductive supply by ring stator or stator head

5.1 Power Consumption and Supply Voltage

Power consumption of the SCT is, amongst others, mainly dependent on the sensors connected (e.g. bridge circuits). A minimal voltage of > 7,5 V is necessary to operate the SCTs.

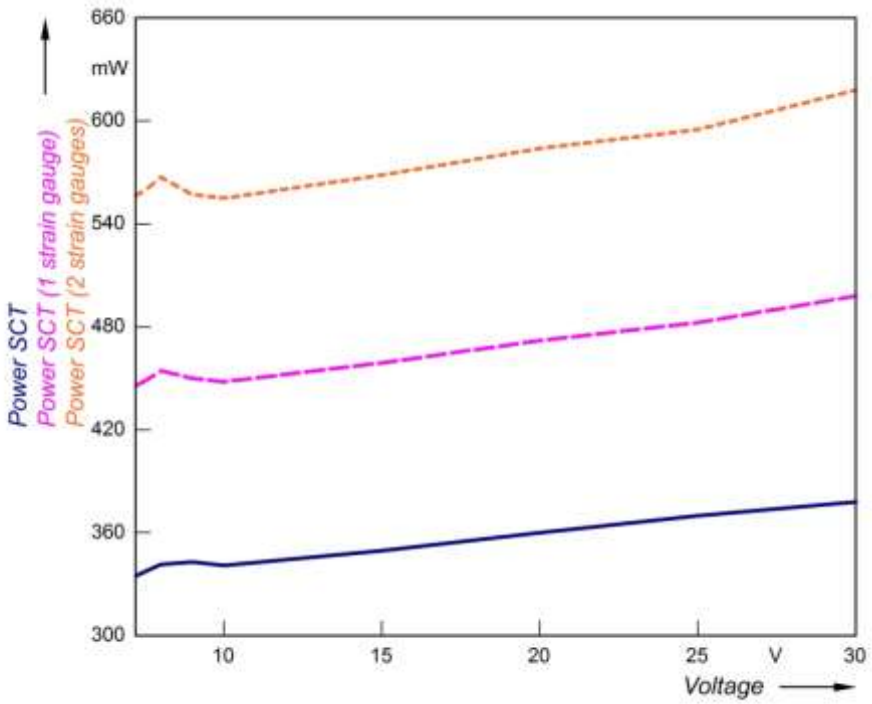


Figure 31: SCT power consumption. Power SCT (2 strain gauges) estimated from the data Power SCT and Power SCT (1 strain gauge) (parallel circuit of two 350Ω resistances).

5.2 Battery Supply

The D^{X} can be supplied with commercial 9 V batteries. Operating time is 3-6 hrs – dependent on sensors connected.

Connect the positive pole of the battery to *DC Power Plus*, the negative to *DC Power Ground* (see section 2.2).

4

5.3 Integrated Rechargeable Batteries

CAEMAX offers solutions with rechargeable batteries, with rechargeable and SCT being integrated in one housing, for numerous standard applications. Please contact us for further details.

5.4 Ring Stator

The CAEMAX ring stator provides noncontact energy supply of D^{x} transmitters (SCTs) by inductive coupling: An alternating magnetic field from the stator ring induces voltage in the secondary coil on the device. This induced voltage is used for supply of the D^{X} transmitter unit (SCT).

5.4.1 Overview

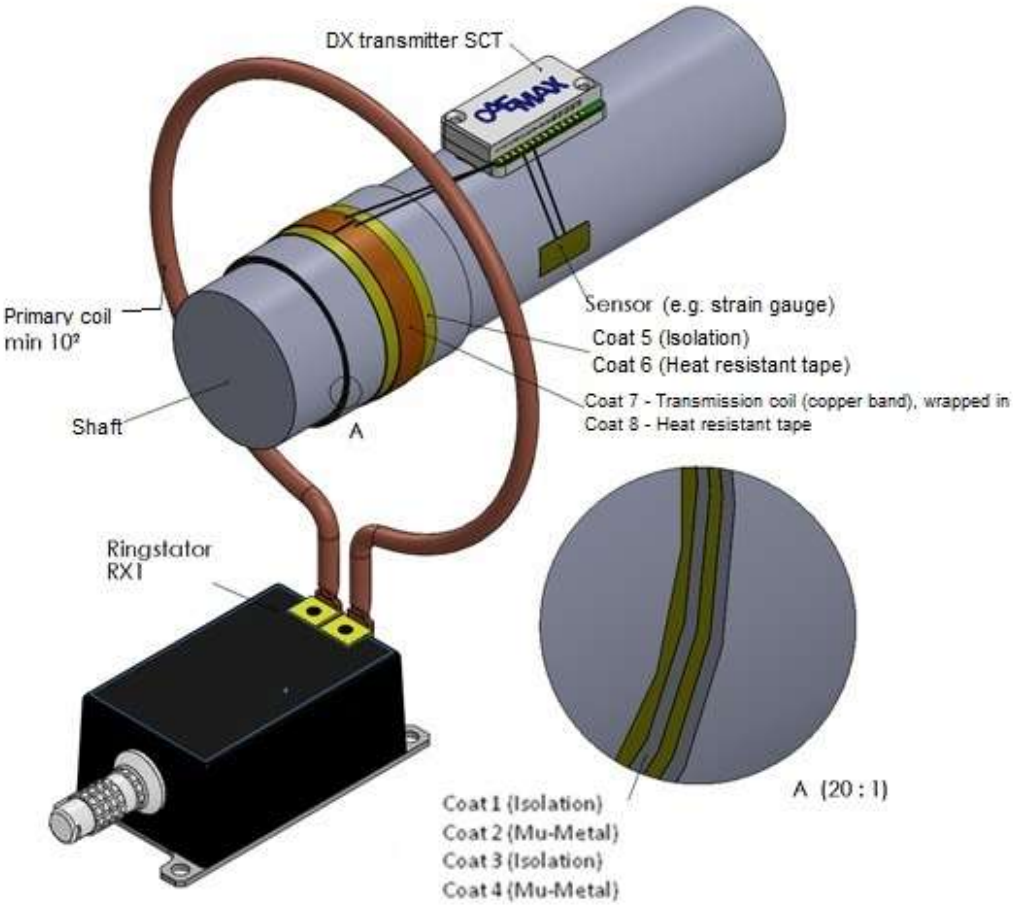


Figure 32: Ring stator schematic overview

5.4.2 Technical Data

Dimensions	ca. 84x54x37mm w/o copper wire
Diameter of copper wire	ca. 8mm
Weight	ca. 324 g w/o copper wire
Temperature range	-10°C … +85°C
Transmission distance	0 … 70 mm
Diameter of primary coil	30 … 1000 mm
Ratio secondary/primary coil	> 1: 3
Power consumption	max. 20 W
Efficiency	< 0.1
Transmission frequency	30 ... 60 kHz, automatically controlled
Supply voltage	9 … 36 V/DC
Protection class	IP 67
Connecting cable	Lemo plug, banana plugs, length 5m
Connectors	Lemo

5.4.3 Installation and Placing into Operation

- Mount the ring stator electronics at an arbitrary place next to the axle shaft.

  Please note: Temperature rise of the stator electronics above 80°C may lead to damage or even breakdown of the stator. To avoid that, provide sufficient heat dissipation, e.g. by installing the stator on a metallic surface.

- Shape the copper band/copper tube to a ring as shown in

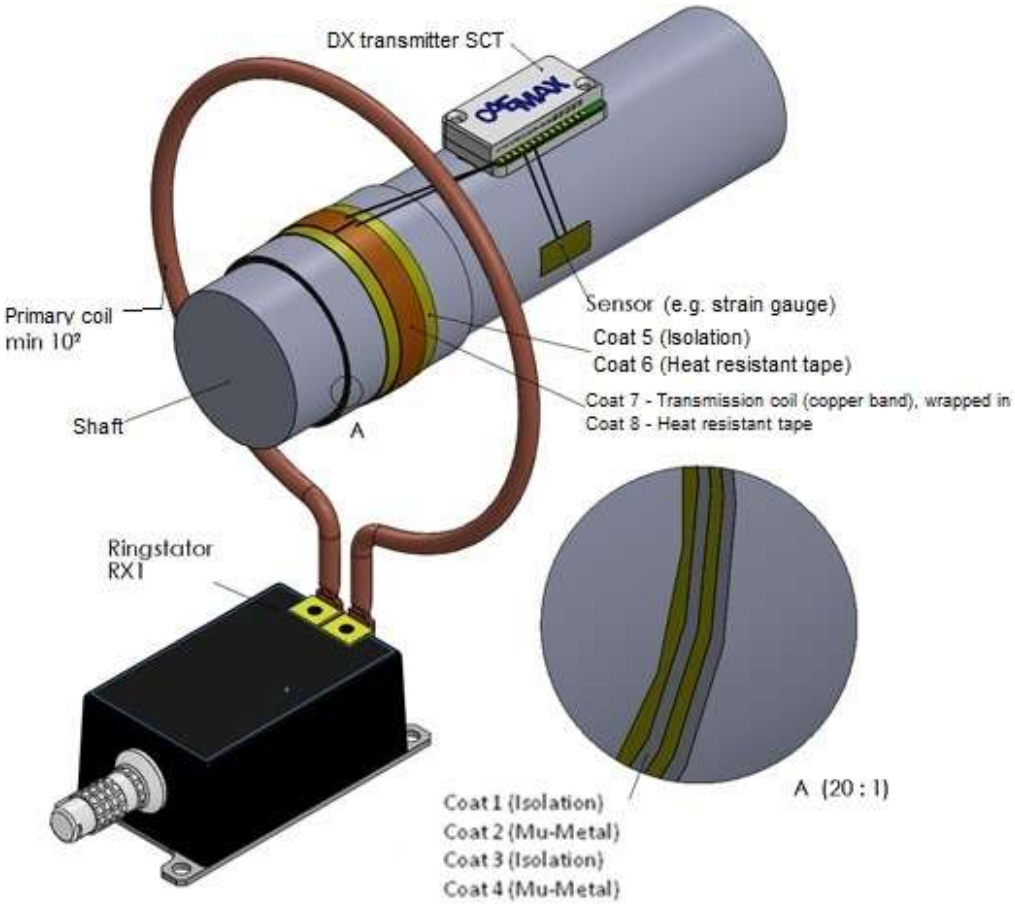


Figure 32 and shorten it to the appropriate length. After a check-up of length and shape, drill a hole at each end of the copper band to fix it with 2 M5x6 screws to the stator housing (refer to Figure 33). The soft copper material is easy to compress (e.g. with a vice). The D^x ring stator is designed for a ring diameter from 300 mm to 1000 mm.

Figure 33: copper tube with holes

Please note: The lower the distance between the primary coil and the secondary coil, the better the efficiency of the energy transfer. However, when installing take into account the height of the secondary coil and insulation layer, as well as any possible movements and unbalances to the shaft.

- Install the secondary coil to the axle as described in section 6.5.2. The transmission coil is to be installed directly beneath the primary coil.

- Install the D^X transmitter unit (SCT) to the axle and connect it. The connection strands of the secondary coil have to be connected with the SCT inputs IP1 and IP2 (refer to section 2.2).

- Fix the stator ring with two M5x6 bolts to the stator housing. To guarantee a maximum contact area for electron transfer, make sure the contact areas at the copper ring are absolutely smooth and bare (remove edges and oxide film!) and tighten the connection screws properly (refer to Figure 34).

- **Important:** Use the potentiometer screw on the stator housing to set its power to minimum value. The direction of rotation for decreasing the stator power is indicated on the housing. When the potentiometer screw has reached its minimum position, you will hear a click sound even though you can turn it further.

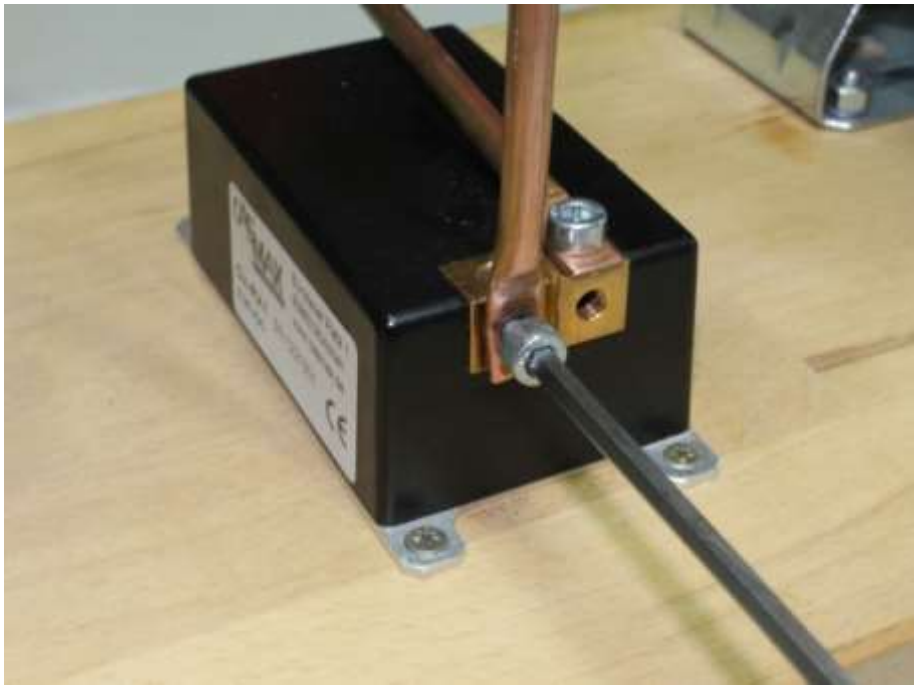


Figure 34: tightening of the stator ring

- Plug in the power cable of the ring stator and connect it to a 9 ...36 V DC power source.

  Please note: The DC connector of the D^{X} RCI is **not** designed to supply a ring stator or stator head while the RCI AC power supply is connected!

- Wait for a short time (approx. 30 seconds). Check whether the D^{X} SCT is sufficiently supplied with power. To do this, measure the voltage between the EX- and EX+ outputs (e.g. the power supply of the strain gauges). If the power supply of the D^{X} SCT is sufficient, you measure a voltage of 4.096 V DC.

  Please note: The operating point, i.e. the optimum frequency of the alternating electrical field at the stator ring, is automatically set and readjusted by the stator electronics. The operating point of the system is dependent on a variety of factors, mainly on the length of the primary coil. If the stator is put into operation for the first time, the determination of the optimum frequency may take several minutes.

- If you measure less than 4.096 V DC between EX- and EX+, check the effective value V_{AC} of the alternating voltage between IP1 and IP2. If 0 V < V_{AC} < 0.6 V, increase the power of the stator with the potentiometer at the stator housing (refer to Figure 35). **Please proceed slowly**. The direction of rotation for a power decrease or increase is depicted on the stator housing: Turn the potentiometer screw in the (+) direction to increase the power of the stator. To decrease the power, turn the screw in (-) direction.

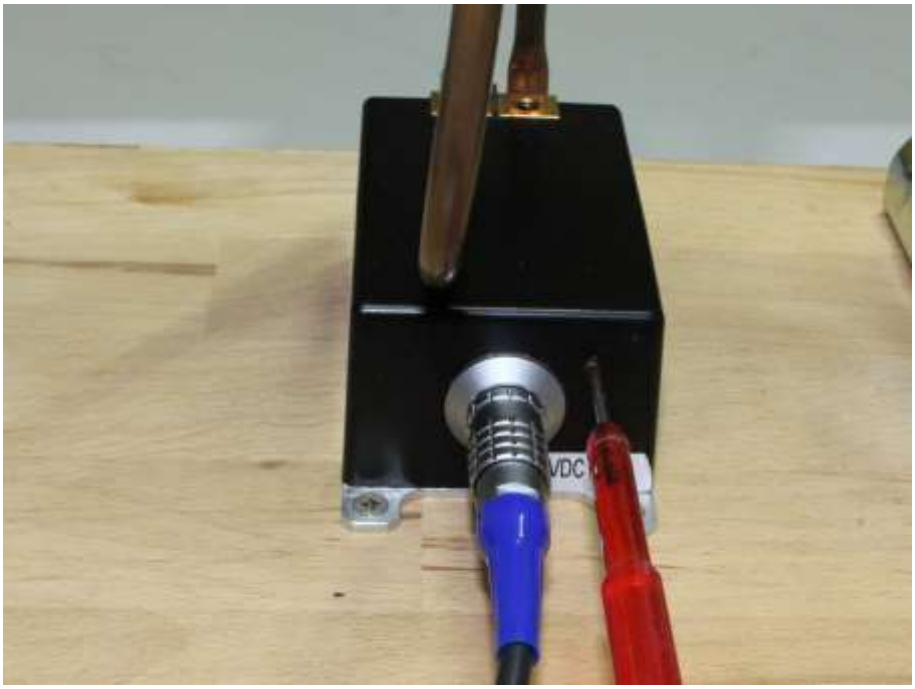


Figure 35: Adjusting the stator power via potentiometer screw

For more detailed troubleshooting instructions, please refer to section 10.1.

5.5 Stator Head

The CAEMAX stator head provides noncontact energy supply of D^X transmitters (SCTs) by inductive coupling: An alternating magnetic field from the stator head induces voltage in the secondary coil on the device. This induced voltage is used for supply of the D^X transmitter unit (SCT).

5.5.1 Technical Data

dimensions	ca. 84x54x37mm
weight	ca. 324 g
temperature range	-10°C … +85°C
transmission distance	5… 35 mm
power consumption	max. 25 W
efficiency	< 0.1
supply voltage	9 … 36 V/DC
protection class	IP 67
connecting cable	Lemo plug, banana plugs, length 5m
connectors	Lemo.

5.5.2 Installation and Placing into Operation

- Mount the stator electronics at an arbitrary place next to the axle shaft.

  Please note: Temperature rise of the stator electronics above 80°C may lead to damage or even breakdown of the stator. To avoid that, provide sufficient heat dissipation, e.g. by installing the stator on a metallic surface.

- Install the secondary coil to the axle as described in section 6.5.2. The transmission coil is to be installed directly below the stator.

- Install the D^X transmitter unit (SCT) to the axle and connect it. The connection strands of the secondary coil have to be connected with the SCT inputs IP1 and IP2 (refer to section 2.2).

- Plug in the power cable of the ring stator and connect it to a 9 ...36 V DC power source.

  Please note: The DC connector of the D^X RCI is **not** designed to supply a ring stator or stator head while the RCI AC power supply is connected! A commercially available plug-in power supply with at least 30 W power can be used for the power supply.

- Wait for a couple of minutes. Check whether the D^X SCT is sufficiently supplied with power. To do this, measure the voltage between the EX- and EX+ outputs (e.g. the power supply of the strain gauges). If the power supply of the D^X SCT is sufficient, you measure a voltage of 4.096 V DC.

Please note: The operating point, i.e. the optimum frequency of the alternating electrical field, is automatically set and readjusted by the stator electronics. The operating point of the system is dependent on a variety of factors. If the stator is put into operation for the first time, the determination of the optimum frequency may take several minutes.

- If you measure less than 4.096 V DC between EX- and EX+, check the effective value V_{AC} of the alternating voltage between IP1 and IP2. If 0 V < V_{AC} < 0.6 V, increase the power of the stator with the potentiometer at the stator housing (refer to Figure 35). Turn the potentiometer screw clockwise to increase the power of the stator. To decrease the power, turn the screw in counterclockwise direction.

For more detailed troubleshooting instructions, please refer to section 10.1.

For instructions on installing the stator and secondary winding, refer to section 6.5.

6 Installation

6.1 General Information

- The transducer (sensor), the DX -SCT and the transformer winding should be mounted close to each other.
- In order to obtain accurate measurement results, the connection wires between sensor and SCT have to be twisted in pairs, the signal lines In+ twisted with In- and the sensor supply cables +5 V twisted with GND. Make sure no sensor cables intersect with the connection cables.
- The mounting holes of the SCTs are for fixing only. They may be tightened with a maximum torque of 32 Ncm.
- Assembly expertise of the measuring transducer (strain gauge, thermo couple) is assumed. Therefore, this procedure will not be discussed any further.

6.2 Safety Instructions

- Do not use damaged or defective cables!
- Do not touch the rotating shaft!
- Do not reach into the gap between the shaft and the stator while running!
- Avoid any contact with the rotor contacts while operating!
- Avoid close contact of the stator with data mediums or other devices and systems to be protected from magnetic fields.
- Telemetry systems consist of electrostatic sensitive components. Operation only by qualified personnel!
- This is a class A device, i.e. suited for industrial use. This device may cause radio interference in the living area; in this case the operator can be required to carry into effect adequate measures and pay for them.
- Temperatures above 80°C may lead to damage or breakdown of the stator. Therefore, ensure dissipation of thermal energy caused by operation of the stator, e.g. by installing it on a metallic surface.

6.3 Installation of the RCI

- Connect the RCI to a power source. Therefore, use the DC input (9 … 36V/DC) or connect it to the line voltage with the included power cable.
- If the D^X is to be configured with your computer, connect the Ethernet interfaces of PC and RCI with the included Ethernet cable.
- For data transmission via CAN, connect a CAN cable (CAN1: CAN output; CAN2: CAN input).

  Please note: The RCI has **no** built-in termination resistor. If the device is placed at the end of a CAN measurement chain, a 120 Ω termination resistor has to be placed between the two connectors.
- For analog measurement data, connect the BNC cable to the analog outputs of the RCI. These are freely assignable to all measurement data channels (for configuration see section 3.8).

6.4 Installation of the SCT on a Rotating Device

After the sensors have been connected to the SCT, it can be fastened to the rotating device.

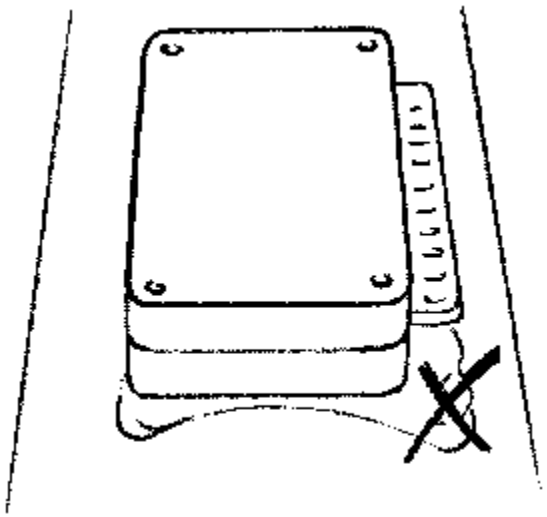


Figure 36: Shaft with SCT

When attaching the SCT, make sure that it is supported on the shaft. If necessary, a suitable substructure must be constructed.

The attachment can be carried out via a constructive solution. The simplest solution is attaching with two belt straps, which are adapted to the occurring centrifugal forces.

When mounting the SCT at high speeds and large shaft diameters, CAEMAX offers axial and radial SCT housings designed for higher centrifugal forces.

Make sure the connections remain free of tensions during operation. Mechanical tensions on the soldering points may lead to system failure.

Connect the SCT to a power source. The SCT will start operating as soon as it is supplied with power. To connect a power source, see section 2.2. If you are using a ring stator or a stator head for inductive power supply, see section 5.4.

Please note: To check for sufficient power supply, measure the input current of the strain gauges (see section 2.2). When power supply is sufficient, output voltage is 4.096 ± 0.1 Volts.

6.5 Installation of Secondary Coil for Inductive Power Supply

Measurements on rotating shafts are a standard application of the D^X telemetry system. All steps for attaching a secondary winding on the shaft are shown below. The required materials can be ordered at CAEMAX (D^X mounting kit).

6.5.1 Overall View

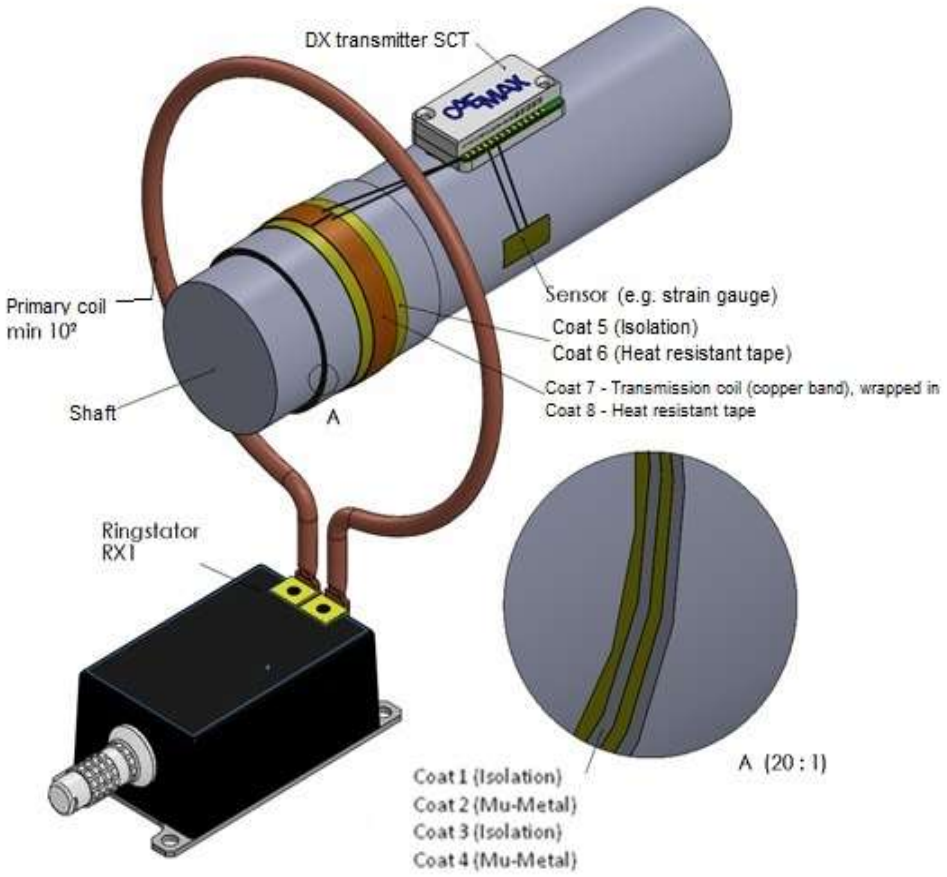


Figure 37: Ringstator installation

If the secondary coil is installed correctly, the application is supposed to look as depicted in figure 37.

6.5.2 Step by Step Instructions

1. Wrap the shaft with insulating tape.

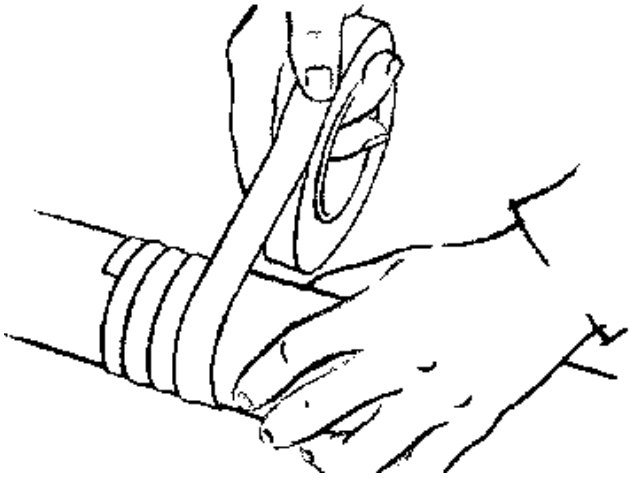


Figure 38: insulation of the shaft

The insulated surface has to cover a larger area than the Mu-metal to be applied subsequently in order to prevent short-circuit between the Mu-metal and the shaft.

2. Cut the first layer of the mu-metal with protective foil to the required length, it should be long enough to wrap around the shaft's circumference. Pull off the protective film and glue the mu-metal onto the shaft (see figure 39). Its extremities must **not** touch; in order to prevent short-circuits. A gap of approx. 1mm is required.

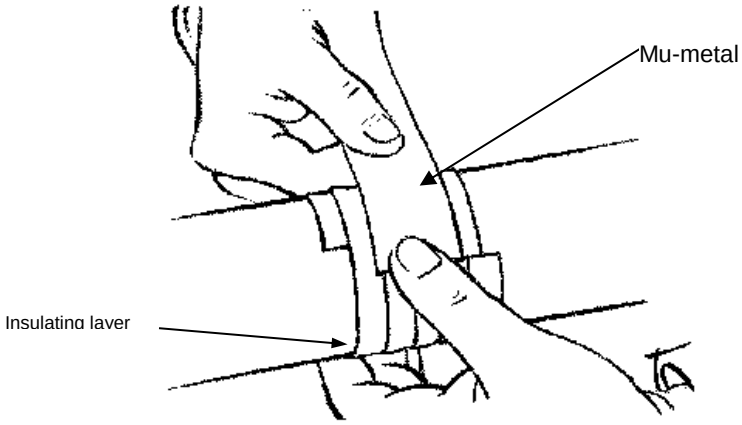


Figure 39: 1st mu-metal layer application

3. Insulate the mu-metal as described in step 1.

4. Apply the 2nd mu-metal layer as described in step 2. Make sure to leave a gap of approx. 1 mm between the edges.

   Please note: The gap of the 2nd mu metal layer has to be offset by at least 90° from the 1st gap.

5. Insulate the second mu-metal layer completely (see step 1).

6. Apply a first layer of heat resistant tape.

7. Apply the secondary copper winding centrally to the insulated mu-metal (see figure 40).

   Please note: Leave a gap of approx. 1mm between both ends of the copper band. If the ends of the secondary coil (copper band) contact, the device will not be supplied with energy.

The ends of the copper strip must not touch.
The distance should be at least 1 mm.

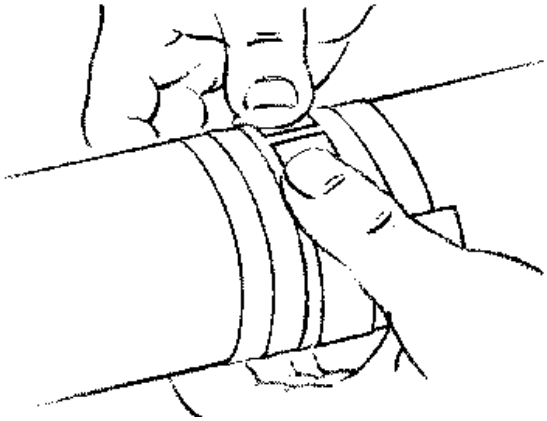
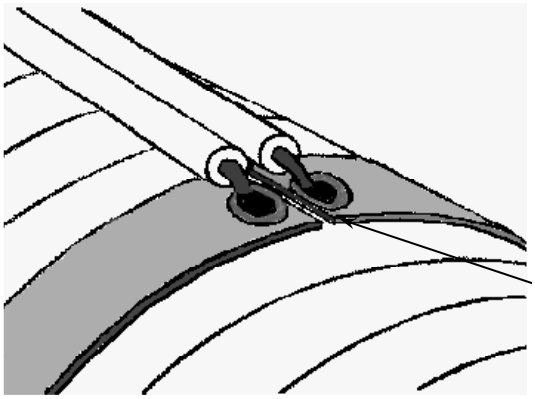


Figure 40: Installation of copper band

8. Solder one strand to each of the copper band extremities (the strands' surface should be as large as possible: 0.62 mm^2 or AWG 20) and a maximum length of 100 mm. These solder joints must not contact other as well. Make sure the strands lie flat and close to each other to avoid collision with the stator when rotating. Soldering is easier when the insulating coat on top of the copper bands is carefully removed and then covered with soldering tin (see figure 41).



Strands must not contact (min. distance 2mm).

Figure 41: connection strands of secondary coil

The strands should be soldered as flat as possible to the copper band. Sensor cables and connection cables should not cross. Wrap the secondary coil with 3 layers of heat-resistant adhesive tape to prevent overheating.
For measurements on high speed or high temperature shafts, CAEMAX offers special solutions (half shells, special casings, etc.)
For further questions and instructions concerning your individual situation, please contact CAEMAX support.

9. Apply secondary layer of heat resistant tape.

10. Now connect the SCT to the secondary coil (see connecting diagram in section 2.2). Therefore, use the connections designated for inductive power supply.

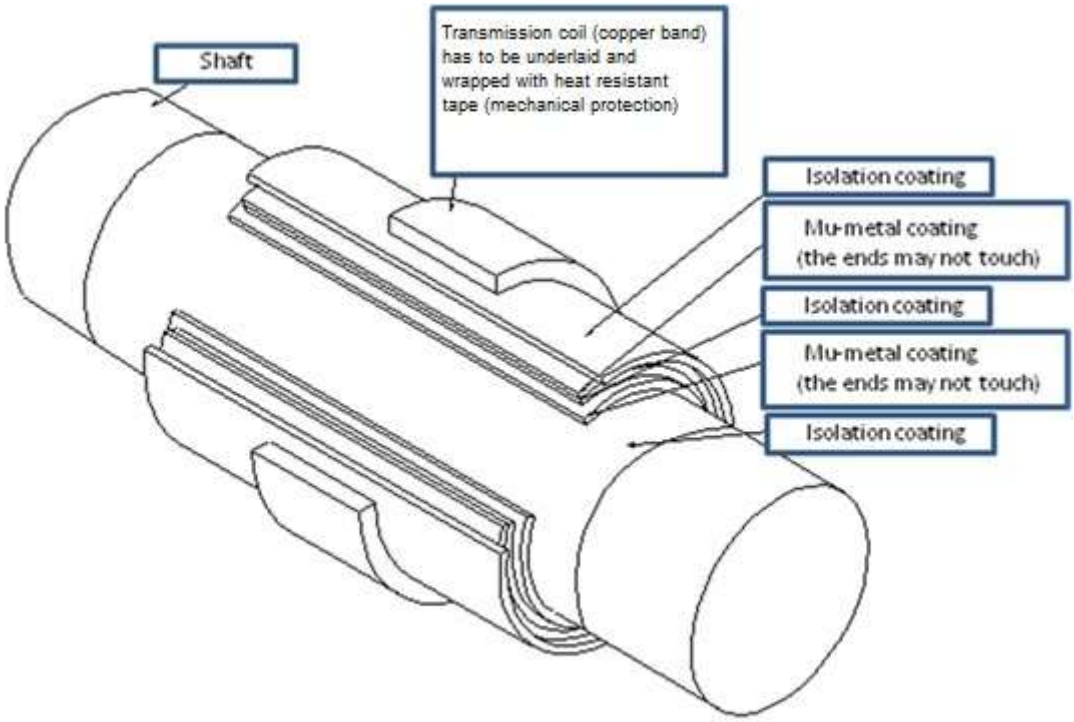


Figure 42: cross-section of secondary coil for inductive power supply

7 Accessories

7.1 Casings for D^{X} Transmitter Units

We offer a variety of different types of casings for SCT mounting and protection, which can be customized in size and shape for your application.

7.1.1 SCT casing with Breakout Cable

Figure 43: SCT casing with breakout cable

Technical data:

- dimensions 72mm x 55mm x 10mm
- POM material
- multiple fixing options
- shielded sensor lines

Connecting diagram:

cable **6 x** 22AWG	
black	IP1
brown	DC+
red	IP2
orange	DC-
yellow	EX-
green	EX+

cable **8 x** 24AWG (sensors) shielding connected to EX-	
black	I4
brown	I3
red	I2
orange	I1
yellow	I6
green	GND
blue	I5-
purple	I5+

7.2 D^{X} Antennas

For trouble-free signal transmission in different applications, select from a variety of antenna types.

7.2.1 Planar Antenna

- Cable length approx. 5 m (optional 7 … 10m), SMA connector
- Universal mounting possibilities
- Dimensions: 72mm x 55mm x 10mm
- POM material

Figure 44: D^{X} planar antenna

7.2.2 Side Mirror Antenna

For driving tests on public roads, the measurement system should be constructed as unobtrusively as possible. With the supplied rubber strap holder, the antenna can be attached quickly and easily to the side mirrors of the vehicle.

Figure 45: D^{X} side mirror antenna

7.3 D^{X} Satellites

In unfavorable transmission and reception conditions due to shading, reflections etc. Up to two satellite receivers can be connected instead of the rod antennas, which transmit their data digitally to the RCI. The synchronicity is retained here as well. The satellite receivers can be located up to 30 m away from the reception unit.

Figure 46: D^{X} satellite receiver

8 D^{X} Custom Systems

8.1 RPM measurement option

8.1.1 System Overview

The system consists of a modified receiver unit (RCI) and one or more transmitter units (see section 2.2). For RPM measurement, the included incremental angle sensor is used.

With the RPM measurement option, the menu navigation differs in some points from the standard menu described in section 4.1. The differing pages are described in section 8.2.

8.1.2 Terminal Assignment of modified RCI

Figure 47: Back of modified RCI

SMA-jack (Ant1, Ant 2):	Antenna plug
Banana jack:	Power supply 9 V … 36 V
Power-socket:	External power supply connection
USB-connectors:	USB 2.0 Full Speed/12 Mbit for Plug and Play-Configuration
Head/RSU 1 (male)	D-SUB 15 connector socket for the incremental angle sensor
Head/RSU 2 (female)	D-SUB 15 connector socket for a satellite unit (RSU)
Ethernet:	10/100 Mbit Network connection with Web server for the configuration
SD-Card (sideways):	Standard SD-Slot for storing the configuration. Optional: autonomous data storage, currently, up to 4 GB.
BNC jacks (up front):	6 analog outputs, freely assignable

8.1.3 Incremental Angle Sensor

Figure 48: Incremental angle sensor

Technical Specification

Diameter:	100 mm
Number of increments:	8000
max. measurable rotational speed:	± 5999 rpm
System accuracy:	± 0.1°
Working temperature:	-10°C … +70°C
Vibration resistance:	10 g/50 Hz
Supply voltage stator head:	24V/DC, supply via RCI
Protection class:	IP 67

8.1.4 Operating Instructions

Please note: Due to system modifications, only one satellite receiver can be used in your telemetry system, with the other D-SUB 15 connector being used to connect the incremental angle sensor.

8.1.5 Instructions for Commissioning and Maintenance

Please note: When installing the stator head, take care to be compliant with the specified clearance dimensions (see figure below). In particular, the distance between magnetic ring and stator head must not exceed 2 mms.

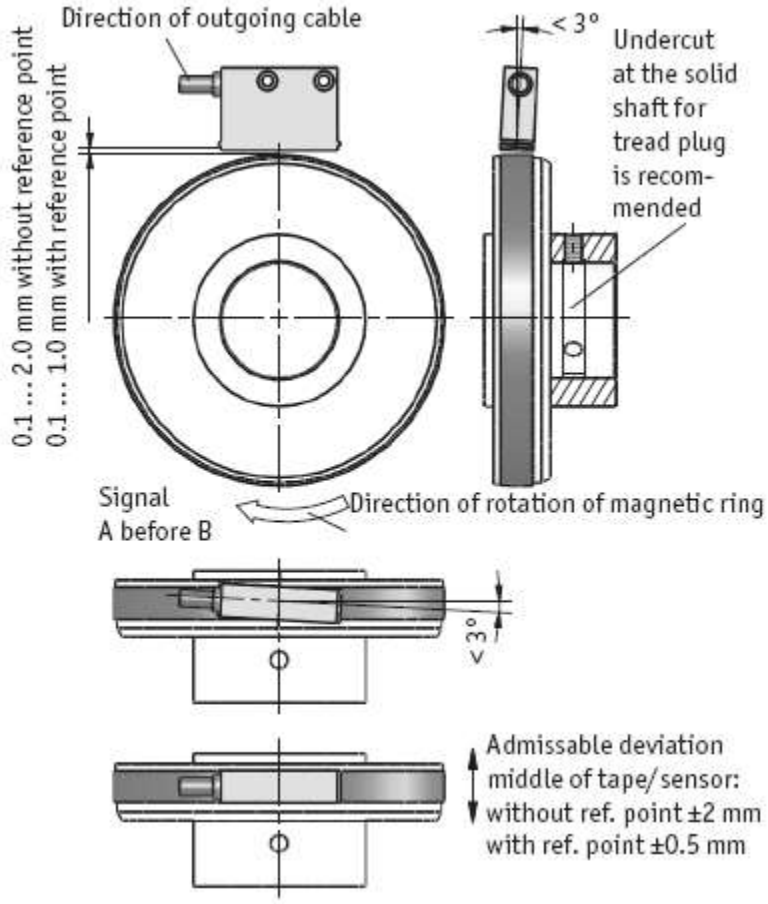


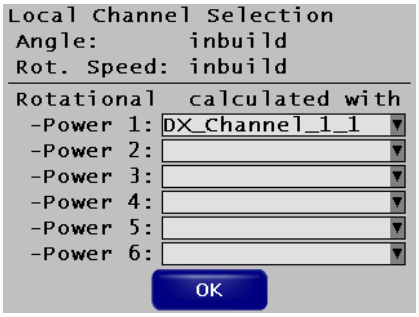
Figure 49: Schematic diagram of incremental angle sensor

- Insert the stator head plug into the socket *Head/RSU1* on the receiver unit (RCI).
- The surface of the magnetic tape has to be cleaned from time to time with a soft cloth after contamination with dust, shavings or humidity.

8.2 Settings

The menu of the DX special system for measuring rotational speed is identical to the DX standard menu (see section 4.1) in large parts. All the different menu items are described below.

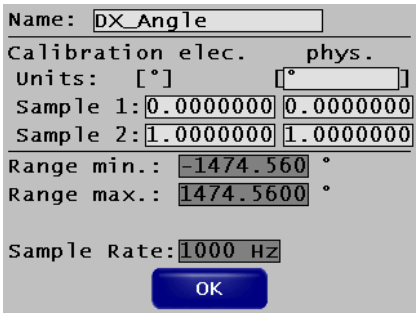
8.2.1 Menu: Channels → Local/RCI → Selection



Angle:	Angle of rotation (fixed channel assignment)
Rot. Speed:	Rotational speed (fixed channel assignment)
Power 1:	Power is calculated from the selected channel multiplied by the rotational speed *Rot. Speed* according to the formula $$Power = rot\_speed \cdot torque$$
Power 2:	see Power 1
Power 3:	see Power 1
Power 4:	see Power 1
Power 5:	see Power 1
Power 6:	see Power 1
OK:	Exit menu

Please note: In order to change settings permanently, you have to record your current configuration with the *Save* button in the menu → *Load/Save*

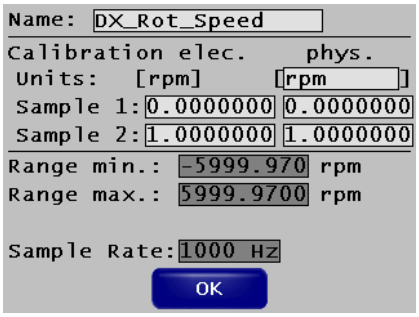
8.2.2 Menu: Channels → Local/RCI → DX_Angle



Name:	Channel name
Sample 1	Two-point calibration of channel
Sample 2:	**Please note:** no input required here due to factory calibration
Range min	Minimum output value (fix -1473.560°)
Range max:	Maximum output value (fix +1473.560°))
Sample Rate:	Sample Rate (equal to sample rate of SCT channels) Change global sample rate with CHANNELS → DEVICE X → CHANNEL_X_Y → SAMPLE RATE (follow instructions in section 3.6.3)
OK:	Exit menu

Please note: In order to change settings permanently, you have to record your current configuration with the *Save* button in the menu → *Load/Save*

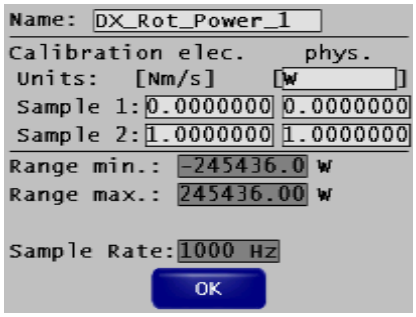
8.2.3 Menu: Channels → Local/RCI → Rot. Speed



Name:	Channel name
Sample 1	Two-point calibration of channel
Sample 2:	**Please note:** no input required here due to factory calibration
Range min	minimal value (-5999.97 rpm fixed)
Range max:	maximal value (5999.97 rpm fixed)
Sample Rate:	Sample Rate (equal to sample rate of SCT channels) Change global sample rate with CHANNELS → DEVICE X → CHANNEL_X_Y → SAMPLE RATE (follow instructions in section 3.6.3)
OK:	Confirm/Exit menu

Please note: In order to change settings permanently, you have to record your current configuration with the *Save* button in the menu → *Load/Save*

8.2.4 Menu: Channels → Local/RCI → Rot.Power



Name:	Channel name
Sample 1	Two-point calibration of output.
Sample 2:	**Please note:** no input required here due to factory calibration
Range min	Minimum measurement value (calculated from channels *Rot.Speed* and *Channel_1*)
Range max:	Maximum measurement value (calculated from channels *Rot.Speed* and *Channel_1*)
Sample Rate:	Sample Rate (equal to sample rate of SCT channels) Change global sample rate with CHANNELS → DEVICE X → CHANNEL_X_Y → SAMPLE RATE (follow instructions in section 3.6.3)
OK:	Confirm/exit

Please note: In order to change settings permanently, you have to record your current configuration with the *Save* button in the menu → *Load/Save*

9 Maintenance and Storage

9.1 Cleaning and Maintenance

Due to its construction, the telemetry system is protected against contamination of its electronic parts. Contaminations of the case can be removed with non-agressive agents like isopropyl alcohol when the device is switched off.
Due to constructional design of D^{X} transmitter and receiver, there is no maintenance required, if cables are protected from mechanical stress.

9.2 Sensor Input Calibration

CAEMAX Technologie GmbH recommends yearly calibration of SCT sensor inputs. For further information, please contact

info@caemax.de

9.3 Storage

The telemetry system can be stored for later usage. However, it has to be protected from:

- Electrostatic charging (may destruct electronic parts)
- Humidity (leads to corrosion)

Permissible storage temperature: -10...40 °C

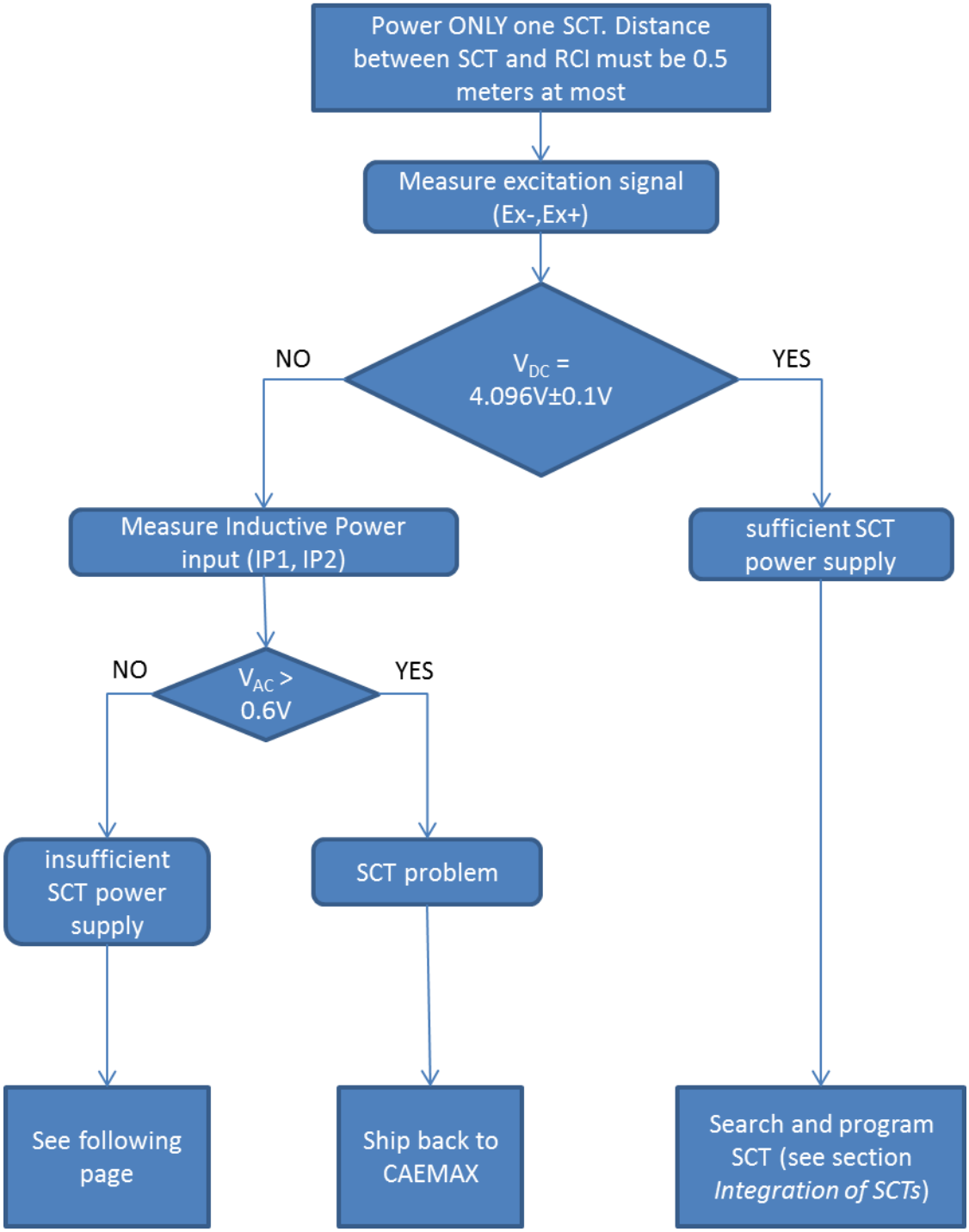
Avoid tangles when storing cables. The modules must not be damaged mechanically when being packed. Batteries have to be stored separately from the modules, so that the latter cannot be damaged in case of leaking batteries.

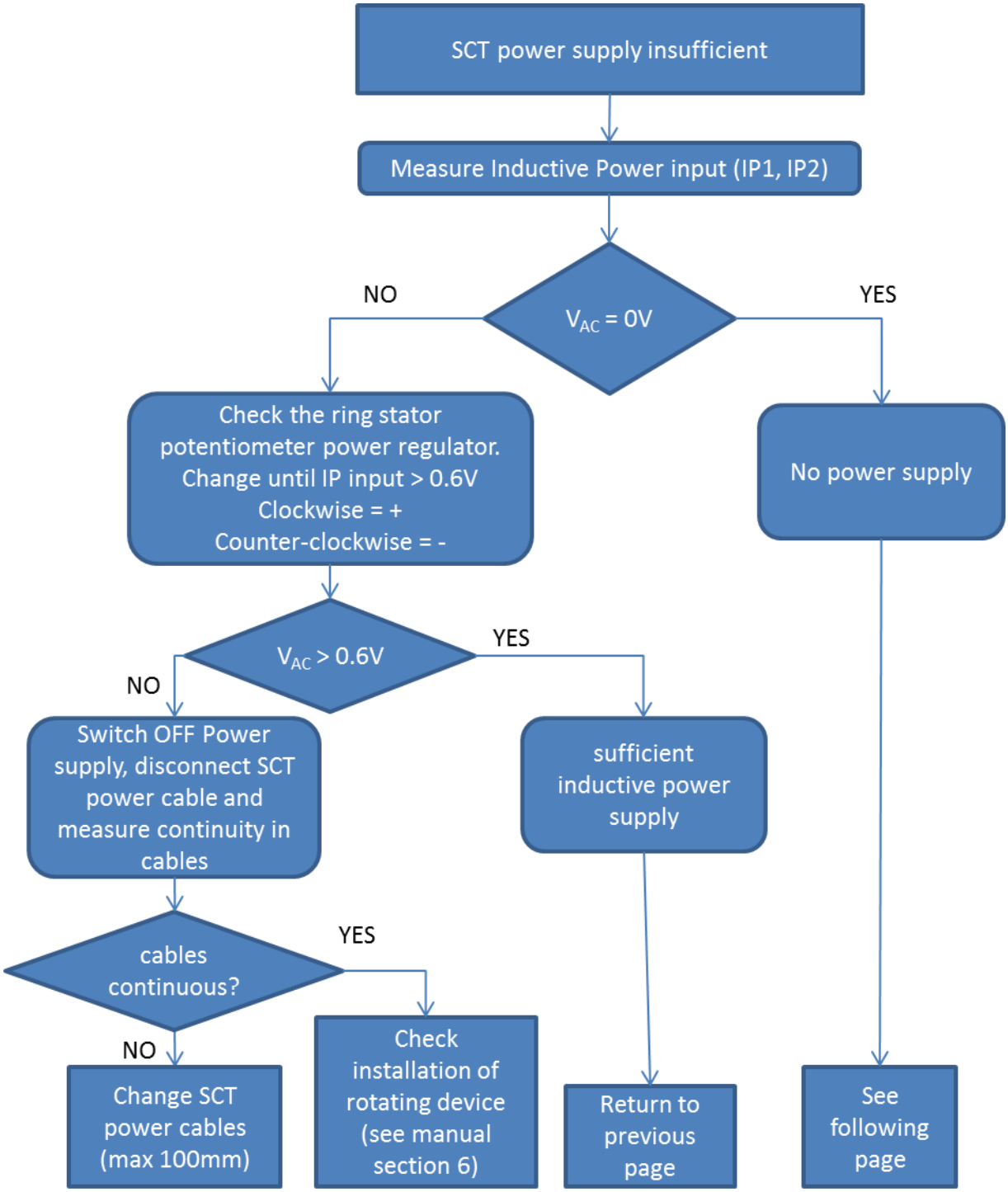
9.4 Customer Cable Modification

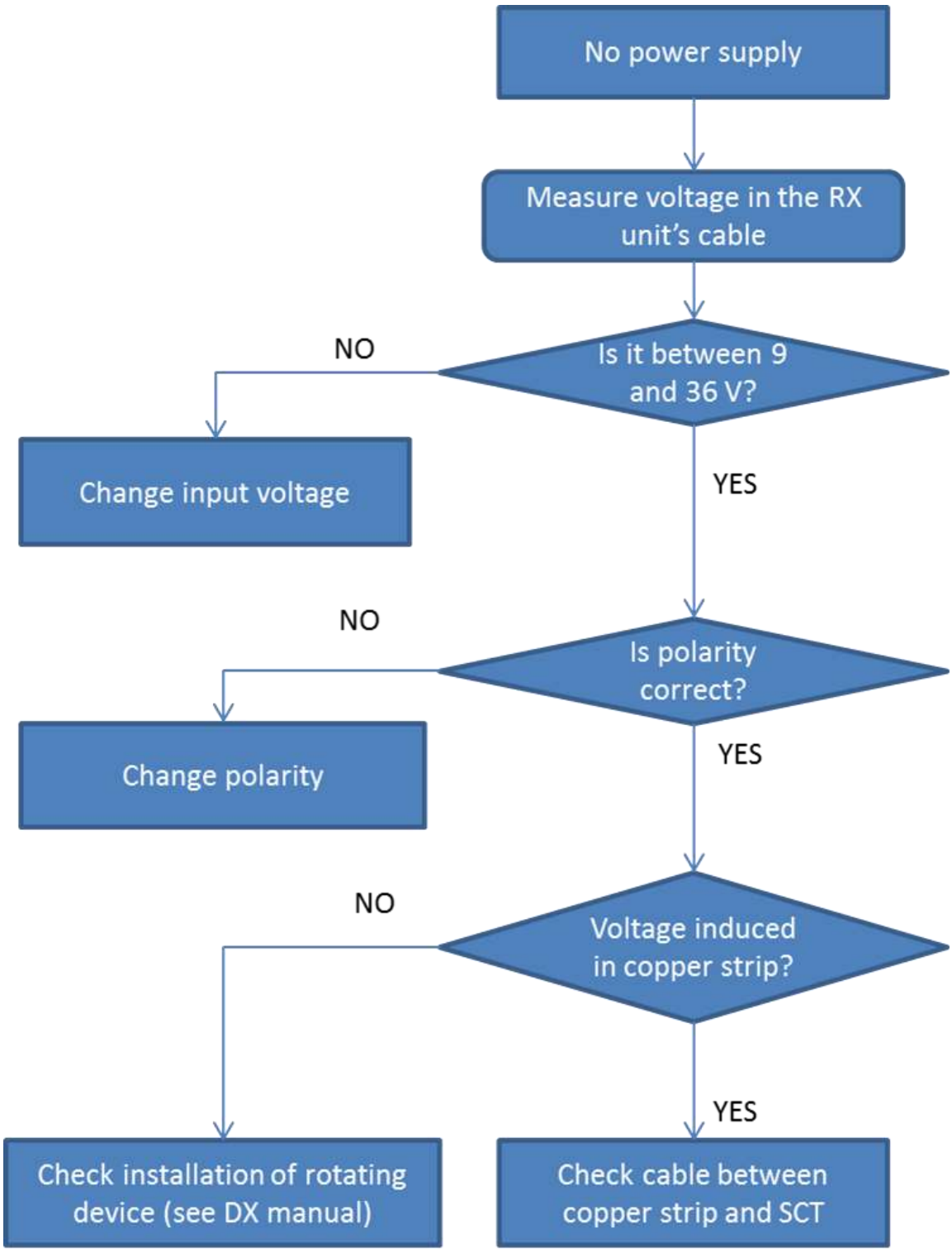
When lengthening and/or altering cables and plugs on your own, keep in mind that you have to provide sufficient insulation and to connect adequately. In case the customer carries out cable modifications on his own, the manufacturer’s function guarantee expires.

10 Questions & Answers

10.1 Inductive Power Supply: Troubleshooting




SCT power supply insufficient
Measure Inductive Power input (IP1, IP2)
V_{AC} = 0V
NO
YES
Check the ring stator potentiometer power regulator. Change until IP input > 0.6V Clockwise = + Counter-clockwise = -
No power supply
V_{AC} > 0.6V
YES
NO
Switch OFF Power supply, disconnect SCT power cable and measure continuity in cables
sufficient inductive power supply
cables continuous?
YES
NO
Change SCT power cables (max 100mm)
Check installation of rotating device (see manual section 6)
Return to previous page
See following page


No power supply
Measure voltage in the RX unit's cable
Is it between 9 and 36 V?
NO
Change input voltage
YES
Is polarity correct?
NO
Change polarity
YES
Voltage induced in copper strip?
NO
Check installation of rotating device (see DX manual)
YES
Check cable between copper strip and SCT

10.2 Integration of SCTs

If problems with your telemetry systems occur, it can be necessary to reintegrate the SCTs. In that case, please regard the following instructions.

1. Turn the D^{X} RCI on.
2. With *Devices → Device X*, delete all registered devices with the *Delete* button.
3. Disconnect all SCTs from the power supply, except the one to be integrated.
4. Integrate the active SCT (see section 3.5).
5. Repeat step 4 until all SCTs are integrated.

10.3 Changing the transmission frequency of SCT and RCI

If two DX receiving units (RCIs) are operated in parallel, different transmission frequencies (here referred to as freq1 and freq2) must be set for each receiving unit and corresponding transmitting units (SCTs).

The following example describes the configuration of a system with two RCIs, RCI 1 and RCI 2, as well as 4 SCTs. SCT1 and SCT2 are operated with RCI1, SCT3 and SCT4 with RCI2

1. Switch the receiving unit 1 **on** (RCI 1) and the receiving unit 2 **off** (RCI 2).
2. Turn off **all** transmission units (SCTs) except for the SCT you wish to connect (i.e., interrupt the power supply).
3. Set the RCI to the same frequency as the SCT to which you want to establish a connection (in the menu under *Devices → Base RCI → Radio Frequency*). Default setting at delivery: 864 MHz.
4. Locate SCT 1 (*Devices → Device 1 → Search*). After the message *Device found!* Appears. Continue with the configuration.
5. Assign the logical number 1 (under *Devices → Device 1 → Logical Number*, see section 3.5)
6. Change the transmission frequency of SCT 1 (under *Devices → Device 1 → Frequency*) to the desired transmission frequency **freq1**. For a trouble-free operation, the transmission frequencies should be as far apart as possible (i.e., **freq1** = 864 MHz for RCI 1 and **freq2** = 870.0 MHz for RCI 2)
7. Program the SCT 1 (*Devices → Device 1 → Program*).
   Attention: Due to the changed transmission frequency, the SCT is no longer available!
8. After the message *Program done!* Appears. Turn off the SCT1 (disconnection from the power supply).
9. Now turn on the SCT2.
10. Repeat steps 3-8 with the SCT 2. Similar to the step described in 5, now define the logical number 3.
11. Change the transmission frequency of the RCI (*Devices → Base RCI*) to the frequency set at SCT1 and SCT2 **freq1**. Confirm with *Program*.
12. Turn both SCTs on.
13. Test whether SCT 1 and SCT 2 are found with *Devices → RCI X → Search*. Leave the menu with OK.
14. Switch off RCI 1, SCT1 and SCT2 again and start RCI 2.

15. Switch on SCT 3 and proceed with the transmitter connection as described in 3-8. However, select a different transmission frequency (e.g., **freq2** = 870 MHz).
16. Switch on SCT4 and proceed as described in section 10. Select the same transmission frequency as for SCT3 (e.g., **freq2** = 870 MHz).
17. Change the reception frequency of the RCI2 as described under 11. to the new transmission frequency **freq2**
18. Test whether SCT3 and SCT4 are found as described in section 13.
19. The system is ready for operation.

Caution: SCT1 and SCT2 are now configured via RCI1, SCT3 and SCT4 are configured via RCI2. If you want to change channel parameters such as the sampling rate, both systems must be configured separately.

10.4 Unstable signal, when connecting more than one SCT

It's often necessary, after programming the frequency and "logical number", to program a channel on each SCT in order to receive interference-free reception.

10.5 D^{X} RCI Firmware Update

10.5.1 Checking firmware status

You can see the firmware status of your D^{X} telemetry system in the *Options* menu under *Firmware Version*.

10.5.2 Download new firmware

The latest firmware version can be found in the download area of the CAEMAX homepage

http://www.caemax.de/support/downloads/

Please note that you must register to download software on our homepage. This registration is free of charge for you.

Download and save the file *FIRMWARE.hex*. On your desktop.

Before the update, please note:
The *FIRMWARE.hex* is renamed to *FIRMWARE.sav* after the update. If this file already exists in your root directory, it must first be deleted.

In addition, the root directory contains the *SYSTEM* folder, which contains the directory structure of the D^{X} and **can** also be updated.
If you want, you must delete this folder **before** updating the firmware and replace it with a new version of the folder.

10.5.3 Installing new firmware

10.5.3.1 Upload via Ethernet connection

If you have an Ethernet connection to your D^{X} Telemetry system, you can upload the file via the upload function of your browser. Open a web browser and call the IP address of the D^{X} (see also section 3.4).

Select the *Download* menu item.

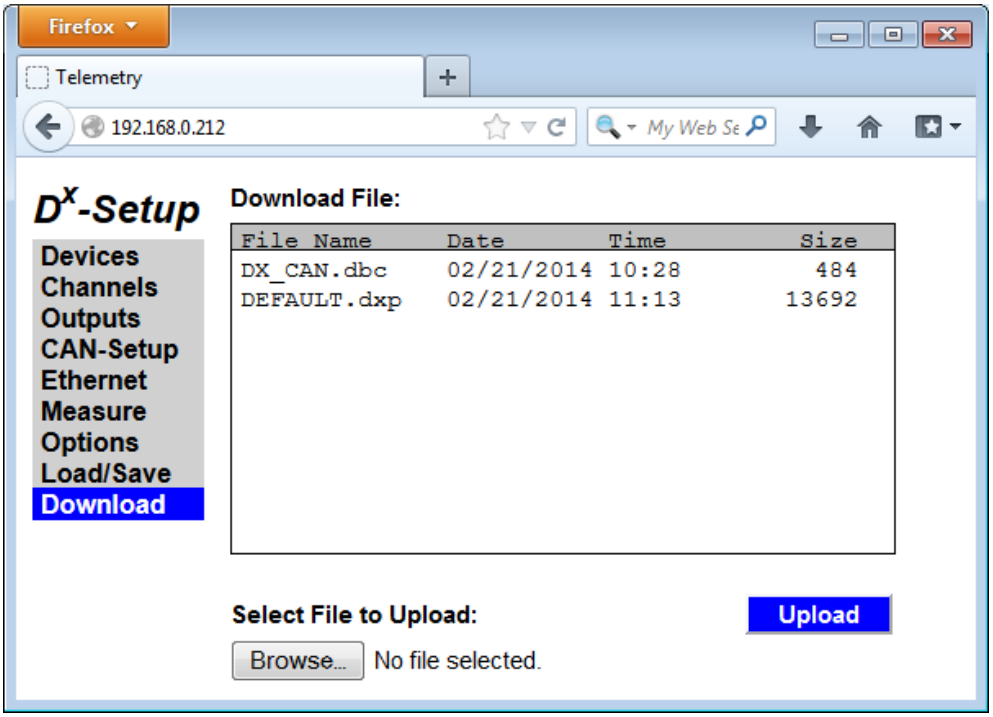


Figure 50: Firmware upload

In the *Select File to Upload* section, select the *FIRMWARE.hex* file from the Browse button and click *Upload*. The file is now written to the root directory of the SD card.

Now switch the D^X off and on again (see section 3.3). When the D^X is rebooted, the new firmware is automatically installed. Confirm with *OK*.

Check the firmware status in the Options menu item.

10.5.3.2 Upload via SD card
Turn off the RCI. Remove the SD card (right side) and insert it into the card reader of your PC.

Save the file *FIRMWARE.hex* in the root directory of the SD card.

When the file is saved, and the SD card can be safely removed. Reinsert it into the RCI.

Start the D^X. On restart, the new firmware is automatically installed. Confirm with *OK*.

Check the firmware status in the *Options* menu item.

11 EG Declaration of Conformity (after EN ISO/IEC 17050-1:2010)

The manufacturer **CAEMAX Technologie GmbH**
Bunzlauer Platz 1
D-80992 München

Declares that the following product:

Product name : **D^x telemetry**
Type : **D^X-RCI / D^X-SCT**
Serial number : **DX-RCI-xxxxx / DX-SCT-xx-xxx**

is in conformity with the following provisions:

- **low voltage directive 2006/95/EG** **(2006 edition)**
- **EMC directive 2004/108/EG** **(2004 edition)**

The following norms and technical specification have been applied:

EN 61010-1	safety requirements for electrical equipment for measurement, control and laboratory use
EN 55011	industrial, scientific and medical radiofrequency equipment – electromagnetic disturbance characteristics – limits and methods of measurement
EN 61326-1	electrical equipment for measurement, control and laboratory use – EMC requirements – part 1: general requirements
EN 300220-1/2	electromagnetic compatibility and radio spectrum matters (ERM) – short range devices (SRD)

Munich	**30.11.2010**	**F. Ketelhut**
Location	Date	Authorized person

According to EN ISO/IEC 17050-1:2010, Par. 6.1g, this document is valid without signature.

12 Formulas

12.1 Sensitivity of torsion measuring points

The following formulas are valid for a steel shaft, a full bridge and a k factor of 2.0 for the strain gauge.

S	= Sensitivity in mV/V
S_{STEEL}	= Sensitivity in mV/V
M_{TMAX}	= Maximum torque in Nm
d	= Diameter of solid shaft
D_A	= Outer diameter of hollow shaft
d_I	= Inner diameter of hollow shaft
k	= Correction factor: 3,03 for Al 2,05 for Ti approx. 70 for unfilled plastics

12.1.1 Solid shaft sensitivity calculation

$$S_{STEEL} = \frac{M_{TMAX}}{d^3} \cdot 62{,}1$$

12.1.2 Hollow shaft sensitivity calculation

$$S_{STEEL} = \frac{M_{TMAX} \cdot d_A}{\left(d_A^4 - d_I^4\right)} \cdot 62{,}1$$

12.1.3 k-factor sensitivity calculation

$$S = S_{STEEL} \cdot \frac{k}{2}$$