

IEC 60870-5-103 Protocol Description for Earthfault-Detection-Relay EOR-3D

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1 IEC 60870-5-103 Protocol

This document describes the characteristics of the IEC 60870-5-103 communication protocol of EORD-3D device. The EORD-3D IEC 60870-5-103 Implementation acts as controlled station definition (slave).

2 IEC 60870-5-103 Physical Layer

EOR-3D devices can be connected to an IEC 60870-5-103 Network in order to communicate via RS232 or RS485.

2.1 Parameters of the IEC 60870-5-103 connection

The different parameters of the IEC 60870-5-103 connection are as follows:

- RS232 connection
- Isolated two-point RS485 connection (2kV 50Hz)
- Communication speed can be configured

2.1.1 Transmission mode

Baud rate:

- 9600
- 19200
- 38400
- 57600
- 115200

Mode:

- 1 start / 8 bits / 1 stop: total 10 bits
- 1 start / 8 bits / even parity / 1 stop: total 11 bits
- 1 start / 8 bits / odd parity / 1 stop: total 11 bits
- 1 start / 8 bits / none parity / 2 stop: total 11 bits

--> 1,5 Stop bits are not supported

3 IEC 60870-5-103 Link Layer

The EOR-3D IEC 60870-5-103 slave implementation, resets the cyclic measurement II (Type 9) counter on start up of a successful connection in the link layer. After that the measurement counter is incremented to have correct data of cyclic measurements II at a successful connection. After a broken connection at the next successful connection the transmission of the measurements II starts from the beginning with continuous and coherent new data.

3.1 IEC 60870-5-103 Link Layer Timeout

The Link Layer, detects a Timeout (TR) after 24 hours.

4 IEC 60870-5-103 Application Layer

One common address of the ASDU is identical with the station address.

4.1 General Type Identifications in monitor directions

Following Type Identifications in monitor direction are implemented:

- 01 time-tagged message
- 02 time-tagged message with relative time
- 03 measurands I
- 04 time-tagged measurands with relative time
- 05 identification
- 06 time synchronization
- 08 general interrogation termination
- 09 measurands II
- 23 list of recorded disturbances
- 26 ready for transmission of disturbance data
- 27 ready for transmission of a channel
- 28 ready for transmission of tags
- 29 transmission of tags
- 30 transmission of disturbance values
- 31 end of transmission

4.2 General Type Identifications in control directions

Following Type Identifications in control direction are implemented:

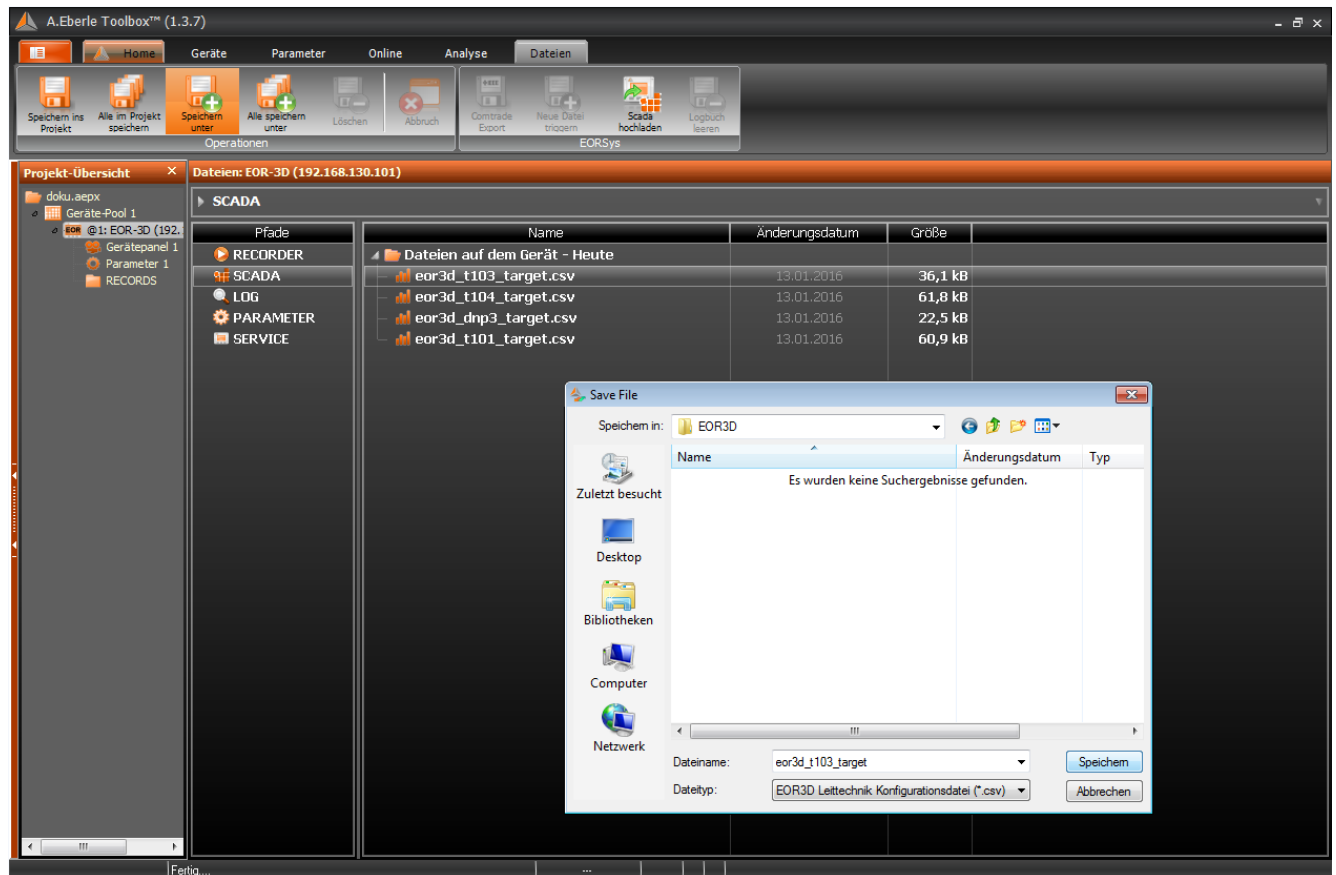
- 06 time synchronization
- 07 general interrogation
- 20 general command
- 23 order for disturbance data transmission

4.3 CSV configuration of the IEC 60870-5-103 slave

The EOR-3D IEC 60870-5-103 slave can be configured through a csv file on the target. On start up of the system the configuration csv file will be loaded and the IEC 60870-5-103 slave is operational. This file has to be

placed in the param directory (ftp/appfs/eor3dapp1/param) on the target (this is the directory where also other EOB-3D configurations can be found). It can be transferred to the EOB-3D with the Toolbox download.

After changing the file, it has to be saved and **has also to be saved as MSDOS CSV** file. Then the CSV file has to be transferred to the target via the Upload Scada (ftp/appfs/eor3dapp1/param).

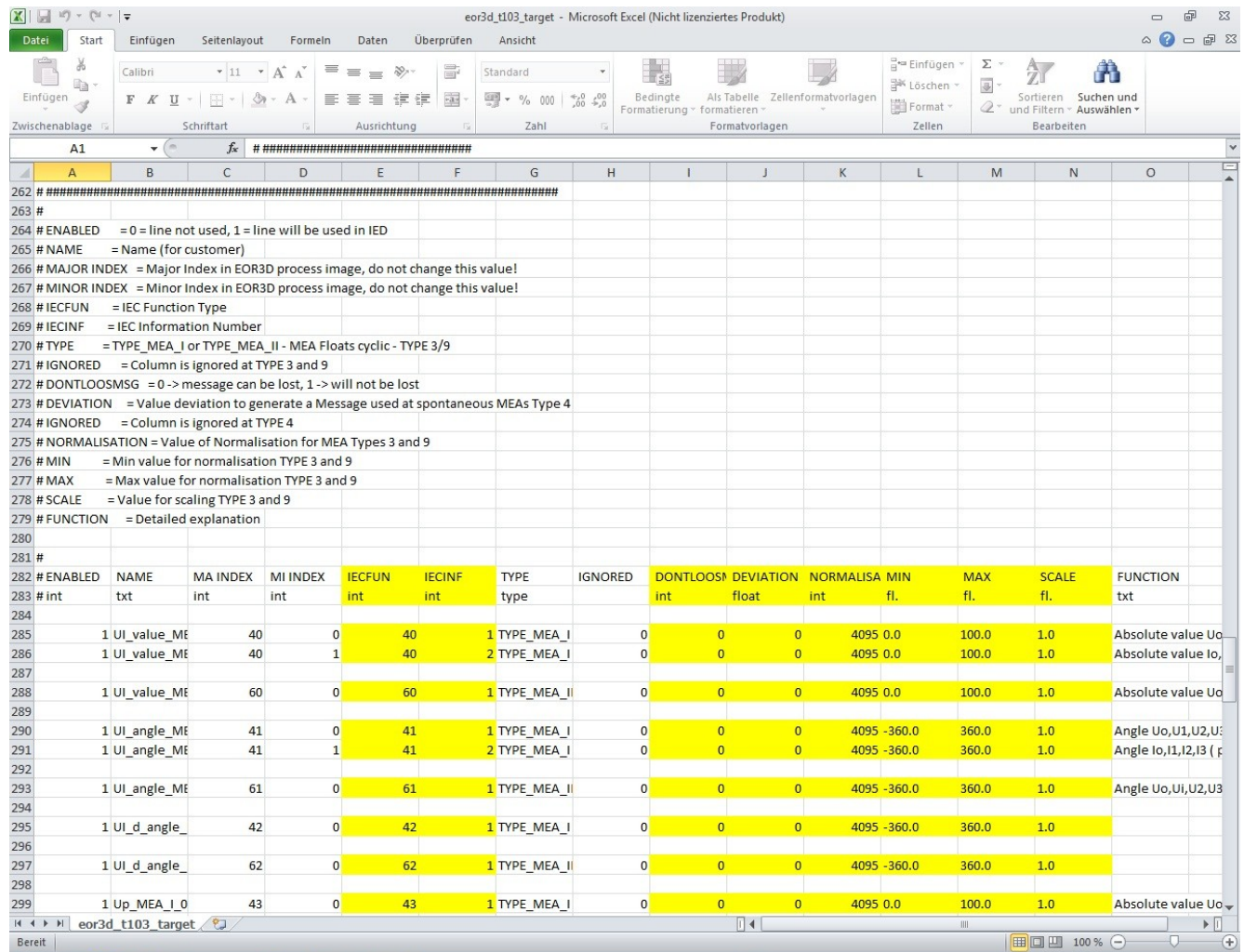


Picture 1: Toolbox download

4.4 Detailed CSV configuration (Step by step)

The default eor3d_t103_target.csv file has an explanation for every possible type of transition included. Please look direct in the file for changes. Normal step by step configuration would be:

- Download the csv file from the device
- Change the csv file for you needs with an editor or Microsoft Excel
- Save the file as eor3d_t104_target.csv (MSDOS File format when using excel)
- Upload the file to the target with Toolbox Upload Scada



#	ENABLED	NAME	MA INDEX	MI INDEX	IECFUN	IECINF	TYPE	IGNORED	DONTLOOS	DEVIATION	NORMALISA	MIN	MAX	SCALE	FUNCTION
# int	txt	int	int	int	int	int	type		int	float	int	fl.	fl.	fl.	txt
285	1	UI_value_ME	40	0	40		1 TYPE_MEAI	0	0	0	4095 0.0	100.0	1.0		Absolute value Uo
286	1	UI_value_ME	40	1	40		2 TYPE_MEAI	0	0	0	4095 0.0	100.0	1.0		Absolute value Io
288	1	UI_value_ME	60	0	60		1 TYPE_MEAI	0	0	0	4095 0.0	100.0	1.0		Absolute value Uo
290	1	UI_angle_ME	41	0	41		1 TYPE_MEAI	0	0	0	4095 -360.0	360.0	1.0		Angle Uo,U1,U2,U3
291	1	UI_angle_ME	41	1	41		2 TYPE_MEAI	0	0	0	4095 -360.0	360.0	1.0		Angle Io,I1,I2,I3 (p
293	1	UI_angle_ME	61	0	61		1 TYPE_MEAI	0	0	0	4095 -360.0	360.0	1.0		Angle Uo,Ui,U2,U3
295	1	UI_d_angle	42	0	42		1 TYPE_MEAI	0	0	0	4095 -360.0	360.0	1.0		
297	1	UI_d_angle	62	0	62		1 TYPE_MEAI	0	0	0	4095 -360.0	360.0	1.0		
299	1	Up_MEAI_0	43	0	43		1 TYPE_MEAI	0	0	0	4095 0.0	100.0	1.0		Absolute value Uo

Picture 2: csv demo

4.4.1 Monitor Direction

The EOR-3D IEC 60870-5-103 slave sets up all configurations from the csv file. Time Tags are locally generated where no time tags are delivered from the EOR-3D Earth Fault Detection Algorithm. Normally on Indications and disturbance datasets time tags are delivered from the EOR-3D Earth Fault Detection Algorithm. On measurements the time tags or relative time is generated by the EOR-3D IEC 60870-5-103 slave.

4.4.1.1 DPI time-tagged, DPI with relative time (Type 1 and 2)

Standard DPI messages with time tag or relative time are included. Please take a look in the csv file which events can be configured.

4.4.1.2 Measurement Normalisation (MEA Type 3 and 9)

Standard normalized measurements are included. Please take a look in the csv file which events can be configured. With min, max and scale and normalisation in the csv the value can be normalized.

Calculation of the normalisation used in EOR-3D:

real_value = from EOR-3D Earth Fault Detection Algorithm

value = real_value * scale(from csv);

value_int = value;

value_int = normalisation(from csv) / max(from csv) * value_int;

value_int gets transmitted with check of overrun, error and sign, min (from csv) is only used to check the overrun bit.

4095 is the maximum value, normal 4095 is interpreted as 120% (1.2 x of the real value), change the scale value accordingly to you needs. In the demo csv file scale is set to 1.0, so the maximum value is transferred as 4095.

4.4.1.3 Measurements with Relative Time (MEA Type 4)

Standard spontaneous measurements with relative time tag are included. Please take a look in the csv file which events can be configured.

4.4.1.4 A-Eberle Compact Int Values with Time-tag

A-Eberle custom specific Integer values are included. With that values a compact version of (BI, BIF, BO, BOF, LED) Indications can be transferred at once. 4 byte are used for the value the last 4 bytes is a standard 60870-5-103 Time Tag.

4.4.1.5 Transmit Disturb Dataset (Type 24)

The EOR-3D transmits 8 channels on a disturbance dataset (Uo,U1,U2,U3,Io,I1,I2,I3). If the disturbance Dataset on the target is greater, only 2sec are transmitted. Correct values of RFA, RPV and RSV have to configured in the csv file. In comparison to the disturb dataset from EOR-3D Earth Fault Detection Algorithm, the disturbance datasets (values) in the EOR-3D IEC 60870-5-103 slave are divided by 256 to fit in the 16bit value for disturbance datasets. Disturbance dataset tags is included. There the 8 BO (Binary Output) status information is transmitted.

Default the transmission is disturbance dataset is disabled in the csv file:

```
0;DISTURB_1;200;0;160;0;TYPE_DISTURB_TIME_TAGGED;0;0;0;1.0;1.0;1.0;Disturbance channel 1;
0;DISTURB_2;200;1;160;1;TYPE_DISTURB_TIME_TAGGED;0;0;0;1.0;1.0;1.0;Disturbance channel 2;
0;DISTURB_3;200;2;160;2;TYPE_DISTURB_TIME_TAGGED;0;0;0;1.0;1.0;1.0;Disturbance channel 3;
0;DISTURB_4;200;3;160;3;TYPE_DISTURB_TIME_TAGGED;0;0;0;1.0;1.0;1.0;Disturbance channel 4;
0;DISTURB_5;200;4;160;4;TYPE_DISTURB_TIME_TAGGED;0;0;0;1.0;1.0;1.0;Disturbance channel 5;
0;DISTURB_6;200;5;160;5;TYPE_DISTURB_TIME_TAGGED;0;0;0;1.0;1.0;1.0;Disturbance channel 6;
0;DISTURB_7;200;6;160;6;TYPE_DISTURB_TIME_TAGGED;0;0;0;1.0;1.0;1.0;Disturbance channel 7;
0;DISTURB_8;200;7;160;7;TYPE_DISTURB_TIME_TAGGED;0;0;0;1.0;1.0;1.0;Disturbance channel 8;
```

To enable disturbance Dataset change the first column for all channels to 1. Disturbance dataset can only be enabled or disabled for all channels, to enable or disable one channel is **not supported**!

4.4.2 Control direction

4.4.2.1 Time sync (Type 6)

The standard time sync of IEC 60870-5-103 is included. The system time and the real time clock gets set.

4.4.2.2 General interrogation (Type 7)

The standard general interrogation command of IEC 60870-5-103 is included. All configured elements from the csv can be read through this command.

4.4.2.3 Commands (Type 20)

DPI Commands for higher level system are included. Take a look into the csv which commands can be send to the EOR-3D.

4.4.2.4 Request overview of disturb dataset (Type 23)

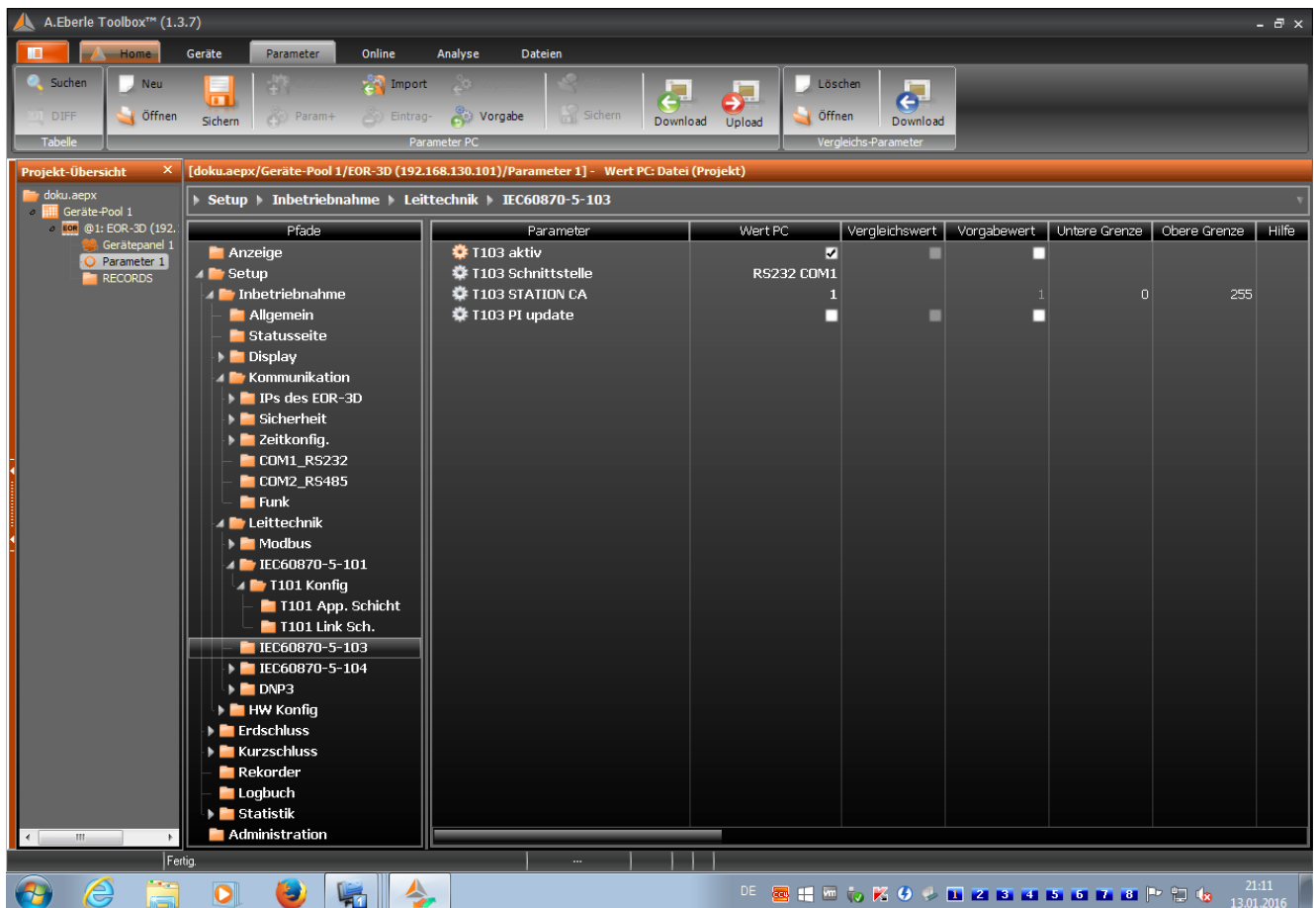
The standard request overview command of IEC 60870-5-103 for disturbance datasets is included.

4.4.2.5 Transmit disturb dataset (Type 24)

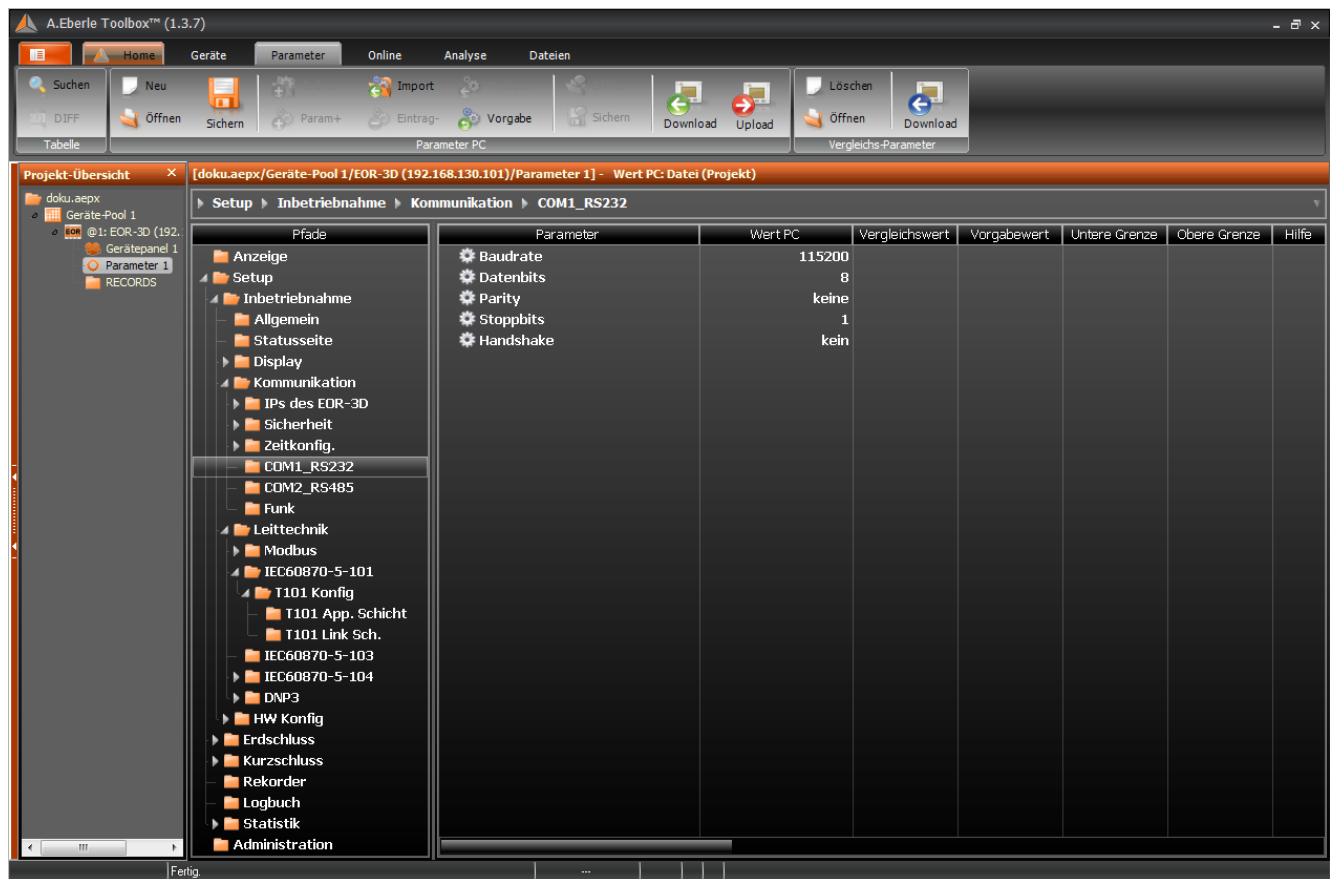
Please look at Transmit disturb dataset (Type 24) in monitor direction in the csv file. On Normal operation 8 disturbance datasets can be stored in the IEC 60870-5-103 process image. If more disturbance datasets occur the oldest gets deleted.

5 IEC 60870-5-103 EOR-3D Toolbox configuration

- T103 active (disable - all data 0 / enable update data)
 --> On a changed from 0 to 1 the IEC 60870-5-103 slave gets it new configuration.
- Protocol (disabled / COM2 RS485 / COM1 RS232)
- T103 Station CA
- T103 PI Update (Update PI Image IEC 60870-5-103 Slave)



Picture 3: Toolbox configuration



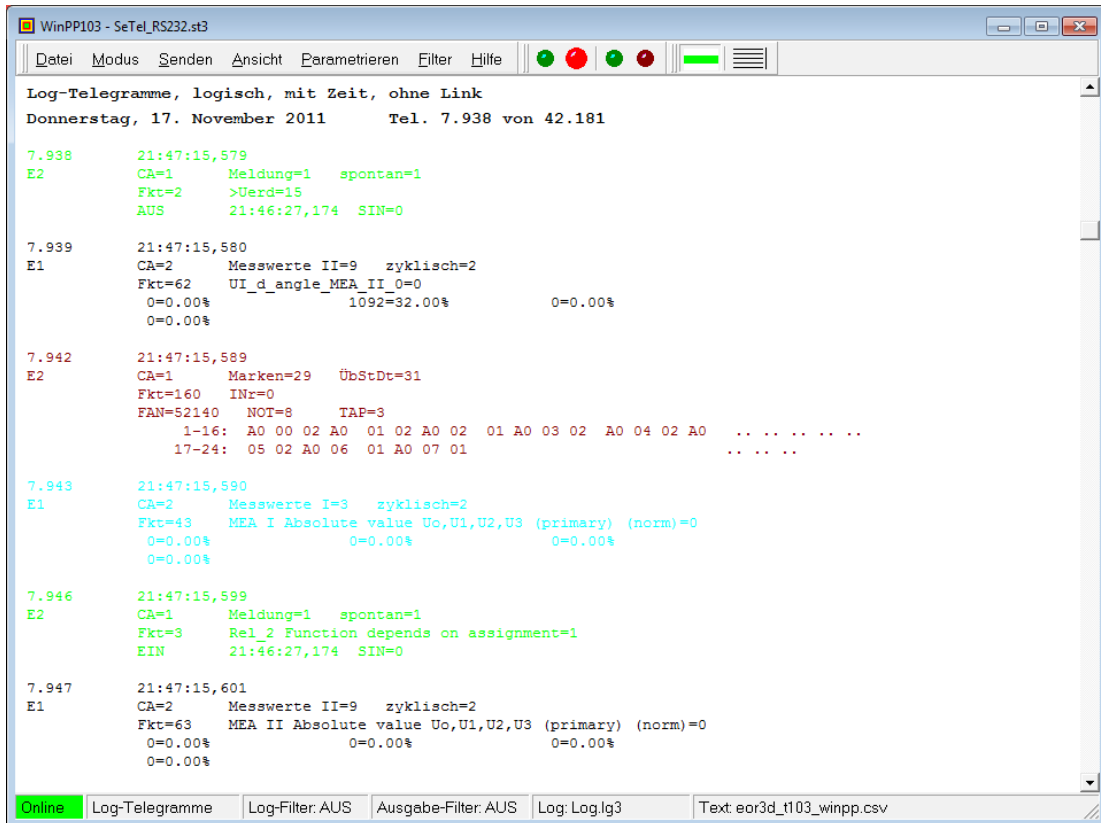
Picture 4: Toolbox serial configuration

5.1 Process Image Update

On normal operation the EOR-3D IEC 60870-5-103 slave process image is only updated if an event is send. If the configuration with csv file has deviation configured events are only send if enough deviation occurs. It can be configured that the internal process image also gets updated if not enough deviation occurs. Normal higher level systems check the slave of correctness if the event has the same date like the general interrogation. So this configuration is default turned off. It can be switched that the general interrogation always sends the most actual data.

6 IEC 60870-5-103 Demo WinPP103

As a short example of the IEC 60870-5-103 slave implementation the Fink WinPP103 is used.



The screenshot shows the WinPP103 - SeTel_RS232.st3 application window. The main display area shows log-telegram data for Thursday, November 17, 2011, at 17:47:15. The data is organized into several entries, each with a timestamp and a list of parameters. The parameters include CA (Control Address), Fkt (Function Code), AUS (Alarm/Status), and various measurement values (Messwerte) for II (Current) and U (Voltage). The interface also includes a menu bar (Datei, Modus, Senden, Ansicht, Parametrieren, Filter, Hilfe) and a status bar at the bottom with buttons for Online, Log-Telegramme, Log-Filter: AUS, Ausgabe-Filter: AUS, Log: Log.lg3, and Text: eor3d_t103_winpp.csv.

```

Log-Telegramme, logisch, mit Zeit, ohne Link
Donnerstag, 17. November 2011      Tel. 7.938 von 42.181

7.938      21:47:15,579
E2      CA=1      Meldung=1      spontan=1
      Fkt=2      >Uerd=15
      AUS      21:46:27,174      SIN=0

7.939      21:47:15,580
E1      CA=2      Messwerte II=9      zyklisch=2
      Fkt=62      UI_d_angle_MEA_II_0=0
      0=0.00%      1092=32.00%      0=0.00%
      0=0.00%

7.942      21:47:15,589
E2      CA=1      Marken=29      ÜbStDt=31
      Fkt=160      INr=0
      FAN=52140      NOT=8      TAP=3
      1-16: A0 00 02 A0 01 02 A0 02 01 A0 03 02 A0 04 02 A0 ... ..
      17-24: 05 02 A0 06 01 A0 07 01 ... ..

7.943      21:47:15,590
E1      CA=2      Messwerte I=3      zyklisch=2
      Fkt=43      MEA I Absolute value Uo,U1,U2,U3 (primary) (norm)=0
      0=0.00%      0=0.00%      0=0.00%
      0=0.00%

7.946      21:47:15,599
E2      CA=1      Meldung=1      spontan=1
      Fkt=3      Rel_2 Function depends on assignment=1
      EIN      21:46:27,174      SIN=0

7.947      21:47:15,601
E1      CA=2      Messwerte II=9      zyklisch=2
      Fkt=63      MEA II Absolute value Uo,U1,U2,U3 (primary) (norm)=0
      0=0.00%      0=0.00%      0=0.00%
      0=0.00%
  
```

Picture 5: WinPP

7 BI (Binary Input) – Hardware differences

BE3 to BE6 is only available on EOR-3D compact Hardware Version!