Manual

Congratulations for buying your EASY-ROTOR-CONTROL DUO (shortly **ERC-DUO**). This document will guide you through the needed steps for installation, configuration and calibration of the **ERC-DUO**. You will reach the best result by following these instructions step by step.

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For a Quick-Start-guide please read the document Quickstart-Guide_ERC-DUO_V20.

Safety-Instructions

- Don’t continue using the product if it is damaged.
- Keep electronic assemblies and components away from children!
- Products that carry electric voltages must be handled by taking care about the valid instructions and regulations.
- If the product must be repaired, only use original spare parts! Using different parts may cause property damage and personal injury! The repair has only to be done by an expert!
- The product is designed to work in clean and dry areas inside buildings.
- Prevent the product of humidity, water and heat.
- Don’t use the product in areas where explosive gases, vapor or dust are or may occur.
- Don’t let the product fall or apply mechanical stress as the product may be damaged.

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1. Description

ERC-DUO is a computer-interface designed to connect various Rotators of the manufacturers Yaesu™ and Kenpro™ to a computer.

- AZ-rotators: Yaesu™ G-800/1000/2800 DXA/DXC with 6-pin Mini-DIN connector
- AZ&EL-rotators: Yaesu™/Kenpro™ G/KR-5400/5500/5600 with 8-pin DIN connector

On the computer-side it provides an USB-interface and a build-in USB/serial-interface with a FTDI™-chip to provide a virtual-comport on any Windows, MacOS or Linux-machine.
On the rotator-side it can be easily connected to the rotators control-box with the cable that came with your interface.
All further technical information can be retrieved from the appendices in this manual.

2. Bill of material (BOM

ERC-DUO V1.1 Bill Of Material		
QTY	**Type**	**Value**
1	Interface	ERC-DUO V2.0
1	Cable to control-box	Mini-DIN6, 2m or DIN8, 1m
1	USB-cable	A to B 1.8m

3. Connection of ERC-DUO to the control-box

Plug the cable with the Mini-DIN6- or the DIN8-connectors into the ERC-DUO and the other side into the rotators control-box.

4. Establishing the USB-connection

Plug the USB-cable with the USB-B-connector into the ERC-DUO.

Plug the USB A-connector to a free USB-connector on your computer.

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Depending on your operating-system, you will be asked to install an USB-driver. This driver is available on the FTDI™-homepage. Please search for 'FTDI VCP'.
After successful installation of the driver, a new COM-Port (COMn) is available. You can identify the COM-port-number by inspecting the hardware-settings of your computer (e.g. in the COM&LPT-section of the device-manager in Windows).

5. The Service-Tool for Windows

If you use another OS than Windows (MacOS or Linux), please read appendix 5 for calibration and configuration of the ERC-DUO with a terminal-program.

The setup-program of the Service-Tool is in the data-package you received with your ERC-DUO.

Start the setup-program **setup_ServiceTool-DUO_Vnn.EXE** (nn=version) and follow the instructions. The setup-program will automatically install the Service-Tool in the program directory (or any other if you choose a different one) and puts an icon on your desktop if requested to do so.

Start the Service-Tool.

If installed for the first time, the Service-Tool is configured to COM1, which is most properly not the com-port, which was assigned to the ERC-DUO by the device-manager of your computer, hence after Start-Up the program may bring up an error-message because of the wrong COM-Port.
Confirm the error-message and choose the right COM-Port. The Service-Tool will check the availability of the ERC-DUO at the chosen COM-Port. If successful, the Service-Tool will read the configuration-parameters of the ERC-DUO and populates the configuration- and the calibration-panels.

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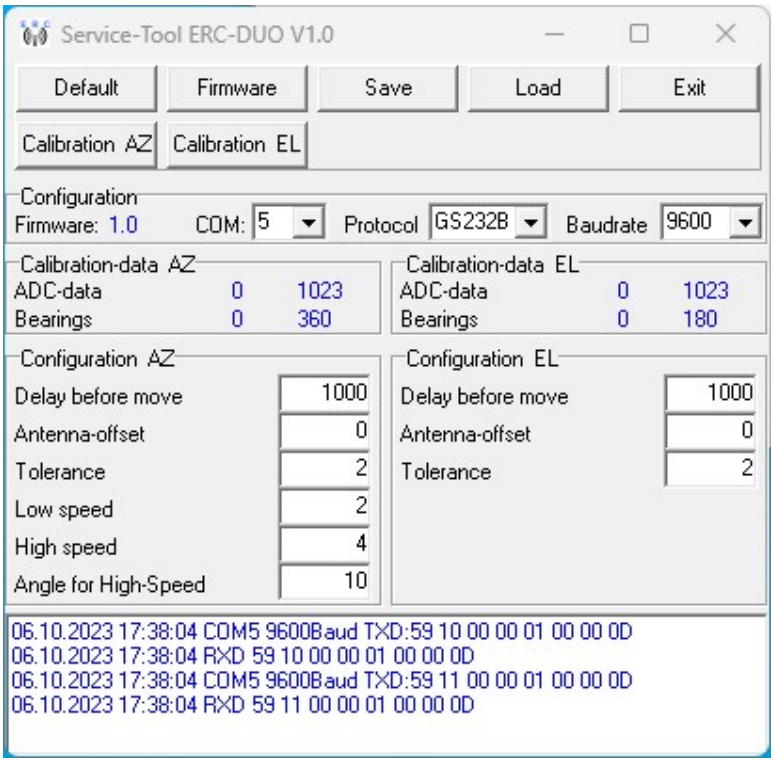
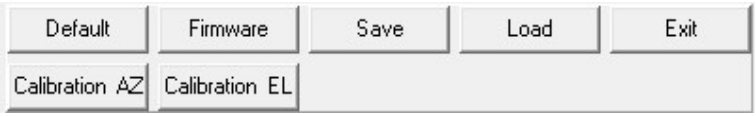


Buttons



- Default
  - Loads the factory-default values for calibration and configuration. **Attention : All data will get lost !** If needed, save them first with the Save-button.
- Firmware
  - Starts the Upload process for the Firmware to the ERC. More information is available in the chapter **5.1 Firmware-Update.**
- Save
  - Saves the current configuration- and calibration-data to a file (.ERC). This file may be useful to recover a configuration or to send us for inspection.
- Load
  - Loads an already saved configuration- and calibration-file (.ERC) to the Service-Tool and ERC.
- Exit
  - Terminates the Service-Tool.
- Calibration AZ or Calibration EL
  - Starts the calibration-process for AZ or EL. More information is available in chapter **5.2 Calibration.**

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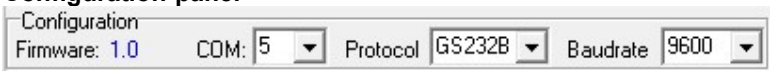
Configuration-panel

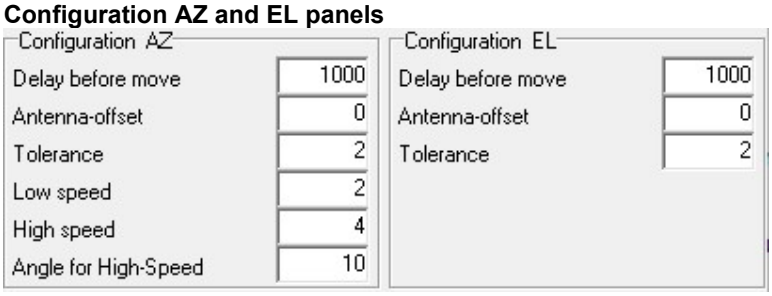


- Firmware
  - shows the Firmware-version loaded to the ERC-DUO
- COM
  - Let you choose the COM-port (1..32) for communication with the ERC.
- Protocol
  - Let you choose between the standard-protocols used by the programs that support rotor-controlling.
    - GS232B: a subset of the GS232B-commandset by YAESU™
    - GS232A: a subset of the GS232A-commandset by YAESU™
    - DCU-1: a subset of the DCU-1-commandset by HYGAIN™ including the extension for position-feedback
- Baudrate
  - Let you choose the communication-speed (4800, 9600) between the computer and the ERC-DUO

Calibration-data AZ and EL panels

- ADC-data
  - Shows the minimum- and the maximum-values of the ADC (Analog-Digital-Converter) that appeared during the calibration-process. The ADC values represent the feedback-voltage coming from the potentiometer in the rotators head.
- Bearings
  - Show the bearings of the rotator used during the calibration-process, Typical values are
    - AZ: 0 360 or 0 450 (which represents a rotator with an overlap of 90°
    - EL: 0 90 or 0 180

Configuration AZ and EL panels



- Delay before move
  - Possible values: 0..5000 ms (milliseconds)
  - This is a very important configuration-item that should never be 0. It configures the delay in milliseconds before the rotator starts to move. It is the delay that is used to start the rotator but that also is used to start rotation after a stop has performed, e.g. when the rotator should change the rotation-direction. Setting this value to 0 or very low value will apply unneeded stress to the rotator or the whole structure (antenna, tower, etc...). A recommended value is 1000 ms (1 second).
- Antenna-offset
  - Possible values: -180° to +180° for AZ and -90° to +90° for EL
  - If the direction of your antenna is misaligned to the direction of the rotator, you can use this value to recalculate the correct position.
- Tolerance
  - possible values: 0° to 10°

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- If you don't want the rotator to follow every change in direction you can put a value here.
- Example: Put a value of 5°. If your current position is 234° and a new target-position is between 229° and 239° the rotator will not move. This may improve the lifetime of your rotator. This feature is also very useful when tracking satellites as the tracking software will always send a new command to the ERC, when the new position has changed by 1°. It depends on the beam-width of the antenna used, which value is useful here.

- Low speed, High speed and Angle for high-Speed
  - Used to control the speed of an AZ-rotator. More details in the chapter **5.3 Speed-control.**

5.1 Firmware-Update

You can check the Firmware installed (Firmware-Version in the info-panel) against the latest Firmware available at www.easy-rotor-control.com in the download-area.
As the ERC has a bootloader, new Firmware can be uploaded from your computer directly to the ERC by the USB-interface.

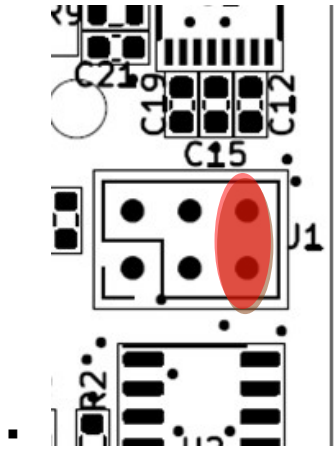
To upload another Firmware follow this procedure:

- Save the new Firmware (e.g. ERC-DUO_V10.acy) to the same folder, where the Service-Tool is installed (e.g. C:\Program Files (x86)\ERC-DUO_V11).
- Start the upload process by pressing the Firmware-button.
- Select the file (.ACY) you want to upload.
- The Firmware-upload performs fully automatic and after the upload has performed, the new Firmware-version is visible in the configuration-panel. The upload typically takes 45 seconds when the ERC is configured to 9600 Baud. It will be slower at 4800 Baud.

If, due to whatever reason, a Firmware-update fails (e.g. bad communication or power-fail during the update) and leaves an incomplete or defect Firmware on the ERC, a new automatic Firmware-update may not be possible anymore.

In this case there is a recovery-function implemented in the design of ERC to start the upload-process manually:

- Open the enclosure of the ERC-DUO
- Start the Service-Tool and confirm the error-message.
- Start the Firmware-upload process.
- Now the ERC needs to be reset: Shorten 2 pins of J1 as marked in red in the following picture with a piece of wire or a tweezers.



- Wait a second and remove the short again.
- This will reset the controller and starts the upload-process.

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5.2 Calibration

The calibration of the ERC is a software-assisted procedure.

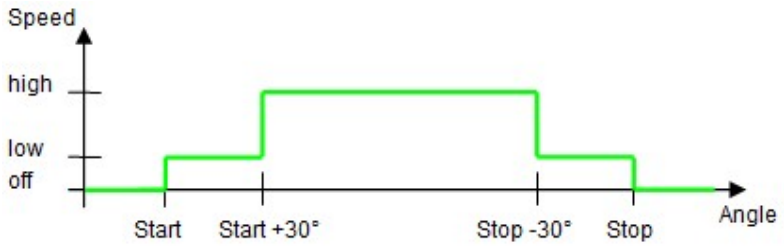
After the ERC-DUO is connected the first time to a new rotator, it has to be calibrated. This calibration is a one-time-task and the result of calibration will be stored inside the ERC-DUO.
To calibrate the ERC-DUO, it has to measure the rotor-feedback-voltages at both ends of the rotation-range including a possible overlap in AZ (turning radius > 360°). The calibration is a software-guided procedure, which will be started by pressing the Calibration AZ-button of the Service-Tool for calibration AZ and the Calibration EL-button for calibration of EL. Just follow the instructions given by the calibration-assistant.

5.3 Speed-control

ERC-DUO provides an automatic speed-control for the DXA/DXC-series of rotators like this (example for a speed angle of 30°):

- rotator starts moving with low-speed
- after 30° the rotator speeds up to high-speed
- 30° prior to reaching the target-position, rotator will again slow down to low speed.

This takes away stress from the whole structure, especially with large antenna-arrays or heavy antennas.



The rotators from Yaesu™ allow the speed-control in 4 stages:1 - 2 - 3 – 4, where 1 is the lowest speed and 4 is the highest speed

Low speed	2
High speed	4
Angle for High-Speed	30

Low speed
possible values: 1 / 2 / 3 / 4

- configured to 1: low speed will be performed with speed 1
- configured to 2: low speed will be performed with speed 2
- configured to 3: low speed will be performed with speed 3
- configured to 4: low speed will be performed with speed 4

High speed
possible values: 1 / 2 / 3 / 4

- configured to 1: high speed will be performed with speed 1
- configured to 2: high speed will be performed with speed 2
- configured to 3: high speed will be performed with speed 3
- configured to 4: high speed will be performed with speed 4

Speed angle
possible values: 0 - 30

- defines the angle for low-speed at the beginning and end of a turn

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6. First check of calibration with Rotor-Control DUO

The setup-program of the rotor-control-program Rotor-Control DUO is in the data-package supplied with your interface.

Start the setup-program **setup_RotorControl-DUO_Vnn.EXE** and follow the instructions.
The setup-program will automatically install Rotor-Control DUO in the program directory (or any other if you choose a different one) and puts an icon on your desktop if requested to do so.

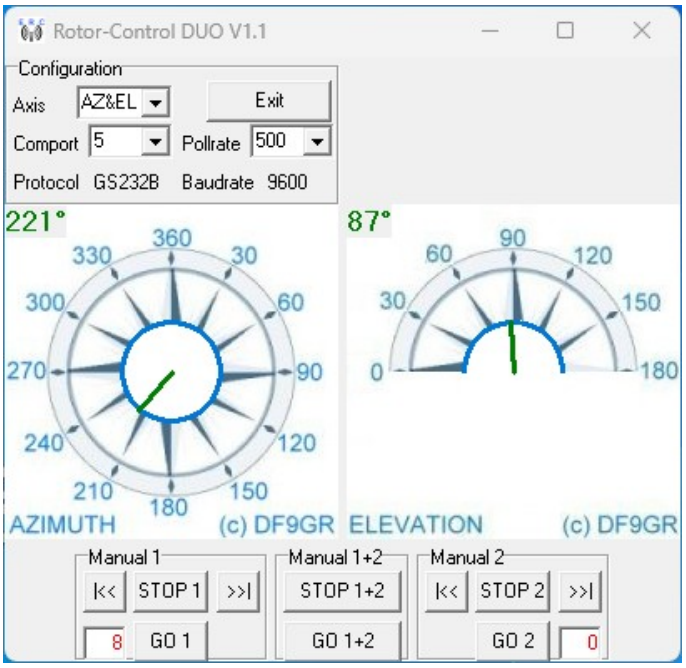
Start Rotor-Control DUO.

If installed for the first time, Rotor Control DUO is configured to COM1, which is most properly not the com-port, which was assigned to the ERC-DUO by the hardware-manager of your computer, hence after Start-Up the program may not show any position-information from the ERC.
Choose the right COM-Port. If successful, Rotor-Control DUO will read the position of the rotator and show a green pointer and a green value indicating the position.

The protocol (GS232A, GS232B or DCU-1) and the baudrate (4800 or 9600) will be read automatically from the ERC-DUO.

Rotor-Control DUO can be configured to work for a AZ/EL setup or a AZ only setup. If your ERC-DUO is configured to protocol DCU-1, Rotor Control DUO switches automatically to the AZ only-view as protocol DCU-1 does not support elevation.

AZ&EL



AZ only

The green pointers and numbers show the current position of the rotators. Targets can be put at the red numbers. You can control the rotators for Azimuth and Elevation separately or together. Click the GO-buttons or click on any point of the graphics to start the rotation and click the STOP-buttons to stop rotation.

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7. Connection of ERC-DUO to other programs

Please take care about the following issues, if you want to control your ERC-DUO with other programs (logging, contesting, SAT/EME-tracking, etc…):

- Choose the right COM-port. Be sure, no other program (e.g. the ERC-DUO Service-Tool) is using the same COM-port. Windows does not allow more than 1 application to access a COM-port at the same time.
- The baudrate in the program must be same as configured in ERC-DUO (9600 or 4800)
    - The speed of ERC-DUO is shown in the Service-Tool
- Adjust the comport in the program to: N-8-1 (No Parity, 8 databits,1 stopbit)
- Use the same protocol in the program and ERC-DUO (GS232B, GS232A or DCU-1)
    - The protocol of ERC-DUO is shown the Service-Tool
- For more details on Settings of ERC-DUO and the many compatible programs, please read the Software-Guide on our homepage at www.schmidt-alba.de/eshop/

8. Trouble-Shooting

In case of any problems, please provide us with the following information :

- Model of rotator used
- Operating system of your PC (e.g. Windows XP, Vista, 7, 8, 10, 11 (32 or 64 bit), MacOS, Linux)
- Version of the Service-Tool (if Windows is your operating-system)
- Version of Firmware of the ERC
- 3rd. party software used for controlling the rotor, if the problem comes with this software.
- Save your calibration and configuration with the Save-button of the Service-tool to an .ERC-file and send it to us (if Windows is your operating-system).

Send any request to ERC@schmidt-alba.de.

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Appendices

Appendix 1: Specification

ERC-DUO specification

Mechanical Dimensions
- PCB: 60,6mm x 40mm
- Enclosure: 63mm x 50mm x 30 mm

DC Supply
- USB-powered 5VDC, current consumption: max 10mA

Temperature-range
- 0°C to 70°C

Measurement input circuits (rotor feedback voltage)
- range: 0 to 7V against ground with a resolution of 10 bit
- input-impedance: > 25KOhm
- protected with TVS-diodes against high voltage bursts coming through the rotor-cable
- protected against RF with build in low-pass filters

Outputs
- CW, CCW, UP, DWN: Open collector-outputs against ground
- max. current per open-collector-output with 2 outputs simultaneously at 100% duty-cycle and 70° C: 380mA
- Speed: 4 stage DAC with high-Impedance output-voltages of 0,5V to 4,5V

Communication-interface
- USB through type B connector
- build-in USB/serial converter with FTDI™-chip FT231X
- original and not modified drivers for Windows, Linux, MacOS by FTDI™

Controller
- 8-bit RISC-architecture by Microchip™
- bootloader to update Firmware through USB (Windows only)
- supported protocols for rotor-control
    - subset of Yaesu™ GS232A / GS232B (ref. Appendix 4)
    - subset of Hygain™ DCU-1 and extensions for position feedback (ref. Appendix 4)

Firmware supported features
- delay before rotator starts moving
- antenna offset
- support of overlap up to 180° for AZ-rotator
- speed-function for AZ-rotator
- tolerance of position
- software-calibration
- security stop if rotor doesn´t move
- configurable communication-speed: 4800 - 9600 Baud
- save and load of all calibration- and configuration-data through Windows Service-Tool
- configuration / calibration also through Application Programming Interface (ref. Appendix 5)

Service-Tool and Rotor-Control DUO
- Supported operating systems
    - Windows 2000 and XP
    - Windows Vista, 7, 8, 10 (32 bit and 64 bit) and 11

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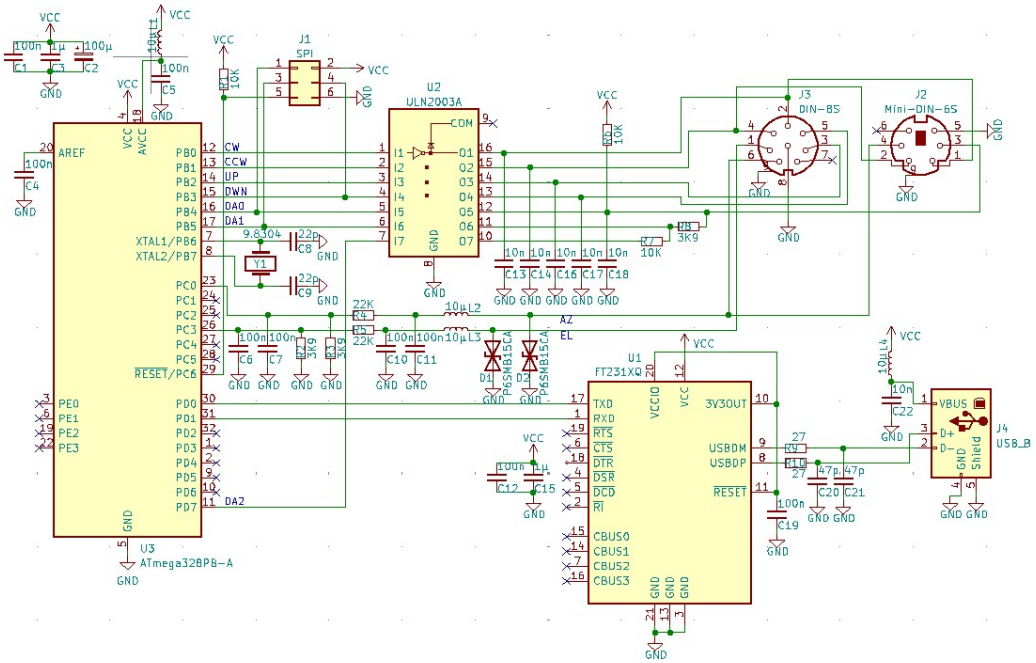
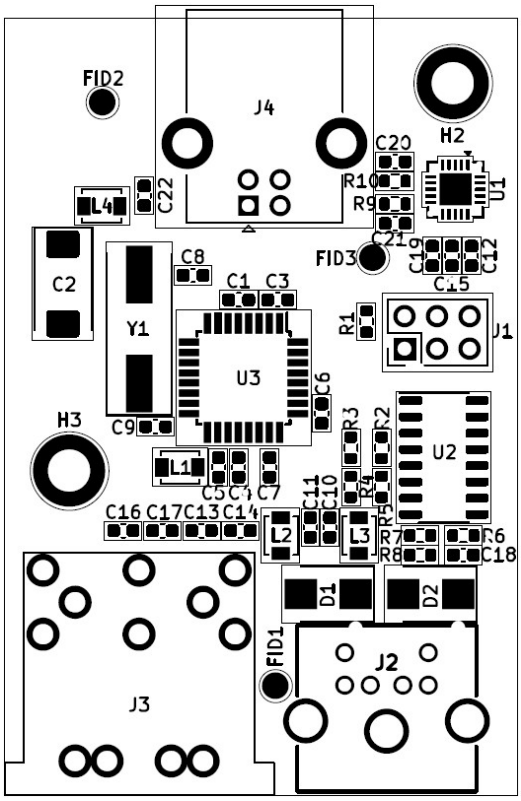
Appendix 2: Schematics ERC-DUO



Appendix 3: Assembly-plan ERC-DUO



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Appendix 4: Rotor-protocol command-sets

Remarks for the annotation in this document:

<cr> = carriage return and represent the decimal-value 13 = Hex-value 0Dh
<lf> = line feed and represents the decimal-value 10 = Hex-value 0Ah
aaa = a 3-digit azimuth-position with leading 0
eee = a 3-digit elevation-position with leading 0
<s> = space and represents the decimal-value 32 = Hex-value 20h

DCU-1 with extensions for position-request (Azimuth only)

Some commands are redundant with slight differences to keep compatibility to the different implementations of the DCU-1-protocol in different programs

Command to ERC-DUO	Description	Returned from ERC-DUO
AI1;<cr>	Request position azimuth	;aaa
AI1;	Request position azimuth	;aaa
AM1;<cr>	Execute rotation	
AM1;	Execute rotation	
AP1aaa;<cr>	Set azimuth-position to aaa	
AP1aaa;	Set azimuth-position to aaa	
AS1;	Stop rotation	
D	Rotate CCW	
MGaaa	Rotate azimuth to aaa	
U	Rotate CW	
;	Stop rotation	

GS232 A and B

The only difference in A and B is the format how a position is returned from the ERC

Command to ERC-DUO	Description	Returned from ERC-DUO
A<cr>	Stop rotation azimuth	<cr>
B<cr> (in GS232A-mode)	Request position elevation	+0eee<cr><lf>
B<cr> (in GS232B-mode)	Request position elevation	EL=eee<cr><lf>
C<cr> (in GS232A-mode)	Request position azimuth	+0aaa<cr><lf>
C<cr> (in GS232B-mode)	Request position azimuth	AZ=aaa<cr><lf>
C2<cr> (in GS232A-mode)	Request position azimuth + elevation	+0aaa+0eee<cr><lf>
C2<cr> (in GS232B-mode)	Request position azimuth + elevation	AZ=aaa<s><s>EL=eee<cr><lf>
D<cr>	Rotate elevation DOWN	<cr>
E<cr>	Stops rotation elevation	<cr>
L<cr>	Rotate azimuth CCW	<cr>
Maaa<cr>	Rotate azimuth to aaa	<cr>
R<cr>	Rotate azimuth CW	<cr>
S<cr>	Stops rotation azimuth + elevation	<cr>
U<cr>	Rotate elevation UP	<cr>
Waaa<s>eee<cr>	Rotate azimuth to aaa and Rotate elevation to eee	<cr>

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Appendix 5: API (application programming interface)

If another OS than Windows is used (e.g. MacOS or Linux), the Service-Tool that came with your ERC-DUO is of no use.
In order to perform configuration- and calibration-tasks, ERC-DUO provides a programming-interface, which can be easily used with a terminal-program.

Remarks for the annotation in this document:
<cr> = carriage return and represent the Ascii-code 13 = Hex-code 0D

Start the terminal-program, set the right COM-port and the communication-speed (default speed is 9600 Baud)

Commands to read the configuration- and calibration-parameters of ERC-DUO:

A read-command consist of a leading **r**, followed by a **3 letter command** and followed by a **<cr>**
The answer of the ERC-DUO is a leading **a**, followed by the same **3 letter command**, followed by a **4 digit value** and followed by a **<cr>**

API ERC-DUO V10	cmd to ERC-DUO	answer from ERC-DUO	Example	Range	default	Explanation
Command	**ASCII**	**ASCII**				
Read firmware-version	r F M W (cr)	a F M W 0 1 0 0 (cr)	V1.00	1.00...9.99		
Read baudrate	r B A U (cr)	a B A U 9 6 0 0 (cr)	9600	4800/9600	9600	
Read protocol	r P R O (cr)	a P R O 0 0 0 1 (cr)	1=GS232B	0/1/2	1	0=GS232A, 1=GS232B, 3=DCU1
Read calibration-angle right AZ	r A R 1 (cr)	a A R 1 0 3 6 0 (cr)	360°	0...360	360	
Read calibration-angle left AZ	r A L 1 (cr)	a A L 1 0 0 0 0 (cr)	0°	0...360	0	
Read calibration-ADC right AZ	r C R 1 (cr)	a C R 1 1 0 1 0 (cr)	ADC=1010	0...1023	1023	
Read calibration-ADC left AZ	r C L 1 (cr)	a C L 1 0 0 0 5 (cr)	ADC=5	0...1023	0	
Read delay before move AZ	r D M 1 (cr)	a D M 1 1 0 0 0 (cr)	1000	0...5000	1000	milliseconds before rotor starts moving
Read tolerance AZ	r T O 1 (cr)	a T O 1 0 0 0 2 (cr)	2	0…10	2	tolerance where the rotator does not follow
Read antenna-offset AZ	r A O 1 (cr)	a A O 1 - 0 9 0 (cr)	-90°	-180…+180	0	
Read speed-angle AZ	r S A 1 (cr)	a S A 1 0 0 0 3 (cr)	3	0/1/2/3	3	0=0°, 1=10°, 2=20°, 3=30°
Read speed at low-speed AZ	r S L 1 (cr)	a S L 1 0 0 0 1 (cr)	1	1/2/3/4	1	1=speed1, 2=speed2, 3=speed3, 4=speed4
Read speed at high-speed AZ	r S H 1 (cr)	a S H 1 0 0 0 0 (cr)	0	1/2/3/4	3	1=speed1, 2=speed2, 3=speed3, 4=speed4
Read calibration-angle up EL	r A R 2 (cr)	a A R 2 0 1 8 0 (cr)	180°	0…180	180	
Read calibration-angle down EL	r A L 2 (cr)	a A L 2 0 0 0 0 (cr)	0°	0...360	0	
Read calibration-ADC up EL	r C R 2 (cr)	a C R 2 1 0 1 0 (cr)	ADC=1010	0...1023	1023	
Read calibration-ADC down EL	r C L 2 (cr)	a C L 2 0 0 0 5 (cr)	ADC=5	0...1023	0	
Read delay before move EL	r D M 2 (cr)	a D M 2 1 0 0 0 (cr)	1000	0...5000	1000	milliseconds before rotor starts moving
Read tolerance EL	r T O 2 (cr)	a T O 2 0 0 0 2 (cr)	2	0…10	2	tolerance where the rotator does not follow
Read anntenna-offset EL	r A O 2 (cr)	a A O 2 - 0 9 0 (cr)	-90°	-180…+180	0	

Commands to set the configuration of ERC-DUO:

A set-command is a leading **s**, followed by a **3 letter command**, followed by a **4 digit value** and followed by a **<cr>.** The ERC does not answer to a set-command but you can verify the success of your set-command by using the appropriate read-command (see above).
Tip: if you changed the baudrate with the set-command, your terminal-program needs to be adjusted accordingly. Otherwise there is no further communication possible.

API ERC-DUO V10	cmd to ERC-DUO	Example	Range	default	Explanation
Command	**ASCII**				
Set baudrate	s B A U 9 6 0 0 (cr)	9600	4800/9600	9600	
Set protocol	s P R O 0 0 0 1 (cr)	1=GS232B	0/1/2	1	0=GS232A, 1=GS232B, 3=DCU1
Set factory fefault values	s F D V 0 0 0 0 (cr)				sets the ERC to factory default values
Set delay before move AZ	s D M 1 1 0 0 0 (cr)	1000	0...5000	1000	milliseconds before rotor starts moving
Set tolerance AZ	s T O 1 0 0 0 2 (cr)	2	0…10	2	tolerance where the rotator does not follow
Set antenna-offset AZ	s A O 1 0 0 0 0 (cr)	-90°	-180…+180	0	
Set speed-angle AZ	s S A 1 0 0 0 3 (cr)	3	0/1/2/3	3	0=0°, 1=10°, 2=20°, 3=30°
Set speed at low-speed AZ	s S L 1 0 0 0 1 (cr)	1	1/2/3/4	1	1=speed1, 2=speed2, 3=speed3, 4=speed4
Set speed at high-speed	s S H 1 0 0 0 0 (cr)	0	1/2/3/4	3	1=speed1, 2=speed2, 3=speed3, 4=speed4
Set delay before move EL	s D M 2 1 0 0 0 (cr)	1000	0...5000	1000	milliseconds before rotor starts moving
Set tolerance EL	s T O 2 0 0 0 2 (cr)	2	0…10	2	tolerance where the rotator does not follow
Set antenna-offset EL	s A O 2 0 0 0 0 (cr)	-90°	-180…+180	0	

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Example for setting the delay before move to 2000 milliseconds = 2 seconds:

- Send to ERC-DUO: sDB12000<cr>

- The result of setting can be read back from the ERC-DUO like this:
  - Send to ERC-DUO: rDB1<cr>
  - ERC-DUO answers: aDB12000<cr> (2000 is the 'delay before move' in milliseconds)

If a command to ERC-DUO is wrong or a value is out of range an error is reported from ERC-DUO

- If an incorrect read-command was received, ERC-DUO sends: r-ERROR
- If an incorrect set-command was received, ERC-DUO sends: s-ERROR

Commands to calibrate the ERC-DUO:

A set-calibration command is a leading **s**, followed by a **3 letter command**, followed by a **4 digit value** and followed by a **<cr>.**

API ERC-DUO V10	cmd to ERC-DUO									Example	Range	default	Explanation
Command	ASCII												
Set calibration-angle right AZ	s	C	R	1	0	3	6	0	(cr)	360°	0…360	360	use 90 if your rotator has an overlap to 90°
Set calibration-angle left AZ	s	C	L	1	0	0	0	0	(cr)	0°	0…360	0	
Set calibration-angle up EL	s	C	R	2	0	3	6	0	(cr)	180°	0…180	180	us 90 if your EL-rotator is limited to 90°
Set calibration-angle down EL	s	C	L	2	0	0	0	0	(cr)	0°	0…360	0	

Example for calibration of the AZ-rotator:

- Situation: your rotator has a turning-range of 450° (overlap of 90°) and is moving clockwise 0° -> 90° -> 180° -> 270°-> 360° -> 90°
- Move your rotator manually to the most counter-clockwise (CCW) position at 0°
  - Send to ERC-DUO: sCL10000<cr>
- Move your rotator manually to the most clockwise (CW) position at 90°
  - Send to ERC-DUO: sCR10090<cr>
- The result of calibration can be read back from the ERC-DUO like this:
  - Send to ERC-DUO: rAL1<cr>
  - ERC-DUO answers: aAL10000<cr> (0000 is the angle at most CCW position)
  - Send to ERC-DUO: rAR1<cr>
  - ERC-DUO answers: aAR10090<cr> (0090 is the angle at most CW position)
  - Send to ERC-DUO: rCL1<cr>
  - ERC-DUO answers: aCR10004<cr> (0004 is the ADC-value at 0° CCW)
  - Send to ERC-DUO: rCR1<cr>
  - ERC-DUO answers: aCR10711<cr> (0711 is the ADC-value at 90° CW)

Example for calibration of the EL-rotator:

- Situation: your rotator has a turning-range of 180° and is moving upwards 0° -> 90° -> 180°
- Move your rotator manually to the most downward (DWN) position at 0°
  - Send to ERC-DUO: sCL20000<cr>
- Move your rotator manually to the most upward (UP) position at 180°
  - Send to ERC-DUO: sCR20180<cr>
- The result of calibration can be read back from the ERC-DUO like this:
  - Send to ERC-DUO: rAL2<cr>
  - ERC-DUO answers: aAL20000<cr> (0000 is the angle at most DWN position)
  - Send to ERC-DUO: rAR2<cr>
  - ERC-DUO answers: aAR20180<cr> (0180 is the angle at most UP position)
  - Send to ERC-DUO: rCL2<cr>
  - ERC-DUO answers: aCR20002<cr> (0002 is the ADC-value at 0° DWN)
  - Send to ERC-DUO: rCR2<cr>
  - ERC-DUO answers: aCR20812<cr> (0812 is the ADC-value at 180° UP)

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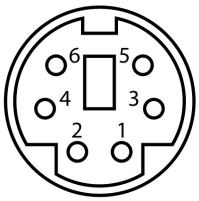
Appendix 6: Rotor-connectors

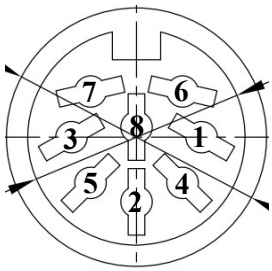
6-pin Mini-DIN connector for AZ (looking from outside to the ERC-DUO)

Pin	
1	CW
2	CCW
3	Speed
4	Position AZ
5	GND
6	Not used



8-pin DIN connector for AZ & EL (looking from outside to the ERC-DUO)

Pin	
1	Position EL
2	CW
3	UP
4	CCW
5	DWN
6	Position AZ
7	Not used
8	GND



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