

IEC 60870-5-104 Protocol Description for Earthfault-Detection-Relay EOR-3D

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1 IEC 60870-5-104 Protocol

This document describes the characteristics of the IEC 60870-5-104 communication protocol of EORD-3D device. EOR-3D IEC 60870-5-104 Implementation acts as controlled station definition (slave).

2 IEC 60870-5-104 Physical Layer

EOR-3D devices can be connected to a IEC 60870-5-104 Network in order to communicate via TCP/IP on Ethernet Network.

3 IEC 60870-5-104 Link Layer

3.1 Parameters of the IEC 60870-5-104 connection

The possible parameters of the EOR-3D IEC 60870-5-104 Network connection are shown as follows:

- One TCP/IP connection which is bind or is not bind to the Systems IP address
- and
- 4 Redundant TCP/IP connections which are bind to redundant IP network with the same port addresses
- or
- 4 Redundant TCP/IP connections which are bind to the system IP addresses, with 4 different port addresses

3.2 Timeouts

Parameter	Default value	Remarks
t ₀	30 s	Time-out of connection establishment
t ₁	15 s	Time-out of send or test APDUs
t ₂	10 s	Time-out for acknowledges in case of no data messages t ₂ < t ₁
t ₃	20 s	Time-out for sending test frames in case of a long idle state

3.3 Number of outstanding I format APDUs k and latest acknowledge APDUs (w)

Parameter	Default value	Remarks
k	12	APDUs Maximum difference receive sequence number to send state variable
w	8	PDUs Latest acknowledge after receiving w I format APDUs

4 IEC 60870-5-104 Application Layer

The parameters of the EOR-3D IEC 60870-5-104 application layer connection are shown as follows:

- Common address of ASDU: Two octets
- Information object address: Three octets
- Cause of transmission: Two octets (with originator address). Originator address is set to zero if not used.

4.1 Process information in monitor direction

Following process informations in monitor direction are implemented:

- | | |
|--|-----------|
| • <01> := Single-point information | M_SP_NA_1 |
| • <03> := Double-point information | M_DP_NA_1 |
| • <07> := Bitstring of 32 bit | M_BO_NA_1 |
| • <13> := Measured value, short floating point value | M_ME_NC_1 |
| • <30> := Single-point information with time tag | M_SP_TB_1 |
| • <31> := Double-point information with time tag | M_DP_TB_1 |
| • <33> := Bitstring of 32 bit with time tag | M_BO_TB_1 |
| • <36> := Measured value, short floating point value with time tag | M_ME_TF_1 |

4.2 Process information in control direction

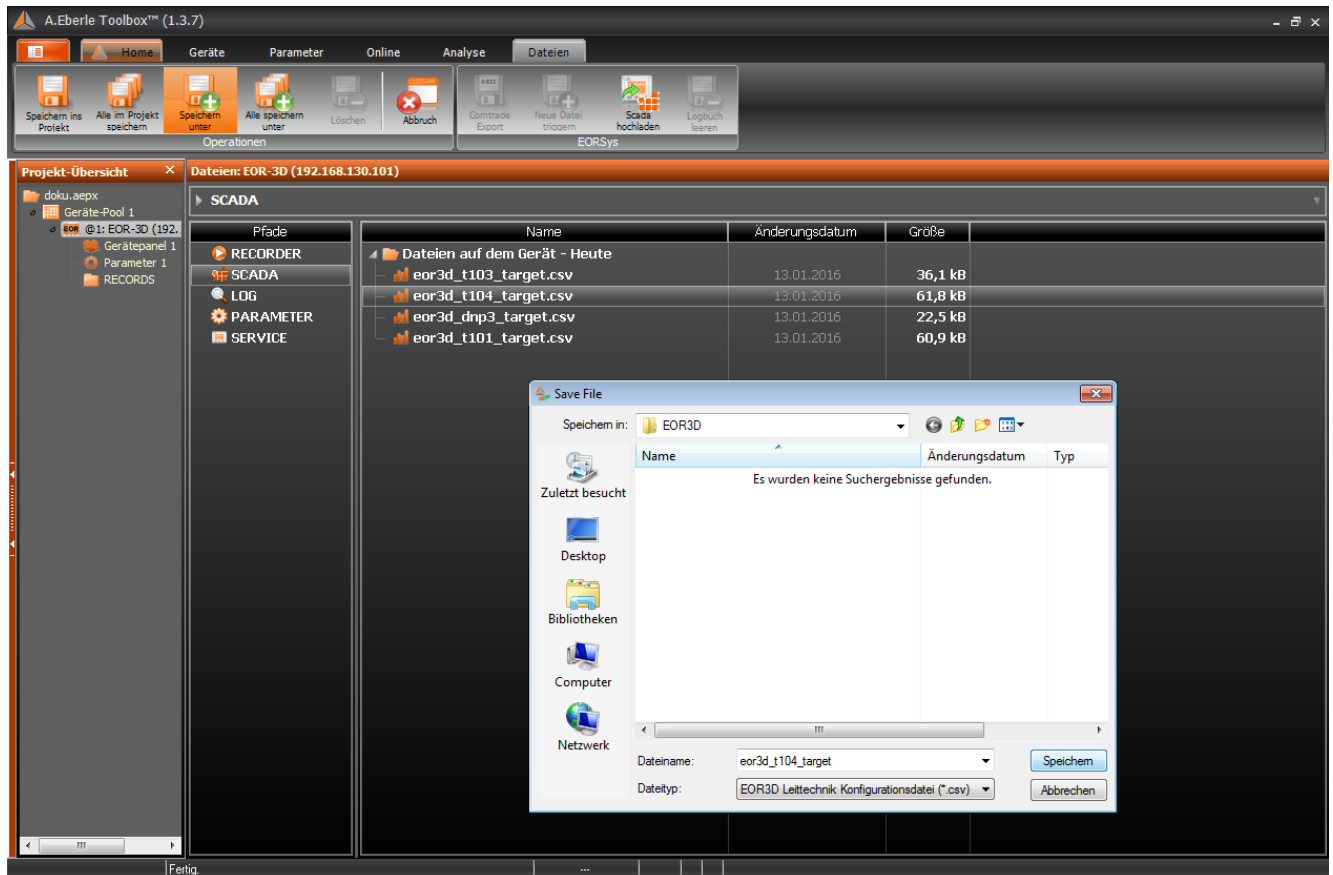
Following process informations in control direction are implemented:

- | | |
|---|-----------|
| • <46> := Double command | C_DC_NA_1 |
| • <59> := Double command with time tag | C_DC_TA_1 |
| • <100>:= Interrogation command | C_IC_NA_1 |
| • <103>:= Clock synchronization command | C_CS_NA_1 |

4.3 CSV configuration of the IEC 60870-5-104 slave

The EOR-3D IEC 60870-5-104 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 60870-5-104 slave is operational. This file has to be placed in the directory ftp/appfs/eor3dapp1/param on the target (this is the directory where also other EOR-3D configurations can be found). It can be transferred to the EOR-3D with the Toolbox download.

Then the CSV file has to be transferred to the target via the Toolbox Upload Scada (ftp/appfs/eor3dapp1/param).

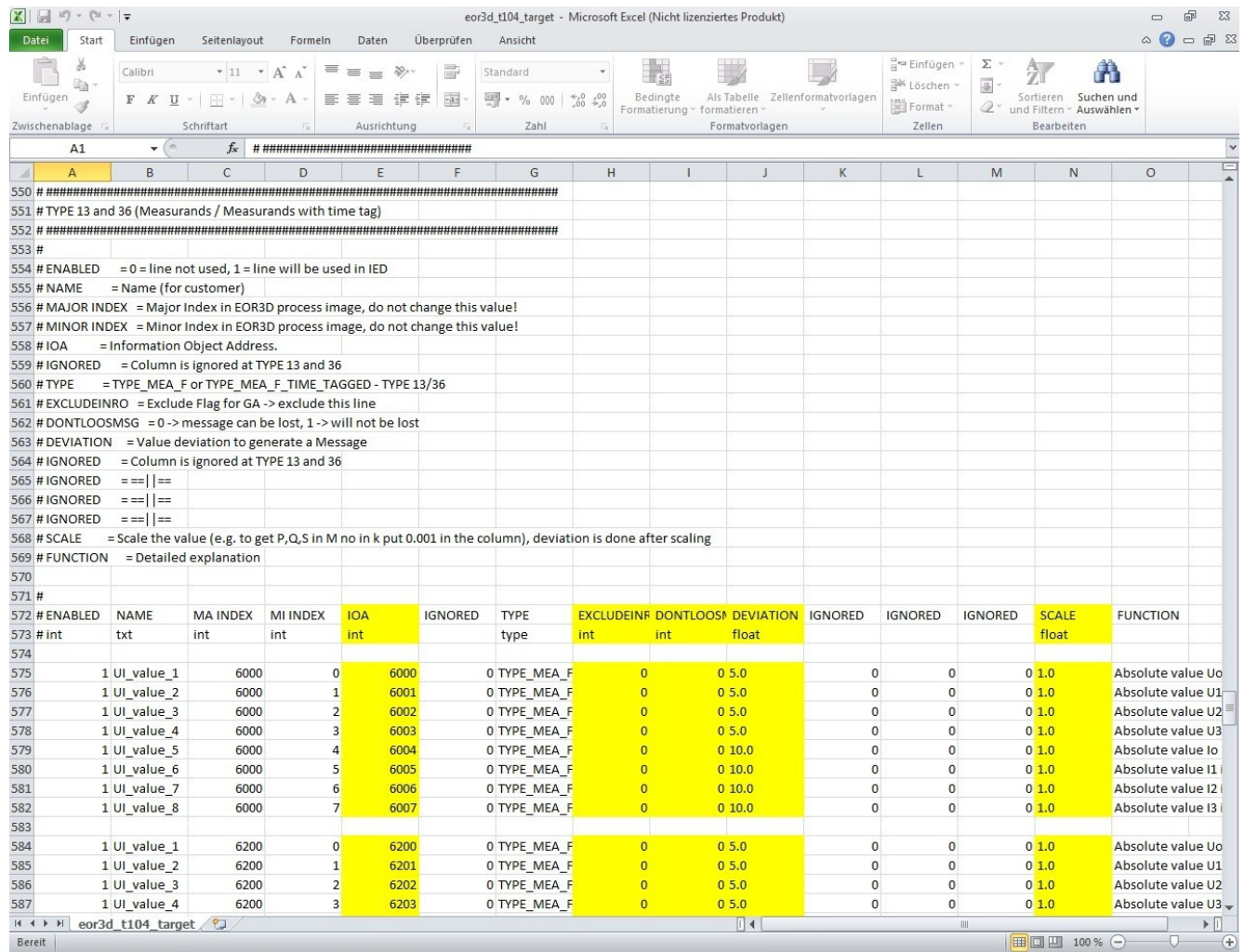


Picture 1: Toolbox download

4.4 Detailed CSV configuration (Step by step)

The default eor3d_t104_target.csv file has the explanation for every possible configuration included. Please look direct in the file for changes. Normal step by step configuration would be:

- Download the csv file from the device with Toolbox download
- Change the csv file for you needs with a 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	IOA	IGNORED	TYPE	EXCLUDEINFR	DONTLOOS	DEVIATION	IGNORED	IGNORED	IGNORED	SCALE	FUNCTION
572	#														
573	# int	txt	int	int	int		type	int	int	float				float	
574															
575	1	UI_value_1	6000	0	6000	0	TYPE_MEA_F	0	0	5.0	0	0	0	1.0	Absolute value Uo
576	1	UI_value_2	6000	1	6001	0	TYPE_MEA_F	0	0	5.0	0	0	0	1.0	Absolute value U1
577	1	UI_value_3	6000	2	6002	0	TYPE_MEA_F	0	0	5.0	0	0	0	1.0	Absolute value U2
578	1	UI_value_4	6000	3	6003	0	TYPE_MEA_F	0	0	5.0	0	0	0	1.0	Absolute value U3
579	1	UI_value_5	6000	4	6004	0	TYPE_MEA_F	0	0	10.0	0	0	0	1.0	Absolute value Io
580	1	UI_value_6	6000	5	6005	0	TYPE_MEA_F	0	0	10.0	0	0	0	1.0	Absolute value I1
581	1	UI_value_7	6000	6	6006	0	TYPE_MEA_F	0	0	10.0	0	0	0	1.0	Absolute value I2
582	1	UI_value_8	6000	7	6007	0	TYPE_MEA_F	0	0	10.0	0	0	0	1.0	Absolute value I3
583															
584	1	UI_value_1	6200	0	6200	0	TYPE_MEA_F	0	0	5.0	0	0	0	1.0	Absolute value Uo
585	1	UI_value_2	6200	1	6201	0	TYPE_MEA_F	0	0	5.0	0	0	0	1.0	Absolute value U1
586	1	UI_value_3	6200	2	6202	0	TYPE_MEA_F	0	0	5.0	0	0	0	1.0	Absolute value U2
587	1	UI_value_4	6200	3	6203	0	TYPE_MEA_F	0	0	5.0	0	0	0	1.0	Absolute value U3

Picture 2: csv demo

4.4.1 Monitor Direction

4.4.1.1 Single-point inf. / with time tag (1,30)

Standard SPI informations with time tag or not are included. Please take a look in the csv file which events can be configured.

4.4.1.2 Double-point inf. / with time tag (3,31)

Standard DPI informations with time tag or not are included. Please take a look in the csv file which events can be configured.

4.4.1.3 Bitstring of 32 bit inf. / with time tag (7,33)

Standard Bitstring informations with time tag or not are included. Please take a look in the csv file which events can be configured.

With Bitstring a compact version of all (BI, BIF, BO, BOF, LED) are transferred at once (SPI or DPI compact to one value).

4.4.1.4 Short floating point value / with time tag (13,36)

Standard spontaneous measurements with or without time tag are included. Please take a look in the csv file which events can be configured.

4.4.2 Control Direction

4.4.2.1 Double-point command / with time tag (46,59)

Standard DPI commands with time tag or not are included. Please take a look in the csv file which commands can be configured.

When used as double-point commands with time tag and the difference in the time drift between controlling station and the EOR-3D is greater then 20sec the command is ignored! Timesync!

IEC 60870-5-104 commands are atomic! Only send next command when you got ACTON+ and ACTTERM or ACTON-, it is not allowed to send more commands at once. If it is needed or wanted to send more commands in a list make sure that a delay of 250ms is between every command!

After a successful command a return information caused by a remote command (COT=11) is send on this instance and on every redundant instance!

4.4.2.2 Interrogation command (100)

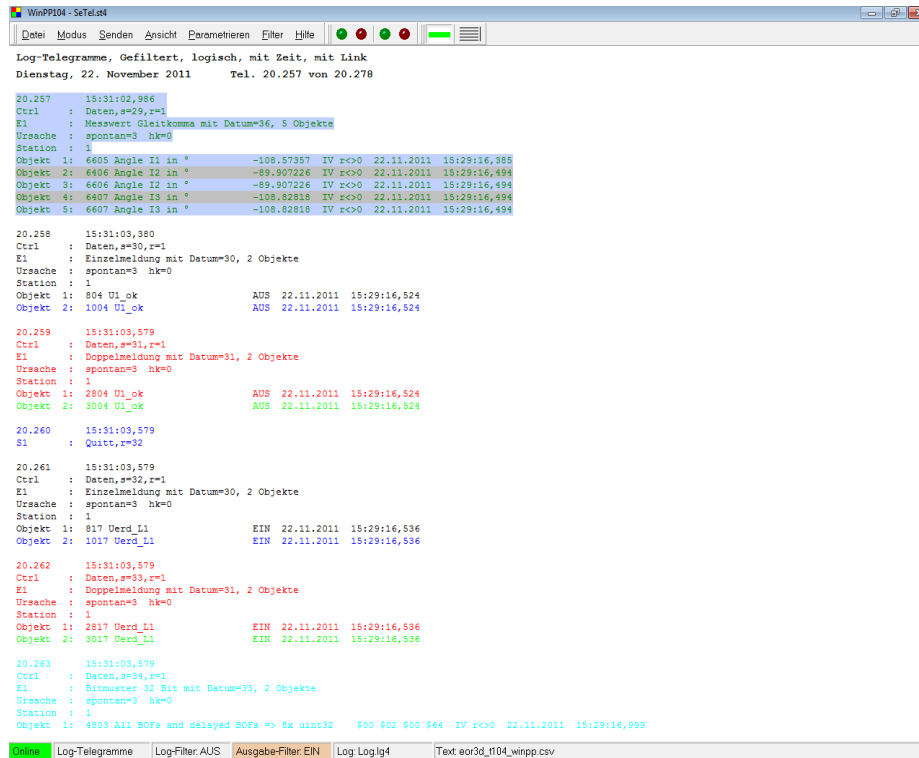
The standard interrogation command of IEC 60870-5-104 is included. All configured elements from the csv file can be read through this command.

4.4.2.3 Time Sync (103)

The standard time sync of IEC 60870-5-104 is included. The system time and the real time clock gets set.

5 IEC 60870-5-104 Demo WinPP104

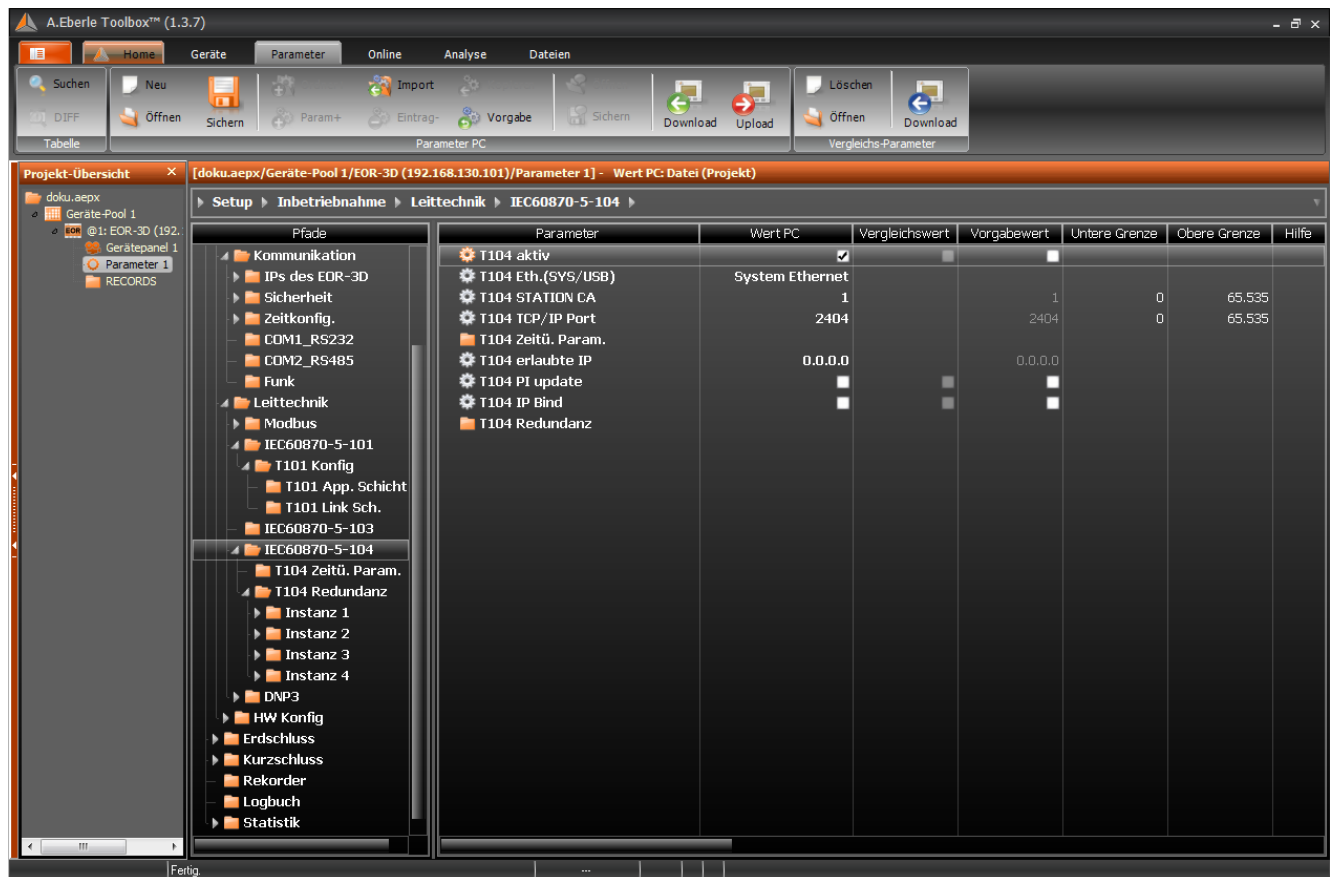
As a short example of the EOR-3D IEC 60870-5-104 slave implementation the Fink WinPP104 is used.



Picture 3: WinPP

6 IEC 60870-5-104 EOR-3D Toolbox configuration

- T104 active (disable - all configuration data 0 / enable update data)
--> On a changed from 0 to 1 the IEC 60870-5-104 slave gets it new configuration.
- T104 Station CA
- T104 allowed IP Address of the opposite station (default 0.0.0.0 = everyone)
- T104 TCP/IP Port Address of the 1st Instance of T104 (default 2404)
- T104 PI Update (Update PI Image IEC 60870-5-104 Slave)
- T104 SysIP bind (Bind to the System IP address, only needed on redundant systems)



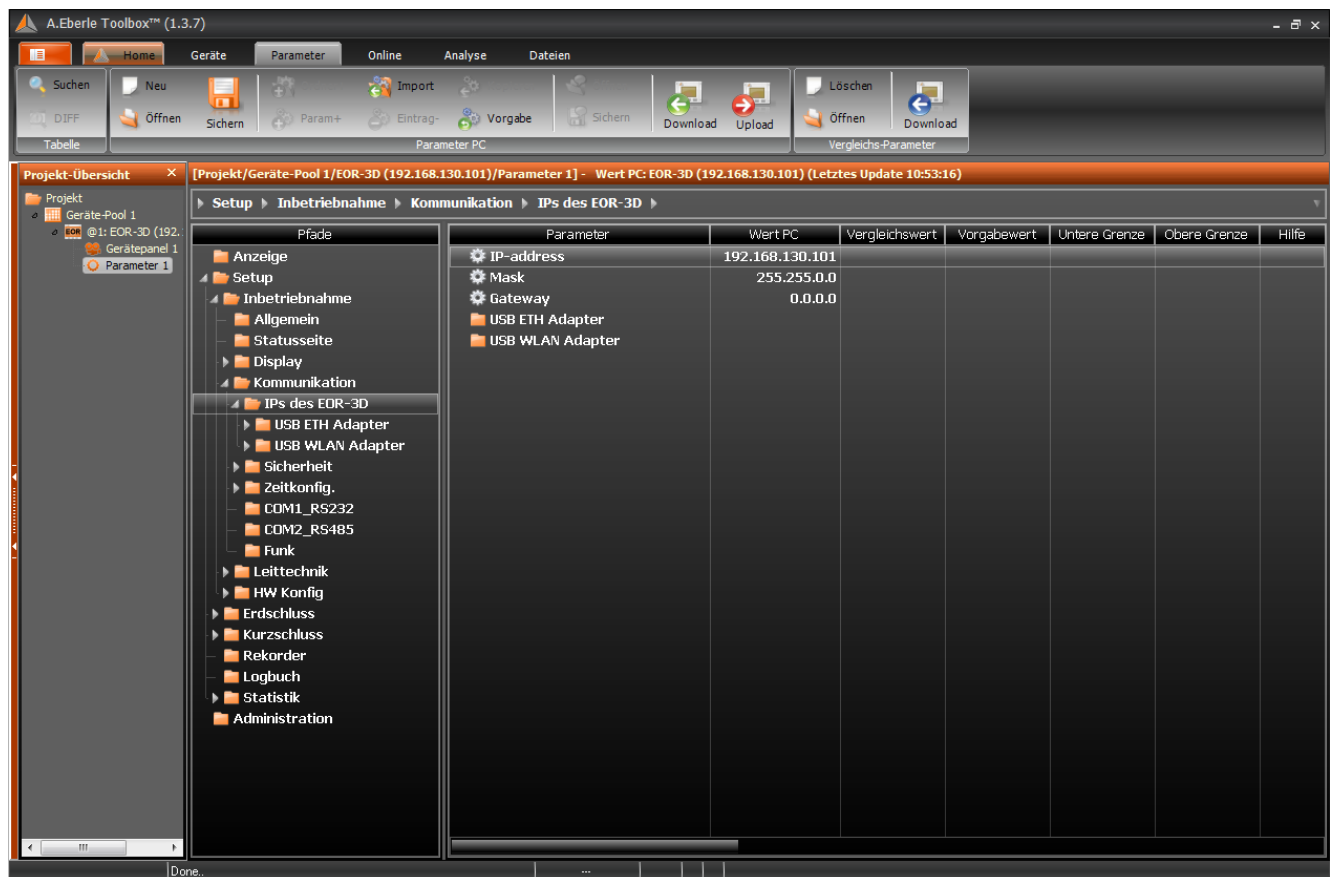
Picture 4: Toolbox configuration

6.1 TCP / IP Configurations

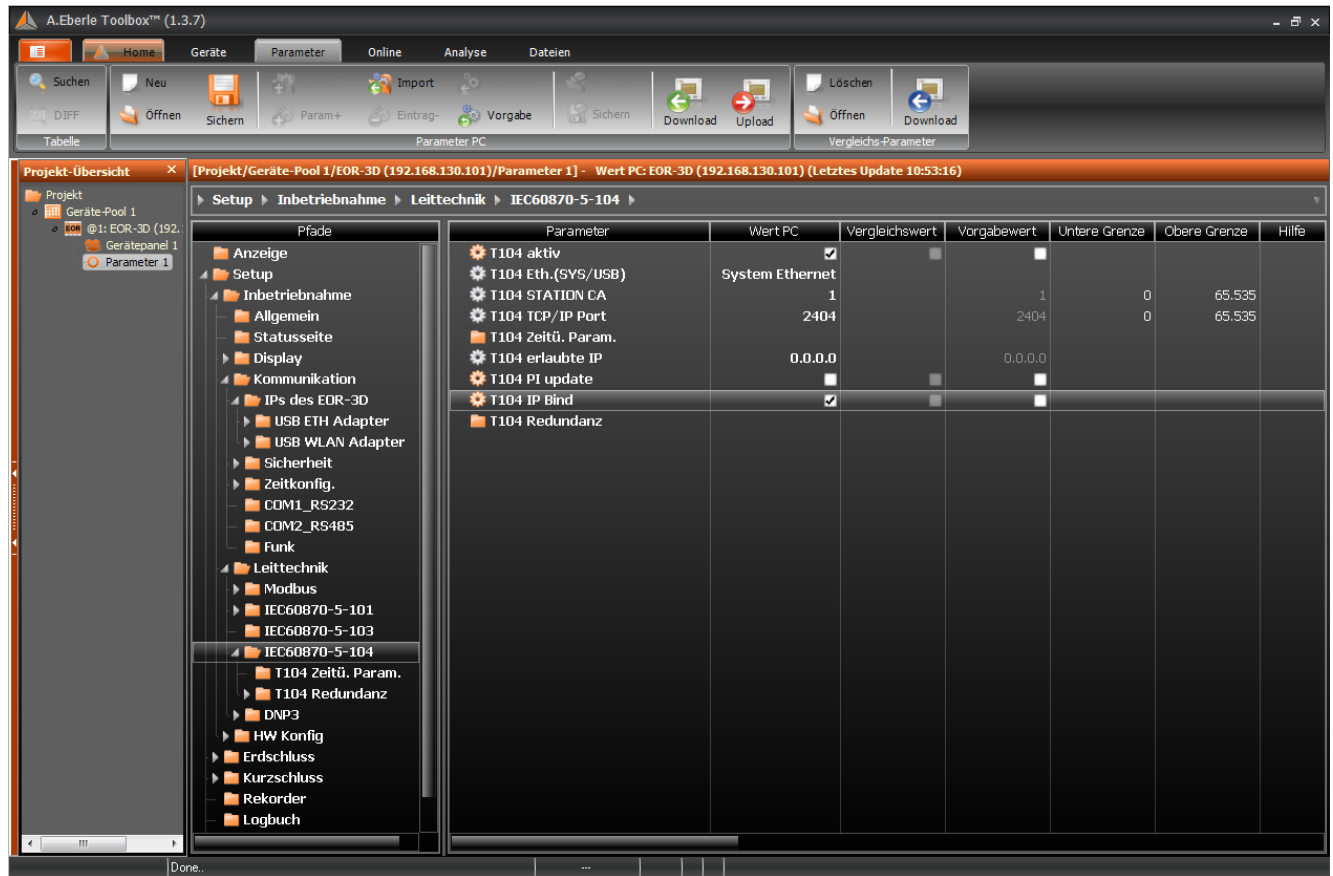
6.2 Bind system IP address

It is possible to bind the first Instance of the EOR-3D IEC 60870-5-104 Slave to the system IP address. This is helpfully when using redundancy communications or when using other networks on the EOR-3D like Wifi or UMTS. So the EOR-3D IEC 60870-5-104 slave only listen on the systems IP address on the Ethernet network if this is set to 1.

When using redundant IEC 60870-5-104 communications with different IP addresses and same port addresses the T104 SysIP bind value has to be set to 1!



Picture 5: Toolbox T104 configuration IP



Picture 6: Toolbox T104 configuration bind SysIP

6.3 Redundancy Systems

The EOR-3D IEC 60870-5-104 slave can handle 5 IEC 60870-5-104 connections at the same time in redundant way. Every instance has its own IEC 60870-5-104 process image, the messages are generated from the EOR-3D Earth Fault Detection Algorithm for every connected instance.

The EOR-3D IEC 60870-5-104 slave does not queue any events or messages. If a opposite system is connected, messages will be transferred and the process image will be updated.

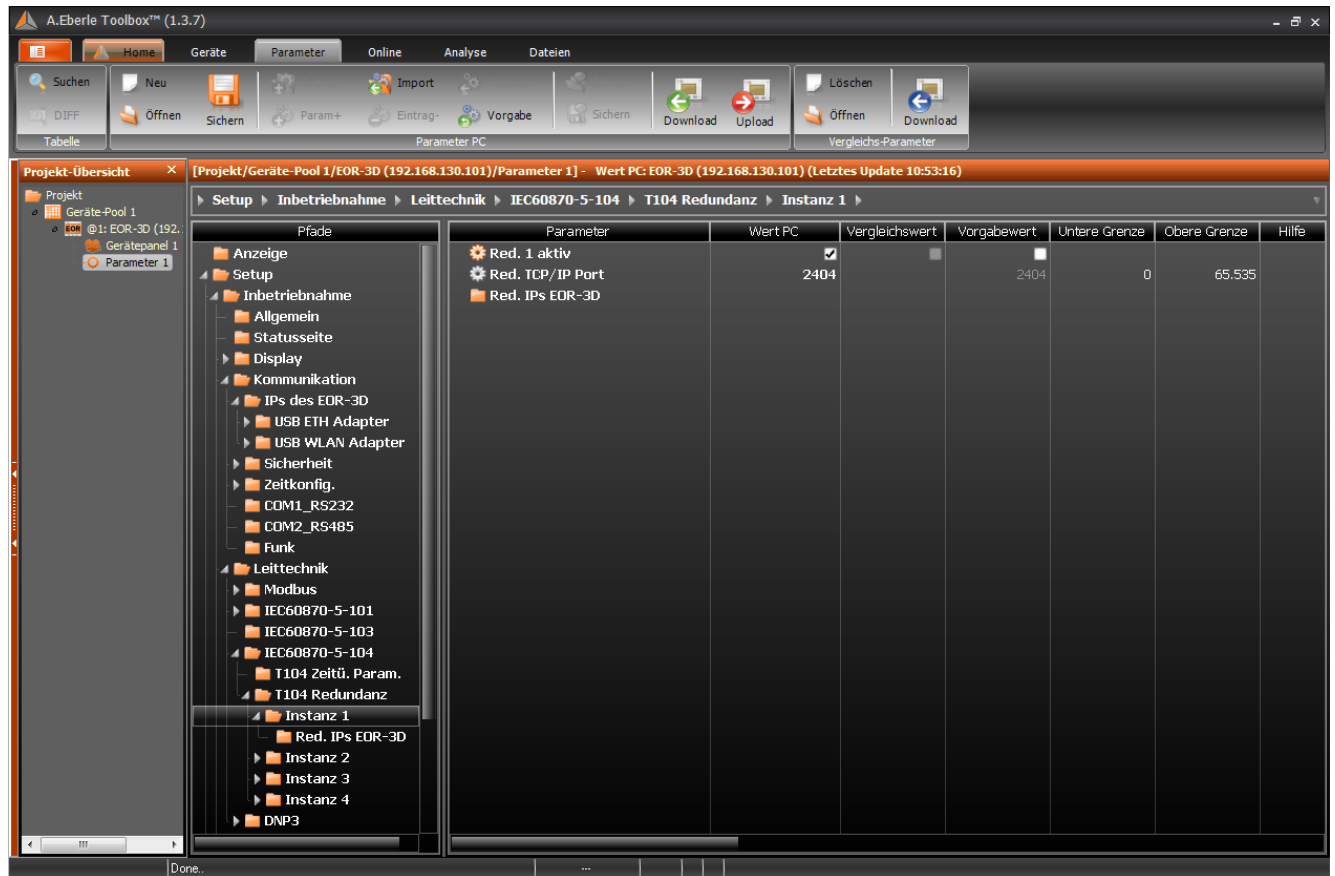
If no connection is there, the EOR-3D IEC 60870-5-104 slave will not update the process image or queue messages! If a connection is re-established the EOR-3D IEC 60870-5-104 slave will look for differences in the process image and then will send out new messages. So after the re-established connection and after this messages the general interrogation command is correct!

The redundant instances will always be connected (binded) to the configured IP Address! If no IP address is configured for the redundant Instances (0.0.0.0) they listen on all networks!

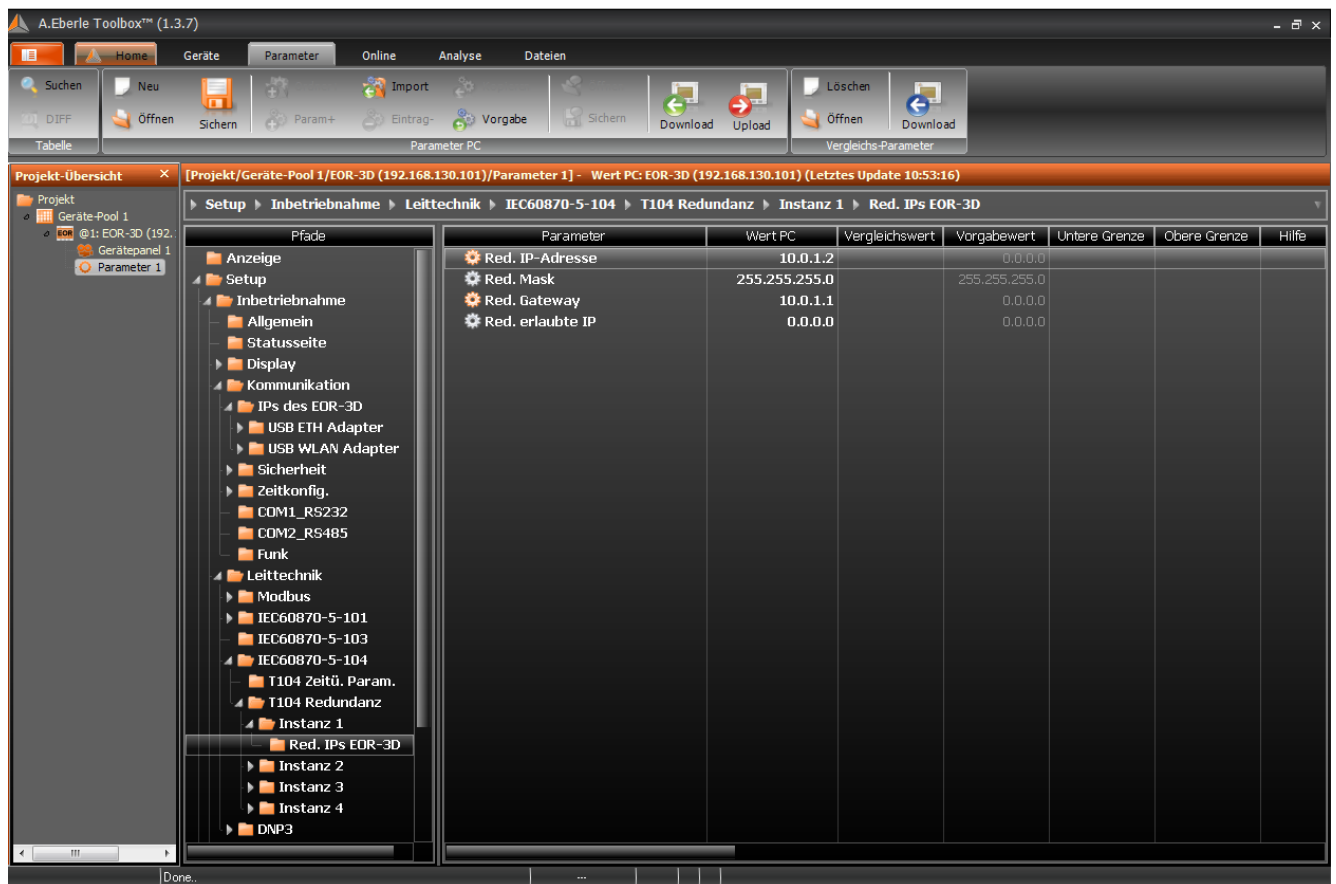
When using redundant instances with same ports always bind the first instance to the System IP address! Without it will listen on all networks, so other redundant instances can't start up, because instance one listens on all networks and has the same port!

6.3.1 Redundancy System – different networks

As example following screen-shot shows a EOR-3D IEC 60870-5-104 slave with 3 instances an different networks and the same ports. So when using different networks the Instance 1 has to be connected(bind) to the system IP address. Without that, the redundant Instances 2 and 3 can not be started because the first instance listens on all other networks.



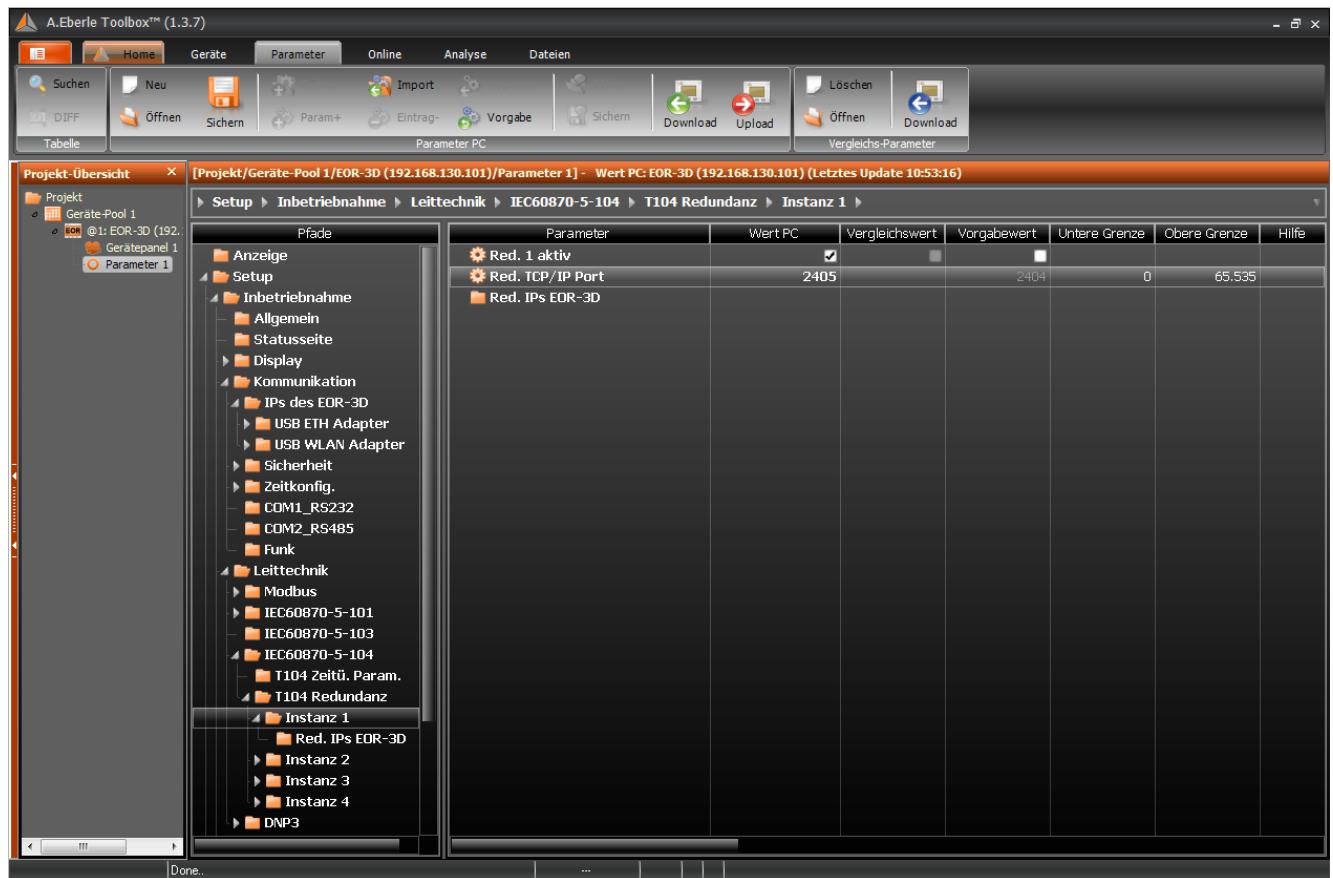
Picture 7: Toolbox T104 - different networks 1



Picture 8: Toolbox T104 - different networks 2

6.3.2 Redundancy System – different ports

As example following screen shot shows a EOR-3D IEC 60870-5-104 slave with 3 instances an different ports. The three Instances are not connected (binded) to any network, so the listen on all networks with different ports.



Picture 9: Toolbox T104 - different ports

6.4 Process Image Update

On normal operation the EOR-3D IEC 60870-5-104 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.

7 BI (Binary Input) – Hardware differences

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