LUMILOOP

LASER-POWERED SENSOR SYSTEMS

User's Manual

LSProbe 1.2

10kHz – 6GHz
3D E-FIELD PROBE

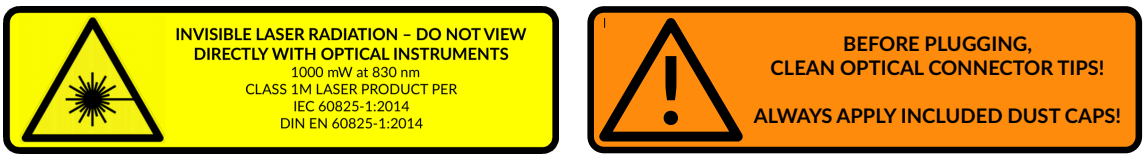
E-Field Probe	1	2
Hardware Revision		
Serial Number		
Internal Calibration Date	_____/ ____/ ____	_____/ ____/ ____
External Calibration Date	_____/ ____/ ____	_____/ ____/ ____
Computer Interface		
Hardware Revision		
Serial Number		
Final System Test		
Date	_____/ ____/ ____	_____/ ____/ ____
Signature		

Contents

1 Safety Instructions

You have purchased a high precision measurement system. Please read the User Manual carefully before operating the field probe. Please handle all parts with care, especially the fiber optics and its connectors.

- Avoid any unnecessary force that may cause the fiber to bend sharply and break.
- Cap end face when optical connectors are not plugged.
- Clean any dirt from the end face (see Section 5.1.1).
- Avoid any unnecessary stress. All components of the system are sensitive to shock and impact.
- There are no serviceable parts inside this product. Open neither the CI-250 controller nor the field probe. Opening can void the warranty. If there is any failure, please contact LUMILOOP GmbH.



(a) Laser Classification (b) Cleaning Advice

Figure 1: *Safety Instructions*

Laser Safety

The LSProbe system is a closed system and is thus classified as a class 1M laser product, according to IEC 60825-1:2014 / DIN EN 60825-1:2015-07. This is true as long as the Laser supply is turned on only after checking connection and integrity of the fiber cable, as advised in Section 5.1.

However, this classification does not handle the danger arising from an accidential disconnection or damage of the fiber during operation. According to IEC 60825-2 / DIN EN 60825-2 ("*Safety of optical fibre communication systems*"), the LSProbe features an Automatic Power Reduction (APR). If there is any interruption in the communication between E-Field Probe and Computer Interface, or a sudden power decrease, the power laser is turned off within one millisecond. This APR is deactivated temporarily during startup and measurement mode changes. The deactivated APR is visualized by the blinking orange "Laser on" indicator on the Computer Interface (see Section 3.1.2). Interrupting optical connections during this time is dangerous!

2 System Overview

The miniaturized 6 GHz 3D E-Field Probe LSProbe enables unattended, continuous E-field measurements with high resolution, high speed and low noise. Its galvanically insulated laser power supply eliminates the need for batteries. LSProbe is not limited to the acquisition of quasi-static fields. With its sampling rate of up to 2 MSamples/s LSProbe is also able to measure rapidly changing electric fields. The field probe's large dynamic range and fast pulse response make it applicable to entirely new use cases.

Every LSProbe comes with a complete set of calibration data for unparalleled linearity, temperature stability and frequency compensation. The high-accuracy in-house calibration data can be further enhanced by external accredited calibration laboratories.

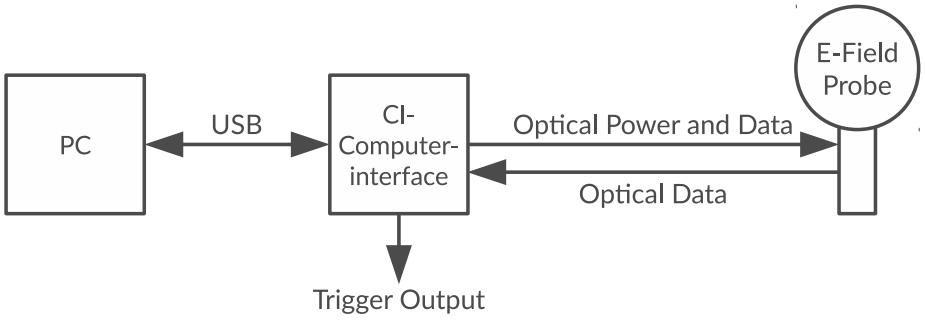


Figure 2: *LSProbe system block diagram*

As shown in Figure 2 LSProbe consists of a 3D E-field probe which records E-field values using logarithmic power detectors and analog-to-digital converters. The digital sample values are transmitted to a Computer Interface digitally using an optical fiber. The Computer Interface also serves to supply the E-field probe optically and handles external trigger signals. It attaches to a host computer via USB. The LSProbe TCP Server handles USB communication, application of calibration data, data post-processing and communication with client programs via TCP/IP SCPI commands, e.g. the LSProbe Graphical User Interface (GUI).

Moreover, the TCP Server receives SCPI commands via its standard input and replies via its standard output. This enables simple manual configuration and verification of the LSProbe's operation by typing/pasting commands into a command. The feature can also be used to connect the TCP to third party software using a standard IO pipe.

Multiple LSProbes may be connected to one TCP Server instance to form a Multiprobe System consisting of synchronized E-field probes which is especially suitable for field distribution analysis, statistical field analysis and reverberation chamber applications.

2.1 Data Acquisition and Processing

The software delivered with the LUMILOOP LSProbe 1.2 E-field probe system consists of:

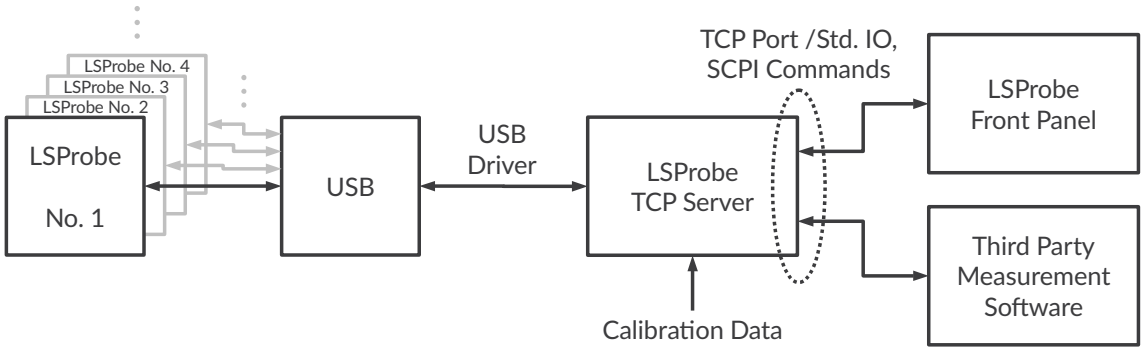


Figure 3: *LSProbe software block diagram*

- the LSProbe USB driver,
- the LSProbe TCP Server,
- the LSProbe Graphical User Interface (GUI) and
- the LSProbe external calibration data import tool.

As shown in Figure 3 one instance of the LSProbe TCP Server communicates with all Computer Interfaces connected to the host computer via USB 2.0. The TCP Server configures the Computer Interface, streams all field strength and auxiliary data, applies calibration data to the received field strength values, handles trigger events, performs sensor data buffering and post-processing. The TCP server provides an exhaustive set of SCPI commands for simple and reliable text-based integration into test and measurement automation solutions, see Section 10. Concurrent access to all Computer Interfaces is offered to up to 16 TCP clients.

All third party EMC software accesses the LSProbe TCP Server through SCPI commands, examples are given in Section 5.3.2 and Section 5.4.2. When operating multiple TCP client programs in parallel, the user is responsible for avoiding undesired interference. For example, one client must not change the measurement mode while another client relies on a different setting. Generally, concurrent access to the LSProbe TCP Server is discouraged except for debugging purposes.

The LSProbe GUI detailed in Section 5 is a graphical user interface for configuring and monitoring the system as well as measuring and logging data. As all clients it may connect to a local or remote TCP Server.

2.2 Statistical Analysis

The LSProbe TCP Server is able to perform a statistical evaluation of field strength data originating from one or more E-field probes. Thus reducing the programming effort, communication overhead, memory requirements and CPU load. Both scalar statistics values and histogram-like distributions are accessible through the LSProbe TCP Server. Figure 4 shows a simplified data flow diagram for both continuous and triggered statistics.

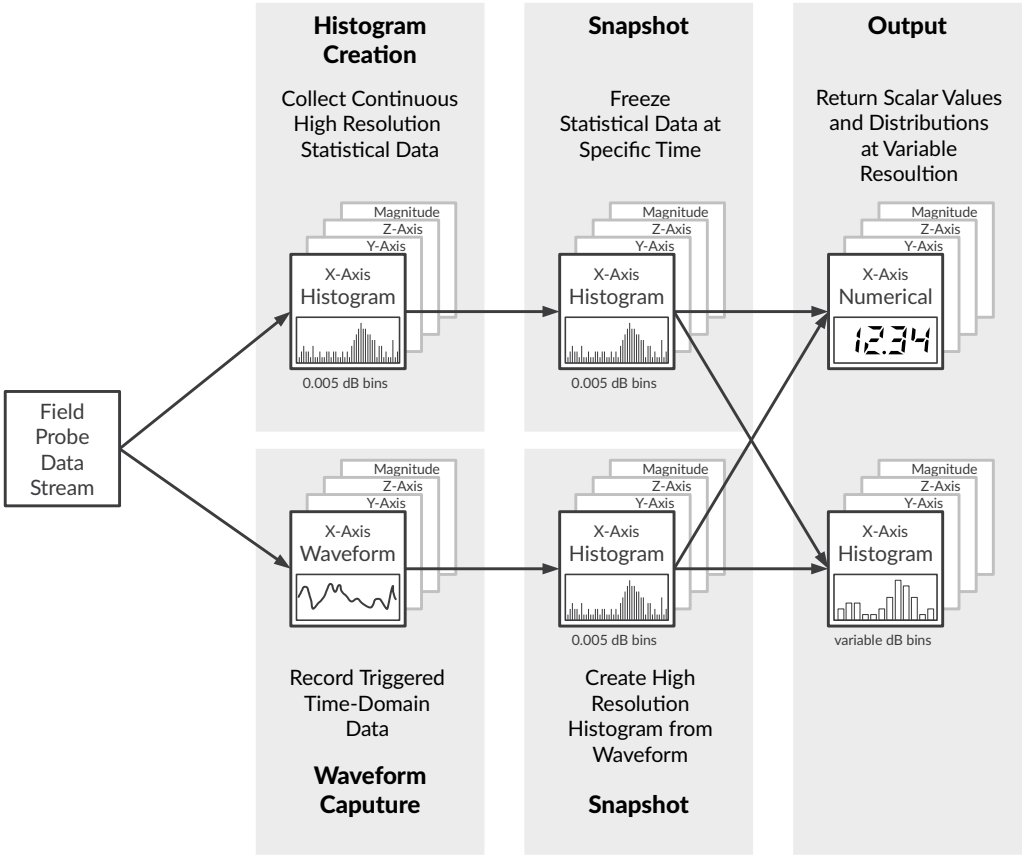


Figure 4: *Data flow diagram for continuous and triggered statistics*

2.3 Continuous Statistics

Continuous statistics are based on four histograms generated from all incoming E-field strength values. There is one histogram for x-, y- and z-axis each in addition to one histogram for E-field strength magnitude. Histograms are created at a resolution of 1/200 dB. Data collection is enabled and disabled using dedicated signal lines described in Section 3.2. Continuous statistics consume a minimal amount of memory since timing information is discarded in the process of creating histogram data. Consequently, continuous statistics can be recorded for arbitrary durations of time. Scalar statistics values and histogram-like distributions use statistics snapshots, i.e. copies of the continuously updated histogram, created at specific times. Snapshot creation for multiple E-field probes is synchronized using dedicated signal lines detailed in Section 3.2. Hardware-based snapshot creation ensures that Multiprobe statistics will not be distorted by latencies introduced by buffering, the USB bus or the operating system's data processing. Histogram-like distributions and associated E-field values can be queried at a lower level of detail than the 1/200 dB default of the snapshot histograms. See Section 5.5.2 and 5.5.4 for details.

2.4 Triggered Statistics

Triggered statistics create snapshot histograms from triggered waveforms. Consequently, a set of x-, y-, z-axis and magnitude E-field waveforms must be recorded in full before statistics evaluation may take place. When compared to continuous statistics triggered statistics have the advantage of preserving timing information in the form of the triggered waveforms. However, triggered statistics also have a number of disadvantages relative to continuous statistics:

- Triggered statistics requires memory in proportion to the length of time to be evaluated and the number of E-field probes in a system, i.e. approximately 26 MB per second and field probe. For a single probe setup this limits the maximum waveform length to approximately 100 seconds.
- For the same duration of time creating a snapshot histogram from triggered waveforms is significantly slower than a continuous statistics snapshot. This is due to the fact that triggered statistics must evaluate all samples in the recorded waveforms while continuous statistics merely require a copy of the continuously updated histogram for every snapshot.
- Triggered statistics are only available for the recorded waveforms as a whole, continuous statistics may take statistics snapshots as data is being recorded.
- Triggered statistics may introduce significant delays in TCP Server to client communication, especially when recording large waveforms.

It is therefore generally preferable to rely on continuous statistics when timing information is not essential.

2.5 Stream Recording

The LSProbe TCP Server is able to save a stream of continuously recorded x-, y- and z-axis E-Field values to disk. This can be done for one or multiple E-Field Probes. The Computer Interfaces' trigger signals can be employed to synchronize multiple streams. One Computer Interface acts as the stream master, sending one synchronization pulse for every 256 samples. All other Computer Interfaces act as stream slaves and use the master's synchronization pulses to ensure an identical sampling rate. See Figures 11, 12 and 13 for the required physical connections to the BNC connector and Ext1 RJ45 socket.

Stream files are stored in the path specified by the LSPROBE_SAVE_PATH environment variable and adhere to the naming convention in Section 11.2.4. File names start with an arbitrary prefix string followed by the E-Field Probe's serial number and a unique time stamp. A new stream file or set of stream files, containing an updated time stamp, will be created every 1,000,000,000 samples. In order to minimize disk storage requirements and CPU load data are saved using the binary format detailed in Section 11.2.4.

3 LSProbe Hardware

3.1 E-field Probe Components

The hardware delivered with the LUMILOOP LSProbe 1.2 E-field Probe System consists of:

- an E-Field Probe with fixed fiber optic cables,
- a Computer Interface (CI) and
- a universal input mains-adapter.

3.1.1 E-Field Probe

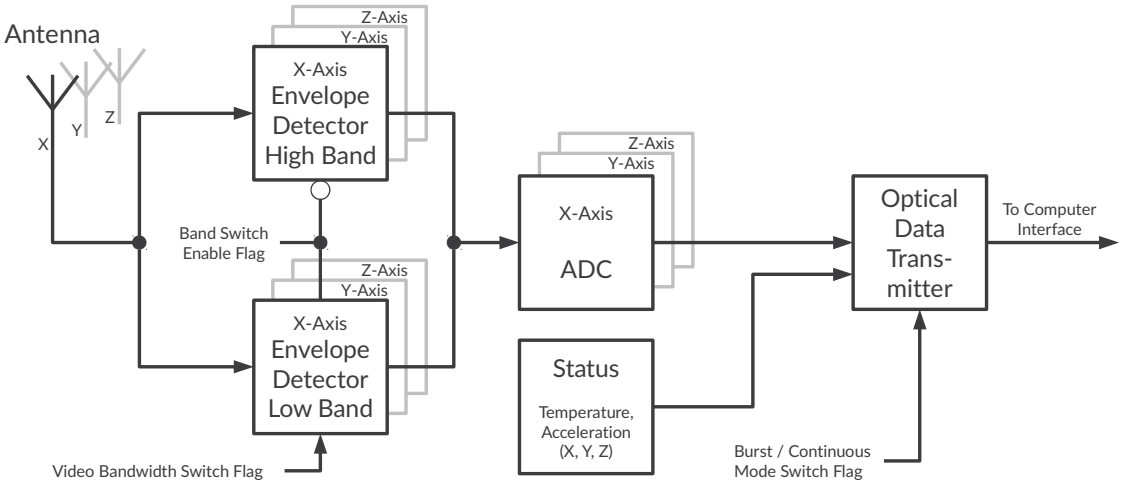


Figure 5: *E-Field Probe block diagram*

Figure 5 shows the simplified block diagram of the E-Field Probe. Three electrically short monopole antennas are used to detect x-, y- and z-axis electrical fields over a wide range of frequencies and field strengths. Each axis has got one dedicated low-band and one dedicated high-band logarithmic field strength detector, of which one is selectable at a time using a mode flag (see Table 1). The low-band stretches from 10 kHz to 400 MHz, the high-band from 30 MHz to 6 GHz.

E-Field Probe video bandwidth is defined as the -3 dB cut-off frequency of the first order low pass filter operating on the envelope of each logarithmic field strength detector. For accurate operation the detected frequency should be at least ten times larger than the video bandwidth. The low-band detector offers a choice between low and high video bandwidth, i.e. approximately 500 Hz and 1 MHz selectable using a mode flag (see Table 1). The high-band detector has a fixed video bandwidth of approximately 3 MHz.

For each axis a 14 bit analog-to-digital converter (ADC) is used to digitize the detected signal level. A mode flag is used to select either 500 kSamples/s continuous sampling or 2 MSamples/s burst mode

sampling. In burst mode each burst frame contains 597 x-, y- and z-axis field strength values, the E-Field Probe sends approximately 1000 burst frames per second.

The E-Field Probe's optical data transmitter combines field strength values, acceleration, temperature and voltage values and additional status information to form a digital, checksum-protected optical data stream.

The E-Field Probe offers eight[1] modes. Each mode is characterized by a specific frequency range, video bandwidth, sampling rate and sample timing, as listed in Table 1.

Table 1: *E-Field Probe measurement modes overview*

Mode	Minimum Frequency	Maximum Frequency	Video Bandwidth	Sampling Rate	Effective Sampling Rate	Sample Timing
0	30 MHz	6 GHz	3 MHz	500 kS/s	500 kS/s	continuous
1	10 kHz 30 MHz	29.$\overline{9}$ MHz 6 GHz	500 Hz 3 MHz	500 kS/s	80 kS/s	interleaved burst
2	10 MHz	400 MHz	1 MHz	500 kS/s	500 kS/s	continuous
3	10 kHz	400 MHz	500 Hz	500 kS/s	500 kS/s	continuous
4	30 MHz	6 GHz	3 MHz	2 MS/s	566 kS/s	burst
5	10 kHz 30 MHz	29.$\overline{9}$ MHz 6 GHz	500 Hz 3 MHz	2 MS/s	90 kS/s	interleaved burst
6	10 MHz	400 MHz	1 MHz	2 MS/s	566 kS/s	burst
7	10 kHz	400 MHz	500 Hz	2 MS/s	566 kS/s	burst

In mode 0 and 4 only the high band envelope detector is active. In mode 2, 3, 6 and 7 only the low band envelope detector is active. In mode 1 and 5 the high band and low band envelope detectors are active in an interleaved fashion. Consequently, mode 0, 2, 3, 4, 6 and 7 offer the largest number of samples per second but require a mode change in accordance with the operating frequency. Mode 1 and 5 span the E-field Probe's entire frequency range but offer fewer samples per second.

When using SCPI Commands or third party EMC software special care must be taken to ensure an appropriate mode setting and low-pass filtering for the measurement task at hand.

3.1.2 Computer Interface

The Computer Interface connects the field probe to a host computer. It contains:

[1] Units delivered before February 2017 have six modes and do not support mode 1 and 5.

- a supply laser powering the field probe and transmitting data to the E-Field Probe,
- a thermoelectric, i.e. Peltier, temperature controller for cooling or heating the supply laser,
- an optical receiver for E-Field Probe data,
- a BNC trigger input or output connector for synchronization and
- a USB 2.0 interface connecting to the host computer.

As shown in Figure 6 the main switch is located on the left side of the front panel. In "0" position, it disconnects Computer Interface's external 5 V supply. The right side of the front panel is occupied by the air outlet of the laser temperature controller and must not be obstructed. Four labeled LED indicators display the Computer Interface's operating state as follows:

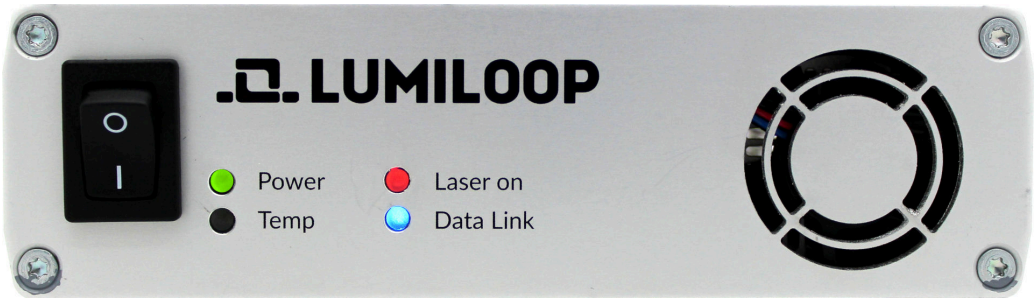


Figure 6: *Computer Interface front panel*

POWER (GREEN)

Flashing
Main switch is on, Computer Interface is inactive.

Continuously on
USB connection to TCP Server has been established.

Continuously off
Main switch is off, mains adapter is disconnected or Computer Interface firmware is missing or compromised, see Section 4.4 for details.

TEMP (RED)

Continuously off
Temperature of the supply laser is being controlled within the laser's safe operating range if the laser's LED is flashing or continuously on.

Continuously on
Temperature of the laser is above its safe operating range, laser is being cooled.

Flashing
Temperature of the laser is below its safe operating range, laser is being heated.

LASER ON (ORANGE)

Continuously off
: The supply laser is off.

Flashing
: The supply laser is on, the E-Field Probe is in start-up or mode change operation. The rapid laser shutdown safety function has been deactivated temporarily. **The optical cables must not be disconnected in this state.**

Continuously on
: The supply laser is on, the E-Filed Probe is operating in the requested mode. The rapid laser shutdown safety function is operational.

DATA LINK (BLUE)

Continuously off
: No data is being received from the E-Field Probe.

Flashing
: The optical data and power link has failed and the supply laser has been turned off.

Continuously on
: Data is being received from the E-Field Probe.

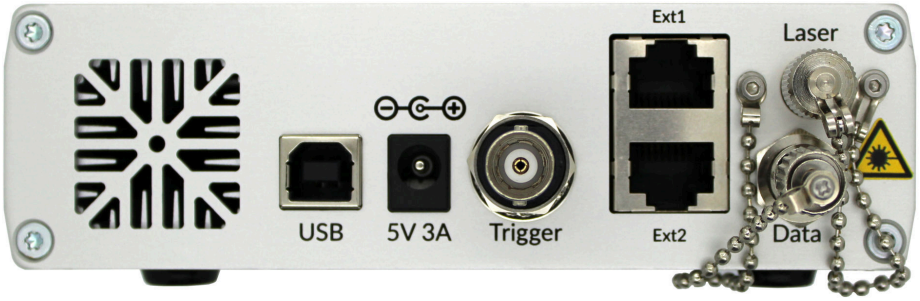


Figure 7: *Computer Interface back panel*

The Computer Interface's back panel shown in Figure 7 contains the air inlet of the laser temperature controller and must not be obstructed.

Optical connectors are located on the right side of the back panel. ***When the optical fibers are disconnected, connectors must be covered with the supplied dust caps as shown in Figure 7.*** The upper FC connector is the supply laser output. The lower ST connector is the optical data input.

The following electrical connectors are located at the bottom edge of the back panel, left to right:

USB
: USB B connector attaching the Computer Interface to the host computer.

5 V 3 A
: External DC power supply, barrel jack 2.1/5.5 mm.

TRIGGER
: Trigger output or input BNC connector using 5 V CMOS logic levels.

EXT 1
: RJ45 extension connector for Multiprobe Systems. ***No Ethernet interface!***

EXT 2
: Reserved for future use. ***No Ethernet interface, do not connect!***

3.2 Multiprobe Systems

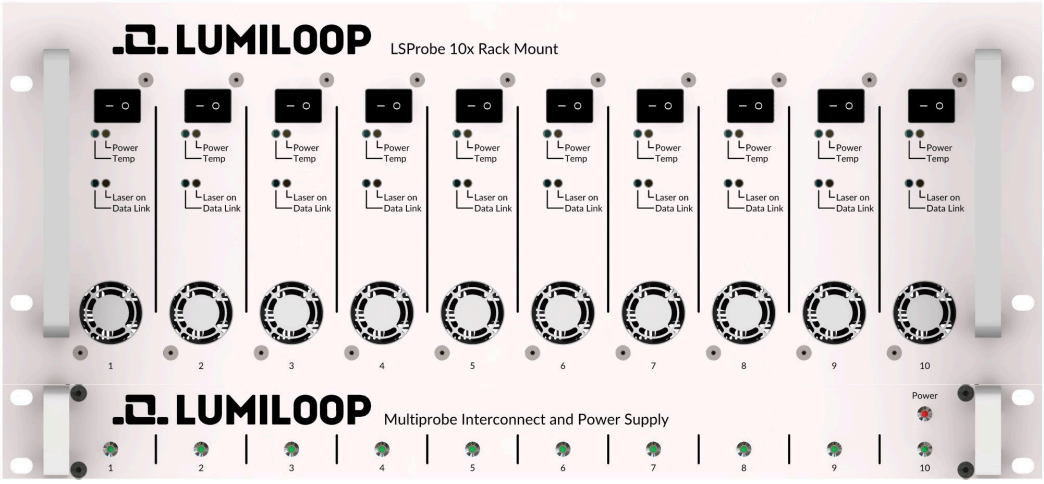


Figure 8: *Multiprobe Interconnect and Power Supply unit with ten E-Field Probes*

Continuous E-field statistics for Multiprobe setups require a hardware link via the "Ext 1" extension connector of each Computer Interface. For systems with two probes a straight shielded RJ45 (EIA/-TIA 568) patch cable is sufficient, see Figure 9. For larger Multiprobe Systems a Multiprobe Interconnect and Power Supply unit as shown in Figure 10 connects to each Computer Interface. Note that the barrel plug patch cables used for supplying the Computer Interfaces via the Multiprobe Interconnect and Power Supply unit are not shown.

In a Multiprobe System one Computer Interface is configured as the master Computer Interface. The Multiprobe master controls continuous statistics collection via dedicated enable and snapshot lines. The hardware link also carries lines indicating the master/slave status of each Computer Interface in a Multiprobe System. As shown in Figure 8 there are dedicated indicator LEDs on the Multiprobe Interconnect and Power Supply unit. The master is indicated by a flashing LED. Multiprobe slaves' LEDs are on continuously if the statistics collection is turned on. Continuously off LEDs indicate that statistics collection is off.

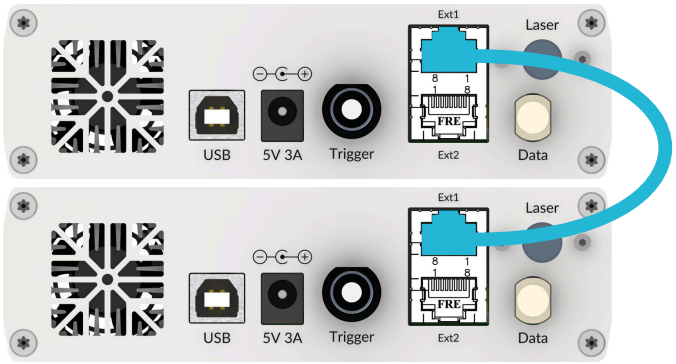


Figure 9: *Multiprobe connection for two E-field probes*

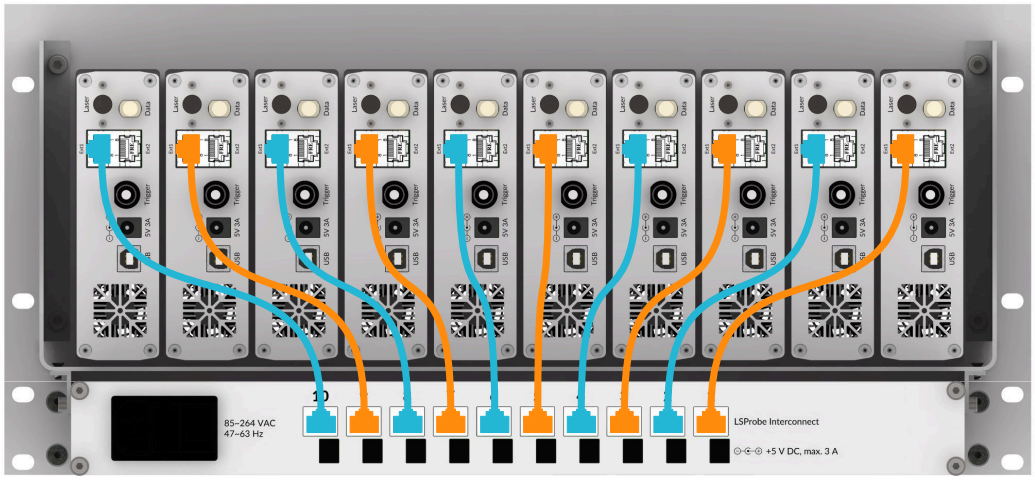


Figure 10: *Multiprobe connections for ten E-field probes*

3.3 Trigger Inputs and Outputs

The Computer Interface features two independent trigger inputs and outputs. The BNC connector on the back of the Computer Interface uses a single-ended 5 V CMOS logic trigger signal. Figures 11 and 12 show the basic point-to-point setup for using an external device as either trigger target or trigger source. The external device can be another Computer Interface or an electrically compatible third-party device.

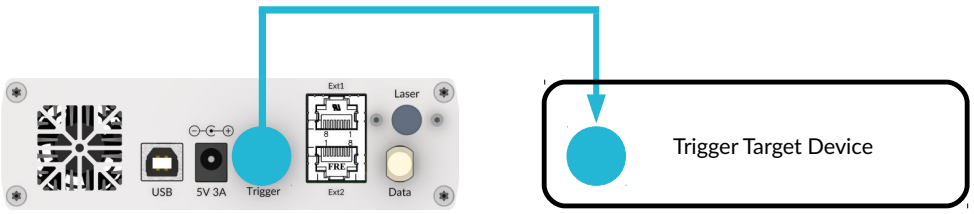


Figure 11: *External trigger output using BNC connector*

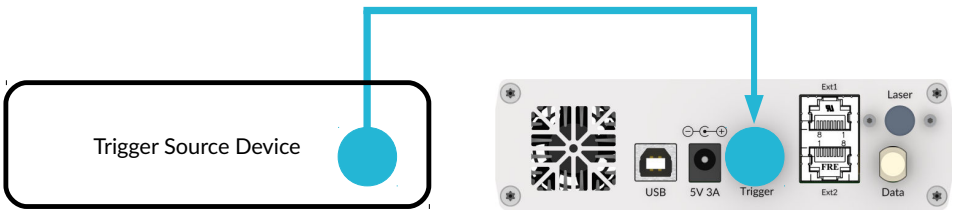


Figure 12: *External trigger input using BNC connector*

The Ext1 RJ45 socket on the back of the Computer Interface uses a differential 3.3 V CMOS logic trigger signal. This signal can be used to exchange trigger signals in a Multiprobe setup containing two or more Computer Interfaces as shown in Figure 13. When a Multiprobe Power Supply Unit is connected all Computer Interfaces automatically share a pair of dedicated differential logic lines. The Ext1 RJ45 sockets are not recommended for use with third-party devices.

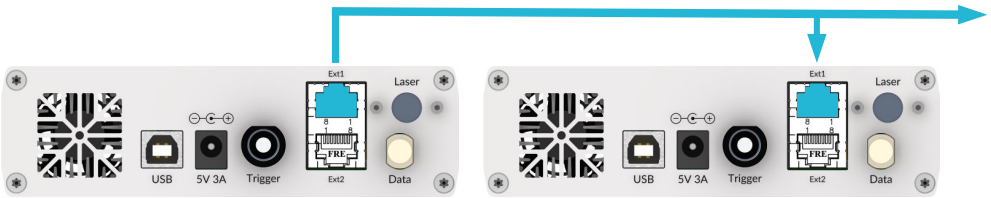


Figure 13: *External trigger input and output using Ext1 RJ45 sockets*

4 LSProbe Software

4.1 LSProbe TCP Server and GUI Installation

Software installation consists of the following steps:

1. Run the TCP Server and GUI installer. Following the displayed installation instructions carefully. When asked for permissions for driver installation grant the permissions, this is required for serial protocol emulation as described in Section 7 on page 67.
2. Copy the supplied calibration data into the directory selected during TCP Server and GUI installation. E.g. if the calibration data directory is `C:\Program Files (x86)\LSProbe_1.2\cal\` and the serial number of the E-Field Probe is 42, please copy the whole directory named `sn42` from the installation medium into the `cal` directory. Repeat the procedure for all LSProbe E-Field Probes connected to the host computer.
3. Install the LabView RTE as detailed in Section 4.3.

The TCP Server host name, the TCP Server port as well as paths for data storage and calibration files are set via system-wide environment variables which are set during TCP Server installation. Variables may also be modified manually or be overwritten by user variables:

`LSPROBE_HOST`
: Set to the hostname or IP address of the computer running the TCP Server. This variable is used by the LSProbe GUI only.

`LSPROBE_PORT`
: Set to the desired TCP port of the LSProbe TCP Server. This variable is used by the LSProbe TCP Server and GUI, both default to port 10,000 if the variable is not defined.

`LSPROBE_CAL_PATH`
: Points to the directory containing the calibration data sub-directories for all attached E-Field Probes. This variable is used by the LSProbe TCP server only.

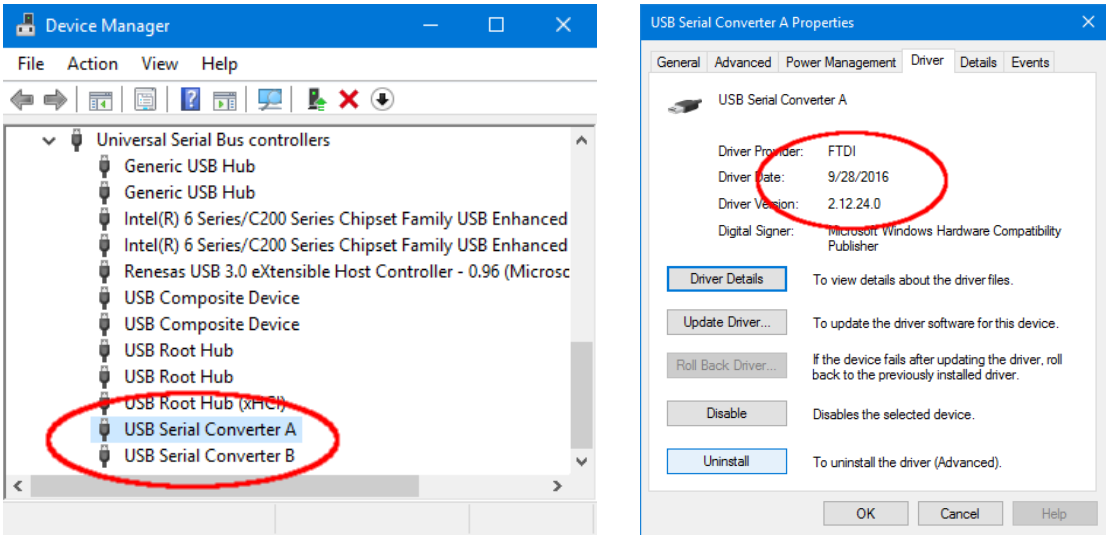
`LSPROBE_SAVE_PATH`
: Points to the directory that saved files and settings will be stored in. This variable is used by the LSProbe GUI only.

If the LSProbe TCP Server and LSProbe GUI are supposed to run on different host computers, the installer must be run on both systems. The environment variable `LSPROBE_HOST` of the system running the LSProbe GUI must be set to point to the host computer running the LSProbe TCP Server. Moreover, the environment variable `LSPROBE_PORT` must be set identically.

4.2 USB Driver Installation

If the host computer has access to the online Microsoft Windows Update, the drivers should be installed automatically when a Computer Interface is connected and powered-up for the first time. Note that for normal operation no internet access is required.

After successful driver installation the Device Manager will list the Computer Interface as "USB Serial Converter A" and "USB Serial Converter B" as shown in Figure 14(a) and (b). Note that the device naming is generic and references neither LUMILOOP nor LSProbe. However, this does not affect the proper operation of the E-field probe.



(a) Device Manager USB device (b) Current FTDI USB driver version

Figure 14: *Correctly installed FTDI USB driver*

If the automated install fails, or if the host computer has no Internet connection, execute the FTDI USB driver installer `CDM v2.12.06 WHQL Certified.exe` contained in the the LSProbe installation path's `lib` directory as shown in Figure 15.

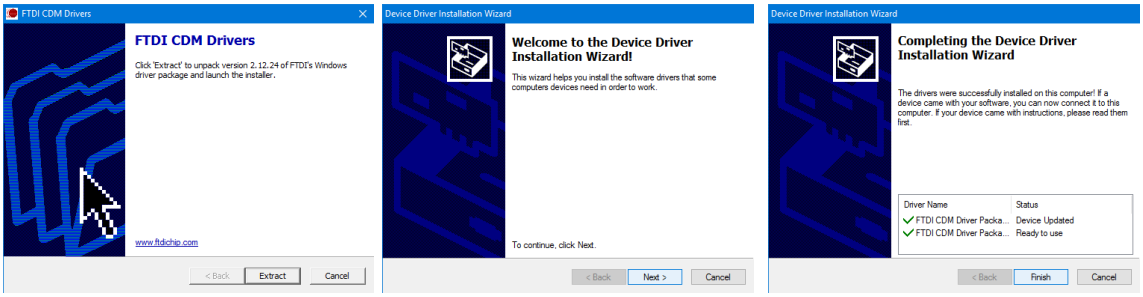


Figure 15: *Manual FTDI USB device driver installation*

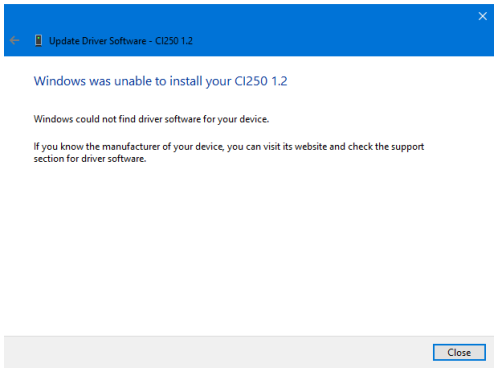
It is strongly advised to observe the following recommendations:

- Plug the LSProbe Computer Interface directly into the computer. Do not use a USB hub or docking station.
- Do not connect other high bandwidth USB devices to the same USB root hub. In rare cases this may reduce read performance significantly, resulting in unreliable operation and eventual loss of measurement data.

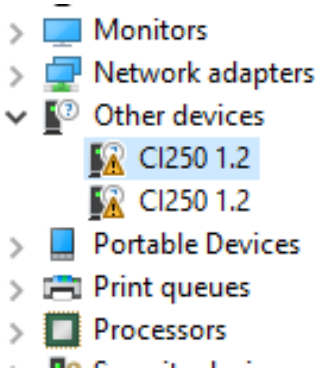
- Especially, do not operate the Computer Interface on a USB port where a USB graphics adapter is installed or was previously installed. The USB graphics driver may disturb communications even if the hardware is no longer attached.

4.2.1 Troubleshooting USB Driver Installation

If no Computer Interface and no other FTDI hardware have previously been connected to the computer and automatic Windows driver installation is deactivated or no Internet connection is available the error message shown in Figure 16(a) will be displayed. In this case the Device Manager's "Other devices" section will give an output similar to Figure 16(b), listing the CI250 Computer Interface's USB end points as unknown devices.



(a) Installation failure message



(b) Device Manager output

Figure 16: *USB device driver failure messages*

Make sure that you are using the most recent FTDI USB driver. The driver version at the time of writing is 2.12.24. Using out-of-date USB drivers may result in improper operation.

Check the driver version by opening the Device Manager and extending the "USB-Controller" category. Right-click "USB Serial Converter A" and select "Properties". Open the "Driver" tab to view the FTDI USB driver version as shown in Figure 14(b). If an older version of the FTDI driver has been installed click on "Uninstall". In the following dialog, make sure to check "Uninstall the driver software for this device" as shown in Figure 17, failing to do so will prevent driver updates.

Make sure to repeat the uninstall process for all Computer Interface devices using old FTDI USB driver versions. Note that the process must be executed for both "USB Serial Converter A" and "USB Serial Converter B" of every Computer Interface. Power-cycle each Computer Interface and repeat the installation procedure as described above in Section 4.2.

4.3 LabVIEW Run Time Environment Installation

The LSProbe GUI requires an installed 32 bit LabVIEW 2012 Run Time Environment or 32 bit LabVIEW 2012 Development System. If either software package is already installed on the host com-

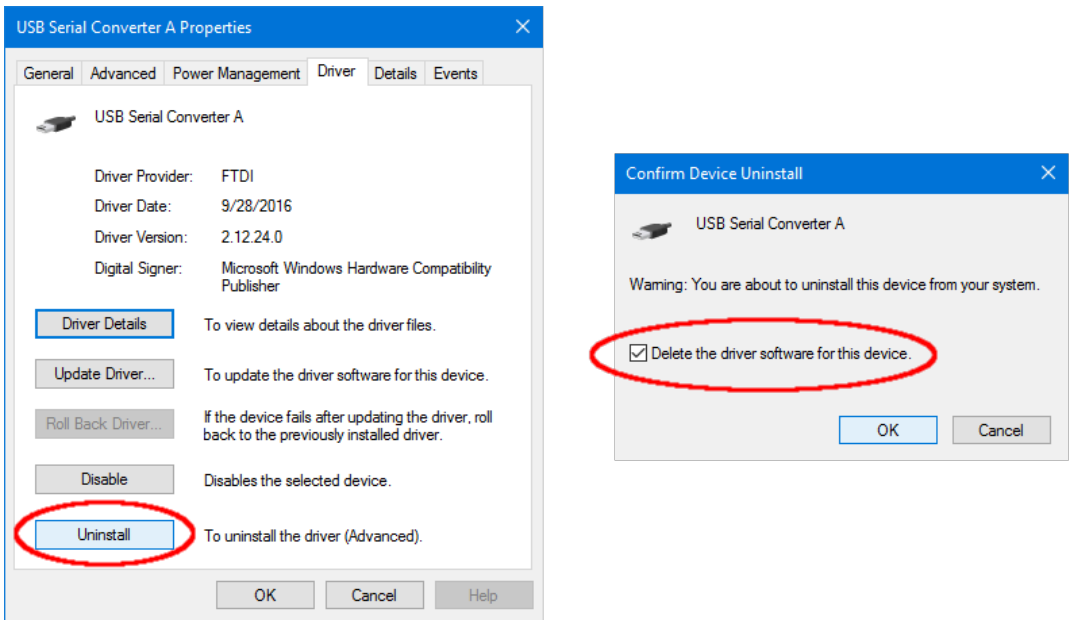


Figure 17: *Uninstalling the FTDI USB driver*

puter, no further steps are required. Otherwise the LabVIEW 2012 Run Time Environment needs to be installed from an installation medium or via download from `http://www.ni.com/download/labview-run-time-engine-2012/3433/en/`.

4.4 Updating the Computer Interface Firmware

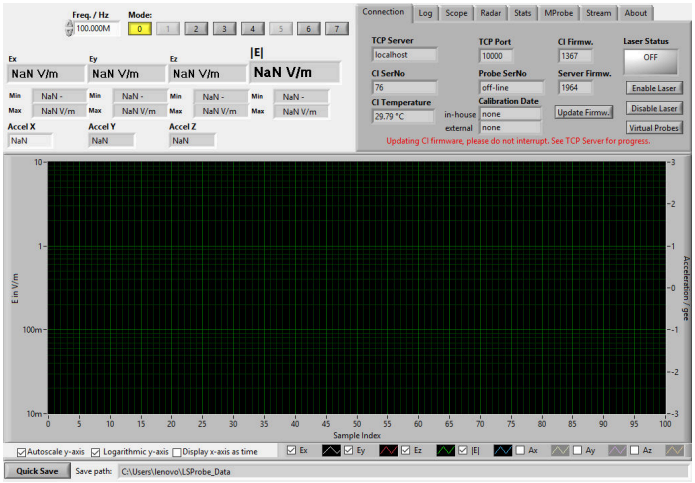


Figure 18: *Firmware update function of the LSProbe GUI*

The Computer Interface's firmware may be updated using the LSProbe TCP Server and GUI. The TCP Server executable incorporates the firmware image required for proper operation. Always ensure

that the firmware version provided by the TCP Server matches the Computer Interface's firmware version. Both version numbers are displayed inside the LSProbe GUI's "Connection" tab.

Follow the instructions below to update the firmware of all connected Computer Interfaces using the LSProbe GUI:

1. Switch all Computer Interfaces (off and) on.
2. (Re-)Start the TCP Server.
3. (Re-)Start the LSProbe GUI.
4. Click the "Update Firmware" inside the "Connection' tab.
5. Observe the update progress displayed by the TCP Server. The update process takes approximately one minute per Computer Interface.
   WARNING: Do not interrupt power supply or USB connection during firmware updates!
6. After completing the update all Computer Interfaces will perform a power-on reset and resume normal operation.

A firmware update may also be initiated using SCPI commands. See the description of the »:SYSTem:FWUPdate <FirmwareVersion>[,<MProbe>]« SCPI command for details.

If the firmware update does not complete successfully or is interrupted for any reason follow the instructions below:

1. Switch all Computer Interface (off and) on.
2. Open a command window.
3. Navigate to the install path of the TCP Server using "cd".
4. Run "LSProbe_TCP_Server.exe -f" and observe the update progress displayed by the TCP Server.
   WARNING: Do not interrupt power supply or USB connection during firmware updates!
5. After completing the update the TCP Server start normally, using the updated firmware.

When encountering problems during the update of multiple Computer Interfaces, switch off or disconnect all but one Computer Interface and repeat the update for one Computer Interface at a time, using one of the methods described above.

5 Measuring E-Fields

5.1 Getting Ready to Measure

5.1.1 Making Optical Connections

If the optical fibers have already been installed make sure that there is no obvious damage to the fibers and that there are no sharp bends or pinches. **WARNING: Never switch the Computer Interface on with no E-Field Probe being connected to it!** For optical fiber installation follow the steps below carefully for one optical fiber at a time, starting with the ST Data connector (black bend protection):

1. Remove the dust caps and place them in their respective holders.
2. Check the ceramic ferrules for apparent damage.
3. Always clean the fiber connectors before plugging! This is essential for preventing dust-induced fiber burn-in. Use a lint-free tissue, wetted with isopropyl alcohol (IPA) or a fiber optic connector cleaner, and gently wipe the front surface of the ceramic ferrules.
4. Plug in the ST Data connector (black bend protection) and lock the bayonet nut connector.
5. Plug in the FC laser supply connector (red bend protection) and tighten its nut. Make sure that the connectors key slides into the corresponding notch, Figure 19 for the correct alignment.

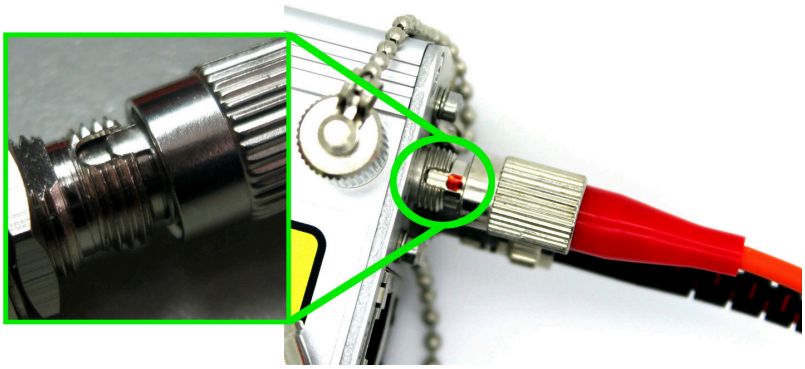


Figure 19: *FC fiber connector alignment*

When unplugging fiber optics, **always** place the supplied dust caps **immediately** on both the fiber cable connectors and the optical ports of the Computer Interface. Purchasing a fiber optics cleaning kit is strongly recommended.

If frequent plugging of the fiber optics is expected, purchasing a sacrificial optical cable assembly is recommended (see Figure 20). The kit consists of two duplex fiber optic couplers and four short duplex patch cables – two for immediate use and two spares. In case of a fiber connector burn-in the sacrificial patch cables can be replaced quickly, without turning the system in for service.

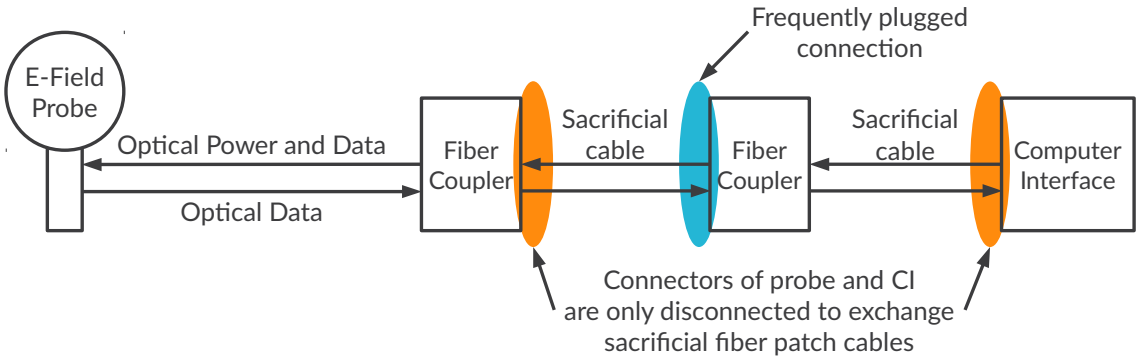


Figure 20: *Sacrificial optical cable assembly*

5.1.2 Making Electrical Connections

When installing the LUMILOOP LSProbe 1.2 E-Field Probe system for the first time make the following electrical connections:

1. Connect the supplied mains adapter.
2. Connect the Computer Interface to the host computer using the supplied USB cable.
3. Connect the Computer Interface to any trigger sources or sinks via the BNC trigger connector.

Switch on the Computer Interface setting the front panel switch to "1" and observe the green power LED starting to flash.

5.2 E-Field Probe Start-Up and Mode Selection

5.2.1 Starting the LSProbe TCP Server

Carefully follow all instructions in the previous sections. Start the LSProbe TCP Server and ensure correct operation by verifying that the green power LED is constantly on and the LSProbe TCP Server has enumerated all connected Computer Interfaces, listing their serial numbers similar to Figure 21. The LSProbe TCP Server will open inside a terminal window displaying status information, debugging output and error messages.

Upon start-up the LSProbe TCP Server will display a tabular summary of available in-house and external calibration data. After Computer Interface enumeration the LSProbe TCP Server will list all detected Computer Interfaces with their respective serial numbers and firmware revision numbers. See Section 4.4 for a description of available firmware update methods.

If Computer Interfaces are added to or removed from the host computer after starting the LSProbe TCP Server the server will detect the respective events and display an updated Computer Interface overview table. Re-enumeration may also be triggered by sending a »*RST« SCPI command.

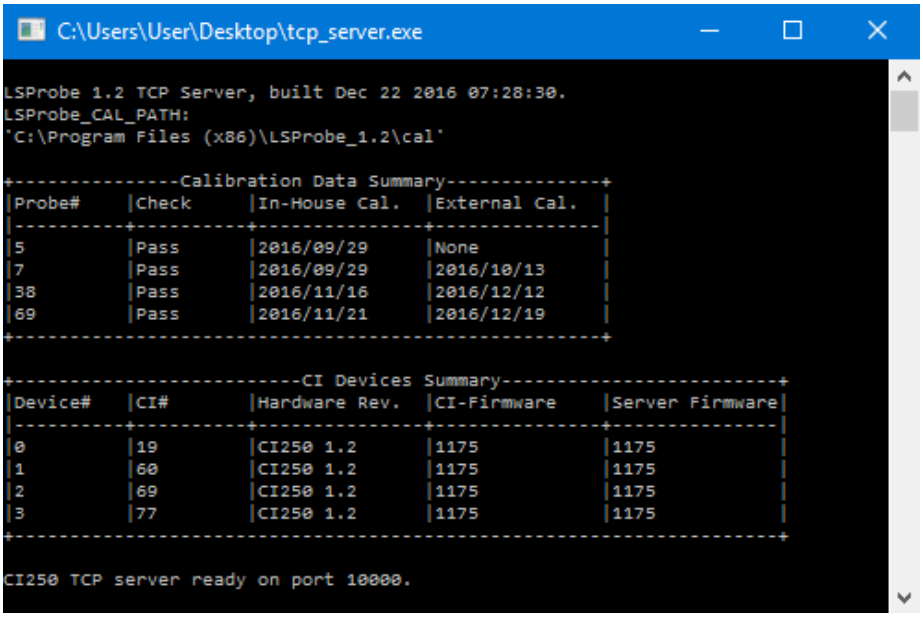


Figure 21: *LSProbe TCP Server terminal window*

Since the LSProbe TCP Server needs to open a TCP port, the system's firewall may ask for permission for network access. Access must be granted to operate the LSProbe TCP Server (see Figure 22).

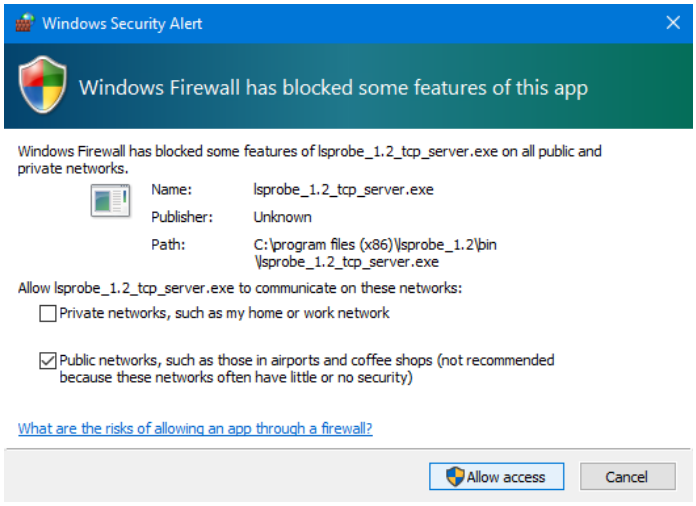


Figure 22: *Microsoft Windows Firewall requesting TCP port access permissions*

5.2.2 General Notes on the LSProbe GUI

The LSProbe GUI is intended as an easy to use demonstration software for all LSProbe capabilities. The LSProbe GUI is designed in such a way that it will not issue any configuration commands to the LSProbe TCP Server unless the user changes a setting using one of the controls. This feature allows

for running the LSProbe TCP Server with any third-party EMC software and observe all E-Field Probe settings and measurement results. This feature is especially useful during third party EMC software integration and function testing.

(a) Match (b) Mismatch

Figure 23: *Frequency control for matching (a) and mismatching (b) TCP Server and GUI settings*

When there is a mismatch between a setting of the LSProbe TCP Server and the expected setting of the GUI, the text of the control element will turn red. Black control element text indicates that the TCP Server's settings are in sync with the GUI. Figure 23 shows the behavior of the GUI for matching and mismatching frequency and mode settings.

5.2.3 Enabling the Supply Laser Using the GUI

Upon start-up the LSProbe GUI will attempt to automatically connect to the TCP Server using the configured host and port. Figure 24 shows the GUI upon start-up. The Computer Interface number, LSProbe serial number and temperature of the selected Computer Interface will be displayed. The "Probe SerNo" field will display "OFF-LINE" instead of the probe's serial number if the E-Field Probe connected to the Computer Interface is turned off. If no Computer Interfaces have been enumerated by the LSProbe TCP Server the "CI SerNo" field will display "NONE".

Clicking the "Enable Laser" button will activate the supply laser and set the E-Field Probe to the desired mode of operation. The orange "Laser on" indicator LED will show the activity of the supply laser. **WARNING: When the orange LED is flashing, Automatic Power Reduction (APR) is disabled. Interrupting optical connections is dangerous!** The GUI's "Laser Status" indicator will turn yellow and display "Startup, Eye Safe OFF" to warn the user of this fact (see Figure 25).

As soon as both the orange "Laser on" indicator and the blue "Data Link" indicator are continuously on Automatic Power Reduction is active and the laser connection is eye-safe. If any of the optical fibers gets interrupted, the supply laser will be switched off within one millisecond and the GUI will present the red indicator shown in Figure 25.

5.2.4 Mode Selection Using the GUI

For accurate E-field strength measurements the field's frequency must be specified using the "Freq./Hz" input field. Values are entered in Hertz, SI unit prefixes may be used, e.g. "1.8G" for 1.8 GHz. The actual decimal separator is determined by the host computer's system language. When selecting a mode via the buttons "0" through "7" the user must ensure that "Frequency/Hz" is appropriate for the selection. Frequency values outside a mode's supported frequency range will not be

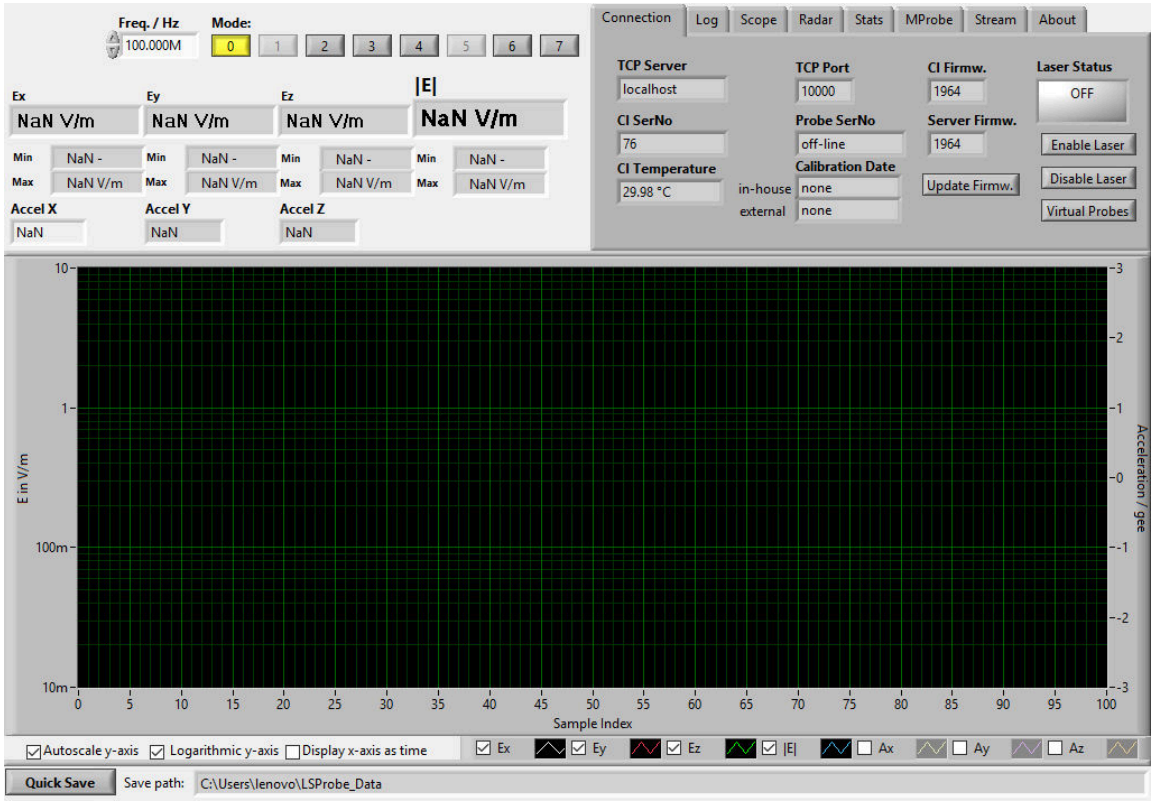


Figure 24: *LSProbe GUI Connection tab upon startup*

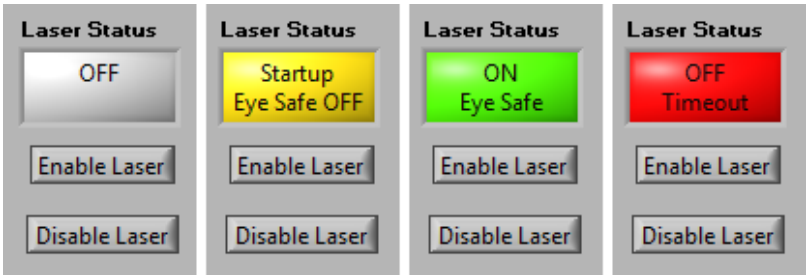


Figure 25: *LSProbe GUI laser indicator when off, during start-up, in safe operation and upon encountering a time-out error*

accepted by the entry field. See Table 1 on page 17 for a list of supported modes, their frequency ranges and sampling rates. Hovering the mouse pointer over any of the mode selection buttons of the GUI will display a tool-tip containing a brief description of the mode. During startup the mode buttons' background will be colored yellow, stable operation in the selected mode is indicated by a green background color.

5.2.5 Enabling the Supply Laser and Mode Selection Using SCPI Commands

After establishing the TCP/IP connection the SCPI commands »:SYSTem:CISerial? [<MProbe>]« and »:SYSTem:CISerial <Value>« can be used to query all enumerated Computer Interfaces and set the serial number of the Computer Interface to be accessed. If only a single Computer Interface is attached to the host computer it will be selected automatically and its serial number can be queried using »:SYSTem:CISerial? [<MProbe>]«. »:SYSTem:CISerial? [<MProbe>]« and »:MEASure[:FProbe]:SERialnumber? [<MProbe>]« can be used with the MProbe parameter set to zero to list all enumerated Computer Interfaces and their corresponding connected field probe numbers.

The desired mode of the selected E-Field Probe is set using »:SYSTem:MODe <Mode>[,<MProbe>]« refer to Table 1 on page 17 for a list of valid modes. Set the operating frequency in Hz using »:SYSTem:FREQuency <Frequency>[,<MProbe>]«, frequencies outside a mode's supported frequency range will be diverted to the nearest supported frequency. »:SYSTem:FREQuency? [<MProbe>]« can be used to verify the frequency setting.

»:SYSTem:LASer:ENable <Value>[,<MProbe>]« is used to enable the supply laser. During start-up the commands »:MEASure[:FProbe]:MODe? [<MProbe>]« and »:SYSTem:LASer:TOut? [<MProbe>]« are used to poll the optical link status until either the requested mode has been set successfully or a time-out condition and thus a faulty optical link has been detected. The E-Field Probe may take several tens of seconds to successfully set a mode. »:SYSTem:MODe <Mode>[,<MProbe>]« may be issued at any time to request a mode change in which case the described polling procedure needs to be repeated. **WARNING: As long as the requested mode has not been established and the orange LED is flashing, Automatic Power Reduction (APR) is disabled. Interrupting optical connections is dangerous!**

5.3 Continuous E-Field Measurements

While the LSProbe E-Field Probe is capable of exceptionally high speed measurements it is also able to perform high precision measurements of quasi-static electric fields. For continuous E-Field Measurements the TCP Server receives all field strength values, applies calibration data and performs low-pass filtering if configured accordingly. X-, y- and z-axis acceleration data is recorded and optionally low-pass filtered as well. The acceleration values give an indication which axis is pointing up, when an antenna is pointing directly up a value of one gee is returned for the corresponding axis' acceleration, minus one gee will be returned when the antenna is pointing directly down.

5.3.1 Continuous Measurements Using the GUI

As shown in Figure 26 continuous measurements are configured through the "Log" tab. E-field and acceleration data is displayed both textually and graphically. Values are polled constantly, resulting in an update rate in the order of 100 samples per second. The actual polling frequency depends on the speed of the host computer and the speed of the network connection. The calibrated range of field strength values is displayed textually below the x-, y-, z- and magnitude-value of the electric field strength.

Figure 26: *LSProbe GUI data logger view*

"Graph Length" determines the maximum number of samples displayed in the plot at the bottom of the window. It will show at most this many most recent values, older values will be discarded. To display the elapsed time instead of sample indexes for graphs' x-axis and graph length select the "Display x-axis as time" check box. The plot can be paused using "Pause Graph" and cleared using the "Clear" button. By way of the "Log" tab the logging of continuously polled values and of the Trigger, Statistic, Multiprobe and Radar data can each be turned on and off. If enabled new arriving data of the specific subsystem gets immediately written to a log file. The button "Quick Save" allows a shortcut for the logging of the currently viewed data without previously having enabled the log feature. The data gets logged to a file whose prefix is determined by the "File Prefix" text input field. Log files are saved according to LSPROBE_SAVE_PATH. The E-Field Probe serial number, a date and time string and a csv file suffix will be appended to each new log file. See Section 11.1.1 on page 138 for

file format details.

Low pass filter settings are done through the "E LP-Filter" and "Accel. LP-Filter" numeric input fields. A value of 0 disables low-pass filtering. A non-zero value sets the -3 dB cut-off frequency for the first order low-pass filter used for E-field and acceleration values, for example 10 Hz. When changing the frequency the E-field low-pass filter output value will be updated directly, i.e. low-pass filtered values will see a step response instead of a slewing of values.

The controls below the plot pane offer shortcuts for enabling and disabling automatic y-axis scaling, logarithmic and linear display of the y-axis and choosing between sample index and time as the unit for the graphs' x-scale. The plot pane also supports adjusting the x- and y-axis by clicking the first or last index of the axis labels and setting its value. Individual graphs can be disabled by unchecking the graph labels at the bottom of the plot pane. Right-clicking the plot pane exposes a number of generic function including data export to the host computer's clip board.

5.3.2 Continuous Measurements Using SCPI Commands

After setting up mode and frequency as described in Section 5.2.5 the E-field low-pass filter frequency is configured through »:MEASure[:FProbe]:Efield:LPFrequency <Frequency>[,<MProbe>]«. A synchronized set of component values and magnitude can be queried through »:MEASure[:FProbe]:Efield:ALL? [<MProbe>]«, this is the recommended method ensuring that component values and magnitude have been acquired at the same time. E-field values can be queried individually through

- »:MEASure[:FProbe]:Efield:X? [<MProbe>]«,
- »:MEASure[:FProbe]:Efield:Y? [<MProbe>]«,
- »:MEASure[:FProbe]:Efield:Z? [<MProbe>]« and
- »:MEASure[:FProbe]:Efield:MAGnitude? [<MProbe>]«.

The acceleration low-pass filter frequency is configured through »:MEASure[:FProbe]:ACCeleration:LPFrequency <Frequency>[,<MProbe>]«. Acceleration values can be queried through

- »:MEASure[:FProbe]:ACCeleration:X? [<MProbe>]«,
- »:MEASure[:FProbe]:ACCeleration:Y? [<MProbe>]« and
- »:MEASure[:FProbe]:ACCeleration:Z? [<MProbe>]«.

5.4 Triggered E-Field Measurements

Triggered E-Field Measurements allow the user to take full advantage of the LSProbe E-Field Probe's exceptionally high speed measurements. Waveform acquisition can be triggered by software, using an external trigger signal or edge-sensitive field strength triggering.

5.4.1 Triggered Measurements Using the GUI

Figure 27 shows the LSProbe GUI in field scope mode which is entered by selecting the "Scope" tab. In field scope mode the textual display shows the averaged field strength and acceleration values for the displayed waveforms in addition to the calibrated range of field strength values displayed textually below the x-, y-, z- and magnitude-value of the electric field strength.

The "Trigger Source" drop-down box is used for selecting rising or falling edge external BNC, external RJ45, x-, y- or z-axis E-field value triggering. For the latter the threshold value in V/m can be set via "X/Y/Z Threshold". Via "Mode" automatic free-running triggering, normal event-based triggering and one-shot single triggering can be selected. "Trigger State" displays the condition of the trigger system. The length of the acquired waveform is determined by the "Trigger Length" numeric input field, setting the number of samples for each triggered waveform. "Trigger Begin" sets the start of the saved waveform relative to the position of the trigger event. "Trigger Begin", "Trigger Length" and the graph's x-axis can be displayed as time by selecting the "Display x-axis as time" checking box. Time values are displayed according to the sampling rates in Table 1. The "Arm" and "Force" buttons serve to prepare the trigger system and to force triggering regardless of actual trigger events. The "BNC Trigger Output" and "RJ45 Trigger Output" drop down menus are used to enable trigger output via the Computer Interface's BNC connector and "Ext1" RJ45 socket, and set their respective polarities. Triggers can be output either when encountering a trigger event, including forced triggering, or for synchronization triggering described in Section 10.6.38.

5.4.2 Triggered Measurements Using SCPI Commands

The state of the trigger system is queried using »:TRIGger:STATe? [<Timeout>,<MProbe>]«. Configuring the triggered measurements must take place in IDLE state. Waveform querying must take place when the trigger system is in DONE state. The SCPI commands »:TRIGger:CLear [<MProbe>]«, »:TRIGger:ARM [<MProbe>]« and »:TRIGger:FORce [<MProbe>]« are used for directly manipulating the state of the trigger system. Figure 28 shows all valid trigger states and state transitions.

The trigger source and polarity are set using »:TRIGger:SOURce <Source>[,<MProbe>]« and »:TRIGger:FALLing <0/1>[,<MProbe>]«. If field strength triggering is to be performed the trigger level is set using »:TRIGger:LEVel <Level>[,<MProbe>]«. The trigger length is set using »:TRIGger:LENgth <Length>[,<MProbe>]« and »:TRIGger:BEGin <Index>[,<MProbe>]«. The corresponding query commands are »:TRIGger:LENgth? [<MProbe>]« and »:TRIGger:BEGin? [<MProbe>]«. Trigger output is configured using :TRIGger:OUTput <0/1>[,<MProbe>], :TRIGger:INVert <0/1>[,<MProbe>] and :TRIGger:SYNC <0/1>[,<MProbe>].

In DONE state the waveform values can be queried using the commands

- »:TRIGger[:WAVeform]:Efield:X? [<MProbe>]«,
- »:TRIGger[:WAVeform]:Efield:Y? [<MProbe>]«,
- »:TRIGger[:WAVeform]:Efield:Z? [<MProbe>]« and
- »:TRIGger[:WAVeform]:Efield:MAGnitude? [<MProbe>]«.

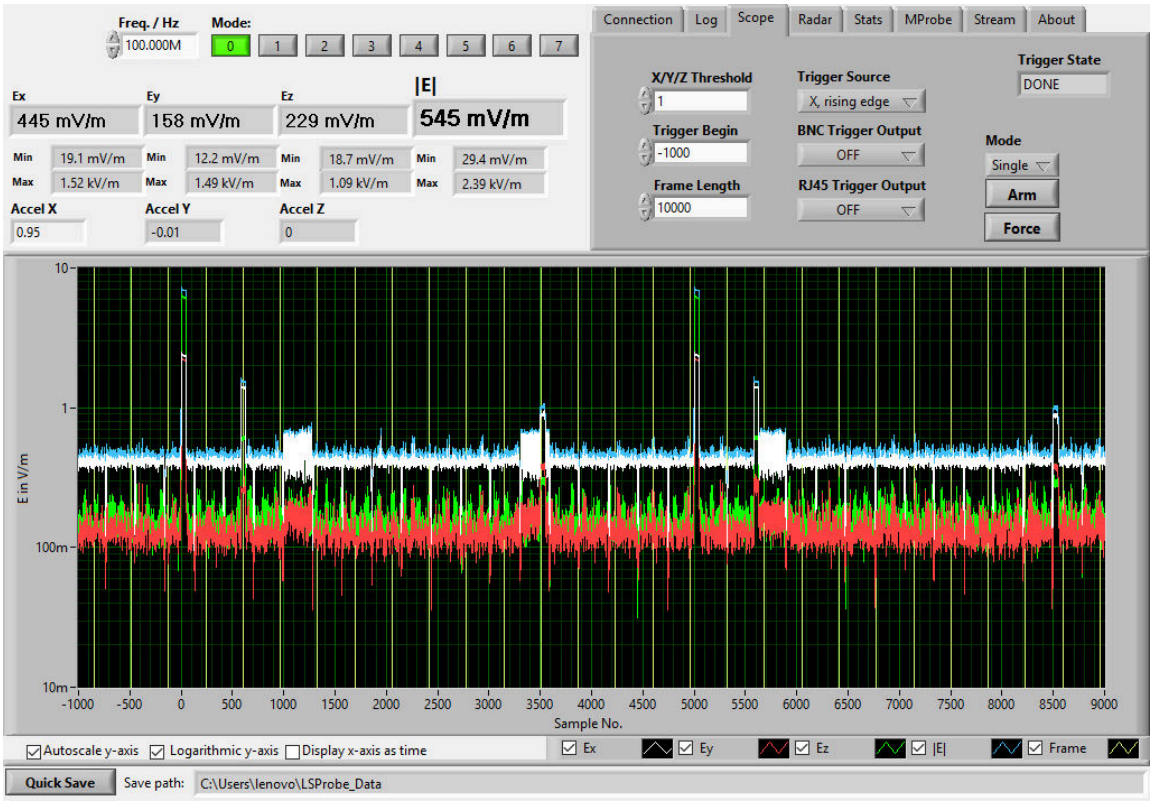


Figure 27: *LSProbe GUI, Scope tab*

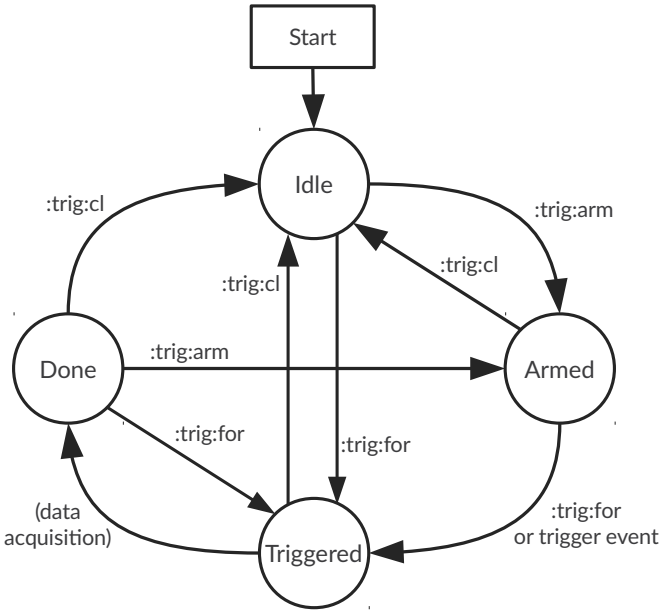


Figure 28: *Trigger system states and state transitions*

Average waveform values can be queried using »:TRIGger[:WAVeform]:Efield:ALL? [<MProbe>]«. If fast and efficient waveform readout is required the binary waveform readout command »:TRIGger[:WAVeform]:Efield:BINary? [<MProbe>]« can be used.

5.4.3 Triggered Radar Pulse Measurements Using the GUI

LSProbe is able to scan a trigger frame for pulses and find their positions and field strengths. In mode 0 and 2 pulses above a specified threshold can be detected if they are longer than 2 µs and at least 2 µs apart. In mode 4 and 6 pulses above a specified threshold can be detected if they are longer than 0.5 µs and at least 0.5 µs apart. Pulse measurements in mode 1, 3, 5 and 7 are not recommended due to their lower video band withs.

For pulses containing one or two samples the pulse's field strength is defined as the larger of the two field strength values. For pulses containing at least three samples the pulse's field strength is defined as the arithmetic mean of all but the first and last sample value of the pulse, Figure 29 denotes these samples using squares.

Pulses starting before the beginning or end of a waveform in any mode and pulses starting before the beginning of frames in mode 4, 5, 6 and 7 will only be detected if they contain at least two samples. The last sample of the pulse is always discarded and the pulse's field strength in this special case is defined as the arithmetic mean of all preceding field strength values. Pulses ending after the end of a waveform or frame are handled in the same way, discarding the pulse's first sample value instead of the pulse's last sample value.

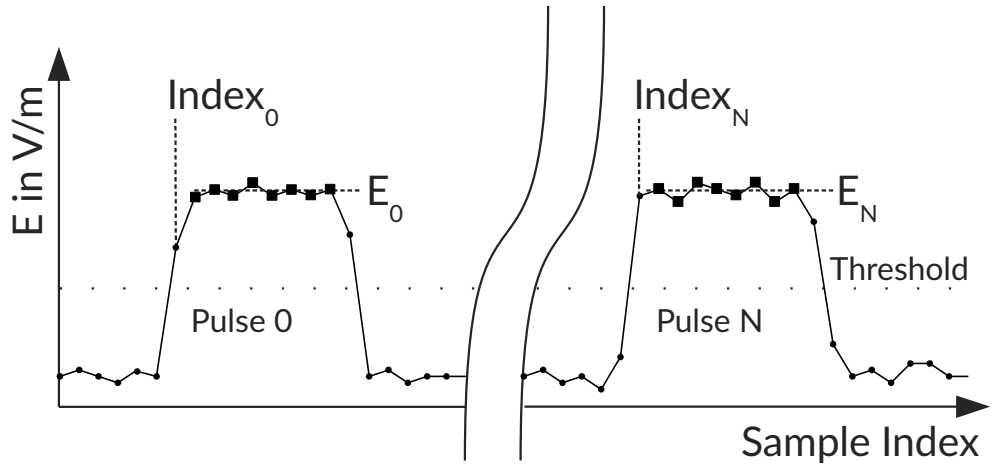


Figure 29: *Principle of radar pulse detection*

In order to enable pulse detection and evaluation within the LSProbe GUI select the "Radar" tab and enable "Enable Radar" as shown in Figure 30. Both averaged and per-pulse maximum field strength

values are displayed for x, y, z and magnitude. Averaged values are shown on top, the start index of individual pulses and their maximum field strength value are displayed below. If no pulses are detected the averaged E-field values will display "NaN". The sample index is given relative to the trigger position and represents the first sample exceeding the given threshold. The "Index" input field can be used to step through individual pulses, the first value has an index of zero. An invalid index will display "NaN" for sample index and field strength. By selecting the "Display x-axis as time" check box the "Index" values of pulses and x-axis labels of the waveform graph will be displayed in seconds. If the radar subsystem is turned off the "Pulses" field will be set to zero and all other fields get cleared.

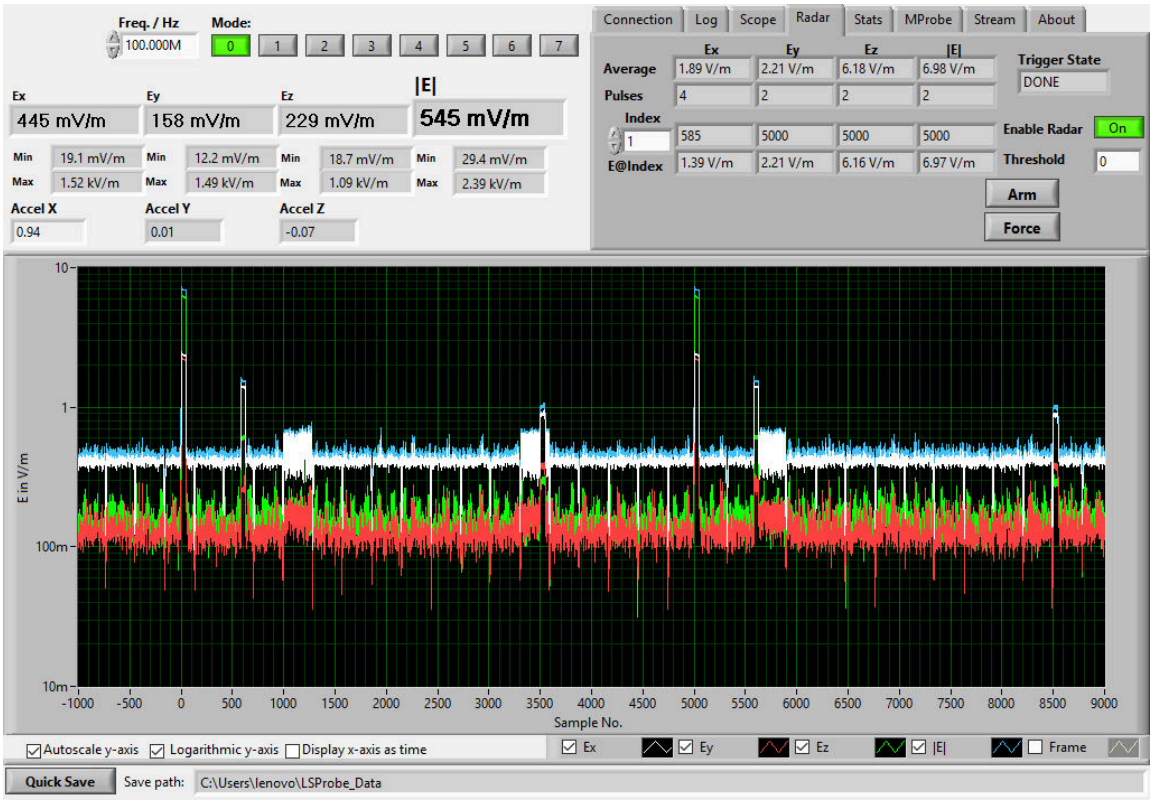


Figure 30: *LSProbe GUI, Radar tab*

The "Arm" and "Force" buttons are duplicated from the "Scope" tab to enable waveform acquisition without switching to the "Scope" tab. All trigger settings are performed via the "Scope" tab. Pulse evaluation is performed for the latest trigger frame and with every change in the threshold value .

The same threshold value is used for all E-field components and magnitude values, it is set via the "Threshold" input field. If set to zero the arithmetic mean of maximum and minimum field strength is used as a threshold. Both minimum and maximum field strength value are accessible via the statistics subsystem, see Section 5.5. A value other than zero sets the threshold value in V/m. Figure 29 shows the relationship of trigger frame values, pulse indices and pulse values.

The number of detected pulses can differ for each axis and magnitude values, the numeric fields "Pulses" give the number of pulses found for each axis and the magnitude values.

5.4.4 Triggered Radar Pulse Measurements Using SCPI Commands

See Section 10 page 78 for details regarding triggered value acquisition. Pulse detection requires the trigger system to be in DONE state. Pairs of sample index and maximum pulse field strength values can be obtained through the »:TRIGger[:WAVeform]:RADar:X? [<Threshold>][,<MProbe>]«, »:TRIGger[:WAVeform]:RADar:Y? [<Threshold>][,<MProbe>]«, »:TRIGger[:WAVeform]:RADar:Z? [<Threshold>][,<MProbe>]« and »:TRIGger[:WAVeform]:RADar:MAGnitude? [<Threshold>][,<MProbe>]« commands. Averaged maximum pulse field strength values can be queried using »:TRIGger[:WAVeform]:RADar:ALL? [<Threshold>][,<MProbe>]«. All commands accept an optional parameter specifying the threshold field strength value if the parameter is absent a threshold of 50% will be used. For a single triggered event the data evaluation can be performed with different threshold values, as long as no new trigger event is prompted and the trigger state remains DONE.

5.5 E-Field Statistics

Two types of E-Field statistics are available for the LUMILOOP LSProbe 1.2 E-Field Probe, continuous E-field statistics as described in Section 5.5.1 and triggered E-field statistics based on acquired waveforms as described in Section 5.5.3. Continuous E-Field statistics evaluate all measured E-field values between enabling statistics and statistics snapshot creation. Continuous E-Field statistics are collected in the background and can be performed over arbitrary periods of time. Triggered E-Field statistics evaluate only E-field values of a single recorded set of waveforms. All SCPI commands of the statistics subsystem are applicable to both continuously and triggered E-field values.

5.5.1 Continuous E-Field Statistics using the GUI

All statistics functions are controlled via the the "Stats" tab of the LSProbe GUI, see Figure 31. See section 5.5 for an explanation of the operating principle.

As explained in Section 3.2 continuous E-Field statistics use a physical connection for enabling statistics collection and snapshot creation. Consequently, one master Computer Interface must be set for continuous E-field statistics. This also applies to single probe systems where the Computer Interface must always be configured to be the master Computer Interface. By default the first enumerated Computer Interface will be configured as the statistics master, all others will be configured as statistics slaves. A different Computer Interface may be configured as the statistics master via the "Stats Master" drop-down list.

In order to enable continuous E-Field statistics in the LSProbe GUI select "Continuous" from the "Mode" drop-down list, this will enable additional controls for continuous E-Field statistics.

The "Stat. Enable" button is used to enable and disable continuous E-field statistics collection via the statistics master Computer Interface. Continuous statistics data can be viewed in the form of statistics snapshots as described in Section 5.5. A statistics snapshot can be created manually by clicking

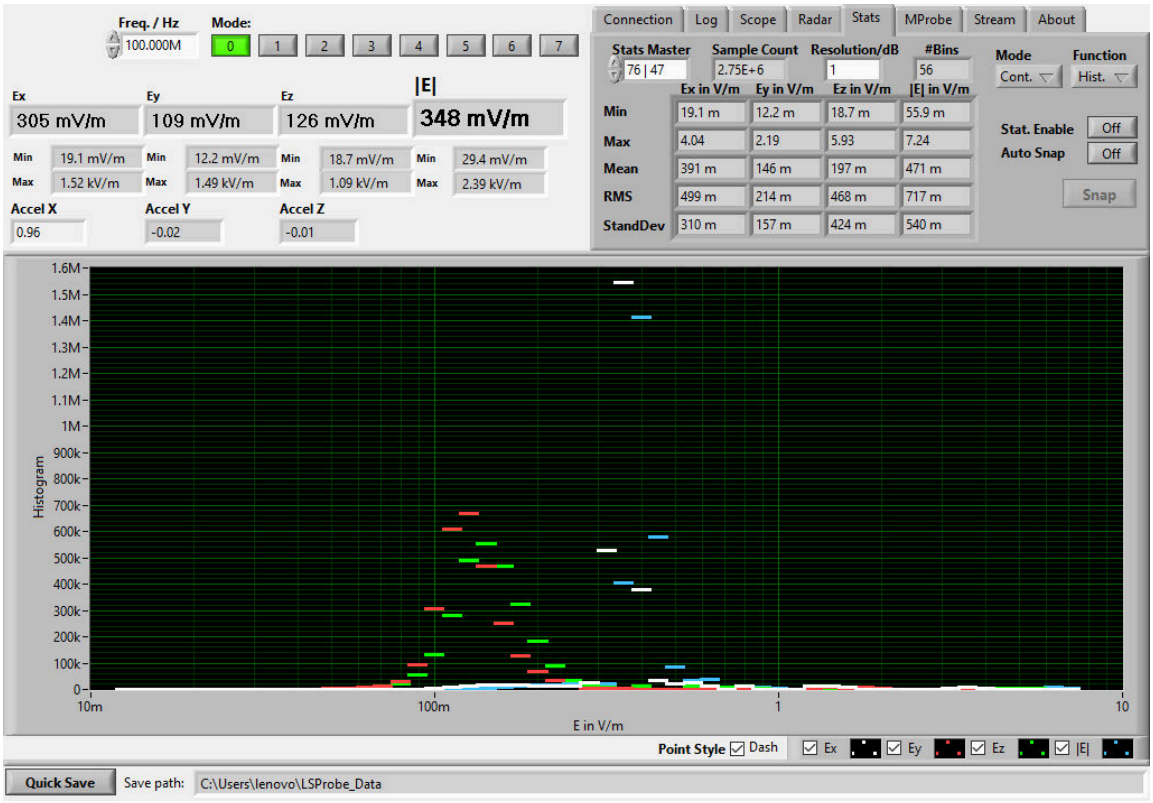


Figure 31: *LSProbe GUI, Statistics tab*

on the "Snap" button. A statistics snapshot will also be created when statistics collection is disabled via the "Stat. Enable" botton. Automatic statistics snapshot creation is enabled via the "Auto Snap" button, making the GUI trigger a new statistics snapshot after each update of the statistics display. The total number of samples used for the most recent statistics snapshot is displayed in the "Sample Count" display field. For Multiprobe systems this number may vary slightly due to minimally different local clock frequencies of each E-field probe.

All output is based on the most recent statistics snapshot. See the SCPI command reference in Section 10 for a detailed description of scalar and histogram-like statistics values.

The table displayed in the "Stats" tab lists all scalar statistics values for the currently selected combination of Computer Interface and E-Field Probe. Maximum, minimum, arithmetic mean, root mean square and standard deviation are displayed for the x-, y- and z-components of the E-field and its magnitude.

Histogram-like statistics are selected via the "Function" drop-down list. Available choices are histogram, discrete relative probability distribution, discrete cumulative probability distribution and discrete complementary cumulative probability distribution.

Histogram-like statistics are displayed in the main plot area. The style of the displayed graphs is adjustable via the "Point Style" checkbox below the plot area. If selected, dashes stretching each E-field strength bin will be displayed, otherwise one point will be plotted for every E-field strength bin.

The E-field strength resolution in dB can be set via the "Resolution" input field, determining the size of the E-field strength bins. Its smallest permissible value, yielding the maximum E-field strength resolution, is 0.005 V/m. The number of bins resulting from the set E-field strength resolution and E-field strength distribution is shown in the "#Bins" display field.

5.5.2 Continuous E-Field Statistics using SCPI Commands

Continuous statistics and triggered statistics are accessible using a common set of SCPI commands. An SCPI command's function is determined by the parameter Triggered. If set to 0 an SCPI command applies to continuous statistics, if set to 1 an SCPI command applies to triggered statistics. In most cases the parameter Triggered is optional, making the SCPI command default to continuous statistics.

The continuous statistics master Computer Interface is set by selecting it using »:SYSTem:CISerial <Value>« followed by setting its master status to one using »:STATistics:MAster <State>«. The master/slave status of any Computer Interface may be queried using »:STATistics:MAster? [<MProbe>]«.

Continuous E-field statistics collection is started by issuing »:STATistics:ENable <State>[,<MProbe>]« with the parameter State set to one to the statistics master Computer Interface. Statistics snapshots will be generated on receiving either »:STATistics:SNAPshot [<Triggered>][,<MProbe>]« or »:STATistics:ENable <State>[,<MProbe>]« with the parameter State set to zero. The snapshot counter will be incremented by one for every new snapshot, the counter(s) can be queried using »:STATistics:COUnt? [<MProbe>]«. Using this query enables snapshot

synchronization since snapshot query and execution are inherently asynchronous for continuous E-field statistics. Enabling continuous statistics will reset the snapshot counter to zero. »:STATistics:SAMples? [<Triggered>][,<MProbe>]« returns the number of samples used for the most recent statistics snapshot.

Scalar statistics values can be read using the commands described in Sections 10.7.12 through 10.7.36. Histogram-like statistics values are returned by the commands described in Sections 10.7.38 through 10.7.53.

The resolution for histogram-like values is set using »:STATistics:RESolution <Resolution>[,<MProbe>]«. The resulting number of bins, the offset of the bin with the smallest E-field strength and the center field strength of each bin can be queried via »:STATistics:HISTogram:SIZe? [<Triggered>][,<MProbe>]«, »:STATistics:HISTogram:OFFset? [<Triggered>][,<MProbe>]« and »:STATistics:Efield? [<Triggered>][,<MProbe>]« respectively. All statistics values are also available in binary format, see »:STATistics:BINary? [<Triggered>][,<MProbe>]« for details.

5.5.3 Triggered E-Field Statistics using the GUI

Continuous E-Field statistics use waveform data for building the scalar and histogram-like values discussed in the previous section. See Section 5.4 for a description of waveform acquisition. Triggerd E-Field Statistics do not rely on the physical connections required for continuous E-field statistics. For Triggerd E-Field Statistics there is no statistics master, no statistics enable function and no hardware-based snapshot feature.

In order to access triggered E-Field statistics in the LSProbe GUI select "Triggered" from the "Mode" drop-down list, this will enable additional controls for triggered E-Field statistics.

A statistics snapshot based on the most recently acquired waveforms can be created manually by clicking on the "Snap" button. Automatic statistics snapshot creation is enabled via the "Auto Snap" button, making the GUI take a new triggered snapshot upon receiving a new E-field value waveform. The "Arm" and "Force" buttons are provided for ease of use and are identical in function to the buttons described in Section 5.4.

Triggered Statistics data is viewed in the form of statistics snapshots as described in Section 5.5. All scalar and histogram-like values are controlled and displayed as described in the previous sections. When displaying triggered statistics data the "Function" drop-down list may additionally be set to "Scope" for more convenient viewing of scalar statistics values and triggered waveforms at the same time.

5.5.4 Triggered E-Field Statistics using SCPI Commands

Triggered statistics SCPI commands require the parameter Triggered to be set to 1 for all related SCPI commands. Statistical evaluation requires a valid set of triggered waveforms, see Section 5.4.2 for details about waveform acquisition.

Snapshot histograms are generated using »:STATistics:SNAPshot [<Triggered>][,<MProbe>]«. There is no trigger snapshot counter. Instead, triggered snapshot generation is performed synchronously making statistics values available immediately after issuing the SCPI snapshot command.

Scalar and histogram-like statistics values can be obtained using the same SCPI commands as described in Section with the parameter Triggered set to 1 at all times.

5.6 Multiprobe Systems Using the GUI

If more than one Computer Interface have been enumerated by the LSProbe TCP Server the LSProbe GUI will display a drop-down list and "ALL" button in the upper left corner of the LSProbe GUI as shown in Figure 32. The drop-down list contains Computer Interface serial numbers and associated E-Field Probe serial numbers or "OFF" if the probes are not turned on, separated by "|". Changing the selected value of the drop-down list will display measurement values and settings for the selected Computer Interface/E-Field Probe. The "ALL" button determines whether settings will be applied to the selected Computer Interface/E-Field Probe only or to all Computer Interfaces/E-Field Probes at the same time.

For Multiprobe setups the statistics SCPI command subsystem is used to calculate statistics values as described in the previous sections. The GUI offers six predefined ISO standard setups for the demonstration of Multiprobe functionality. These six setups are accomplished by defining special cases of a more generalized Multiprobe system using the Multiprobe SCPI command subsystem. This subsystem is also employed for calculating statistics based on the statistics of multiple E-field probes. Multiprobe statistics can be calculated from continuous and triggered E-field statistics in the same manner as all other statistics values.

Accordingly, the GUI mirrors functionality of the "Stats" tab in the "MProbe" tab, see Figure 32. The selection ring "Stats Master", the drop-down list "Mode", the buttons "Stat. Enable", "Auto Snap", "Arm", "Force" and "Snap" have the same function as described in Section 5.5.1 and are not detailed in this section.

5.6.1 Single and Three Probe Setups According to ISO 11451-2

In accordance with the ISO standard the arithmetic mean of the E-field strength magnitude at a given reference point is calculated over a user defined period of time. Two control probes may be included in the system, thus extending the single probe setup to form a three probe setup, see Figure 33.

In the "Stats" tab set the "Function" dropdown list to "1-Probe System, ISO 11451-2" or "3-Probe System, ISO 11451-2". Select the probe numbers to be used in the Multiprobe setup using the selection rings "Probe 1" and optionally "Control Probe 1/2". Changing these settings will reconfigure the Multiprobe setup immediately. Use the "Save" button to save a Multiprobe setup to file and the "Load" button to restore a Multiprobe setup from file.

Multiprobe results are displayed in the bottom pane normally used for waveforms. The left-hand side gives access to individual probes' minimum, maximum, arithmetic mean, root mean square and

Figure 32: *LSProbe GUI, Multiprobe tab*

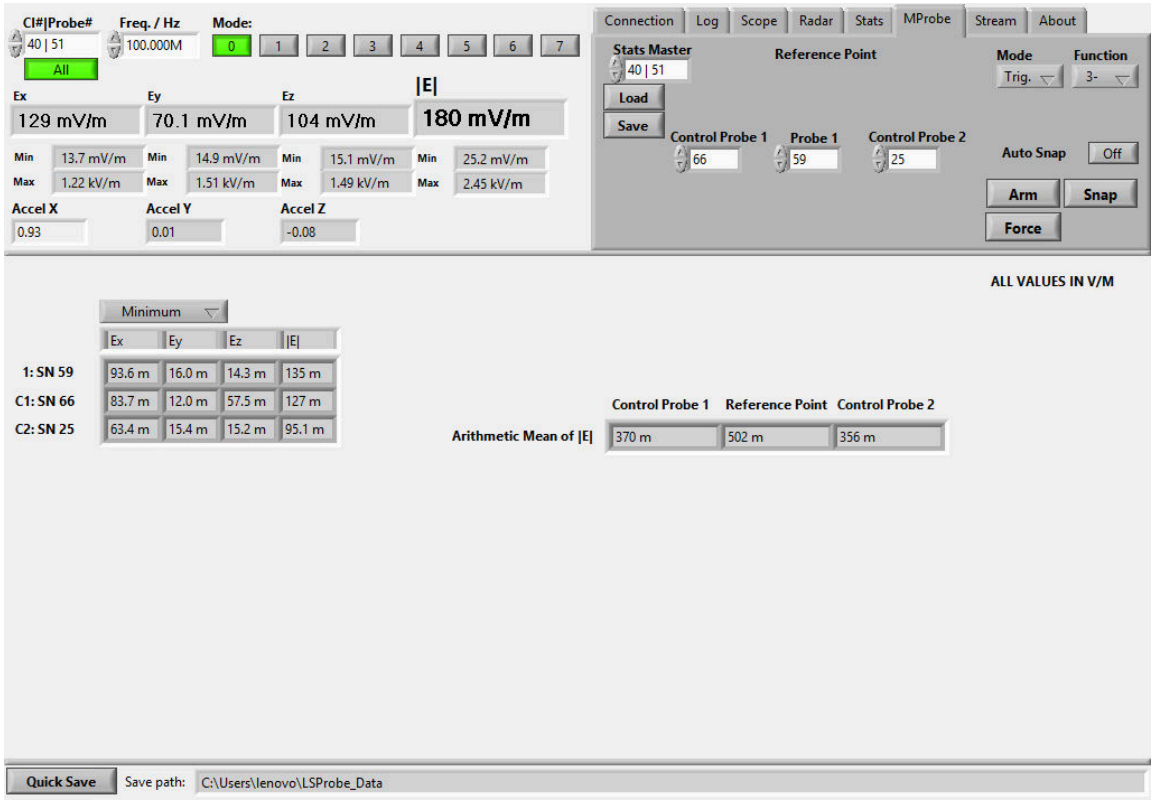


Figure 33: *LSProbe GUI, Multiprobe tab for three probe setups*

standard deviation values for x-, y-, z-axis E-field strength and E-field strength magnitude. The Multiprobe results for the reference point and the control probes are shown in on the right-hand side of the bottom pane. The values give the arithmetic mean of the E-field strength magnitude for the reference point and the the optional two control probes.

5.6.2 Four and Six Probe Setups According to ISO 11451-2

Four and six probe setups are configured and evaluated almost identically to the single and three probe setups described in Section 5.6.1. Instead of a single probe located at the reference point four probes are placed on a reference line. Consequently there are statistics values for four or six E-field probes and one or three Multiprobe statistics values as described in the previous section.

5.6.3 Eight Probe Setups According to ISO 11452-11

Eight probe setups define a probe for the corners of a cube, this is also approximated in the layout of the GUI, see Figure34. Scalar statistics values for each probe are displayed on the left-hand side of the bottom pane in the same fashion as described in Sections 5.6.1 and 5.6.2. All other controls operate in the same way as described in the previous sections.

Figure 34: *LSProbe GUI, Multiprobe tab for eight probe setups*

Multiprobe Statistics for eight probe setups consist of the arithmetic mean, standard deviation and standard deviation in dB for the maximum field strength values of the x-, y-, z- axis, evaluated both separately and jointly. This result is displayed on the right-hand side of the bottom pane.

5.6.4 Field Homogeneity Measurements According to IEC 61000-4-3

For measurements according to IEC 61000-4-3 a total of 48 points are evaluated, this is shown in Figure 35. An eight probe setup can be used to reduce the number of measurement steps to six, down from 48 measurement steps. The positions of the eight probes measured in parallel for each step are setup in the same way as described in Sections 5.6.1, 5.6.2 and 5.6.3.

Figure 35: *LSProbe GUI, Multiprobe tab for field homogeneity measurements*

The left-hand side of the bottom pane is identical to the eight probe setup in section 5.6.3.

The Multiprobe result displays a table and associated heat map of 48 x-, y-, z-axis or E-field magnitude values for minimum, maximum, arithmetic mean, root mean square and standard deviation values for each probe in the 48 probe setup. Values are copied from the eight probe into the right-hand side table by using the "Apply" buttons. The time of application will be displayed in the text fields "Time 1" through "Time 6". Using the "Quick Save" button while displaying the 48 probe display will output a csv file containing the statistics summary for measured points, see also Section 11.1.6.

5.6.5 Multiprobe Setups Using SCPI Commands

Multiprobe setups can be defined by specifying a list of E-Field Probe serial numbers using »:MProbe:FPSerial <MProbe>,<Probe1>[,<Probe2>,...,<ProbeN>]« or by giving a list of Computer Interface serial numbers using »:MProbe:CISerial <MProbe>,<Ci1>[,<Ci2>,...,<CiN>]«. Multiprobe setup definition by E-Field Probe serial numbers requires the respective E-Field Probes to be active, definition by Computer Interface serial numbers only requires the specified Computer Interfaces to be enumerated by the TCP Server.

Multiprobe setups may contain any number of field probes and may contain individual E-Field Probes multiple times, this is especially useful for testing Multiprobe setup with fewer E-Field Probes than required. The MProbe parameter may be set to any integer value greater than zero and serves as a unique Multiprobe setup identifier. Multiprobe setups can be queried using »:MProbe:FPSerial? <MProbe>« and »:MProbe:CISerial? <MProbe>«.

Statistics data covering more than one E-Field Probe is calculated using the »:MProbe:AMAGnitude? <Triggered>,<MProbe>[,<RProbe>]« and »:MProbe:MAXStatistics? <Triggered>,<MProbe>«. »:MProbe:AMAGnitude? <Triggered>,<MProbe>[,<RProbe>]« returns the averaged E-field magnitudes of a Multiprobe setup. »:MProbe:MAXStatistics? <Triggered>,<MProbe>« returns the E-field maximum values of a Multiprobe system, including arithmetic mean, standard deviation and standard deviation expressed in Decibels.

5.7 Stream Recording

5.7.1 Stream Recording Using the GUI

To configure and perform stream recordings select the "Stream" tab of the LSProbe GUI, as depicted in Figure 36.

If synchronization between multiple Computer Interfaces is required, make sure to connect the appropriate signal lines. Set the synchronization Computer Interface using the "Stream Master" drop-down list, the setting defaults to the first enumerated Computer Interface.

The number of samples to be recorded and the number of E-field values to be skipped after every recorded sample are set via the "StreamLength" and "Stream Skip Count" numeric input fields. Make sure to enable the "ALL" button when using multiple Computer Interfaces.

The synchronization source can be selected via the "Stream Sync" drop-down list. The stream file prefix is set via the "Stream Prefix" input field. The number of samples recorded during a stream recording session is displayed in the "StreamProgess" field. If the "Stream Length" input field is set to a non-zero value pressing the "Stream Enable" button will initiate the recording of the set number of samples. A stream recording may be terminated via the "Stream Enable" button before the set number of samples has been reached. If the "Stream Length" input field is set to zero stream recoding must be terminated manually via the "Stream Enable" button. Manual termination of a stream recording can lead to stream files containing a disparate number of samples.

Figure 36: *LSProbe GUI, Stream tab for stream recording*

5.7.2 Stream Recording Using SCPI Commands

Stream synchronization can be configured using the :STReam:SYNC <Sync>[,<MProbe>] SCPI command. When synchronization is enabled the stream master Computer Interface can be changed by setting the prior master CI to slave, selecting the new CI and setting to stream master using the :STReam:MAster <State> and :SYSTem:CISerial <Value> commands.

To set the maximum number of samples to be recorded use the :STReam:LENgth <Length>[,<MProbe>] command. If set to a non-zero number stream recording will terminate automatically after reaching the maximum number of samples.

The stream data rate can be reduced using the :STReam:SKIp? [<MProbe>] command, specifying the number skipped samples following each stored sample. The :STReam:PREfix <String>[,<MProbe>] command can be used to change the stream files' prefix string.

Stream recording is initiated and terminated using the :STReam:ENable <State>[,<MProbe>]. The progress of stream recording can be monitored using the :STReam:PROgress? [<MProbe>] command.

5.7.3 Shutting Down Using the LSProbe GUI

Click on the "Disable Laser" button to disable the supply laser. The orange "Laser on" and blue "Data Link" indicators will turn off. Close the LSProbe GUI window and shut down the TCP Server by typing Ctrl-C in the server window. The green "Power" indicator will change from constant on to flashing. After this set the power switch to OFF.

5.7.4 Shutting Down Using SCPI Commands

The supply laser is turned off using the »:SYSTem:LASer:ENable <Value>[,<MProbe>]« command with "0" as value. Terminate the TCP session and close the TCP server as described above.

5.8 Saving Log Files using the GUI

The "Log" tab contains controls for the file name prefix of LSProbe GUI log files, controlling both one-shot and continuous logging, see Figure 37. Separate log files are created for the "Data Logger", "Scope", "Radar", "Statistics" and "Multiprobe" tabs. One-shot log files are created using the "Quick Save" button in the lower left corner of the GUI window. The "Quick Save" button will create a new log file for the currently active tab of the LSProbe GUI. Continuous logging is enabled using the buttons next to the file name prefix. Continuous logging will add new data to the respective log file as soon as it becomes available.

Log files are stored in the path specified by the environment variable `LSPROBE_SAVE_PATH`, the path is displayed in the lower right corner of the GUI window. Log file names consist of the file name prefix extended by serial number and a timestamp as detailed in Section 11.

Logging of RSSI values, i.e. raw ADC sample values, for x-, y-, and z-axis can be enabled by selecting the "include RSSI" check box. The feature is available for "Basic Log" and "Scope Log" files.

Figure 37: *LSProbe GUI, Data Logger tab*

6 Third Party EMC Software

This section describes the setup of the LSProbe 1.2 E-Field Probe in third party EMC test automation software. Third party support files are installed in separate directories of the `lib` sub-directory of the LSProbe 1.2 install path.

Before running any third party EMC test automation software follow the hardware setup instructions detailed in Section 5.1 on page 28 and start the TCP Server as described in Section 5.2.1 on page 29.

The LSProbe GUI is not required when using third party EMC test automation software. However, the LSProbe GUI may be run in parallel as long as it is used solely for monitoring and no settings are changed using the LSProbe GUI, i.e. the user must not modify any LSProbe GUI controls, e.g. mode, frequency, low-pass filter frequency, etc. The LSProbe GUI is designed in such a way that it will not apply any settings on its own.

6.1 EMC32

LUMILOOP recommends using the most recent version of the R&S EMC32 measurement software since EMC32 integration is always tested against the most recent EMC32 release. The LSProbe 1.2 E-Field Probe is supported by EMC32 version 10.0 and later. Systems delivered before February 2017 do not support operation in mode 1 and require setting up two separate E-field probes for the low band and the high band. Newer systems may also use mode 1 and thus require only a single E-field probe entry.

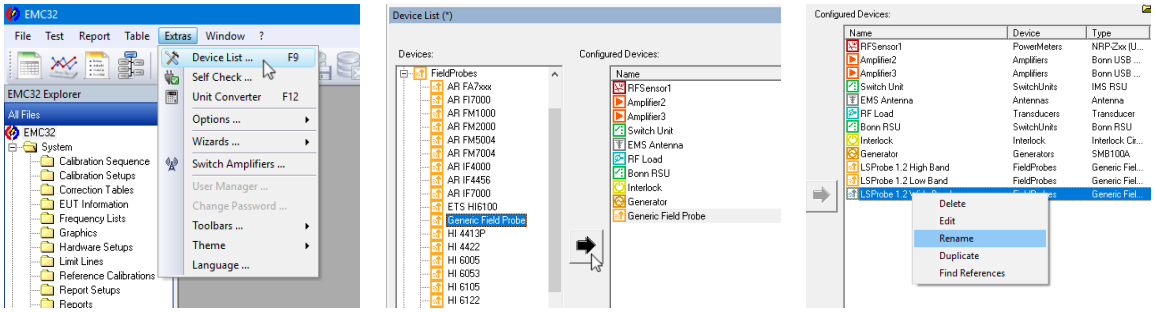
If the EMC32 installation does not already contain the following files copy the dynamic link library (DLL) `FpGeneric.dll` from the `EMC32-10.2` sub-directory of the LSProbe installation path's `lib` directory to the EMC32 installation path's `Execute\Devices` sub-directoy. A typical location is `C:\Program Files\Rohde-Schwarz\EMC32\Execute\Devices`. Also, copy all device configuration files ending in `DeviceConfiguration` from the `EMC32-10.2` sub-directory of the LSProbe installation path's `lib` directory to the EMC32 program data path's `Configuration\Others` sub-directoy, a typical location is `C:\ProgramData\EMC32\Configuration\Others`.

6.1.1 CW fields

To set up the LSProbe 1.2 E-Field Probe in EMC32 run the TCP Server as described in Sections 5.1 and 5.2.1, then start EMC32.

Open the EMC32 Device List via "Extras→Device List" in the menu bar as shown in Figure 38(a). In the "Device List" window select "Generic Field Probe" from the "Devices:" list's "FieldProbes" category and create a new "Configured Device" by clicking on the right-pointing arrow in the center as shown in Figure 38(b). This will create a new entry named "Generic Field Probe". Click the right-pointing arrow again to add a second "Generic Field Probe" entry. One field probe will be used for low band E-fields from 10 kHz to 400 MHz. The other will be used for high band E-fields from 30 MHz to

6 GHz. Rename the first "Generic Field Probe" entry to "LSProbe 1.2 High Band" and the second entry to "LSProbe 1.2 Low Band", use "right-click→Rename" as shown in Figure 38(c). For E-field probes delivered after February 2017 add a third entry named "LSProbe 1.2 Wide Band".



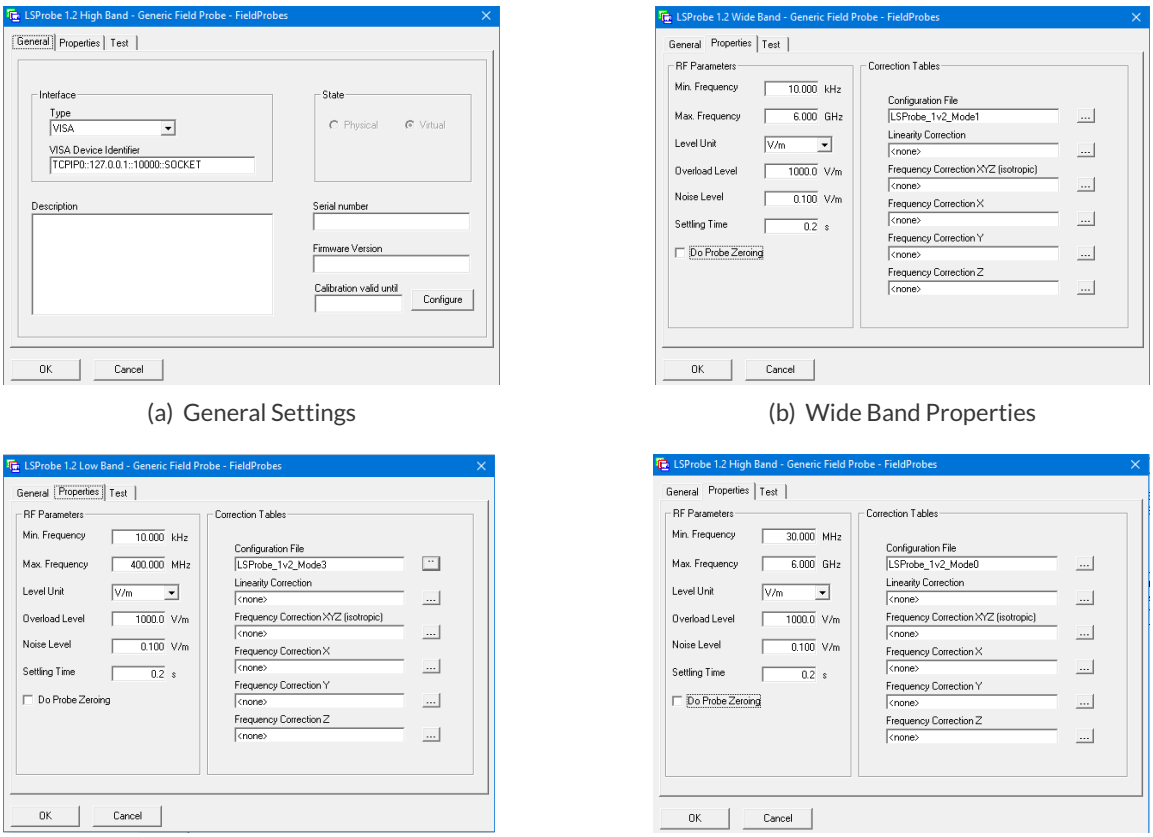
(a) Opening the Device List (b) Adding Generic Field Probes (c) Renaming Field Probes

Figure 38: *Adding the LSProbe 1.2 E-Field Probe in EMC32*

Use "right-click→Edit" to open the Generic Field Probe's settings. In the "General" tab shown in Figure 39(a) edit "VISA Device Identifier" to configure the IP address and TCP port of the LSProbe TCP Server. The identifier string has the generalized format "TCPIP0::<IP address>::<TCP Port>::SOCKET". Usually the LSProbe TCP Server is run on the same computer and listening to the default TCP port 10,000. Consequently, the default identifier string is "TCPIP0::127.0.0.1::10000::SOCKET". All other settings in the "General" tab are optional and may be left unchanged.

Select the "Properties" tab shown in Figure 39(a) through (c), edit all parameters as detailed in Table 2. Select the appropriate file for "Configuration File" located in `...\ProgramData\EMC32\Configuration\Others`. The settling time of 200 ms is chosen in such a way that it guarantees settling of the field strength values with a margin of less than one percent when used with the supplied `.DeviceConfiguration` files. The low pass filter value in the `.DeviceConfiguration` files can be adjusted by the user to accommodate longer or shorter settling times. LSProbe does not require any correction files to be set as all correction is handled transparently by the LSProbe TCP Server. Make sure all correction values are set to "<none>". Click "OK" when you are done.

To finish the setup restart EMC32 and open the EMC32 Device List via "Extras→Device List". Use "right-click→Edit" for the "LSProbe 1.2" entry appropriate for the measurement task and change "State" from "Virtual" to "Physical". This will prompt EMC32 to connect to the LSProbe TCP Server, enable the supply laser and set the appropriate mode. After establishing the correct mode the "Serial number" value turns blue, this is also indicated by the Computer Interface's LEDs as detailed in Section 3.1.2. Only one "LSProbe 1.2" entry may be set to "Physical" at a time, when changing from Low Band to High Band or vice-versa set the "Physical" device to "Virtual" first and set the other device to "Physical" after that.



(a) General Settings

(b) Wide Band Properties

(c) Low Band Properties

(d) High Band Properties

Figure 39: *Configuring LSProbe 1.2 E-Field Probes for Wide, Low and High Band in EMC32*

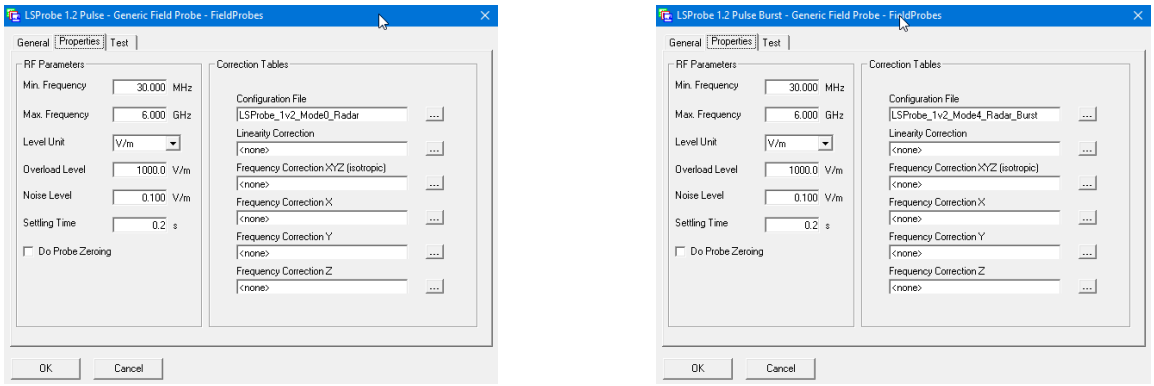
Table 2: *EMC32 Property tab values for Low and High Band*

Setting	Wide Band	Low Band	High Band
Min. Frequency	10.000 kHz	10.000 kHz	30.000 MHz
Max. Frequency	6.000 GHz	400.000 MHz	6.000 GHz
Level Unit	V/m	V/m	V/m
Overload Level	1000	1000	1000
Noise Level	0.1	0.1	0.1
Settling Time	0.2	0.2	0.2
Do Probe Zeroing	unchecked	unchecked	unchecked
Configuration File	Mode1.Device-Configuration	Mode3.Device-Configuration	Mode0.Device-Configuration
Correction Settings	<none>	<none>	<none>

6.1.2 Pulsed fields

For pulsed field strength measurements add two more generic field probe entries to the EMC32 Device List, following the steps described in Section 6.1.1. Rename the two entries to "LSProbe 1.2 Pulse Continuous" and "LSProbe 1.2 Pulse Burst". Use the high band settings from Table 2 for both entries. Substitute "Mode0.Device-Configuration" for "LSProbe_1v2_Mode0_Radar" and "LSProbe_1v2_Mode4_Radar_Burst" respectively. Mode 0 corresponds to the entry "LSProbe 1.2 Pulse Continuous" and mode 4 corresponds to the entry "LSProbe 1.2 Pulse Burst" as shown in Figure 40.

The default setting of both device configuration files is suitable for the GMW-3097 standard. It will use the x-axis field strength for triggering at 10 V/m, record 100,000 samples and retrieve the averaged pulse field strength magnitude and x-, y- and z-axis values. The trigger parameters can be modified by editing the respective device configuration files in lines 49 through 53. See Section 5.4.4 for more information about the trigger subsystem's SCPI commands.



(a) Mode 0 Pulse (Continuous)

(b) Mode 4 Pulse (Burst)

Figure 40: *Configuring LSProbe 1.2 E-Field Probes for pulse measurements in EMC32*

6.2 BAT-EMC

The BAT-EMC test automation software supports CW and pulsed E-field measurements. BAT-EMC requires a DLL file, make sure that "FieldP_Lumliloop_LS12.dll" is present in the BAT-EMC directory "...\BAT-EMC\BAT-EMS".

Please import the provided E-field Fieldmeter equipment models listed in Table 3 by right-clicking on "Fieldmeter" inside the "Equipment" tree structure as shown in Figure 41.

If the IP address and/or the port number of the LSProbe connection differ from the default values of localhost and port 10,000 go to the "Equipment" subsection and change the "Address" input field appropriately, see also Figure 41.

BAT-EMC requires the LSProbe 1.2 Field Probe to be enabled and configured before performing measurements. Before starting BAT-EMC start the LSProbe TCP Server and optionally LSProbe GUI,

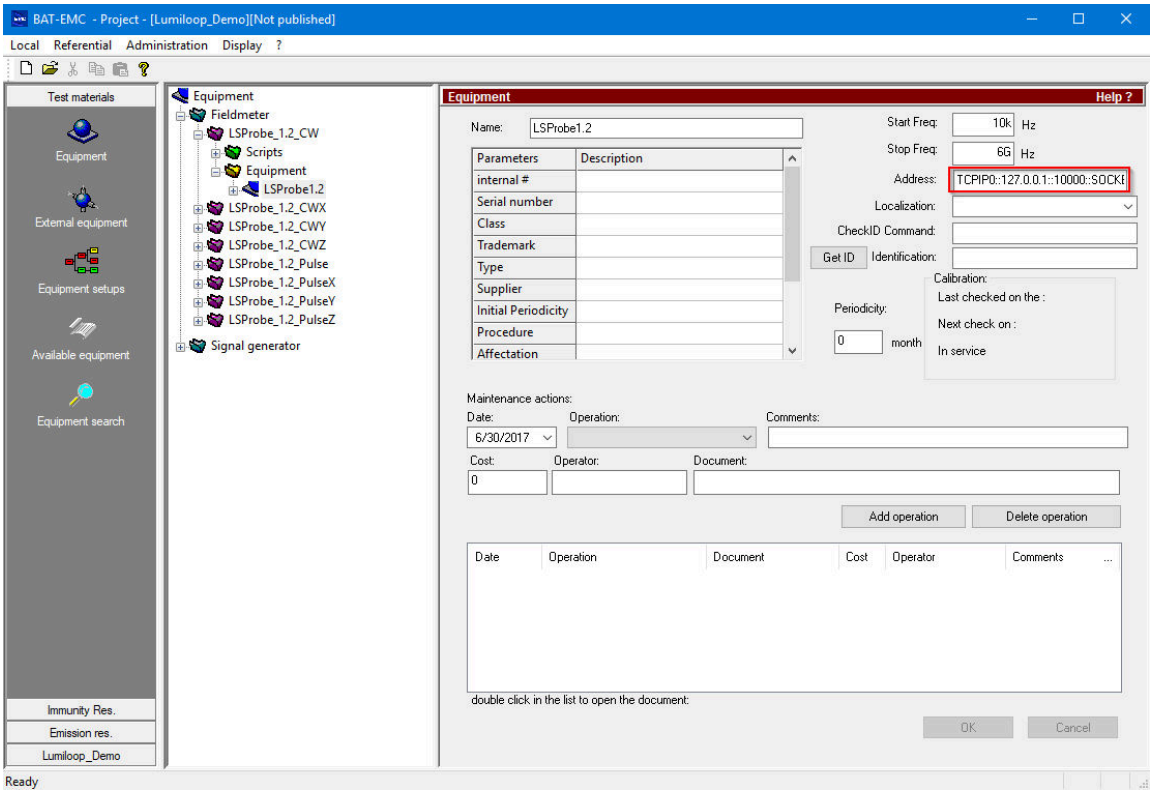


Figure 41: *BAT-EMC Equipment editor, network configuration*

Table 3: *BAT-EMC equipment model files for CW and pulsed fields*

CW	Pulsed
LSProbe_1.2_CW.xml	LSProbe_1.2_Pulse.xml
LSProbe_1.2_CWX.xml	LSProbe_1.2_PulseX.xml
LSProbe_1.2_CWY.xml	LSProbe_1.2_PulseY.xml
LSProbe_1.2_CWZ.xml	LSProbe_1.2_PulseZ.xml

enable the supply laser, and set the desired field probe mode as described in Sections 5.2.1 through 5.2.5.

6.2.1 CW E-field measurements

The Fieldmeter model "LSProbe_1.2_CW" handles all communication including checking the supply laser's status, setting/checking the operating frequency as well as retrieving isotropic, x-, y- and z-axis field strength values. The Fieldmeter returns the isotropic field strength value and stores the field strength of the individual axes in the global variables named "AX", "AY" and "AZ". The three Fieldmeter models "LSProbe_1.2_CW[X/Y/Z]" retrieve the global variables and return the respective axis' field strength values. When measuring x-, y- and z-axis field strengths the "LSProbe_1.2_CW" Fieldmeter model must be called first.

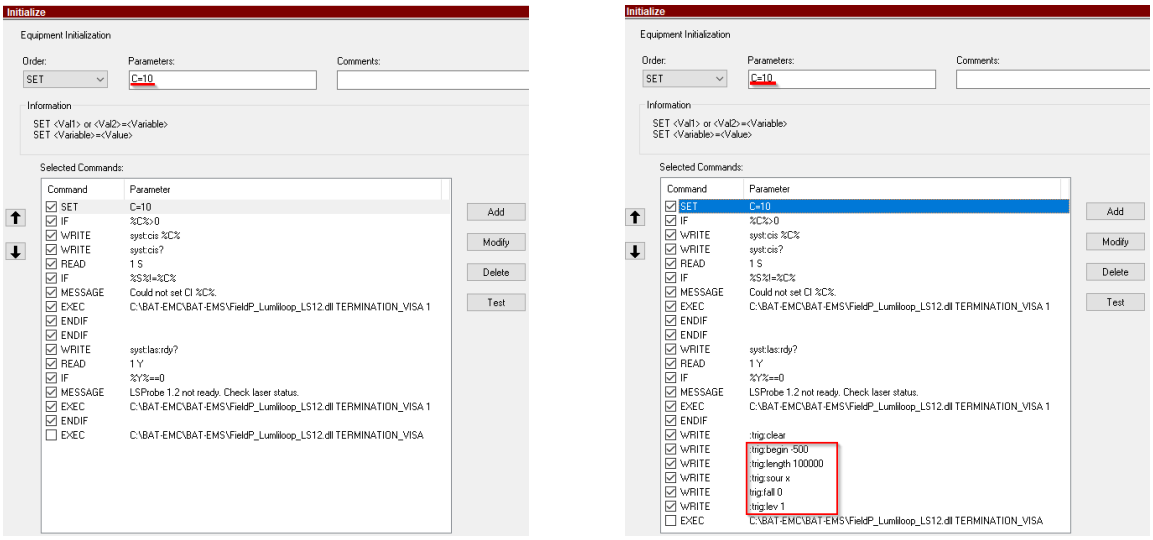
6.2.2 Pulsed E-field measurements

The Fieldmeter model "LSProbe_1.2_Pulse" handles all communication including checking the supply laser's status, setting/checking the operating frequency as well as retrieving isotropic, x-, y- and z-axis field strength values. Additionally, the Fieldmeter model includes commands for trigger subsystem configuration, trigger detection and radar pulse property retrieval. The Fieldmeter returns the isotropic field strength value and stores the field strength of the individual axes using global variables named "AX", "AY" and "AZ". The three Fieldmeter models "LSProbe_1.2_Pulse[X/Y/Z]" read these global variables and return the respective axis' field strength values. When measuring x-, y- and z-axis field strengths the "LSProbe_1.2_CW" Fieldmeter model must be called first.

The trigger subsystem's configuration can be modified via the Fieldmeter model's "Initialize" script, the relevant commands are shown inside the red frame in Figure 42(b). See Section 5.4.4 for more information about the trigger subsystem's SCPI commands.

Figure 43 shows the "Measure level" script of the "LSProbe_1.2_Pulse" Fieldmeter model. Every call to the "Measure level" script arms the trigger subsystem, waits for the trigger subsystem to acquire a waveform, checks the number of pulses and queries the averaged pulsed field strengths.

The default setting of the "LSProbe_1.2_Pulse" Fieldmeter model is suitable for the GMW-3097 standard. It will record 100,000 samples (see the trigger length setting in Figure 42(b)), verify that there



(a) LSProbe_1.2_CW Initalize script (b) LSProbe_1.2_Pulse Initalize script

Figure 42: *Configuring the Initialize scripts for LSProbe 1.2 CW and pulse measurements in BAT-EMC*

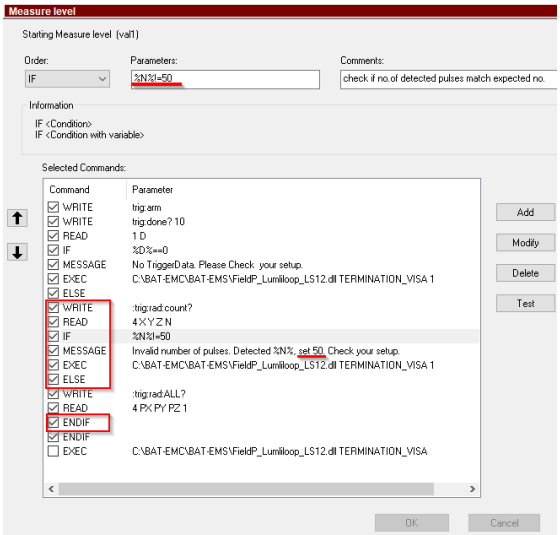


Figure 43: *Addressing a specific Computer Interface using BAT-EMC*

are a total of 50 pulses (see the topmost red frame in Figure 43) and retrieve the averaged pulse field strength magnitude and x-, y- and z-axis values. The trigger source, trigger length and expected pulse count can be modified by editing the respective scripts. Pulse count checking can be disabled by unchecking all boxes in the two lower red frames in Figure 43.

If more than one Computer Interface are attached to the host computer set the variable CI in Figure 42 to a value other than zero. Doing so will enable the setting and verification of the Computer Interface's serial number. The Figure demonstrates setting the Computer Interface serial number to 10, the serial number must be changed to match the desired Computer Interface's serial number. The variable is available for both CW and pulsed Fieldmeter models.

For monitoring multiple Computer Interfaces in parallel create a copy of all Fieldmeter models by right-clicking on the Fieldmeter models and choosing "duplicate". Adjust all model names and Computer Interface serial number variable settings appropriately.

6.3 RadiMation

LUMILOOP recommends using the most recent version of the DARE!! RadiMation measurement software. The LSProbe field probe driver has been included in the RadiMation drivers package since March 2017. The latest version of the RadiMation software and its device drivers package can be downloaded from `http://wiki.dare.nl/wiki/index.php/Main_Page`.

Before using the LSProbe 1.2 E-Field Probe in RadiMation run the LSProbe TCP Server, enable the laser supply and select the desired mode as described in Sections 5.2.1, 5.2.3 and 5.2.4. RadiMation will neither change the supply laser nor the mode setting.

Every newly connected LSProbe field probe needs to be added to the RadiMation device list choosing it from the RadiMation device driver list. Open the "Configuration" window via "Configuration→Configuration" in the menu bar. Inside the "Device Drivers" tab choose "Field sensors" as the "Device Driver Type" as shown in Figure 44

As shown in Figure 45 click the "Add" button and select "LUMILOOP LSProbe 1.2" from the list. Next click the "New" button and enter a description of the field probe, e.g. "LUMILOOP LSProbe 1.2", finish by clicking "Ok".

A "Device Driver Settings" window will open as shown in Figure 46. Click the "Advanced" button and select the "Settings tab". Enter the correct Computer Interface number of the LSProbe to be connected. The low-pass filter frequency is also adjustable in this window. Click "Ok" to close the advanced setting window and the "Device Driver Settings" window. The TCP host and port can be configured using the "Communication" tab.

The newly created field probe device can be selected available via "Devices→Field sensors" as shown in Figure 47.

Figure 48 shows the window used for connecting to and testing the LSProbe 1.2 field probe. Use the "Connect" button for establishing the connection and the "Trigger" button for obtaining field strength readings for the operating frequency set via the "Carrier frequency" control.

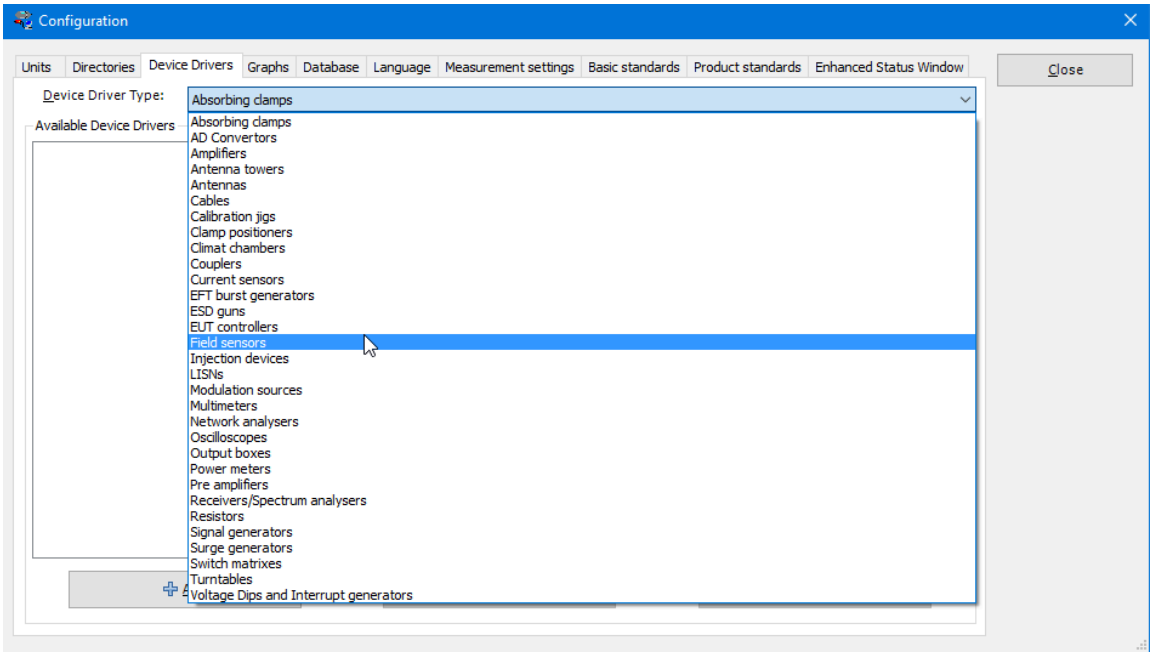


Figure 44: *Choosing field sensors in RadiMation configuration*

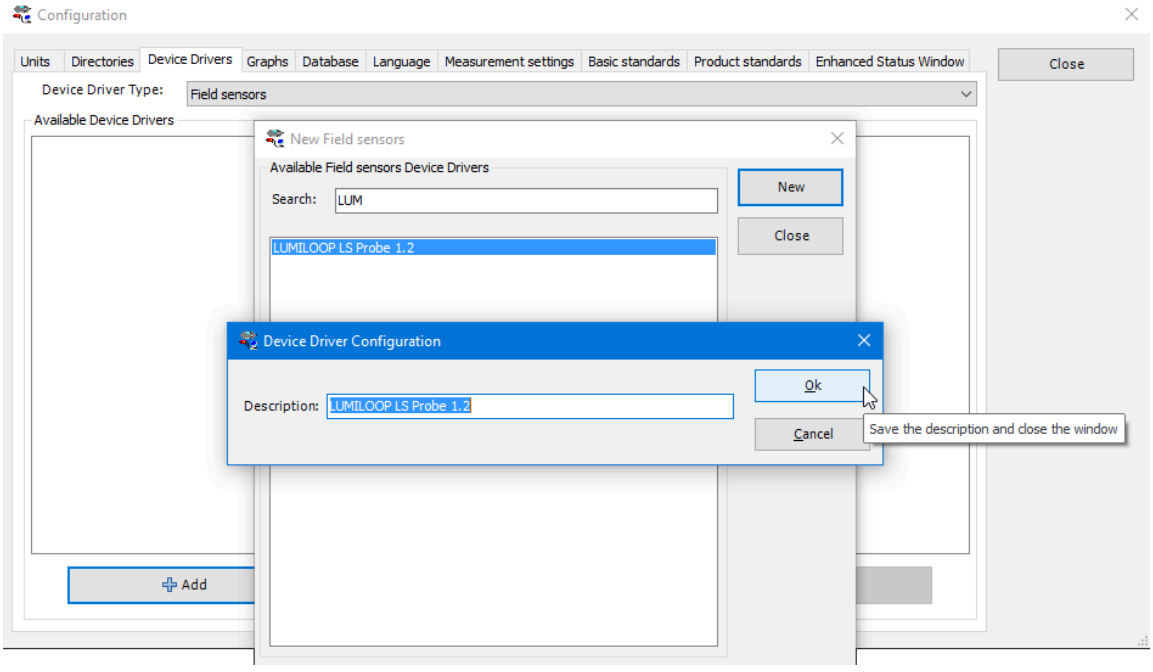


Figure 45: *Adding a new LSProbe field sensor in RadiMation*

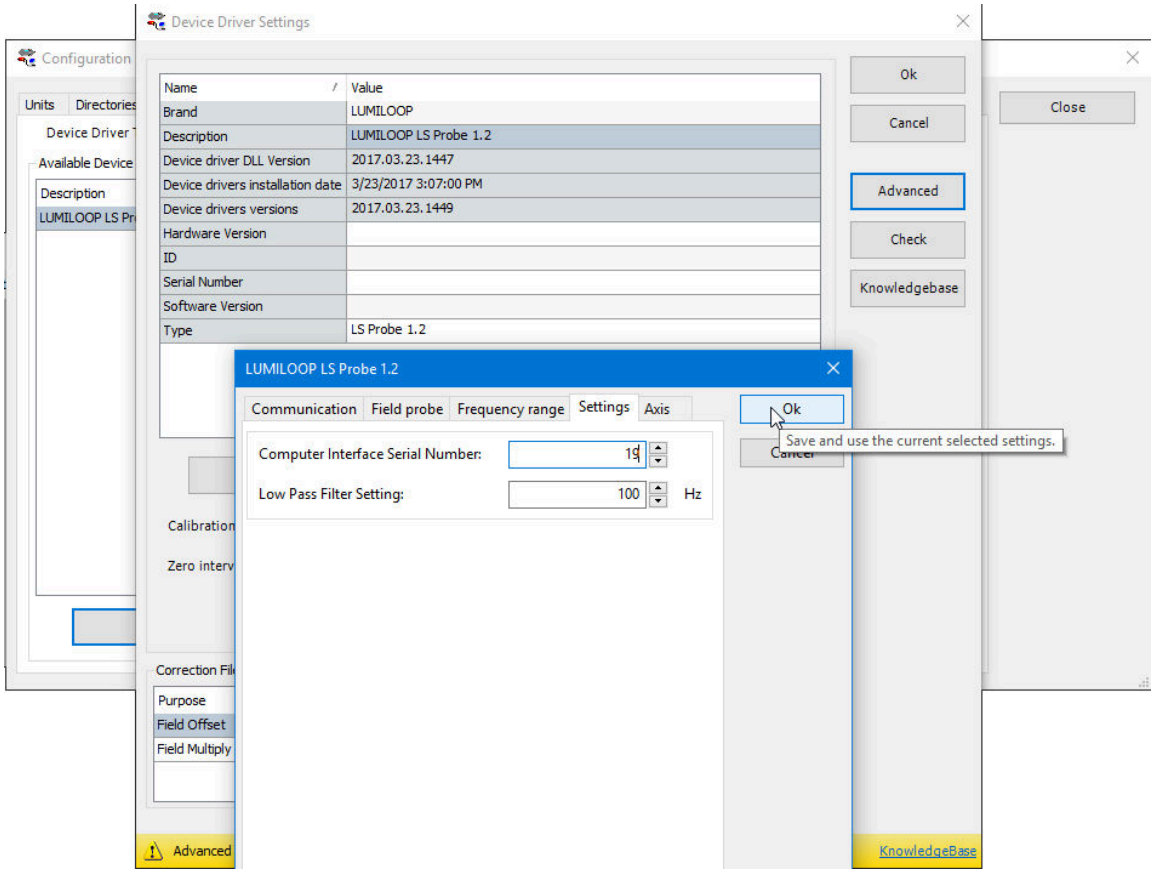


Figure 46: *Configuring LSProbe field probe in RadiMation*

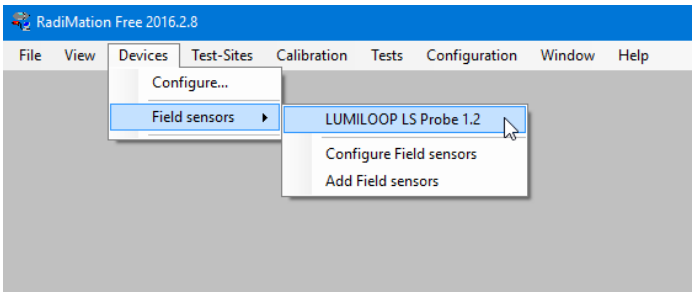


Figure 47: *Selecting new field sensor in RadiMation*

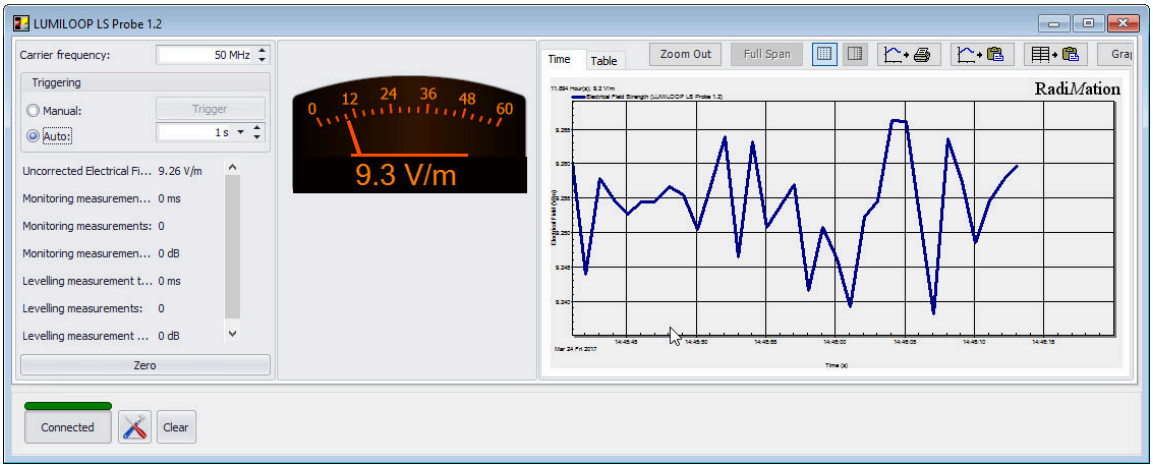


Figure 48: *Connecting and testing LSProbe 1.2 field sensor in RadiMation*

6.4 Win6000

LUMILOOP recommends using the most recent version of the Teseq Win6000 measurement software since Win6000 integration is always tested against the most recent Win6000 release. The LSProbe 1.2 E-Field Probe is supported by Win6000 version 1.35 and later.

Start Win6000 and install the packages `drv_LSProbe1.2_Ver2017-03-27.zip` and `LUMILOOP_LSProbe2.1_Test2.zip` contained in the `lib\Win6000` subdirectory of the LSProbe installation path. As shown in Figure 49 use "Packages→Install Package" in the menu bar for both packages.

By default Win6000 will connect to port 10,000 of an LSProbe TCP Server running on the same host. To change the host or TCP port setting open `LSProbe1.2.drv` typically located in `C:\Teseq\Teseq\Devices`. In line 20 of `LSProbe1.2.drv` change "127.0.0.1" to the desired TCP host and "10000" to the desired TCP port number.

Before using the LSProbe 1.2 E-Field Probe in Win6000 run LSProbe the TCP Server. Open the test setup via "SysConf→Open" and select the "LUMILOOP_LSProbe" setup's subsection "using as device of monitoring system" as shown in Figure 50.

Within the test setup shown in Figure 51, click on "Monitoring" to configure the channels to be recorded.

Choose "LSProbe 1.2" from the list of available devices, name the channel and open the channel's settings dialog as shown in Figure 52. Select the desired mode, sensor type (E-field x-, y-, z-axis magnitude or temperature) and low-pass filter cut-off frequency. Choose whether calibration information is to be shown. Close the configuration by clicking "OK".

Start the measurement via "Run→ Start Automatic Test Execution" in the menu bar. Fill in the following dialogs to configure the recording of measurement data appropriately. Figure 53 shows a measurement run, note that Win6000 will display wait messages when performing mode switching.

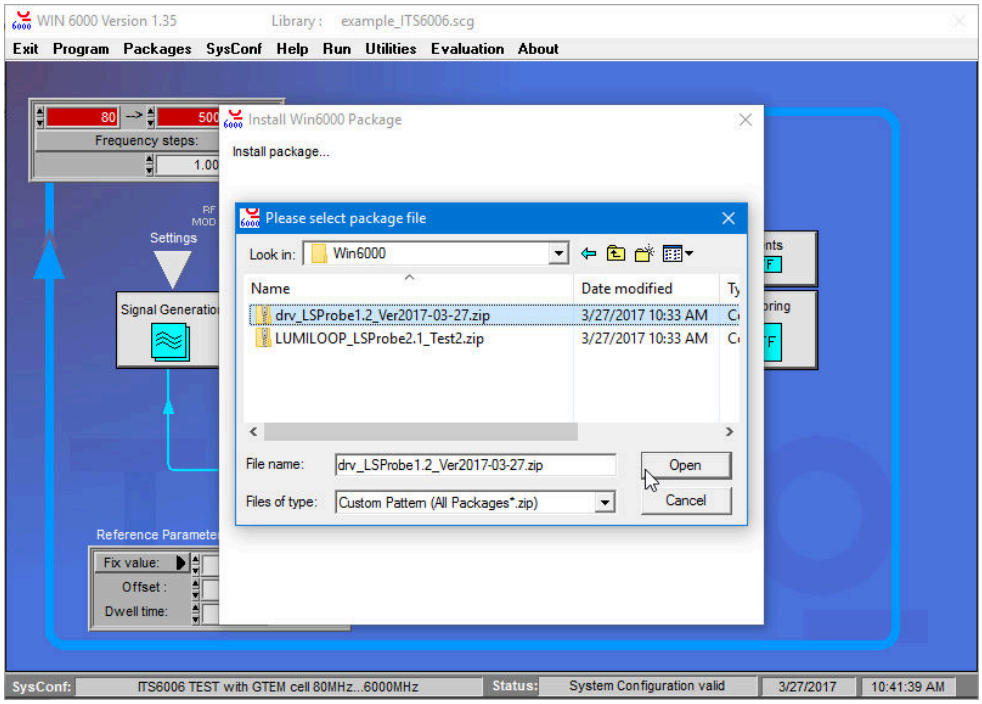


Figure 49: *Installing Win6000 driver and test setup packages*

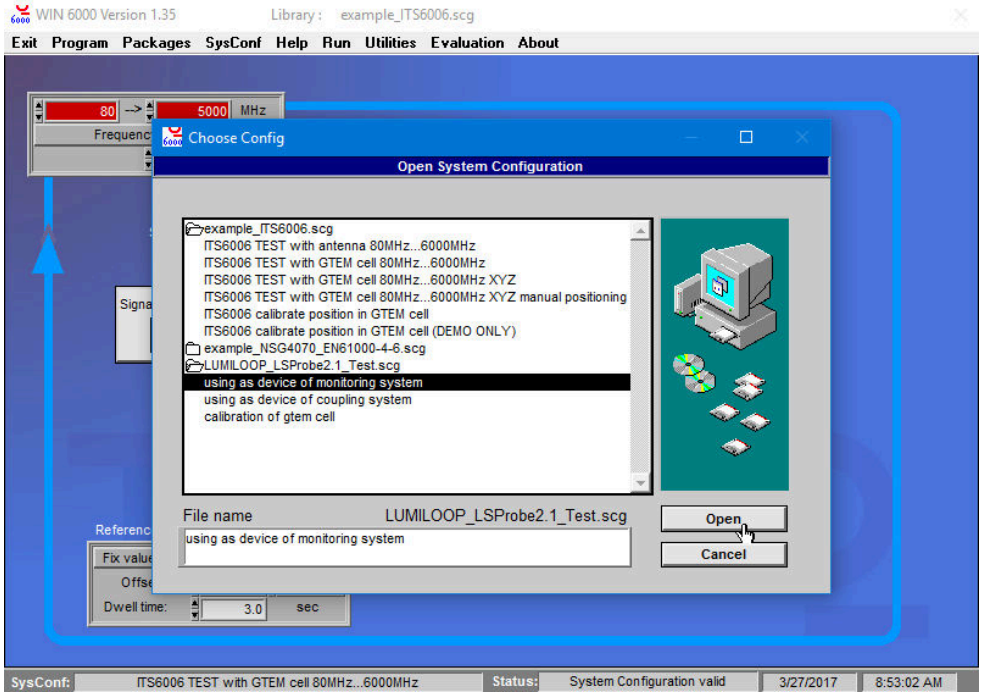


Figure 50: *Loading Win6000 LSProbe 1.2 test setup in Win6000*

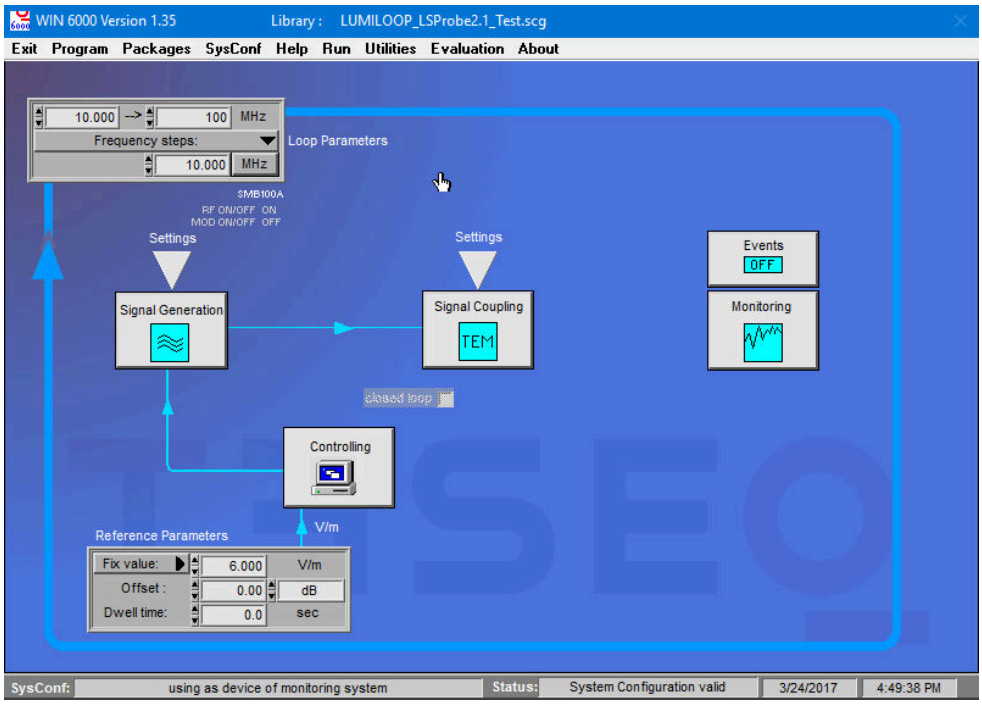


Figure 51: *Configuring LSProbe 1.2 test setup in Win6000*

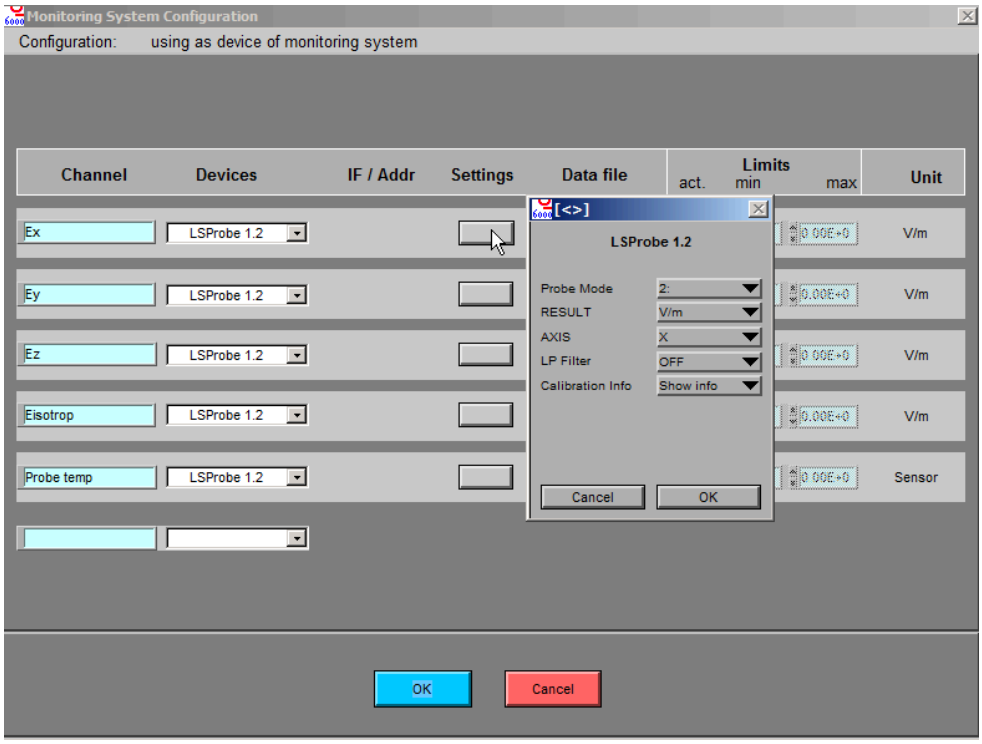


Figure 52: *Selecting LSProbe 1.2 mode, axis and low-pass filter in Win6000*

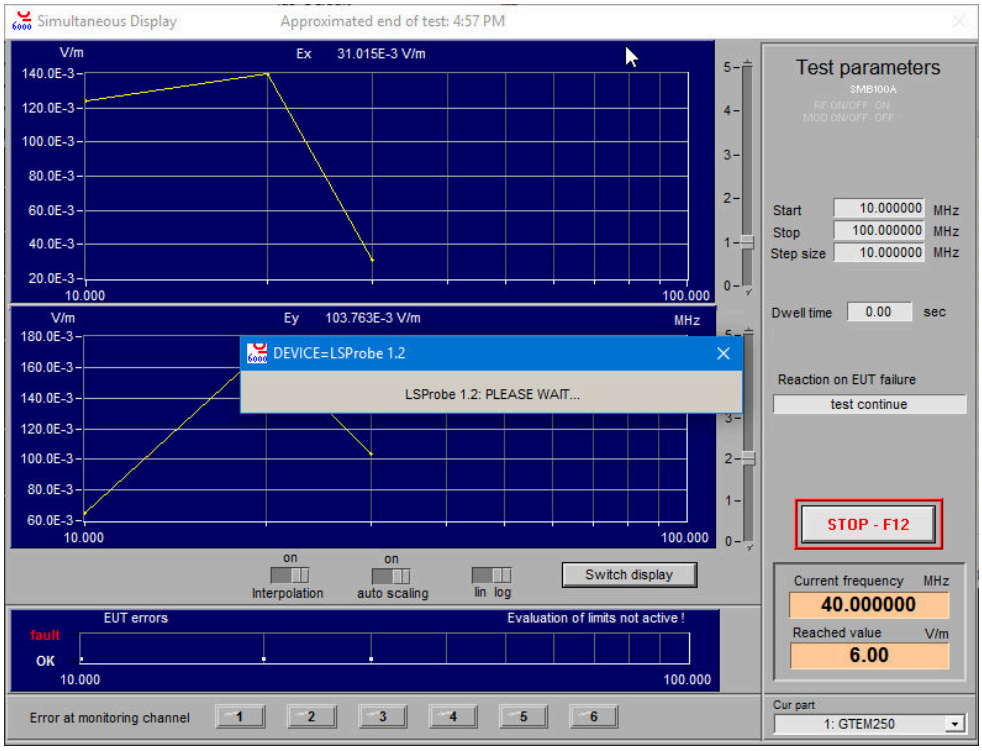
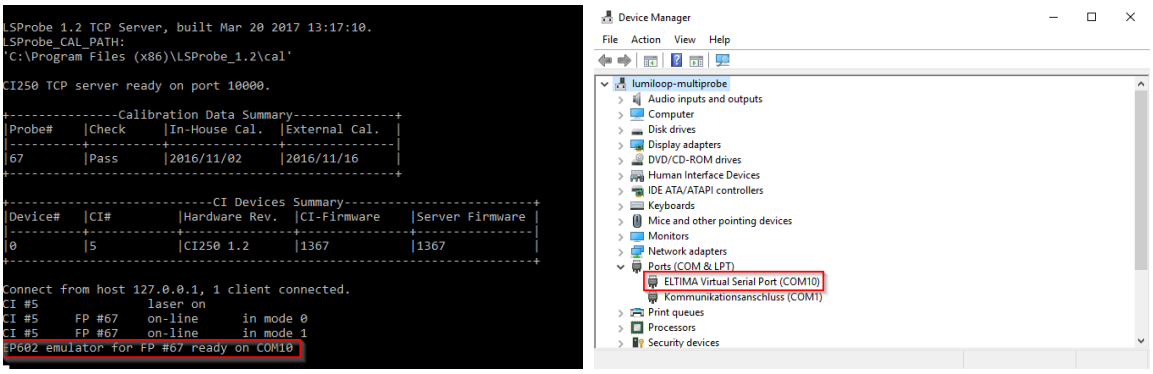


Figure 53: *Measurement run in Win6000*

7 Serial Port Protocol Emulation

The LSProbe TCP Server is capable of closely emulating the serial protocol of the PMM EP60x E-field probe series. This enables the seamless integration into a wide range of existing test setups and third party EMC software without requiring a dedicated device driver. The serial port protocol emulation provides basic asynchronous read-out and filtering of x-, y-, z-axis E-field values and E-field magnitude values. Advanced features such as high speed waveform acquisition, triggering, pulse detection, statistics and Multiprobe setups require a dedicated device driver.

On entering mode 1, which supports the complete operating frequency range, the LSProbe TCP Server will create a virtual serial port and indicate the COM port number as shown in Figure 54. Virtual serial port names start from COM10. The LSProbe TCP Server reserves the lowest available COM number to offer serial command access. The virtual serial port is configured to use 9600 baud, no parity, one stop bit and no flow control. Different settings, especially baud rates will normally not hinder communication over the virtual serial port as the virtual serial line's settings are not enforced strictly.



(a) LSProbe TCP Server (b) Device Manager

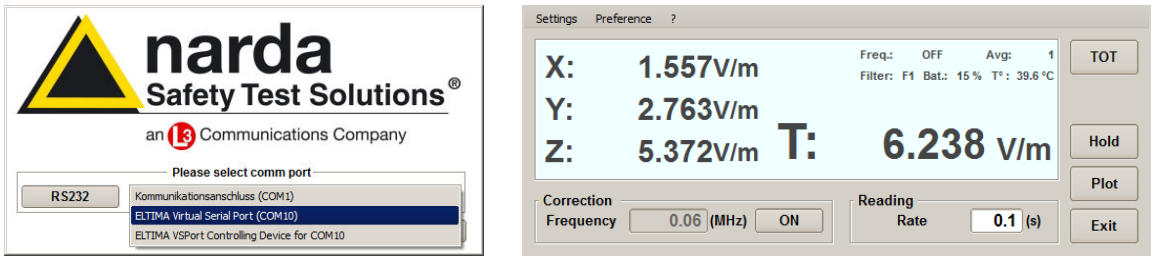
Figure 54: *Virtual serial port for EP60x emulation in mode 1*

7.1 Using LSProbe 1.2 via the WinEP600 Software

Use the LSProbe GUI to enable the supply laser and set the mode to 1 as described in Sections 5.2.3 and 5.2.4. Optionally, close the GUI afterwards.

Run WinEP600 and select the virtual COM port indicated by the LSProbe TCP Server as shown in Figure 55(a). Do **not** use the COM port containing the string "VSPort Controlling Device". Click "RS232" to open the connection.

Figure 55(b) shows the WinEP600 Software communicating with the LSProbe TCP Server. Note that setting frequency correction to "OFF" will in fact not disable frequency correction but set the correction frequency to 10 kHz. The indicated battery voltage is the E-Field Probe's optically generated



(a) Serial Port Section (b) Main Window

Figure 55: *Using WinEp600*

supply voltage, the displayed temperature is the E-Field Probe's internal temperature, which is always significantly higher than its ambient temperature. The E-Field Probe's serial number is available through the help menu under "? → Info → Serial" indicated before the "S" character of the displayed text.

The filter setting is handled in such a fashion that the cut-off frequency will be emulated. The notch characteristics will be ignored. Note that on closing WinEP600 the E-Field Probe will not be shut down even if commanded to. The E-Field Probe can be shut down using the GUI as described in Section 5.7.3.

7.2 Serial Command Reference

All serial commands are case-sensitive, start with a "#" character and end with a "*" character. The two characters following "#" indicate the field probe's address between "00" and "99". An address of "00" will be accepted regardless of the serial number set using the commands "@c" and "@Ia", detailed below.

The supported command strings between serial number and "*" are explained in the following sections.

7.2.1 ?v

Query version string, consisting of emulated field probe type, pseudo firmware version and the calibration date. If available, the external calibration date will be used rather than the in-house calibration date. E.g. the query "#00?v*" will return "vEP602:1.12 11/16;" for a field probe calibrated in November of 2016.

7.2.2 ?p

Query calibration date string of the emulated field probe. If available, the external calibration date will be used rather than the in-house calibration date. E.g. the query "#00?p*" will return "p11/16;" for a field probe calibrated in November of 2016.

7.2.3 ?b

Query E-Field Probe's optically generated supply voltage in V, encoded as a two byte, big endian encoded, 16 bit unsigned integer value. E.g. the query "#00?b*" will return "b" followed by two bytes encoding the voltage code n. The battery voltage can be calculated as $V_{bat} = 4.8\,\mathrm{V}\frac{n}{1024}$.

7.2.4 ?t

Query E-Field Probe's internal temperature in °C, encoded as a two byte, big endian encoded, 16 bit unsigned integer value. E.g. the query "#00?t*" will return "t" followed by two bytes encoding the temperature code t. The battery voltage can be calculated as $T_{int} = 281.7\,^{\circ}\mathrm{C}\left(\frac{1.6t}{1024} - 0.986\right)$.

7.2.5 ?s

Query E-Field Probe's serial number string consisting of a total of 33 characters. E.g. the query "#00?s*" will return "s00001S00000" followed by 21 zero-valued bytes for an E-Field Probe with the serial number 1. The Serial number is contained in the five characters preceding "S".

7.2.6 ?T

Query the square of the E-field strength's magnitude in V²/m², encoded as a four byte, little endian, single precision IEEE floating point number. E.g. the query "#00?T*" will return "T" followed by four bytes containing the squared field strength magnitude.

7.2.7 ?A

Query x-, y- and z-axis components of the E-field strength in V/m, each encoded as a four byte, little endian, single precision IEEE floating point number. E.g. the query "#00?A*" will return "A" followed by three times four bytes containing the field strength value for x-, y- and z-axis.

7.2.8 kf

Set the operating frequency expressed in multiples of 10 kHz. The command returns the character "k" followed by four bytes encoding the operating frequency in MHz as a four byte, little endian, single precision IEEE floating point number. E.g. the command "#00?k 10000*" will set the operating frequency to 100 MHz and return the character "k" followed by four bytes containing the operating frequency in MHz. If the set frequency is outside the E-Field Probe's calibrated frequency range the nearest calibrated frequency will be set and returned.

7.2.9 fn

Set the low-pass filter characteristic. Settings between 0 and 7 are allowed. The command contains a single ASCII-coded number giving the filter number n. The values 0 through 7 correspond to low-pass filter cut-off frequencies of 28, 24, 8, 4.7, 4, 4, 3.2 and 2.3 Hz. Note that the notch characteristics of the original EP60x filter is not implemented by the emulation. The command returns the character "f" followed by one byte echoing the set mode number between 0 and 7. E.g. the command "#00?f0*" will select the first filter characteristic having a 28 Hz cut-off frequency and return "f0".

7.2.10 et

Originally, the command is used to set the time before the EP60x field probe switches off automatically. Since the LSProbe 1.2 is laser-powered, the command serves no useful purpose for emulation. The input of the command is therefore ignored and always acknowledged. E.g. the command "#00?e 300*" for setting the timeout to five minutes will be ignored and be acknowledged by a single "e" character.

7.2.11 !

Originally, the command is used to switch the EP60x field probe off. Since the LSProbe 1.2 is laser-powered, the command serves no useful purpose for emulation. The command is therefore ignored. The command returns no reply.

7.2.12 @c

Enter address-storing mode for the next second. The command returns no reply. E.g. "#00@c*" will enter address-storing mode.

7.2.13 @Ia

When in address-storing mode, set the field probe address to a value between 0 and 99. The command consists of the two characters "@I" followed by the parameter a, two ASCII characters stating an address between "00" and "99". The command returns "ERR" if not in storing mode and "I" followed by two bytes echoing the set address if in storing mode. E.g. "#00@I11*" will set the address to 11 and return "I11".

8 Virtual E-Field Probes

The LSProbe TCP Server is capable of instantiating virtual Computer Interfaces and associated E-Field Probes including the simulation of arbitrary E-Field patterns.

Virtual E-Field Probes can replace physical field probes and signal generators during measurement setup preparation, feature demonstration, third party EMC software development and off-line signal analysis, including Multiprobe setups.

The following virtual Computer Interface and E-Field Probe properties can be can be configured:

- Computer Interface serial number,
- Computer Interface supply laser state,
- Field Probe serial number,
- Field Probe temperature,
- Field Probe operating voltage,
- Field Probe x-, y- and z-axis acceleration and
- Field Probe x-, y- and z-axis E-field strength, see pattern description below.

Virtual Computer Interface serial numbers and Field Probe serial numbers must be unique, i.e. must not duplicate the serial numbers of any physical or virtual units. Virtual E-Field Probe serial numbers must be configured before enabling the virtual supply laser.

E-field patters for x-, y-, and z-axis are simulated by summing up RSSI patterns of the following types:

CW (continuous wave)
: Generates constant RSSI values.

Noise
: Generates random RSSI values with a configurable maximum amplitude whose time-average is zero.

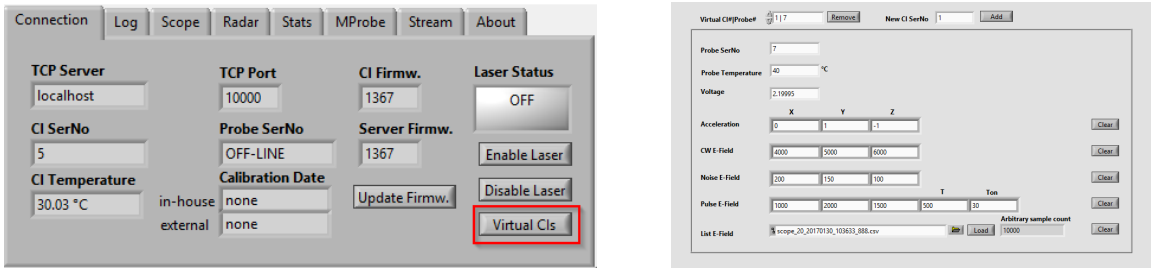
Pulse
: Generates periodically pulsed RSSI values whose OFF-value is zero and whose ON-value is configurable for each axis. The pattern's ON-time and period are configurable and apply to all axes.

List
: Generates a sequence of arbitrary RSSI values, optionally calculated from a list of E-field values, using the present mode, operating frequency and temperature. The sequence is repeated indefinitely.

Virtual E-Field Probes support all modes. Triggering is supported with the exception of external trigger input and output. Virtual E-Field Probes support the collection of continuous statistics. By default virtual Computer Interfaces are configured as statistics slave CIs. Statistics snapshots are recorded when the statistics master CI triggers a snapshot, the master CI may be physical or virtual. Note that a virtual statistics master CI cannot control physical statistics slave Computer Interfaces.

8.1 Controlling Virtual E-Field Probes Using the GUI

To open the "Virtual Probes Control Panel" press the "Virtual Probes" button in the "Connection" tab as shown in Figure 56.



(a) LSProbe GUI (b) Virtual Probes Control Panel

Figure 56: *Opening the Virtual Probes Control Panel of the LSProbe GUI*

Click the "Add" button to add a new virtual Computer Interface with the specified CI serial number. The "Virtual CI#|Probe#" ring lists all connected virtual Computer Interfaces with their associated Field Probe serial numbers. Click the "Remove" button to disconnect the currently selected Computer Interface.

The selected virtual Computer Interface and associated Field Probe can be configured using the controls in the frame below. Virtual Probe serial number, temperature, operating voltage, acceleration and field strength pattern components are set using the controls inside the frame. Settings take effect as soon as they are entered. The "Clear" buttons can be use to reset the corresponding settings to their default values.

E-Field value lists can be loaded from Scope-Log CSV files whose format is described in Section 11.1.2 on page 139. The file name is selected via the "List E-Field" control. Clicking "Load" will append all E-Field values to the virtual Field Probe's list buffer. The list can be emptied using the corresponding "Clear" button.

8.2 Controlling Virtual E-Field Probes Using SCPI Commands

Virtual Computer Interfaces are added using »:VIRTual:CONnect [<CI>]«. »:VIRTual:CISerial?« lists the serial numbers of all virtual Computer Interfaces. The currently selected virtual Computer Interface can be removed using »:VIRTual:DISConnect« The virtual Field Probe's serial number, temperature, supply voltage, acceleration values, and parametric field strength patterns are set/queried using the following SCPI commands:

- »:VIRTual:FPSerial <Value>«/»:VIRTual:FPSerial?«,
- »:VIRTual:TEMPerature <Temperature>«/»:VIRTual:TEMPerature?«,
- »:VIRTual:VOLTage <Voltage>«/»:VIRTual:VOLTage?«,
- »:VIRTual:ACCeleration <ACCx>,<ACCy>,<ACCz>«/»:VIRTual:ACCeleration?«,

- »:VIRTual:CW <RSSIx>,<RSSIy>,<RSSIz>«/»:VIRTual:CW?«,
- »:VIRTual:NOIse <NOISEx>,<NOISEy>,<NOISEz>«/»:VIRTual:NOIse?« and
- »:VIRTual:PULse [<RSSIx>],[<RSSIy>],[<RSSIz>],[<T>],[<Ton>]«/»:VIRTual:PULse?«.

Arbitrary E-field values are appended to the virtual Field Probe's list using »:VIRTual:LIST <RSSIx1>,<RSSIy1>,<RSSIz1>[,...,<RSSIxN>,<RSSIyN>,<RSSIzN>]«. The complete list of E-field strength values is queried using »:VIRTual:LIST?«. »:VIRTual:LCNt?« returns the number of samples in the list. »:VIRTual:LCLear« clears the list of values.

9 Field Probe Calibration

LSProbe 1.2 uses in-house and external calibration files for calculating accurate field strength values based on the ADC values generated by each of the E-Field Probe's axes, see Figure 5 on page 16 for a principle block diagram of the E-Field Probe.

In-house linearity, frequency and temperature compensation files, i.e. LFP files, whose format is detailed in Section 11.2.1, contain the relationship between field strength detector input power and returned ADC value. They cover all axes, modes, frequencies, input power levels and operating temperatures. The LSProbe TCP Server interpolates between these recorded data points to obtain a linearity-compensated and temperature compensated detector characteristic for each axis.

In-house E-field calibration files, i.e. IE files, whose format is detailed in Section 11.2.2, contain the ADC values for a constant E-field strength and operating temperature. Standard values are 10 V/m and room temperature. They cover all axes, modes and frequencies. The LSProbe TCP Server uses the detector characteristics generated from the LPF files in combination with the values contained in the IE files to interpolate the in-house calibrated E-field strength.

The reference field strength for the in-house E-field calibration is established using a transfer standard, i.e. a reference E-Field Probe. Using a transfer standard results in an increased calibration uncertainty and represents no accredited procedure. Therefore, LSProbe supports the inclusion of externally generated, accredited calibration data.

External field strength calibration files, i.e. EE files, whose format is detailed in Section 11.2.3, contain the E-field strength errors in Decibels for a constant E-field strength, constant operating temperature and desired number of frequencies. Typically, 10 V/m and room temperature are used, the default set of frequencies is given below. A different field strength value can be chosen as long as the field strength can be generated for the entire calibration frequency range. Though it is recommended to use the given set of calibration frequencies for both external and internal field strength calibration, it is permissible to use a different set of frequencies. The LSProbe TCP Server will interpolate or extrapolate the calibration factors as needed.

The standard calibration frequencies in mode 0 are 30, 40, 50, 60, 70, 80, 90, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, 300, 320, 340, 360, 380, 400, 420, 440, 460, 480, 500, 520, 540, 560, 580, 600, 620, 640, 660, 680, 700, 720, 740, 760, 780, 800, 820, 840, 860, 880, 900, 920, 940, 960, 980, 1000, 1050, 1100, 1150, 1200, 1250, 1300, 1350, 1400, 1450, 1500, 1550, 1600, 1650, 1700, 1750, 1800, 1850, 1900, 1950, 2000, 2050, 2100, 2150, 2200, 2250, 2300, 2350, 2400, 2450, 2500, 2550, 2600, 2650, 2700, 2750, 2800, 2850, 2900, 2950, 3000, 3050, 3100, 3150, 3200, 3250, 3300, 3350, 3400, 3450, 3500, 3550, 3600, 3650, 3700, 3750, 3800, 3850, 3900, 3950, 4000, 4050, 4100, 4150, 4200, 4250, 4300, 4350, 4400, 4450, 4500, 4550, 4600, 4650, 4700, 4750, 4800, 4850, 4900, 4950, 5000, 5050, 5100, 5150, 5200, 5250, 5300, 5350, 5400, 5450, 5500, 5550, 5600, 5650, 5700, 5750, 5800, 5850, 5900, 5950 and 6000 MHz.

The standard calibration frequencies in mode 3 are 0.01, 0.015, 0.02, 0.03, 0.05, 0.07, 0.1, 0.3, 0.5, 0.7, 1, 3, 5, 7, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, 300, 320, 340, 360, 380 and 400 MHz.

9.1 Calibration Data Acquisition

External field strength calibration is always performed in mode 0 and 3 against the in-house E-field calibration data, recording the actual and indicated E-field strength. The usage of preexisting external calibration data is prevented by issuing a »:CALibration:EXTernal <Value>[,<MProbe>]« command with the parameter Value set to zero, this command is mandatory.

The following information should be recorded for each combination of mode, frequency and axis, ensuring a verifiably correct calibration procedure:

- operating frequency as set by the calibration setup,
- actual E-field strength generated by the calibration setup,
- x-, y- and z-axis ADC values, i.e. RSSI values, using the SCPI commands »:MEASure[:FProbe]:RSsi:X? [<MProbe>]«, »:MEASure[:FProbe]:RSsi:Y? [<MProbe>]« and »:MEASure[:FProbe]:RSsi:Z? [<MProbe>]«,
- internal field probe temperature, using the »:MEASure[:FProbe]:ATEMPerature? [<MProbe>]« SCPI command,
- set field probe operating frequency, using the »:SYSTem:FREQuency? [<MProbe>]« SCPI command,
- x-, y- and z-axis components and magnitude of the E-field strength, using the »:MEASure[:FProbe]:Efield:ALL? [<MProbe>]« SCPI command,
- Computer Interface serial number, using the »:SYSTem:CISerial? [<MProbe>]« SCPI command,
- E-Field Probe serial number, using the »:MEASure[:FProbe]:SERialnumber? [<MProbe>]« SCPI command,
- E-Field Probe mode, using the »:MEASure[:FProbe]:MODe? [<MProbe>]« SCPI command,
- Computer Interface firmware version, using the »:SYSTem:REVision? [<MProbe>]« SCPI command,
- LSProbe TCP Server firmware version, using the »:SYSTem:FWUPdate?« SCPI command,
- the time stamp of the measurement.

For maximum accuracy the laser supply should be enabled at least 20 minutes before the first measurement, allowing the E-Field Probe to warm up and settle at a constant temperature.

9.2 Automated Calibration Data Import

External field strength calibration CSV files need to be derived from the data acquired during the calibration procedure. The LSProbe software installation includes the "CalImport" program for simple, quick and error-free calibration data import. The default file format and naming conventions are stated below. If your calibration setup cannot meet these conventions contact LUMILOOP for inclusion of a suitable import function in the "CalImport" program.

By default the import tool expects a total of nine CSV files for each field probe as input, three files for each axis. For each axis two files contain the data for measurements in mode 0 and one file contains the data for measurements in mode 3. Measurements in mode 0 are stored in two separate files, one for low frequencies, e.g. up to 1 GHz and one for high frequencies, e.g. higher than 1 GHz.

In order for the "CalImport" program to recognize the described files the following case-sensitive naming conventions must be followed:

- exactly nine files must be stored in one directory,
- all files must end in `.csv`,
- x/y/z axis files must start with `x`/`y`/`z`,
- mode 0 low frequency files must contain `_Mode0_MHz_`,
- mode 0 high frequency files must contain `_Mode0_GHz_`,
- mode 3 files must contain the string `_Mode3_MHz_`.

The CSV files must fulfill the following conventions:

- columns are separated by semicolons (`;`),
- line breaks are indicated by newline charachters (`\n`),
- the first line contains the column header, this information is ignored by the "CalImport" program
- starting with the second line values are stated as decimal integers, floating point numbers or exponentially coded floating point numbers, using the period character (`.`) as the decimal separator.

The CSV files must contain the following 18 columns:

1. calibration setup frequency in MHz, regardless of the CSV file's name
2. actual E-field strength in V/m
3. x-axis RSSI value in LSB
4. y-axis RSSI value in LSB
5. z-axis RSSI value in LSB
6. internal probe temperature in °C
7. operating frequency as output by E-Field Probe in Hz
8. power picked up by directional coupler of dBm, if value is not available set value to zero
9. x-axis E-field strength in V/m
10. y-axis E-field strength in V/m
11. z-axis E-field strength in V/m
12. magnitude of E-field strength in V/m
13. Computer Interface serial number
14. Field Probe serial number
15. Field Probe mode
16. firmware revision number of Computer Interface
17. firmware revision provided by LSProbe TCP Server
18. time stamp of measurement, expressed as the number of seconds since Jan 1 1904

The "CalImport" program is depicted in Figure 57. Follow these steps for calibration data import:

- Enter the path containing the files to be imported via the "Calibration Data path" control of the GUI,
- set the value of "Calibration Certificate String",

- set the calibration date via "Year", "Month" and "Day",
- press the button "Import CSV files",
- verify the correctness of the file names displayed under "Mode 3 GTEM X/Y/Z", "Mode 0 GTEM X/Y/Z" and "Mode 0 Absorber X/Y/Z",
- review the contents of the text displayed under "Contents of generated file",
- review the graph displayed within the "Graphs" tab,
- review the values displayed within the "Numeric Data" tab,
- press the button "Export CSV file" and store the external field strength calibration CSV file as `snX.csv`, where `X` denotes the decimally coded Field Probe serial number, e.g. `sn12.csv`.

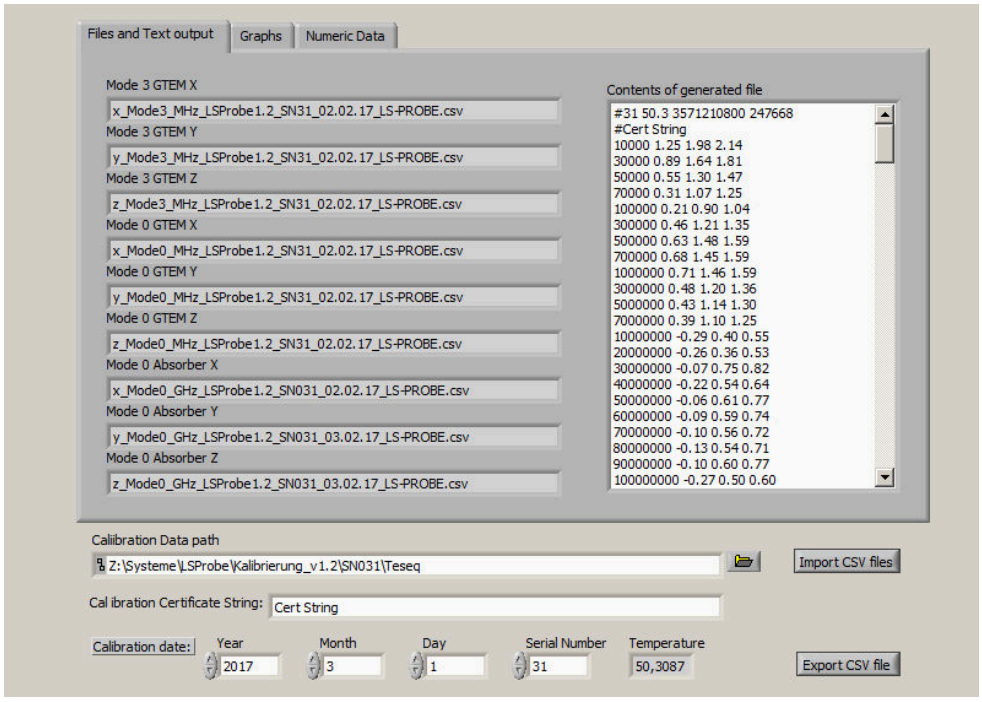


Figure 57: *"CalImport" calibration data import program*

The "CalImport" program uses data recorded in mode 3 for frequencies lower than 30 MHz. All other values use measurement data recorded in mode 0.

10 SCPI Command Reference

10.1 Multiprobe Behavior

Most SCPI commands support the optional MProbe parameter determining the Multiprobe behavior of the respective command. The following MProbe parameters are available:

EMPTY
: If the MProbe parameter is omitted the command will only be executed for the presently active Computer Interface.

0
: If the MProbe parameter is set to zero the command is executed for all enumerated Computer Interfaces. Computer Interfaces will be enumerated and displayed sorted by their serial numbers starting with the smallest value.

N
: If the MProbe parameter set to a number N that is greater than zero the command will be executed for all Computer Interfaces of the specified Multiprobe setup, see :MProbe:FPSerial? <MProbe> and :MProbe:CISerial? <MProbe> for the order of E-Field Probe and Computer Interface serial numbers.

When any SCPI command is executed for more than one field probe, i.e. the MProbe parameter refers to multiple Computer Interfaces, the command behaves as if executed for each Computer Interface of the specified Multiprobe system successively. The order of execution is the same as the serial numbers returned by »:MProbe:FPSerial? <MProbe>« and »:MProbe:CISerial? <MProbe>«. All output will be joined on a single line by replacing line breaks between the output of different Computer Interfaces with commas. For the sake of brevity the return value descriptions in the following sections do not explicitly state the return values for Multiprobe calls if they conform to the format explained above.

10.2 Generic Commands

10.2.1 *CLS

Clear all status registers and structures, e.g. error queue.

10.2.2 *ESE <ESR>

Set event status enable register. This feature is currently not implemented.

PARAMETERS:
: Integer value for event status register.

10.2.3 *ESE?

Query event status enable register. This feature is currently not implemented.

RETURN VALUE:
Returns the integer value of the event status register.

10.2.4 *ESR?

Query the most recent error status register value. The error will be removed from error queue.

RETURN VALUE:
Value of most recent errors in error queue.

10.2.5 *IDN?

Query TCP Server identification string.

RETURN VALUE:
Comma-separated string, consisting of maker, product name, product version, TCP server build date and TCP server build time, e.g. »LUMILOOP,LSProbe,1.2,Jun 2 2016,08:07:06«.

10.2.6 *OPC

Set operation complete flag after the completion of the previously sent command. This feature is currently not implemented.

10.2.7 *OPC?

Query operation complete flag. This feature is currently not implemented.

RETURN VALUE:
Always 1.

10.2.8 *RST

Reset TCP server. This will close all previously opened Computer Interfaces, rescan the USB bus and open all detected Computer Interfaces. This will perform a power-on reset of all Computer Interfaces.

The TCP server will print enumeration status information to its standard error output.

10.2.9 *SRE <int>

Set service request enable register. This feature is currently not implemented.

PARAMETER:
Integer value of service request enable register.

10.2.10 *SRE?

Query service request enable register. This feature is currently not implemented.

RETURN VALUE:
Always 0.

10.2.11 *STB?

Query status byte. Note that only bit 4 is currently implemented.

RETURN VALUE:
The returned integer value contains the following status flags:

BIT 0
Unused bit.

BIT 1
Protection event flag, currently not implemented.

BIT 2
Error/Event queue message available.

BIT 3
Questionable status, currently not implemented.

BIT 4
Message available, currently not implemented.

BIT 5
Standard event status register, currently not implemented.

BIT 6
Service request, currently not implemented.

BIT 7
Operation status flag, currently not implemented.

10.2.12 *TST?

Initiate self test and return test result. This feature is currently not implemented.

RETURN VALUE:

0 on success and 1 on passing the self test.

10.2.13 *WAI

Wait for the completion of the previously issued command. This feature is currently not implemented.

10.3 :SYSTem Commands

10.3.1 :SYSTem:ERRor[:NEXT]?

Query most recent entry in system error queue and remove entry from error queue.

RETURN VALUE:

Returns comma-separated error and error message string enclosed in quotes, e.g. »0,"No error".«

10.3.2 :SYSTem:ERRor:COUNt?

Query number of entries in system error queue.

RETURN VALUE:

Number of values in error queue.

10.3.3 :SYSTem:CISerial <Value>

Select active Computer Interface by serial number. The old syntax "SYSTem:SNUMber:SET <Value>" remains supported.

PARAMETER:

One serial number out of the list returned by :SYSTem:CISerial? [<MProbe>] with the MProbe parameter set to 0.

10.3.4 :SYSTem:CISerial? [<MProbe>]

Query serial number of one or multiple Computer Interfaces. The old syntax "SYSTem:SNUMber:GET? [<MProbe>]" remains supported.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

Unsigned integer-valued serial number of selected Computer Interface or comma-separated list of Computer Interface serial numbers for Multiprobe systems. If no Computer Interfaces have been enumerated the command will return NAN.

10.3.5 :SYSTem:MAKer? [<MProbe>]

Query maker identification string of one or multiple Computer Interfaces.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

Name string of the device maker, e.g. »LUMILOOP«.

10.3.6 :SYSTem:DEVice? [<MProbe>]

Query device identification string of one or multiple Computer Interfaces.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

Name string of the device, e.g. »LSProbe«.

10.3.7 :SYSTem:VERSion? [<MProbe>]

Query device version string of one or multiple Computer Interfaces.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

Version string of the device, e.g. »1.2«.

10.3.8 :SYSTem:REVision? [<MProbe>]

Query firmware revision of one or multiple Computer Interfaces.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUES:

An unsigned integer value indicating the firmware's revision number is returned.

10.3.9 :SYSTem:FWUPdate <FirmwareVersion>[,<MProbe>]

Update Computer Interface FPGA firmware of one or multiple Computer Interfaces. Make sure that the laser is powered off before initiating an update.

PARAMETERS:

The first unsigned integer-valued parameter FirmwareVersion is used to prevent inadvertent firmware updates. It must match the value of the firmware version provided by the TCP server, see :SYSTem:FWUPdate?.

The second optional unsigned integer parameter MProbe is described in Section 10.1.

10.3.10 :SYSTem:FWUPdate?

Query firmware revision provided by TCP server.

RETURN VALUE:

Unsigned integer value specifying the firmware revision number provided by the TCP server.

10.3.11 :SYSTem:DEBUG <Value>

Set value of debug flags in debug register. Doing so makes the TCP output debug information to standard error.

PARAMETER:

Unsigned integer value containing flags for debugging purposes. Setting a bit to 1 enables debug output, setting a bit to 0 disables debug output. The bit positions of the debug flags are defined as follows:

BIT 0

Enable memory consumption information.

BIT 1

Enable timing information.

BIT 2
: Enable echoing of all incoming TCP server messages.

BIT 3
: Enable echoing of all outgoing TCP server messages.

BIT 4
: Enable timing and data throughput information for USB communications.

BIT 5
: Enable calibration data and interpolation information.

BIT 6
: Enable trigger information.

BIT 7
: Enable emulator information.

BIT 8
: Enable streaming information.

BIT 9
: Enable statistic information.

E.g. enable SCPI command input and output debugging by issuing »:syst:debug 12«.

10.3.12 :SYSTem:DEBUG?

Query value of debug flags in debug register.

RETURN VALUE:
: Unsigned integer value containing the debug flags. See :SYSTem:DEBUG <Value> for the description of the individual debug flags.

10.3.13 :SYSTem:LASer:ENable <Value>[,<MProbe>]

Enable or disable supply laser of one or multiple Computer Interfaces.

PARAMETERS:
: Enable laser(s) by setting Value to 1, disable laser(s) by setting value to 0.

  The second, optional unsigned integer parameter MProbe is described in Section 10.1.

10.3.14 :SYSTem:LASer:ENable? [<MProbe>]

Query status of supply laser of one or multiple Computer Interfaces.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUES:

An unsigned integer value indicating the laser supply status will be returned. If a laser is off the return value is 0, if it is on the return value will be 1.

10.3.15 :SYSTem:LASer:RDY? [<MProbe>]

Query mode lock status of one or multiple Computer Interfaces.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUES:

An unsigned integer value of 1 indicates that the system is ready to operate in the configured mode, a value of 0 indicates that the laser supply is either off or in start-up.

10.3.16 :SYSTem:LASer:TOut? [<MProbe>]

Query laser timeout status of one or multiple Computer Interfaces.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUES:

An unsigned integer value of 1 indicates that the laser has been turned off by the safety turn-off function, a value of 0 indicates normal operation. If executed for all Computer Interfaces a list of comma-separated unsigned integer values as described above will be returned in the same order as for :SYSTem:CISerial? [<MProbe>].

10.3.17 :SYSTem:MODe <Mode>[,<MProbe>]

Set E-Field Probe operating mode of one or multiple Computer Interfaces.

PARAMETERS:

The unsigned integer parameter Mode specifies the E-Field Probe operating mode as described in Table 1 on page 17. Valid values are 0, 2, 3, 4, 6 and 7.

The second, optional unsigned integer parameter MProbe is described in Section 10.1.

10.3.18 :SYSTem:MODe? [<MProbe>]

Get E-Field Probe operating mode of one or multiple Computer Interfaces.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUES:

An unsigned integer mode value as described in Table 1 on page 17 will be returned.

10.3.19 :SYSTem:FREQuency <Frequency>[,<MProbe>]

Set frequency for frequency-compensated operation of one or multiple Computer Interfaces.

PARAMETERS:

The first floating point-valued parameter sets the desired frequency. If the frequency exceeds the calibrated frequency range for the mode set via :SYSTem:MODe <Mode>[,<MProbe>] the frequency will be forced to the nearest calibrated frequency.

The second, optional unsigned integer parameter MProbe is described in Section 10.1. E.g. »:syst:freq 1e9,0« will set the compensation frequency to 1 GHz for all enumerated Computer Interfaces, »:syst:freq 2e9« will set the compensation frequency to 2 GHz for the currently selected Computer Interface.

10.3.20 :SYSTem:FREQuency? [<MProbe>]

Query frequency for frequency-compensated operation of one or multiple Computer Interfaces.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUES:

A floating point value indicating the set compensation frequency will be returned.

10.4 :CALibration Commands

10.4.1 :CALibration:EXTernal <Value>[,<MProbe>]

Enable or disable application of external calibration data of one or multiple Computer Interfaces. After start-up the application of external calibration data is enabled.

PARAMETERS:

Enable application of external calibration data by setting Value to 1, disable application by setting Value to 0.

The second, optional unsigned integer parameter MProbe is described in Section 10.1.

10.4.2 :CALibration:EXTernal? [<MProbe>]

Query application of external calibration data of one or multiple Computer Interfaces.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUES:

An unsigned integer value indicating if external calibration data is being applied or not will be returned. If external calibration data is being applied the command returns 1, otherwise zero will be returned. NAN will be returned if the E-Field Probe is off or there is no external calibration data.

10.4.3 :CALibration:CERTificate? [<MProbe>]

Query external calibration certificate string of one or multiple Computer Interfaces.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUES:

An external calibration certificate string as given in the external calibration data CSV file will be returned. If the external calibration data CSV file does not contain a certificate string, the E-Field Probe is off or there is no valid external calibration data "undefined" will be returned.

10.4.4 :CALibration:TStamp? [<MProbe>]

Query in-house and external calibration time stamps of one or multiple Computer Interfaces.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUES:

A pair of unsigned integer values indicating the time stamp of in-house calibration and external calibration will be returned. Tim stamps are expressed as the number of seconds since Jan 1 1904 00:00:00. NAN will be returned if the E-Field Probe is off or there is no valid in-house or external calibration data. NAN will also be returned for the external calibration time stamp if external calibration data has been disabled using :CALibration:EXTernal <Value>[,<MProbe>].

10.5 :MEASure Commands

10.5.1 :MEASure:CInterface:TCold? [<MProbe>]

Query the cold side temperature of the laser's Peltier cooler for one or multiple Computer Interfaces. The cold side temperature is controlled within 15 to 25 °C by Peltier cooler for safe long-time laser

operation.

PARAMETER:
The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:
The command returns the float-valued laser temperature in °C.

10.5.2 :MEASure:CInterface:THot? [<MProbe>]

Query the hot side temperature of the laser's Peltier cooler for one or multiple Computer Interfaces. The temperature is measured at the Computer Interface's tubular heat sink. The temperature value is close to the Peltier cooler's hot side temperature when the laser is being cooled. In the rare case that the laser is being heated this temperature will be lower than the laser's temperature returned from :MEASure:CInterface:THot? [<MProbe>].

PARAMETER:
The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:
The command returns the float-valued laser heat sink temperature in °C.

10.5.3 :MEASure:CInterface:VPeltier? [<MProbe>]

Query Peltier cooler voltage for one or multiple Computer Interfaces.

PARAMETER:
The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:
The command returns the float-valued peltier cooler voltage in Volts.

10.5.4 :MEASure:CInterface:IPeltier? [<MProbe>]

Query Peltier cooler current for one or multiple Computer Interfaces.

PARAMETER:
The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUES:
The command returns the float-valued peltier cooler current in Amperes.

10.5.5 :MEASure:CInterface:VSWLaser? [<MProbe>]

Query switching supply voltage for laser supply for one or multiple Computer Interfaces.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUES:

The command returns the float-valued voltage value of step-down voltage controller in Volts. This supply rail is approximately 200 mV higher than the laser's supply voltage and serves to improve laser supply efficiency.

10.5.6 :MEASure:CInterface:VLINLaser? [<MProbe>]

Query linear regulator voltage for laser supply for one or multiple Computer Interfaces.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUES:

The command returns the float-valued voltage value of linear voltage controller in Volt. This voltage is the laser's supply voltage.

10.5.7 :MEASure:CInterface:ILaser? [<MProbe>]

Query laser supply current for one or multiple Computer Interfaces.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUES:

The command returns the float-valued peltier cooler current in Amperes.

10.5.8 :MEASure:CInterface:MAGnitude? [<MProbe>]

Query magnitude of optical receiver A/B received signal strength for one or multiple Computer Interfaces.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUES:

The command returns the unsigned integer valued magnitude of receiver A followed by receiver B in arbitrary units.

10.5.9 :MEASure[:FProbe]:Efield:X? [<MProbe>]

Query E-field x-axis component for one or multiple Computer Interfaces. The old syntax "MEASure[:PRObe]:Efield:X? [<MProbe>]" remains supported.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUES:

The command returns the float-valued x-axis E-field component in V/m. Values are low-pass filtered as described in :MEASure[:FProbe]:Efield:LPFrequency <Frequency>[,<MProbe>]. NAN will be returned if the E-Field Probe is off, in start-up or if there is no valid calibration data.

10.5.10 :MEASure[:FProbe]:Efield:MINX? [<MProbe>]

Query minimum value of x-axis E-field range for one or multiple Computer Interfaces. The old syntax "MEASure[:PRObe]:Efield:MINX? [<MProbe>]" remains supported.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

The command returns the float-valued minimum calibrated E-field component in V/m. The value is determined using the calibration data for a given frequency and mode. NAN will be returned if the E-Field Probe is off, in start-up or if there is no valid calibration data.

10.5.11 :MEASure[:FProbe]:Efield:MAXX? [<MProbe>]

Query maximum value of x-axis E-field range for one or multiple Computer Interfaces. The old syntax "MEASure[:PRObe]:Efield:MAXX? [<MProbe>]" remains supported.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

The command returns the float-valued maximum calibrated E-field component in V/m. The value is determined using the calibration data for a given frequency and mode. NAN will be returned if the E-Field Probe is off, in start-up or if there is no valid calibration data.

10.5.12 :MEASure[:FProbe]:Efield:Y? [<MProbe>]

Query E-field y-axis component for one or multiple Computer Interfaces, see :MEASure[:FProbe]:Efield:X? [<MProbe>] for a description of parameters and return values. The old syntax "MEASure[:PRObe]:Efield:Y? [<MProbe>]" remains supported.

10.5.13 :MEASure[:FProbe]:Efield:MINY? [<MProbe>]

Query minimum value of y-axis E-field range for one or multiple Computer Interfaces, see :MEASure[:FProbe]:Efield:MINX? [<MProbe>] for a description of parameters and return values. The old syntax "MEASure[:PRObe]:Efield:MINY? [<MProbe>]" remains supported.

10.5.14 :MEASure[:FProbe]:Efield:MAXY? [<MProbe>]

Query maximum value of y-axis E-field range for one or multiple Computer Interfaces, see :MEASure[:FProbe]:Efield:MAXX? [<MProbe>] for a description of parameters and return values. The old syntax "MEASure[:PRObe]:Efield:MAXY? [<MProbe>]" remains supported.

10.5.15 :MEASure[:FProbe]:Efield:Z? [<MProbe>]

Query E-field z-axis component for one or multiple Computer Interfaces, see :MEASure[:FProbe]:Efield:X? [<MProbe>] for a description of parameters and return values. The old syntax "MEASure[:PRObe]:Efield:Z? [<MProbe>]" remains supported.

10.5.16 :MEASure[:FProbe]:Efield:MINZ? [<MProbe>]

Query minimum value of z-axis E-field range for one or multiple Computer Interfaces, see :MEASure[:FProbe]:Efield:MINX? [<MProbe>] for a description of parameters and return values. The old syntax "MEASure[:PRObe]:Efield:MINZ? [<MProbe>]" remains supported.

10.5.17 :MEASure[:FProbe]:Efield:MAXZ? [<MProbe>]

Query minimum value of z-axis E-field range for one or multiple Computer Interfaces, see :MEASure[:FProbe]:Efield:MAXX? [<MProbe>] for a description of parameters and return values. The old syntax "MEASure[:PRObe]:Efield:MAXZ? [<MProbe>]" remains supported.

10.5.18 :MEASure[:FProbe]:Efield:MAGnitude? [<MProbe>]

Query E-field magnitude, i.e. isotropic field strength for one or multiple Computer Interfaces, see :MEASure[:FProbe]:Efield:X? [<MProbe>] for a description of parameters and return values. The old syntax "MEASure[:PRObe]:Efield:MAGnitude? [<MProbe>]" remains supported.

10.5.19 :MEASure[:FProbe]:Efield:MINMAGnitude? [<MProbe>]

Query minimum value of E-field magnitude range for one or multiple Computer Interfaces, i.e. isotropic field strength, see :MEASure[:FProbe]:Efield:MINX? [<MProbe>] for a description of parameters and return values. The old syntax "MEASure[:PRObe]:Efield:MINMAGnitude? [<MProbe>]" remains supported.

10.5.20 :MEASure[:FProbe]:Efield:MAXMAGnitude? [<MProbe>]

Query maximum value of E-field magnitude range for one or multiple Computer Interfaces, i.e. isotropic field strength, see :MEASure[:FProbe]:Efield:MAXX? [<MProbe>] for a description of parameters and return values. The old syntax "MEASure[:PRObe]:Efield:MAXMAGnitude? [<MProbe>]" remains supported.

10.5.21 :MEASure[:FProbe]:Efield:ALL? [<MProbe>]

Query E-field components and magnitude, i.e. x, y, z and isotropic field strength for one or multiple Computer Interfaces. The old syntax "MEASure[:PRObe]:Efield:ALL? [<MProbe>]" remains supported.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUES:

The command returns a list of float-valued x-axis, y-axis, z-axis E-field components and E-field magnitude in V/m, in this order. NAN will be returned if the E-Field Probe is off, in start-up or if there is no valid calibration data.

10.5.22 :MEASure[:FProbe]:Efield:MINALL? [<MProbe>]

Query minimum value of E-field all axis' and magnitude range, i.e. x, y, z and isotropic field strength range for one or multiple Computer Interfaces. The old syntax "MEASure[:PRObe]:Efield:MINALL? [<MProbe>]" remains supported.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUES:

The command returns a list of float-valued x-axis, y-axis, z-axis minimum calibrated E-field components and minimum calibrated E-field magnitude in V/m, in this order. NAN will be returned if the E-Field Probe is off, in start-up or if there is no valid calibration data.

10.5.23 :MEASure[:FProbe]:Efield:MAXALL? [<MProbe>]

Query maximum value of E-field all axis' and magnitude range, i.e. x, y, z and isotropic field strength range, for one or multiple Computer Interfaces, see :MEASure[:FProbe]:Efield:MINALL? [<MProbe>] for details. The old syntax "MEASure[:PRObe]:Efield:MAXALL? [<MProbe>]" remains supported.

10.5.24 :MEASure[:FProbe]:Efield:LPFrequency <Frequency>[,<MProbe>]

Set E-field low-pass filter -3 dB cut-off frequency for one or multiple Computer Interfaces. The old syntax "MEASure[:PRObe]:Efield:LPFrequency <Frequency>[,<MProbe>]" remains supported.

PARAMETER:

Float value specifying the -3 dB cut-off frequency for the first order E-field low-pass filter in Hertz. The filter is applied to calibrated and uncalibrated field strength values. Setting the value to 0 Hz disables low-pass filtering.

The second optional unsigned integer parameter MProbe is described in Section 10.1.

10.5.25 :MEASure[:FProbe]:Efield:LPFrequency? [<MProbe>]

Query E-field low-pass filter -3 dB cut-off frequency for one or multiple Computer Interfaces. The old syntax "MEASure[:PRObe]:Efield:LPFrequency? [<MProbe>]" remains supported.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

The command returns a float value specifying the -3 dB cut-off frequency for the first order E-field low-pass filter in Hertz. A value to 0 indicates that low-pass filtering is disabled.

10.5.26 :MEASure[:FProbe]:RSsi:X? [<MProbe>]

Query RSSI value for x-axis E-field component for one or multiple Computer Interfaces. The old syntax "MEASure[:PRObe]:RSsi:X? [<MProbe>]" remains supported.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

The command returns an unsigned integer value representing the uncalibrated 14 bit ADC value acquired by the x-axis RSSI chip, i.e. received signal strength indicator, used to detect the electrical field strength. The value is low-pass filtered using the same low-pass filter as described in :MEASure[:FProbe]:Efield:LPFrequency <Frequency>[,<MProbe>]. NAN will be returned if the E-Field Probe is off or in start-up.

10.5.27 :MEASure[:FProbe]:RSsi:Y? [<MProbe>]

Query RSSI value for y-axis E-field component for one or multiple Computer Interfaces, see :MEASure[:FProbe]:RSsi:X? [<MProbe>] for a description of parameters and return values. The old syntax "MEASure[:PRObe]:RSsi:Y? [<MProbe>]" remains supported.

10.5.28 :MEASure[:FProbe]:RSsi:Z? [<MProbe>]

Query RSSI value for z-axis E-field component for one or multiple Computer Interfaces, see :MEASure[:FProbe]:RSsi:X? [<MProbe>] for a description of parameters and return values. The old syntax "MEASure[:PRObe]:RSsi:Z? [<MProbe>]" remains supported.

10.5.29 :MEASure[:FProbe]:ACCeleration:X? [<MProbe>]

Query E-Field Probe x-axis acceleration value for one or multiple Computer Interfaces. The old syntax "MEASure[:PRObe]:ACCeleration:X? [<MProbe>]" remains supported.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

The command returns a float value of x-axis acceleration in gees, i.e. multiples of 9.81 m/s^2. A value of one gee will be returned if the x-axis is pointing straight up, minus one gee will be returned if the x-axis is pointing straight down. NAN will be returned if the E-Field Probe is off or in start-up.

10.5.30 :MEASure[:FProbe]:ACCeleration:Y? [<MProbe>]

Query E-Field Probe y-axis acceleration value for one or multiple Computer Interfaces, see :MEASure[:FProbe]:ACCeleration:X? [<MProbe>] for a description of parameters and return values. The old syntax "MEASure[:PRObe]:ACCeleration:Y? [<MProbe>]" remains supported.

10.5.31 :MEASure[:FProbe]:ACCeleration:Z? [<MProbe>]

Query E-Field Probe z-axis acceleration value for one or multiple Computer Interfaces, see :MEASure[:FProbe]:ACCeleration:X? [<MProbe>] for a description of parameters and return values. The old syntax "MEASure[:PRObe]:ACCeleration:Z? [<MProbe>]" remains supported.

10.5.32 :MEASure[:FProbe]:ACCeleration:LPFrequency <Frequency>[,<MProbe>]

Set acceleration low-pass filter -3 dB cut-off frequency for one or multiple Computer Interfaces. The old syntax "MEASure[:PRObe]:ACCeleration:LPFrequency <Frequency>[,<MProbe>]" remains supported.

PARAMETERS:

Float value specifying the -3 dB cut-off frequency for the first oder acceleration low-pass filter in Hz. Setting the value to 0 Hz disables low-pass filtering.

The second optional unsigned integer parameter MProbe is described in Section 10.1.

10.5.33 :MEASure[:FProbe]:ACCeleration:LPFrequency? [<MProbe>]

Query acceleration low-pass filter -3 dB cut-off frequency for one or multiple Computer Interfaces. The old syntax "MEASure[:PRObe]:ACCeleration:LPFrequency? [<MProbe>]" remains supported.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

The command returns a float value specifying the -3 dB cut-off frequency for the first order acceleration low-pass filter in Hertz. A value to 0 indicates that low-pass filtering is disabled.

10.5.34 :MEASure[:FProbe]:MODe? [<MProbe>]

Query E-Field Probe mode for one or multiple Computer Interfaces. The old syntax "MEASure[:PRObe]:MODe? [<MProbe>]" remains supported.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

The command returns a unsigned integer value giving the E-Field Probe's operating mode. Valid modes are 0, 1, 3, 4, 6 and 7. NAN will be returned if the E-Field Probe is off or in start-up.

10.5.35 :MEASure[:FProbe]:TEMPerature? [<MProbe>]

Query E-Field Probe internal temperature for one or multiple Computer Interfaces. The old syntax "MEASure[:PRObe]:TEMPerature? [<MProbe>]" remains supported.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

The command returns the probe temperature in °C. This temperature is typically 20 °C above the probe's ambient temperature. NAN will be returned if the E-Field Probe is off or in start-up.

10.5.36 :MEASure[:FProbe]:ATEMPerature? [<MProbe>]

Query low-pass filtered E-Field Probe internal temperature for one or multiple Computer Interfaces. The old syntax "MEASure[:PRObe]:ATEMPerature? [<MProbe>]" remains supported.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

The command returns a low-pass filtered value as described in :MEASure[:FProbe]:TEMPerature? [<MProbe>]. A 10 Hz first oder low-pass filter is used. NAN will be returned if the E-Field Probe is off or in start-up.

10.5.37 :MEASure[:FProbe]:VOLTage? [<MProbe>]

Query E-Field Probe supply voltage for one or multiple Computer Interfaces. The old syntax "MEASure[:PRObe]:VOLTage? [<MProbe>]" remains supported.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

The command returns the float-valued E-Field Probe supply voltage value in Volts. The voltage the photo diode's voltage generated by the supply laser. NAN will be returned if the E-Field Probe is off or in start-up.

10.5.38 :MEASure[:FProbe]:SERialnumber? [<MProbe>]

Query E-Field Probe serial number for one or multiple Computer Interfaces. The old syntax "MEASure[:PRObe]:SERialnumber? [<MProbe>]" remains supported.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

The command returns the unsigned integer value giving the probe's unique serial number. NAN will be returned if the field probe is off or in start-up.

10.5.39 :MEASure[:FProbe]:REVision? [<MProbe>]

Query Field Probe firmware revision of one or multiple Computer Interfaces. The old syntax "MEASure[:PRObe]:REVision? [<MProbe>]" remains supported.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUES:

An unsigned integer value indicating the Field Probe's firmware's revision number is returned. NAN will be returned if the Field Probe is off or in start-up.

10.5.40 :MEASure[:FProbe]:TIMer? [<MProbe>]

Query E-Field Probe activity timer for one or multiple Computer Interfaces. The old syntax "MEASure[:PRObe]:TIMer? [<MProbe>]" remains supported.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

The command returns the unsigned integer value approximating the E-Field Probe's operating time in seconds. The counter runs over after reaching 4095. NAN will be returned if the field probe is off or in start-up.

10.6 :TRIGger Commands

10.6.1 :TRIGger:COUnt? [<MProbe>]

Query number of detected trigger events for one or multiple E-Field Probes.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

An integer-valued number of trigger events recorded is returned.

10.6.2 :TRIGger:BEGin <Index>[,<MProbe>]

Set index of first sample of trigger frame for one or multiple E-Field Probes.

PARAMETERS:

The first parameter is the integer-valued position of the beginning of the trigger frame relative to the position of the trigger. E.g. »:trig:beg 0« will record samples starting at the trigger position, »:trig:len -100« will record samples starting 100 samples before the trigger position, »:trig:len 100« will record samples starting 100 samples after the trigger position.

The second, optional unsigned integer parameter MProbe is described in Section 10.1.

10.6.3 :TRIGger:BEGin? [<MProbe>]

Query index of first sample of trigger frame for one or multiple E-Field Probes.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

The command returns an integer-valued position of the beginning of the trigger frame relative to the position of the trigger, corresponds to the first parameter of :TRIGger:LENgth <Length>[,<MProbe>]. If executed for multiple Computer Interfaces the command returns a list of integer-valued positions of the beginning of the trigger frame relative to the position of the trigger for each E-Field Probe of the respective list.

10.6.4 :TRIGger:LENgth <Length>[,<MProbe>]

Set length of trigger frame for one or multiple E-Field Probes.

PARAMETERS:

The unsigned integer-valued parameter of the command specifies length of a trigger frame. E.g. »:trig:len 100« will record 100 samples starting at the sample index specified by :TRIGger:BEGin <Index>[,<MProbe>].

The second, optional unsigned integer parameter MProbe is described in Section 10.1.

10.6.5 :TRIGger:LENgth? [<MProbe>]

Query number of samples in trigger frame for one or multiple E-Field Probes.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

The command returns an unsigned integer-valued length of the trigger frame, corresponding to the length set by :TRIGger:LENgth <Length>[,<MProbe>]. If executed for multiple Computer Interfaces the command returns a list of unsigned integer-valued lengths of the trigger frame lengths for each E-Field Probe of the respective list.

10.6.6 :TRIGger:STATe? [<Timeout>,<MProbe>]

Query the state of the trigger system for one or multiple E-Field Probes.

PARAMETER:

The first optional float valued parameter Timeout sets the maximum number of seconds to wait

until encountering a DONE state. If the trigger state is equal to DONE, if Timeout is set to zero, or if Timeout is omitted the command will return immediately.

The second optional unsigned integer parameter MProbe is described in Section 10.1. The second parameter always requires the first parameter to be set.

RETURN VALUE:

The command returns a string value giving the state of the trigger system, valid return values are IDLE, ARMED, TRIGGERED, DONE. See Figure 28 on page 37 for reference.

10.6.7 :TRIGger:DONE? [<Timeout>,<MProbe>]

Query the done state of the trigger system for one or multiple E-Field Probes.

PARAMETER:

The first optional float valued parameter Timeout sets the maximum number of seconds to wait until encountering a DONE state. If the trigger state is equal to DONE, if Timeout is set to zero, or if Timeout is omitted the command will return immediately.

The second optional unsigned integer parameter MProbe is described in Section 10.1. The second parameter always requires the first parameter to be set.

RETURN VALUE:

The command returns an unsigned integer value indicating if the trigger state is done. If the trigger state is IDLE, ARMED or TRIGGERED the return value is 0, if it is DONE the return value will be 1.

10.6.8 :TRIGger[:WAVeform]:Efield:X? [<MProbe>]

Query E-field x-axis component values of trigger frame for one or multiple E-Field Probes.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUES:

The command returns a comma-separated list of float-valued x-axis E-field component values of the trigger frame in V/m. NAN will be returned if the E-Field Probe is off, in start-up, if there is no valid calibration data or if the trigger system state is not equal to DONE.

10.6.9 :TRIGger[:WAVeform]:Efield:Y? [<MProbe>]

Query E-field y-axis component values of trigger frame for one or multiple E-Field Probes, see :TRIGger[:WAVeform]:Efield:X? [<MProbe>] for details about the parameter and the return values.

10.6.10 :TRIGger[:WAVeform]:Efield:Z? [<MProbe>]

Query E-field z-axis component values of trigger frame for one or multiple E-Field Probes, see :TRIGger[:WAVeform]:Efield:X? [<MProbe>] for details about the parameter and the return values.

10.6.11 :TRIGger[:WAVeform]:Efield:MAGnitude? [<MProbe>]

Query E-field magnitude values of trigger frame for one or multiple E-Field Probes, see :TRIGger[:WAVeform]:Efield:X? [<MProbe>] for details about the parameter and the return values.

10.6.12 :TRIGger[:WAVeform]:FRame? [<MProbe>]

Query frame indicator values of trigger frame.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUES:

The command returns a comma-separated list of integer values indicating the burst frame index inside a trigger frame. Valid values are 0 and 1. In mode 0, 2 and 3 the transition from 0 to 1 or vice versa indicates the acquisition of new LF sample values, there is no gap between field strength or RSSI values. In mode 1, 4, 5, 6 and 7 the transition from 0 to 1 or vice versa indicates the beginning of a burst frame and thus a gap of approximately 3.9 ms (for mode 1 and 5) or 0.8 ms (for mode 4, 6, 7) between field strength or RSSI values. NAN will be returned if the E-Field Probe is off, in start-up, if there is no valid calibration data or if the trigger system state is not equal to DONE.

10.6.13 :TRIGger[:WAVeform]:Efield:BINary? [<MProbe>]

Query E-field component values, E-field magnitude values and trigger frame values of trigger frame in binary format for one or multiple E-Field Probes.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUES:

Binary data block followed by a carriage return, new line sequence. The first byte specifies the number of bytes which will be returned.

For each probe P a chunk of binary data will be sent thereafter in the following order, all values are encoded in little endian format:

CI NUMBER

32 bit unsigned integer value giving the serial number of the corresponding Computer Interface. If the probe P is not defined the CI serial number, probe serial number and sample count is set to zero and the binary data block ends.

PROBE NUMBER

32 bit unsigned integer value giving the serial number of the corresponding E-Field Probe. If the E-Field Probe is off or in start-up the probe serial number and sample count is set to zero and the binary data block ends.

SAMPLE COUNT

32 bit unsigned integer value giving the number of samples S in the trigger frame of the corresponding E-Field Probe. The following binary data will contain S values for each of the following values. If there is no valid calibration data or if the trigger system state is not equal to DONE the number of samples is set to zero and the binary data block ends.

X-AXIS

S 32 bit single precision floating point values giving a list of x-axis E-field values in V/m of the trigger frame, see :TRIGger[:WAVeform]:Efield:X? [<MProbe>].

Y-AXIS

S 32 bit single precision floating point values giving a list of y-axis E-field values in V/m of the trigger frame, see :TRIGger[:WAVeform]:Efield:Y? [<MProbe>].

Z-AXIS

S 32 bit single precision floating point values giving a list of z-axis E-field values in V/m of the trigger frame, see :TRIGger[:WAVeform]:Efield:Z? [<MProbe>].

MAGNITUDE

S 32 bit single precision floating point values giving a list of E-field magnitude values in V/m of the trigger frame, see :TRIGger[:WAVeform]:Efield:MAGnitude? [<MProbe>].

FRAME INDICATOR

S 32 bit single precision floating point values giving a list of E-field frame indicator values as described in :TRIGger[:WAVeform]:FRame? [<MProbe>],

X-AXIS RSSI

S 16 bit unsigned integer values, encoded as 32 bit single precision floating point values, giving a list of x-axis RSSI values in LSB of the trigger frame, see :TRIGger[:WAVeform]:RSsi:X? [<MProbe>].

Y-AXIS RSSI

S 16 bit unsigned integer values, encoded as 32 bit single precision floating point values, giving a list of y-axis RSSI values in LSB of the trigger frame, see :TRIGger[:WAVeform]:RSsi:Y? [<MProbe>].

Z-AXIS RSSI

S 16 bit unsigned integer values, encoded as 32 bit single precision floating point

values, giving a list of z-axis RSSI values in LSB of the trigger frame, see :TRIGger[:WAVeform]:RSsi:Z? [<MProbe>].

10.6.14 :TRIGger[:WAVeform]:Efield:BINWait? [<Timeout>,<MProbe>]

Query E-field component values, E-field magnitude values and trigger frame values of trigger frame in binary format for one or multiple E-Field Probes. If data is available for all queried probes a :TRIGger:CLear [<MProbe>] and :TRIGger:ARM [<MProbe>] will be sent automatically.

PARAMETER:

The first optional float valued parameter Timeout sets the maximum number of seconds to wait until encountering a DONE state. If the trigger state is equal to DONE, if Timeout is set to zero, or if Timeout is omitted the command will return immediately.

The second optional unsigned integer parameter MProbe is described in Section 10.1. The second parameter always requires the first parameter to be set.

RETURN VALUES:

See :TRIGger[:WAVeform]:Efield:BINary? [<MProbe>] for a description of the commands return values.

10.6.15 :TRIGger[:WAVeform]:Efield:ALL? [<MProbe>]

Query E-field component values and E-field magnitude averaged over the present trigger frame for one or multiple E-Field Probes.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUES:

The command returns a comma-separated list of four float values giving the x-axis E-field component, y-axis E-field component, z-axis E-field component and E-field magnitude, i.e. isotropic E-field strength, in this order. NAN will be returned if the E-Field Probe is off, in start-up, if there is no valid calibration data or if the trigger system state is not equal to DONE.

10.6.16 :TRIGger[:WAVeform]:RSsi:X? [<MProbe>]

Query E-field x-axis RSSI values of a trigger frame for one or multiple E-Field Probes.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUES:

The command returns a list of unsigned integer values representing the uncalibrated 14 bit ADC

value acquired by the x-axis RSSI chip, i.e. received signal strength indicator, used to detect the electrical field strength. NAN will be returned if the E-Field Probe is off, in start-up or if the trigger system state is not equal to DONE.

10.6.17 :TRIGger[:WAVeform]:RSsi:Y? [<MProbe>]

Query E-field y-axis RSSI values of a trigger frame for one or multiple E-Field Probes, see :TRIGger[:WAVeform]:RSsi:X? [<MProbe>] for details about the parameter and return values.

10.6.18 :TRIGger[:WAVeform]:RSsi:Z? [<MProbe>]

Query E-field z-axis RSSI values of a trigger frame, for one or multiple E-Field Probes, see :TRIGger[:WAVeform]:RSsi:X? [<MProbe>] for details about the parameter and return values.

10.6.19 :TRIGger[:WAVeform]:ACCeleration:X? [<MProbe>]

Query E-Field Probe's x-axis acceleration values of a trigger frame for one or multiple E-Field Probes.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUES:

The command returns a comma-separated list of float-valued acceleration values in gees, i.e. multiples of 9.81 m/s^2, within a trigger frame. A value of one gee will be returned if the x-axis is pointing straight up, minus one gee will be returned if the x-axis is pointing straight down. Since the sampling rate of acceleration values is 1.3 kHz and asynchronous to E-field strength sampling the number of samples is much smaller than :TRIGger[:WAVeform]:Efield:X? [<MProbe>] and can vary by one value for a constant trigger frame length. NAN will be returned if the E-Field Probe is off, in start-up or if the trigger system state is not equal to DONE.

10.6.20 :TRIGger[:WAVeform]:ACCeleration:Y? [<MProbe>]

Query E-Field Probe's y-axis acceleration values of a trigger frame for one or multiple E-Field Probes, see :TRIGger[:WAVeform]:ACCeleration:X? [<MProbe>] for details.

10.6.21 :TRIGger[:WAVeform]:ACCeleration:Z? [<MProbe>]

Query E-Field Probe's z-axis acceleration values of a trigger frame for one or multiple E-Field Probes, see :TRIGger[:WAVeform]:ACCeleration:X? [<MProbe>] for details.

10.6.22 :TRIGger[:WAVeform]:TEMPerature? [<MProbe>]

Query E-Field Probe's internal temperature values of a trigger frame for one or multiple E-Field Probes.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUES:

The command returns a comma-separated list of float-valued temperature values in °C within a trigger frame. See :TRIGger[:WAVeform]:ACCeleration:X? [<MProbe>] for further details about the return value format.

10.6.23 :TRIGger[:WAVeform]:VOLTage? [<MProbe>]

Query E-Field Probe's supply voltage values of a trigger frame for one or multiple E-Field Probes.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUES:

The command returns a comma-separated list of float-valued voltage values in V within a trigger frame. See :TRIGger[:WAVeform]:ACCeleration:X? [<MProbe>] for further details about the return value format.

10.6.24 :TRIGger[:WAVeform]:MAVErage? <Length>,<Margin>

Evaluate trigger frame statistically and return statistics about E-field RSSI values, E-Field Probe timer, acceleration, temperature ADC value, operating mode, voltage ADC value and serial number. The command is able to evaluate a trigger frame by dividing it into equally sized sections and returning statistics about each section. The command is used for calibration purposes in combination with a synchronously triggered signal generator.

PARAMETERS:

The first unsigned integer value specifies the number of E-field RSSI values per evaluated section. The second unsigned integer value specifies the number of E-field RSSI values to skip at the beginning and end of each section.

RETURN VALUES:

List of a multiple of 44 float-valued, comma-separated values, giving the average, mean deviation, minimum and maximum for each evaluated value. If the trigger frame is longer than the number of samples specified by the Length parameter, 44 values will be printed for each trigger frame section. Values are printed in the following order: x-axis E-field RSSI value, y-axis E-field RSSI value, z-axis E-field RSSI values, probe uptime value (Section 10.5.40), x-axis acceleration

(Section 10.5.29), y-axis acceleration, z-axis acceleration, probe temperature ADC value, probe mode value (Section 10.5.34), probe supply voltage ADC value and probe mode number (Section 10.5.34).

10.6.25 :TRIGger:SOURce <Source>[,<MProbe>]

Set trigger source for triggered operation for one or multiple E-Field Probes.

PARAMETER:

String parameter without quotes specifying the trigger source, valid values are SOFT, EXT, EXT2, X, Y, Z and STREAM. When set to SOFT triggering must occur by means of the :TRIGger:FORce [<MProbe>] command. When set to EXT triggering uses the external trigger input configured by :TRIGger:FALLing <0/1>[,<MProbe>] and :TRIGger:OUTput <0/1>[,<MProbe>]. EXT refers to the trigger signal of the BNC connector, EXT2 refers to the trigger signal of the "Ext1´´ RJ45 socket of the respective Computer Interface. When set to either X, Y or Z the field strength value of the selected axis is used for triggering, :TRIGger:LEVel <Level>[,<MProbe>] and :TRIGger:FALLing <0/1>[,<MProbe>] are used for configuration.

The second, optional unsigned integer parameter MProbe is described in Section 10.1.

10.6.26 :TRIGger:SOURce? [<MProbe>]

Query trigger source for triggered operation for one or multiple E-Field Probes.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

The command returns a string value without quotes specifying the trigger source, see :TRIGger:SOURce <Source>[,<MProbe>] for more details.

10.6.27 :TRIGger:ARM [<MProbe>]

Arm trigger, the trigger system will change state from any other trigger state to ARMED for one or multiple E-Field Probes.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

10.6.28 :TRIGger:CLear [<MProbe>]

Clear trigger, the trigger system will change state from any other trigger state to IDLE for one or multiple E-Field Probes.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

10.6.29 :TRIGger:FORce [<MProbe>]

Clear trigger, the trigger system will change state from ARMED to TRIGGERED independent of the trigger source set by :TRIGger:SOURce <Source>[,<MProbe>] for one or multiple E-Field Probes. This command is used to for software triggering.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

10.6.30 :TRIGger:LEVel <Level>[,<MProbe>]

Set the trigger field strength for X, Y and Z triggering for one or multiple E-Field Probes.

PARAMETER:

Floating point parameter specifying the field strength in V/m. Triggering occurs if the field strength crosses the set value.

The second, optional unsigned integer parameter MProbe is described in Section 10.1.

10.6.31 :TRIGger:LEVel? [<MProbe>]

Query the trigger field strength for X, Y and Z triggering for one or multiple E-Field Probes.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUES:

The command returns the trigger level as a float-valued field strength value in V/m. NAN will be returned if the E-Field Probe is off or in start-up.

10.6.32 :TRIGger:FALLing <0/1>[,<MProbe>]

Set the direction for external, X, Y and Z triggering for one or multiple E-Field Probes.

PARAMETERS:

Boolean value of either 0 or 1. If set to 0 the the rising edge of the external trigger signal or passing the threshold value in rising direction will bring the trigger system from the state ARMED to TRIGGERED. If set to 1 the falling edge will be used for triggering.

The second, optional unsigned integer parameter MProbe is described in Section 10.1.

10.6.33 :TRIGger:FALLing? [<MProbe>]

Query the direction for external, X, Y and Z triggering for one or multiple E-Field Probes.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

The command returns the boolean value giving the trigger edge direction, see :TRIGger:FALLing <0/1>[,<MProbe>] for details.

10.6.34 :TRIGger:OUTput <0/1>[,<MProbe>]

Enable or disable the output of a trigger signal via the Computer Interface's BNC connector for one or multiple E-Field Probes.

PARAMETERS:

Boolean value of either 0 or 1. If set to 0 trigger output is disabled and the Computer Interface's BNC connector can be used for trigger input. If set to 1 trigger output is enabled and the Computer Interface's BNC connector cannot be used for trigger input.

The second, optional unsigned integer parameter MProbe is described in Section 10.1.

10.6.35 :TRIGger:OUTput? [<MProbe>]

Query status of trigger output for one or multiple E-Field Probes.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

The command returns a boolean value giving the state of the Computer Interfaces BNC trigger connector, see :TRIGger:OUTput <0/1>[,<MProbe>] for details.

10.6.36 :TRIGger:INVert <0/1>[,<MProbe>]

Set the polarity for trigger output via the Computer Interface's BNC trigger connector for one or multiple E-Field Probes.

PARAMETERS:

Boolean value of either 0 or 1. If set to 0 trigger output uses a rising edge logic signal. If set to 1 a falling edge logic signal will be generated.

The second, optional unsigned integer parameter MProbe is described in Section 10.1.

10.6.37 :TRIGger:INVert? [<MProbe>]

Query the polarity for trigger output via the Computer Interface's BNC trigger connector for one or multiple E-Field Probes.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

The command returns a boolean value of either 0 or 1. See :TRIGger:INVert <0/1>[,<MProbe>] for details.

10.6.38 :TRIGger:SYNC <0/1>[,<MProbe>]

Enable or disable synchronization trigger output using the Computer Interface's BNC trigger connector for one or multiple E-Field Probes. This function is useful for synchronizing signal generators or transmitters with the E-Field Probe.

PARAMETERS:

Boolean value of either 0 or 1. If set to 0 and external trigger output is enabled, output trigger signal as described in :TRIGger:OUTput <0/1>[,<MProbe>] and :TRIGger:INVert <0/1>[,<MProbe>]. If set to 1 and trigger output is enabled, a logic edge will be generated synchronously with E-field value acquisition. If in mode 0 to 3 a 1 µs long pulse is generated once every 2 µs. In mode 4 to 7 a 1 µs long pulse is generated for the first value of a burst frame. In mode 1 and 5 only a subset of sample values is made available by TCP Server.

The second, optional unsigned integer parameter MProbe is described in Section 10.1.

10.6.39 :TRIGger:SYNC? [<MProbe>]

Query the configuration synchronization trigger output for one or multiple E-Field Probes.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

The command returns a boolean value of either 0 or 1. See :TRIGger:SYNC <0/1>[,<MProbe>] for details.

10.6.40 :TRIGger:BPOUTput <0/1>[,<MProbe>]

Enable or disable the output of a trigger signal via the Computer Interface's upper RJ45 connector for one or multiple E-Field Probes. See :TRIGger:OUTput <0/1>[,<MProbe>] for parameters.

10.6.41 :TRIGger:BPOUTput? [<MProbe>]

Query status of trigger output via the Computer Interface's upper RJ45 connector for one or multiple E-Field Probes. See :TRIGger:OUTput? [<MProbe>] for parameter and return value.

10.6.42 :TRIGger:BPINVert <0/1>[,<MProbe>]

Set the polarity for trigger output via the Computer Interface's upper RJ45 connector for one or multiple E-Field Probes. See :TRIGger:INVert <0/1>[,<MProbe>] for parameters.

10.6.43 :TRIGger:BPINVert? [<MProbe>]

Query the polarity for trigger output via the Computer Interface's upper RJ45 connector for one or multiple E-Field Probes. See :TRIGger:INVert? [<MProbe>] for parameter and return value.

10.6.44 :TRIGger:BPSYNC <0/1>[,<MProbe>]

Enable or disable synchronization trigger output via the Computer Interface's upper RJ45 connector for one or multiple E-Field Probes. See :TRIGger:SYNC <0/1>[,<MProbe>] for parameters.´

10.6.45 :TRIGger:BPSYNC? [<MProbe>]

Query the configuration of the synchronization trigger output via the Computer Interface's upper RJ45 connector for one or multiple E-Field Probes. See :TRIGger:SYNC? [<MProbe>] for parameter and return value.

10.6.46 :TRIGger[:WAVeform]:RADar:X? [<Threshold>][,<MProbe>]

Query radar E-field x-axis component values of trigger frame for one or multiple E-Field Probes.

PARAMETER:

The threshold parameter is optional, if omitted or set to zero the arithmetic mean of minimum and maximum field strength will be used as a threshold. If given the parameter specifies the pulse detection threshold in V/m.

The second, optional unsigned integer parameter MProbe is described in Section 10.1. If used the first parameter must also be given.

RETURN VALUES:

The command returns a comma-separated list of unsigned integer numbers giving the number of detected pulses, followed by index/field strength pairs giving the sample position and maximum field strength value of the radar pulse. The first value of each pair gives the sample index

after crossing the threshold value in a rising fashion relative to the trigger position, negative value indicate pulses occurring before trigger detection. The second value of each pair gives the maximum field strength of the respective pulse. The number of pulses will be returned as zero and no index/field strength pairs be returned if no pulses could be detected, the E-Field Probe is off, the probe is in start-up, there is no valid calibration data or the trigger system state is not equal to DONE.

10.6.47 :TRIGger[:WAVeform]:RADar:Y? [<Threshold>][,<MProbe>]

Query radar E-field y-axis component values of trigger frame for one or multiple E-Field Probes, see :TRIGger[:WAVeform]:RADar:X? [<Threshold>][,<MProbe>] for details.

10.6.48 :TRIGger[:WAVeform]:RADar:Z? [<Threshold>][,<MProbe>]

Query radar E-field z-axis component values of trigger frame for one or multiple E-Field Probes, see :TRIGger[:WAVeform]:RADar:X? [<Threshold>][,<MProbe>] for details.

10.6.49 :TRIGger[:WAVeform]:RADar:MAGnitude? [<Threshold>][,<MProbe>]

Query radar E-field magnitude values of trigger frame for one or multiple E-Field Probes, see :TRIGger[:WAVeform]:RADar:X? [<Threshold>][,<MProbe>] for details.

10.6.50 :TRIGger[:WAVeform]:RADar:ALL? [<Threshold>][,<MProbe>]

Query radar E-field component values and radar E-field magnitude averaged over the present trigger frame, for one or multiple E-Field Probes.

PARAMETERS:

The threshold parameter is optional, if omitted the arithmetic mean of minimum and maximum field strength will be used as a threshold. If given the parameter specifies the pulse detection threshold in V/m.

The second, optional unsigned integer parameter MProbe is described in Section 10.1. If used the first parameter must also be given.

RETURN VALUES:

The command returns a comma-separated list of four float values giving the x-axis, y-axis, z-axis and magnitude, i.e. isotropic, E-field strength averaged over all detected pulses, in this order. NAN will be returned if no pulses could be detected, the E-Field Probe is off, the probe is in start-up, there is no valid calibration data or the trigger system state is not equal to DONE.

10.6.51 :TRIGger[:WAVeform]:RADar:COUnt? [<Threshold>][,<MProbe>]

Query number of detected E-field component and radar E-field magnitude pulses in the present trigger frame, for one or multiple E-Field Probes.

PARAMETERS:

The threshold parameter is optional, if omitted the arithmetic mean of minimum and maximum field strength will be used as a threshold. If given the parameter specifies the pulse detection threshold in V/m.

The second, optional unsigned integer parameter MProbe is described in Section 10.1. If used the first parameter must also be given.

RETURN VALUES:

The command returns a comma-separated list of unsigned integer numbers giving the number of detected pulses for the x-axis, y-axis, z-axis and isotropic E-field strength. NAN will be returned if the E-Field Probe is off, the probe is in start-up, there is no valid calibration data or the trigger system state is not equal to DONE.

10.7 :STATistics Commands

10.7.1 :STATistics:MAster <State>

Set currently selected Computer Interface to be the master Computer Interface for continuous statistics collection. The active Computer Interface is set using :SYSTem:CISerial <Value>. By default the first enumerated Computer Interface automatically becomes the continuous statistics master Computer Interface.

PARAMETER:

Setting State to 1 makes the current Computer Interface the master of the continuous statistics subsystem. A State of 0 makes the Computer Interface a slave of the continuous statistics subsystem, i.e. continuous statistics will be controlled by a different Computer Interface.

10.7.2 :STATistics:MAster? [<MProbe>]

Query statistics subsystem master/slave status of the currently active Computer Interface. By default the first enumerated Computer Interface automatically becomes the continuous statistics master Computer Interface.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

The command returns an unsigned integer value containing the master/slave status of the currently active Computer Interface. Slaves return 0, the master returns 1.

10.7.3 :STATistics:ENable <State>[,<MProbe>]

Enable or Disable statistics acquisition for statistics subsystem master Computer Interface . This command is only effective for Computer Interfaces configured as the statistics subsystem master Computer Interface, see :STATistics:MAster <State>. Enabling statistics acquisition resets the snapshot counter queried via :STATistics:COUnt? [<MProbe>].

PARAMETERS:

Setting State to 1 activates statistics acquisition, setting State to 0 disables statistics acquisition for one or multiple E-Field Probes. Changing the state from disabled to enabled will reset and start statistics collection. Changing the state from enabled to disabled will trigger an automatic snapshot identical to issuing :STATistics:SNAPshot [<Triggered>][,<MProbe>] and stop statistics collection, see also :STATistics:SNAPshot [<Triggered>][,<MProbe>].

The second, optional unsigned integer parameter MProbe is described in Section 10.1.

10.7.4 :STATistics:ENable? [<MProbe>]

Query status of statistics acquisition for one or multiple E-Field Probes.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

The command returns an unsigned integer value containing the status of statistics acquisition. A value of 1 is returned when statistics acquisition is enabled, 0 is returned if statistics acquisition is disabled. The enable state of the statistics subsystem is controlled by the statistics subsystem master, see :STATistics:MAster <State> and :STATistics:ENable <State>[,<MProbe>]. All statistics subsystem slave Computer Interfaces are controlled by the statistics master Computer Interface, their return value is thus always be identical to the master Computer Interface if connected correctly.

10.7.5 :STATistics:SNAPshot [<Triggered>][,<MProbe>]

Create a snapshot of either continuously collected statistics, or of waveforms recorded by the trigger subsystem for one or multiple E-Field Probes.

PARAMETERS:

The optional integer-valued parameter Triggered selects the source for the statistics snapshot. If the parameter is omitted or set to 0 a snapshot of the continuously acquired statistics is created for subsequent analysis. This type of statistics snapshot is triggered by the Computer Interface configured as the statistics subsystem master, see :STATistics:MAster <State>. Additionally, statistics acquisition must be enabled using :STATistics:ENable <State>[,<MProbe>] before creating a snapshot.

If the parameter Triggered is set to 1 the most recently acquired triggered waveforms are analyzed to obtain a statistics snapshot for subsequent analysis. This kind of snapshot can only be created for one Computer Interface or multiple Computer Interfaces at a time, see the description of the second parameter below.

The second, optional unsigned integer parameter MProbe determines the Multiprobe behavior of the command as described in the parameter of :SYSTem:CISerial? [<MProbe>]. If the parameter MProbe is set the parameter Triggered is mandatory. For continuous statistics only Computer Interfaces configured as the statistics master Computer Interface will output a snapshot trigger signal.

10.7.6 :STATistics:COUnt? [<MProbe>]

Return continuous statistics snapshot counter for one or multiple E-Field Probes.

The optional unsigned integer parameter MProbe determines the Multiprobe behavior of the command as described in the parameter of :SYSTem:CISerial? [<MProbe>].

RETURN VALUE:

The command returns an unsigned integer value giving the number of snapshots taken for the selected Computer Interface since the start of the last enabling of statistics acquisition.

10.7.7 :STATistics:RESolution <Resolution>[,<MProbe>]

Set resolution for histograms and distribution functions for one or multiple E-Field Probes.

PARAMETERS:

The float-valued parameter Resolution specifies the field strength resolution in dB for all statistics query commands returning histograms and distribution functions. E.g. a value of 1.0 will output histograms with a bin size of 1 dB. Bins are aligned relative to and centered around 1 V/m. The smallest permissible value for Resolution is 0.005 dB, i.e. 1/200 dB.

The second, optional unsigned integer parameter MProbe is described in Section 10.1.

10.7.8 :STATistics:RESolution? [<MProbe>]

Query resolution in dB for histograms and distribution functions for one or multiple E-Field Probes.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

The command returns a float value giving the field strength resolution in decibels for all statistics query commands returning histograms and distribution functions.

10.7.9 :STATistics:HISTogram:SIZe? [<Triggered>][,<MProbe>]

Query number of bins for histograms and distribution functions for one or multiple E-Field Probes.

PARAMETERS:

If no parameter is provided or if Triggered is set to 0 the number of bins for the most recently created snapshot histograms and distribution functions based on continuous statistics acquisition is returned. If the parameter Triggered is set to 1 the number of bins for the most recently created snapshot histograms and distribution functions based on triggered waveforms is returned.

The second, optional unsigned integer parameter MProbe is described in Section 10.1. If the parameter MProbe is set the parameter Triggered is mandatory.

RETURN VALUE:

The command returns an unsigned integer value giving the number of histogram bins for the set resolution, see :STATistics:RESolution <Resolution>[,<MProbe>]. NAN will be returned if there is no valid statistics snapshot data or triggered waveform data.

10.7.10 :STATistics:HISTogram:OFFset? [<Triggered>][,<MProbe>]

Query offset in dB relative to one V/m for all histograms and distribution functions for one or multiple E-Field Probes.

PARAMETERS:

If no parameter is provided or if Triggered is set to 0 the offset for the most recently created snapshot histograms and distribution functions based on continuous statistics acquisition is returned. If the parameter Triggered is set to 1 the offset for the most recently created snapshot histograms and distribution functions based on triggered waveforms is returned.

The second, optional unsigned integer parameter MProbe is described in Section 10.1. If the parameter MProbe is set the parameter Triggered is mandatory.

RETURN VALUE:

The command returns an unsigned integer value giving the offset for the set resolution, see :STATistics:RESolution <Resolution>[,<MProbe>]. NAN will be returned if there is no valid statistics snapshot data or triggered waveform data.

10.7.11 :STATistics:SAMples? [<Triggered>][,<MProbe>]

Query number of sample values used for statistics acquisition for one or multiple E-Field Probes.

PARAMETERS:

If no parameter is provided or if Triggered is set to 0 the number samples per axis used for the most recently created statistics snapshot based on continuous statistics acquisition is returned.

If the parameter Triggered is set to 1 the number of samples per axis used for the most recently created statistics snapshot based on triggered waveforms is returned, i.e. the number of samples returned by :TRIGger:LENgth <Length>[,<MProbe>].

The second, optional unsigned integer parameter MProbe is described in Section 10.1. If the parameter MProbe is set the parameter Triggered is mandatory.

RETURN VALUE:

The command returns an unsigned 64 bit integer value giving the number of samples used to build the respective histogram. NAN will be returned if there is no valid statistics snapshot data or triggered waveform data.

10.7.12 :STATistics:MINimum:X? [<Triggered>][,<MProbe>]

Query x-axis E-field strength minimum of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes.

PARAMETERS:

If no parameter is provided or if Triggered is set to 0 the x-axis E-field strength minimum for the most recently created statistics snapshot based on continuous statistics acquisition is returned. If the parameter Triggered is set to 1 the x-axis E-field strength minimum of the most recently created statistics snapshot based on triggered waveforms is returned.

The second, optional unsigned integer parameter MProbe is described in Section 10.1. If the parameter MProbe is set the parameter Triggered is mandatory.

RETURN VALUE:

The command returns a float-valued x-axis E-field minimum in V/m. NAN will be returned if there is no valid statistics snapshot data or triggered waveform data.

10.7.13 :STATistics:MINimum:Y? [<Triggered>][,<MProbe>]

Query y-axis E-field strength minimum of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes, see :STATistics:MINimum:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.14 :STATistics:MINimum:Z? [<Triggered>][,<MProbe>]

Query z-axis E-field strength minimum of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes, see :STATistics:MINimum:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.15 :STATistics:MINimum:MAGnitude? [<Triggered>][,<MProbe>]

Query E-field strength magnitude minimum of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes, see :STATistics:MINimum:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.16 :STATistics:MINimum:ALL? [<Triggered>][,<MProbe>]

Query x-axis, y-axis, z-axis E-field strength minimum and E-field strength magnitude minimum of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes.

PARAMETERS:

See :STATistics:MINimum:X? [<Triggered>][,<MProbe>] parameter description for details.

RETURN VALUES:

The command returns a comma-separated list of four float values in V/m giving the x-axis, y-axis and z-axis E-field strength minimum followed by the E-field strength magnitude minimum for the most recently created statistics snapshot. NAN will be returned if there is no valid statistics snapshot data or triggered waveform data.

10.7.17 :STATistics:MAXimum:X? [<Triggered>][,<MProbe>]

Query x-axis E-field strength maximum of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes, see :STATistics:MINimum:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.18 :STATistics:MAXimum:Y? [<Triggered>][,<MProbe>]

Query y-axis E-field strength maximum of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes, see :STATistics:MINimum:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.19 :STATistics:MAXimum:Z? [<Triggered>][,<MProbe>]

Query z-axis E-field strength maximum of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes, see :STATistics:MINimum:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.20 :STATistics:MAXimum:MAGnitude? [<Triggered>][,<MProbe>]

Query E-field strength magnitude maximum of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes, see :STATistics:MINimum:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.21 :STATistics:MAXimum:ALL? [<Triggered>][,<MProbe>]

Query x-axis, y-axis, z-axis E-field strength maximum and E-field strength magnitude maximum of the most recent statistics snapshot or triggered waveform, see :STATistics:MINimum:ALL? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.22 :STATistics:MEAN:X? [<Triggered>][,<MProbe>]

Query x-axis E-field strength arithmetic mean of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes, see :STATistics:MINimum:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.23 :STATistics:MEAN:Y? [<Triggered>][,<MProbe>]

Query y-axis E-field strength arithmetic mean of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes, see :STATistics:MINimum:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.24 :STATistics:MEAN:Z? [<Triggered>][,<MProbe>]

Query z-axis E-field strength arithmetic mean of the most recent statistics snapshot for one or multiple E-Field Probes, see :STATistics:MINimum:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.25 :STATistics:MEAN:MAGnitude? [<Triggered>][,<MProbe>]

Query E-field strength magnitude arithmetic mean of the most recent statistics snapshot for one or multiple E-Field Probes, see :STATistics:MINimum:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.26 :STATistics:MEAN:ALL? [<Triggered>][,<MProbe>]

Query x-axis, y-axis, z-axis E-field strength arithmetic mean and E-field strength magnitude arithmetic mean of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes, see :STATistics:MAXimum:ALL? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.27 :STATistics:RMS:X? [<Triggered>][,<MProbe>]

Query x-axis E-field strength root mean square of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes, see :STATistics:MINimum:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.28 :STATistics:RMS:Y? [<Triggered>][,<MProbe>]

Query y-axis E-field strength root mean square of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes, see :STATistics:MINimum:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.29 :STATistics:RMS:Z? [<Triggered>][,<MProbe>]

Query z-axis E-field strength root mean square of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes, see :STATistics:MINimum:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.30 :STATistics:RMS:MAGnitude? [<Triggered>][,<MProbe>]

Query E-field strength magnitude root mean square of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes, see :STATistics:MINimum:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.31 :STATistics:RMS:ALL? [<Triggered>][,<MProbe>]

Query x-axis, y-axis, z-axis E-field strength root mean square and E-field strength magnitude root mean square of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes, see :STATistics:MAXimum:ALL? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.32 :STATistics:SDEViation:X? [<Triggered>][,<MProbe>]

Query x-axis E-field strength standard deviation of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes, see :STATistics:MINimum:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.33 :STATistics:SDEViation:Y? [<Triggered>][,<MProbe>]

Query y-axis E-field strength standard deviation of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes, see :STATistics:MINimum:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.34 :STATistics:SDEViation:Z? [<Triggered>][,<MProbe>]

Query z-axis E-field strength standard deviation of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes, see :STATistics:MINimum:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.35 :STATistics:SDEViation:MAGnitude? [<Triggered>][,<MProbe>]

Query E-field strength magnitude standard deviation of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes, see :STATistics:MINimum:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.36 :STATistics:SDEViation:ALL? [<Triggered>][,<MProbe>]

Query x-axis, y-axis, z-axis E-field strength standard deviation and E-field strength magnitude standard deviation of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes, see :STATistics:MAXimum:ALL? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.37 :STATistics:Efield? [<Triggered>][,<MProbe>]

Query center field strengths of bins used by histograms and distribution functions for one or multiple E-Field Probes.

PARAMETERS:

If no parameter is provided or if Triggered is set to 0 the center field strengths of all bins for the most recently created statistics snapshot based on continuous statistics acquisition are returned. If the parameter Triggered is set to 1 the center field strengths of the most recently created statistics snapshot based on triggered waveforms are returned.

The second, optional unsigned integer parameter MProbe is described in Section 10.1. If the parameter MProbe is set the parameter Triggered is mandatory.

RETURN VALUES:

The command returns a comma-separated list of float-valued E-field strengths in V/m. NAN will be returned if there is no valid statistics snapshot data or triggered waveform data.

10.7.38 :STATistics:HISTogram:X? [<Triggered>][,<MProbe>]

Query x-axis E-field strength histogram for one or multiple E-Field Probes.

PARAMETERS:

If no parameter is provided or if Triggered is set to 0 the x-axis E-field strength histogram for the most recently created statistics snapshot based on continuous statistics acquisition are returned. If the parameter Triggered is set to 1 the x-axis E-field strength histogram of the most recently created statistics snapshot based on triggered waveforms are returned.

The second, optional unsigned integer parameter MProbe is described in Section 10.1. If the parameter MProbe is set the parameter Triggered is mandatory.

RETURN VALUES:

The command returns a comma-separated list of unsigned 64 bit integer values specifying the number of samples of a field strength falling into the associated field strength bins returned by :STATistics:Efield? [<Triggered>][,<MProbe>]. The bin size is specified by :STATistics:RESolution <Resolution>[,<MProbe>]. NAN will be returned if there is no valid statistics snapshot data or triggered waveform data.

10.7.39 :STATistics:HISTogram:Y? [<Triggered>][,<MProbe>]

Query y-axis E-field strength histogram for one or multiple E-Field Probes, see :STATistics:HISTogram:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.40 :STATistics:HISTogram:Z? [<Triggered>][,<MProbe>]

Query z-axis E-field strength histogram for one or multiple E-Field Probes, see :STATistics:HISTogram:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.41 :STATistics:HISTogram:MAGnitude? [<Triggered>][,<MProbe>]

Query E-field strength magnitude histogram for one or multiple E-Field Probes, see :STATistics:HISTogram:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.42 :STATistics:PDF:X? [<Triggered>][,<MProbe>]

Query x-axis E-field strength discrete relative probability distribution of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes.

PARAMETERS:

See :STATistics:MINimum:X? [<Triggered>][,<MProbe>] parameter description for details.

RETURN VALUES:

The command returns a list of float-valued discrete relative probabilities of x-axis E-field strength. Each value is associated with a field strength bin returned by :STATistics:Efield? [<Triggered>][,<MProbe>]. NAN will be returned if there is no valid statistics snapshot data or triggered waveform data.

10.7.43 :STATistics:PDF:Y? [<Triggered>][,<MProbe>]

Query y-axis E-field strength discrete relative probability distribution of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes, see :STATistics:PDF:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.44 :STATistics:PDF:Z? [<Triggered>][,<MProbe>]

Query z-axis E-field strength discrete relative probability distribution of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes, see :STATistics:PDF:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.45 :STATistics:PDF:MAGnitude? [<Triggered>][,<MProbe>]

Query E-field strength magnitude discrete relative probability distribution of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes, see :STATistics:PDF:X? [<Triggered>][,<MProbe>] for for description of parameters and return values.

10.7.46 :STATistics:CDF:X? [<Triggered>][,<MProbe>]

Query x-axis E-field strength discrete cumulative probability distribution of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes, see :STATistics:PDF:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.47 :STATistics:CDF:Y? [<Triggered>][,<MProbe>]

Query y-axis E-field strength discrete cumulative probability distribution of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes, see :STATistics:PDF:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.48 :STATistics:CDF:Z? [<Triggered>][,<MProbe>]

Query z-axis E-field strength discrete cumulative probability distribution of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes, see :STATistics:PDF:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.49 :STATistics:CDF:MAGnitude? [<Triggered>][,<MProbe>]

Query E-field strength magnitude discrete cumulative probability distribution of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes, see :STATistics:PDF:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.50 :STATistics:CCDF:X? [<Triggered>][,<MProbe>]

Query x-axis E-field strength discrete complementary cumulative probability distribution of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes, see :STATistics:PDF:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.51 :STATistics:CCDF:Y? [<Triggered>][,<MProbe>]

Query y-axis E-field strength discrete complementary cumulative probability distribution of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes, see :STATistics:PDF:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.52 :STATistics:CCDF:Z? [<Triggered>][,<MProbe>]

Query z-axis E-field strength discrete complementary cumulative probability distribution of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes, see :STATistics:PDF:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.53 :STATistics:CCDF:MAGnitude? [<Triggered>][,<MProbe>]

Query E-field strength magnitude discrete complementary cumulative probability distribution of the most recent statistics snapshot or triggered waveform for one or multiple E-Field Probes, see :STATistics:PDF:X? [<Triggered>][,<MProbe>] for description of parameters and return values.

10.7.54 :STATistics:BINary? [<Triggered>][,<MProbe>]

Query all statistical values of the most recent statistics snapshot or triggered waveform in binary format for one or multiple E-Field Probes. This command can be used to reduce communications overhead when polling statistical values via software.

PARAMETERS:

See :STATistics:MINimum:X? [<Triggered>][,<MProbe>] parameter description for details.

The first byte specifies the number of bytes of the binary data block which will be returned.

P chunks of binary data will be sent thereafter, one for each referenced E-Field Probe. Statistics data will be returned in the following order.

CI NUMBER

32 bit unsigned integer value giving the serial number of the corresponding Computer Interface. If the probe P is not defined the CI serial number, probe serial number and bin count is set to zero and the binary data block ends.

PROBE NUMBER

32 bit unsigned integer value giving the serial number of the corresponding E-Field Probe. If the E-Field Probe is off or in start-up the probe serial number and bin count is set to zero and the binary data block ends.

BIN COUNT

Four bytes specifying the number of bins N contained in the following binary data, the value is a 32 bit unsigned integer value. If there is no valid statistics snapshot data N will have a value of zero and no further data will be returned for the binary data chunk.

OFFSET

32 bit signed integer value as described in :STATistics:HISTogram:OFFset? [<Triggered>][,<MProbe>].

SAMPLES

64 bit unsigned integer value as described in :STATistics:SAMples? [<Triggered>][,<MProbe>].

RESOLUTION

32 bit single precision floating point value as described in :STATistics:RESolution? [<MProbe>].

MINIMUM

Four 32 bit single precision floating point values as described in :STATistics:MINimum:ALL? [<Triggered>][,<MProbe>].

MAXIMUM

Four 32 bit single precision floating point values as described in :STATistics:MAXimum:ALL? [<Triggered>][,<MProbe>].

ARITHMETIC MEAN

Four 32 bit single precision floating point values as described in :STATistics:MEAN:ALL? [<Triggered>][,<MProbe>].

ROOT MEAN SQUARE

Four 32 bit single precision floating point values as described in :STATistics:RMS:ALL? [<Triggered>][,<MProbe>].

STANDARD DEVIATION

Four 32 bit single precision floating point values as described in :STATistics:SDEViation:ALL? [<Triggered>][,<MProbe>].

BINS

N 32 bit single precision floating point values as described in :STATistics:BINary? [<Triggered>][,<MProbe>].

HISTOGRAM, X

N 64 bit unsigned integer values as described in :STATistics:HISTogram:X? [<Triggered>][,<MProbe>].

HISTOGRAM, Y

N 64 bit unsigned integer values as described in :STATistics:HISTogram:Y? [<Triggered>][,<MProbe>].

HISTOGRAM, Z

N 64 bit unsigned integer values as described in :STATistics:HISTogram:Z? [<Triggered>][,<MProbe>].

HISTOGRAM, MAGNITUDE

N 64 bit unsigned integer values as described in :STATistics:HISTogram:MAGnitude? [<Triggered>][,<MProbe>].

RELATIVE PROBABILITY, X

N 32 bit single precision floating point values as described in :STATistics:PDF:X? [<Triggered>][,<MProbe>].

RELATIVE PROBABILITY, Y

N 32 bit single precision floating point values as described in :STATistics:PDF:Y? [<Triggered>][,<MProbe>].

RELATIVE PROBABILITY, Z

N 32 bit single precision floating point values as described in :STATistics:PDF:X? [<Triggered>][,<MProbe>].

RELATIVE PROBABILITY, MAGNITUDE

N 32 bit single precision floating point values as described in :STATistics:PDF:MAGnitude? [<Triggered>][,<MProbe>].

RELATIVE CUMULATIVE PROBABILITY, X

N 32 bit single precision floating point values as described in :STATistics:CDF:X? [<Triggered>][,<MProbe>].

RELATIVE CUMULATIVE PROBABILITY, Y

N 32 bit single precision floating point values as described in :STATistics:CDF:Y? [<Triggered>][,<MProbe>].

RELATIVE CUMULATIVE PROBABILITY, Z

N 32 bit single precision floating point values as described in :STATistics:CDF:X? [<Triggered>][,<MProbe>].

RELATIVE CUMULATIVE PROBABILITY, MAGNITUDE

N 32 bit single precision floating point values as described in :STATistics:CDF:MAGnitude? [<Triggered>][,<MProbe>].

RELATIVE COMPLEMENTARY CUMULATIVE PROBABILITY, X

N 32 bit single precision floating point values as described in :STATistics:CCDF:X? [<Triggered>][,<MProbe>].

RELATIVE COMPLEMENTARY CUMULATIVE PROBABILITY, Y

N 32 bit single precision floating point values as described in :STATistics:CCDF:Y? [<Triggered>][,<MProbe>].

RELATIVE COMPLEMENTARY CUMULATIVE PROBABILITY, Z

N 32 bit single precision floating point values as described in :STATistics:CCDF:X? [<Triggered>][,<MProbe>].

RELATIVE COMPLEMENTARY CUMULATIVE PROBABILITY, MAGNITUDE

N 32 bit single precision floating point values as described in :STATistics:CCDF:MAGnitude? [<Triggered>][,<MProbe>].

10.8 :MProbe Commands

10.8.1 :MProbe:FPSerial <MProbe>,<Probe1>[,<Probe2>,...,<ProbeN>]

Define a Multiprobe system by specifying one or multiple E-Field Probe serial numbers. The old syntax "MProbe:SET <MProbe>,<Probe1>[,<Probe2>,...,<ProbeN>]" remains supported.

PARAMETERS:

The first unsigned integer parameter MProbe sets the Multiprobe system number for a Multiprobe setup. MProbe must be greater that zero.

The following unsigned integer parameters Probe1 through ProbeN specify the E-Field Probe serial numbers for each E-Field Probe in a Multiprobe setup. The number of E-Field Probes in a Multiprobe setup is determined by the Number of probes specified and must be greater than zero. E.g. a four probe setup requires Probe1 through Probe4 to be specified. Probe serial numbers must be set to one of the active probes queried via :MEASure[:FProbe]:SERialnumber? [<MProbe>], unknown probe serial numbers will cause the command to fail.

10.8.2 :MProbe:FPSerial? <MProbe>

Query E-Field Probe serial number(s) for Multiprobe systems. This command is an alias of :MEASure[:FProbe]:SERialnumber? [<MProbe>] when used with an MProbe parameter. The old syntax "MProbe:GET? <MProbe>" remains supported.

PARAMETERS:

The unsigned integer parameter MProbe specifies the Multiprobe system number defined either automatically for setup number 0, or via :MProbe:FPSerial <MProbe>,<Probe1>[,<Probe2>,...,<ProbeN>] or :MProbe:CISerial <MProbe>,<Ci1>[,<Ci2>,...,<CiN>] for setup numbers greater than zero.

RETURN VALUES:

Comma-separated list of unsigned integers indicating the E-Field Probe serial numbers set for the Multiprobe system specified by the parameter MProbe. NAN will be returned instead of

probe serial numbers if the specified Multiprobe system has not been configured correctly, a configured E-Field Probe is off, in start-up or if there is no valid calibration data for a specified E-Field Probe.

10.8.3 :MProbe:CISerial <MProbe>,<Ci1>[,<Ci2>,...,<CiN>]

Define a Multiprobe system by specifying one or multiple Computer Interface serial numbers. The old syntax "MProbe:SETCi <MProbe>,<Ci1>[,<Ci2>,...,<CiN>]" remains supported.

PARAMETERS:

The first unsigned integer parameter MProbe sets the Multiprobe system number for a Multiprobe setup. MProbe must be greater that zero.

The following unsigned integer parameters Ci1 through CiN specify the Computer Interface serial numbers of a Multiprobe setup. The number of E-Field Probes in a Multiprobe setup is determined by the Number of probes specified and must be greater than zero. E.g. a four probe setup requires Ci1 through Ci4 to be specified. Computer Interface serial numbers must be set to one of the enumerated Computer Interfaces queried via :SYSTem:CISerial? [<MProbe>] unknown Computer Interface serial numbers will cause the command to fail. The command does not depend on the state of the E-Field Probes. Specifically, the supply laser(s) need not be enabled for the command to produce a valid setup.

10.8.4 :MProbe:CISerial? <MProbe>

Query Computer Interface serial number(s) for Multiprobe systems. This command is an alias of :SYSTem:CISerial? [<MProbe>] when used with an MProbe parameter. The old syntax "MProbe:GETCi? <MProbe>" remains supported.

PARAMETERS:

The unsigned integer parameter MProbe specifies the Multiprobe system number defined either automatically for setup number 0, or via :MProbe:FPSerial <MProbe>,<Probe1>[,<Probe2>,...,<ProbeN>] or :MProbe:CISerial <MProbe>,<Ci1>[,<Ci2>,...,<CiN>] for setup numbers greater than zero.

RETURN VALUES:

Comma-separated list of unsigned integers indicating the Computer Interface serial numbers for the Multiprobe system specified by the parameter MProbe. NAN will be returned instead of the probe serial number if the specified Multiprobe system has not been configured. The output of the command does not depend on the state of the field probes. Specifically, the supply laser(s) need not be enabled for the command to return a valid result.

10.8.5 :MProbe:AMAGnitude? <Triggered>,<MProbe>[,<RProbe>]

Query averaged magnitude of a Multiprobe system.

PARAMETERS:

The first parameter Triggered is used to select the source of statistics data. If set to zero snapshots of continuously collected data will be used for averaged magnitude calculation. If set to one triggered waveform data will be used to calculate the averaged magnitude.

The second parameter MProbe specifies the total number of E-Field Probes in the Multiprobe system whose averaged magnitude is to be calculated.

The third optional parameter specifies the number of reference probes RProbe used in the Multiprobe system. If omitted no reference probes will be used. The last RProbe E-Field Probes are used as reference probes.

RETURN VALUES:

RProbe plus one float-valued E-field magnitude values will be returned. The first value is generated by calculating the arithmetic mean of the arithmetic mean of all magnitude values for the first MProbe minus RProbe E-Field Probes. The following RProbe floating point values give the arithmetic mean of the reference probes' arithmetic mean their respective magnitude values.

NAN will be returned if the Multiprobe system setup is invalid, a E-Field Probe is off, a probe is in start-up, there is no snapshot data available or if the statistical data could not be computed.

10.8.6 :MProbe:MAXStatistics? <Triggered>,<MProbe>

Query maximum E-field statistics summary of a Multiprobe system.

PARAMETERS:

The first parameter Triggered is used to select the source of statistics data. If set to zero snapshots of continuously collected data will be used for statistical summary calculation. If set to one triggered waveform data will be used to calculate the statistical summary.

The second parameter MProbe specifies the total number of E-Field Probes in the Multiprobe system whose statistical summary is to be calculated.

RETURN VALUES:

List of twelve 32 bit single precision floating point values containing the following statistics:

- The arithmetic mean of the maximum x-axis E-field component values of every probe in the specified Multiprobe system.
- The arithmetic mean of the maximum y-axis E-field component values of every probe in the specified Multiprobe system.
- The arithmetic mean of the maximum z-axis E-field component values of every probe in the specified Multiprobe system.

- The arithmetic mean of the maximum x-, y- and z-axis E-field component values of every probe in the specified Multiprobe system.
- The standard deviation of the maximum x-axis E-field component values of every probe in the specified Multiprobe system.
- The standard deviation of the maximum y-axis E-field component values of every probe in the specified Multiprobe system.
- The standard deviation of the maximum z-axis E-field component values of every probe in the specified Multiprobe system.
- The standard deviation of the maximum x-, y- and z-axis E-field component values of every probe in the specified Multiprobe system.
- The standard deviation in dB of the maximum x-axis E-field component values of every probe in the specified Multiprobe system.
- The standard deviation in dB of the maximum y-axis E-field component values of every probe in the specified Multiprobe system.
- The standard deviation in dB of the maximum z-axis E-field component values of every probe in the specified Multiprobe system.
- The standard deviation in dB of the maximum x-, y- and z-axis E-field component values of every probe in the specified Multiprobe system.

NAN will be returned if the Multiprobe system setup is invalid, any E-Field Probe of the specified system is off, a probe is in start-up, there is no snapshot data available or if the statistical data could not be computed.

10.9 :VIRTual Computer Interface Commands

10.9.1 :VIRTual:CISerial?

Query serial numbers of connected virtual Computer Interfaces.

RETURN VALUES:

Unsigned integer-valued comma-separated list of all connected virtual Computer Interface serial numbers. If no virtual Computer Interfaces have been enumerated the command will return NAN.

10.9.2 :VIRTual:CONnect [<CI>]

Connect a new virtual Computer Interface.

PARAMETER:

The optional unsigned integer parameter CI specifies the serial number of the virtual Computer Interface. If omitted the default serial number is set to 1.

10.9.3 :VIRTual:DISConnect

Disconnect currently active Computer Interface if it is a virtual Computer Interface.

10.9.4 :VIRTual:FPSerial <Value>

Set virtual E-Field Probe serial number for currently selected virtual Computer Interface.

PARAMETER:

The optional unsigned integer parameter Value sets the desired virtual E-field Probe serial number. The default value is 1.

10.9.5 :VIRTual:FPSerial?

Query E-Field Probe serial number for currently selected virtual Computer Interface.

RETURN VALUE:

The command returns the unsigned integer value giving the virtual Field Probe's serial number. NAN is returned if the virtual Field Probe is off, in start-up or if the currently active Computer Interface is not virtual.

10.9.6 :VIRTual:TEMPerature <Temperature>

Set E-Field Probe internal temperature for the currently selected virtual Computer Interface.

PARAMETER:

The float valued temperature in °C sets the internal temperature of the virtual E-Field Probe. The default is 40 °C.

10.9.7 :VIRTual:TEMPerature?

Query E-Field Probe internal temperature of the currently selected virtual Computer Interface.

RETURN VALUE:

The command returns the virtual Field Probe's temperature in °C. NAN is returned if the active CI is not virtual.

10.9.8 :VIRTual:VOLTage <Voltage>

Set E-Field Probe supply voltage for the currently selected virtual Computer Interface.

PARAMETER:

The float-valued voltage in V sets the supply voltage of the virtual E-Field Probe. The default is 2.1 V.

10.9.9 :VIRTual:VOLTage?

Query virtual E-Field Probe supply voltage.

RETURN VALUE:

The command returns the float-valued virtual E-Field Probe supply voltage value in V. NAN will be returned if the active CI is not virtual.

10.9.10 :VIRTual:ACCeleration <ACCx>,<ACCy>,<ACCz>

Set the x-, y- and z-axis acceleration values for the currently selected virtual E-Field Probe.

PARAMETERS:

The three float-valued parameters set the acceleration values in gee for the virtual E-Field Probe. The default values are 0.

10.9.11 :VIRTual:ACCeleration?

Query the x-, y- and z-axis acceleration values for the currently selected virtual E-Field Probe.

RETURN VALUES:

The command returns a comma-separated list of three float values giving the x-, y- and z-axis acceleration in gee. NAN will be returned if the active CI is not virtual.

10.9.12 :VIRTual:CW <RSSIx>,<RSSIy>,<RSSIz>

Set x-, y- and z-axis CW RSSI value of the currently selected virtual E-Field Probe.

PARAMETERS:

The three unsigned integer parameters x-, y- and z-axis RSSI value set the signal strength indicated by the virtual Field Probe's ADCs. The default values are 0.

10.9.13 :VIRTual:CW?

Query the x-, y- and z-axis RSSI values of the currently selected virtual E-Field Probe.

RETURN VALUES:

The command returns a comma-separated list of three unsigned integer values giving the x-, y- and x-axis RSSI values. NAN will be returned if the active CI is not virtual.

10.9.14 :VIRTual:NOIse <NOISEx>,<NOISEy>,<NOISEz>

Set the maximum added noise amplitude of the currently selected virtual E-Field Probe.

PARAMETERS:

The three unsigned integer parameters x-, y- and z-axis NOISE set the maximum added RSSI value noise amplitude. The time-average of the values is zero. Ranges are distributed evenly between -1 times the given amplitudes and +1 times the given amplitudes. The default values are 0.

10.9.15 :VIRTual:NOIse?

Query the x-axis, y-axis and z-axis RSSI amplitude of the currently selected virtual E-Field Probe.

RETURN VALUES:

The command returns a comma-separated list of three unsigned integer values giving the maximum amplitude of added x-, y-, and z-axis noise in LSB. NAN will be returned if the active CI is not virtual.

10.9.16 :VIRTual:PULse [<RSSIx>],[<RSSIy>],[<RSSIz>],[<T>],[<Ton>]

Set the parameters of the virtual pulse signal for currently selected virtual E-Field Probe.

PARAMETERS:

RSSIX
: unsigned integer value setting the x-axis RSSI pulse value

RSSIY
: unsigned integer value setting the y-axis RSSI pulse value

RSSIZ
: unsigned integer value setting the z-axis RSSI pulse value

T
: unsigned integer value setting the pulse period expressed as a number of samples

TON
: unsigned integer value setting the ON-time at the beginning of reach pulse period expressed as a number of samples

10.9.17 :VIRTual:PULse?

Query the pulse parameters of the currently selected virtual E-Field Probe.

RETURN VALUES:
: The command returns a comma-separated list of five unsigned integer values as described in the parameter's description of :VIRTual:PULse [<RSSIx>],[<RSSIy>],[<RSSIz>],[<T>],[<Ton>]. NAN will be returned if the active CI is not virtual.

10.9.18 :VIRTual:ELIST <Ex1>,<Ey1>,<Ez1>[,...,<ExN>,<EyN>,<EzN>]

Append sets of x-, y- z-axis E-field values to list of the currently selected virtual E-Field Probe.

PARAMETERS:
: Multiples of three float-valued E-field strengths, specifying x-, y- and z-axis E-field values. The command accepts up to tree times 256 values. The E-field values are converted to RSSI values using the currently set mode, frequency and temperature. RSSI values will not be adjusted if either of these parameters is changed. E-field values exceeding the calibrated signal range will be limited to the maximum or minimum calibrated value.

10.9.19 :VIRTual:LIST <RSSIx1>,<RSSIy1>,<RSSIz1>[,...,<RSSIxN>,<RSSIyN>,<RSSIzN>]

Append sets of x-, y- z-axis RSSI values to list of the currently selected virtual E-Field Probe.

PARAMETERS:
: Multiples of three integer-valued RSSI, specifying x-, y- and z-axis RSSI values. The command accepts up to tree times 256 values.

10.9.20 :VIRTual:LIST?

Query the list of arbitrary RSSI values the currently selected virtual E-Field Probe.

RETURN VALUES:
: The command returns a comma separated, unsigned integer list of all x-,y- z-axis RSSI values of the arbitrary E-field value list. NAN will be returned if the active CI is not virtual or the list is empty.

10.9.21 :VIRTual:LCNt?

Query number of samples in arbitrary E-field values list of the currently selected virtual E-Field Probe.

RETURN VALUE:

Unsigned integer-valued number of E-field samples in arbitrary E-field value list. NAN will be returned if the active CI is not virtual.

10.9.22 :VIRTual:LCLear

Clear arbitrary arbitrary E-field value list of the currently selected virtual E-Field Probe.

10.10 :STReam Recording Commands

10.10.1 :STReam:MAster <State>

Set currently selected Computer Interface to be the master Computer Interface for stream recording.

PARAMETER:

Setting State to 1 makes the current Computer Interface the master during stream recording. A State of 0 makes the Computer Interface a slave during stream recording, i.e. stream synchronization is controlled by a different Computer Interface.

10.10.2 :STReam:MAster? [<MProbe>]

Query master/slave status of the currently active Computer Interface during stream recording.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

The command returns an unsigned integer value containing the stream recording master/slave status of the currently active Computer Interface. Slaves return 0, the master returns 1.

10.10.3 :STReam:LENgth <Length>[,<MProbe>]

Set number of samples to be recorded during stream recording for one or multiple E-Field Probes. The parameter can only be set when stream recording is inactive.

PARAMETERS:

The unsigned integer-valued parameter of the command specifies the number of consecutive samples to be streamed. E.g. »:STReam:len 100« will record 100 consecutive samples. Setting Length to zero configures indefinite streaming, i.e. streaming needs to be terminated by issuing a :STReam:ENable? [<MProbe>] command.

The second, optional unsigned integer parameter MProbe is described in Section 10.1.

10.10.4 :STReam:LENgth? [<MProbe>]

Query number of stream samples to be recorded for one or multiple E-Field Probes.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

The command returns the unsigned integer-valued number of samples to be streamed as specified using the :STReam:LENgth <Length>[,<MProbe>] command. A value of zero indicates indefinite streaming. If executed for multiple Computer Interfaces the command returns a list of unsigned integer-valued lengths of the number of streaming samples for each E-Field Probe of the list specified by the MProbe parameter.

10.10.5 :STReam:ENable <State>[,<MProbe>]

Enable or disable stream recording for one or multiple E-Field Probes.

PARAMETERS:

Setting State to 1 activates stream recording, creating a new stream file for each addressed Computer Interface. Setting State to 0 disables stream recording and close the associated stream file(s). See Section 11.2.4 for details about the stream file format.

The second, optional unsigned integer parameter MProbe is described in Section 10.1.

10.10.6 :STReam:ENable? [<MProbe>]

Query status of stream recording for one or multiple E-Field Probes.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

The command returns an unsigned integer value containing the stream recording status. A value of 1 is returned when stream data acquisition is enabled, 0 is returned if stream data acquisition is disabled.

10.10.7 :STReam:PROgress? [<MProbe>]

Query number of samples in current stream recording for one or multiple E-Field Probes.

PARAMETER:

The optional unsigned integer parameter MProbe determines the Multiprobe behavior of the command as described in the parameter of :SYSTem:CISerial? [<MProbe>].

RETURN VALUE:

The command returns an signed integer value giving the number of samples that have been recorded for the selected Computer Interface since the start of stream recording.

10.10.8 :STReam:SKIp <Value>[,<MProbe>]

Set number of strea samples to be skipped for one or multiple E-Field Probes. Parameter may only be set if stream data acquisition is disabled.

PARAMETERS:

The unsigned integer-valued parameter specifies the number of samples used to compute an averaged stream sample. E.g. »:stream:avg 100« will compute for every recorded 100 samples an averaged value and log this value to file. A value of one indicates no averaging occurs.

The second, optional unsigned integer parameter MProbe is described in Section 10.1.

10.10.9 :STReam:SKIp? [<MProbe>]

Query number of strea samples to be skipped for one or multiple E-Field Probes.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

The command returns the unsigned integer-valued number of samples to be skipped after recording a sample during stream recording, it corresponds to the value set using :STReam:SKIp <Value>[,<MProbe>]. If executed for multiple Computer Interfaces the command returns a list of unsigned integer-valued average values for each E-Field Probe of the respective list.

10.10.10 :STReam:PREfix <String>[,<MProbe>]

Set file prefix for stream recording for one or multiple E-Field Probes. The parameter can only be set when stream recording is disabled.

PARAMETERS:

String parameter without quotes specifying the stream log file prefix. String may not exceed 127

characters. The default value is set to "stream". E.g. »:str:pre "streamFile"« will result in a log files named "streamFile_PP_YYYYMMDD_hhmmss_msmsms.csv" to be saved when enabling stream recording. See Section 11.2.4 for a detailed description of stream file naming conventions and the stream file format.

The second, optional unsigned integer parameter MProbe is described in Section 10.1.

10.10.11 :STReam:PREfix? [<MProbe>]

Query file prefix for stream recording for one or multiple E-Field Probes.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

The command returns a string value without quotes specifying the set stream log file prefix, see :STReam:PREfix <String>[,<MProbe>] for more details. If executed for multiple Computer Interfaces the command returns a list of string values containing the value for each E-Field Probe of the respective list.

10.10.12 :STReam:SYNC <Sync>[,<MProbe>]

Set synchronization source for stream recording for one or multiple E-Field Probes.

PARAMETERS:

String parameter without quotes specifying the synchronization source, valid values are OFF, EXT and EXT2. When set to OFF stream recording will start immediately upon enabling using the »:STReam:ENable <State>[,<MProbe>]« command. When set to EXT the Computer Interface's BNC connector will be used to synchronize stream recoding slaves with the stream recording master. When set to EXT2 the Computer Interface's RJ45 socket will be used to synchronize stream recoding slaves with the stream recording master. When set to EXT or EXT2 the slave/master status set using the »:STReam:MAster <State>« command determines the input/output configuration of the respective connector.

The second, optional unsigned integer parameter MProbe is described in Section 10.1.

10.10.13 :STReam:SYNC? [<MProbe>]

Query synchronization source for stream recording for one or multiple E-Field Probes.

PARAMETER:

The optional unsigned integer parameter MProbe is described in Section 10.1.

RETURN VALUE:

The command returns a string value without quotes specifying the set stream synchronization source, see :STReam:SYNC <Sync>[,<MProbe>] for more details. If executed for multiple Computer Interfaces the command returns a list of string values containing the value for each E-Field Probe of the respective list.

11 File Formats

All data used by the LSProbe TCP Server and GUI are stored in the form of tabulator-separated plain ASCII text files. The uniform file extension is `.csv`. Lines are separated by newline characters (ASCII code `0xa`), columns are separated by tabulators.

Numbers are expressed as plain decimal integers, as floating point numbers using "." as the decimal separator, or in exponential format using "." as the decimal separator and "e" as the exponential separator, e.g. "1.2e3" encoding a value of 1,200.

In all examples given below "⊣" denotes a tabulator, ⏎ a newline character, and "↙" a line wrap indicating that the contents of the next line in this document belong to the same line of the `.csv` file.

11.1 LSProbe GUI Log Files

The creation time and E-Field Probe serial number of all log files is saved by attaching a time string formatted as "_N_YYYYMMDD_hhmmss_SSS" to a file's base name. "N","YYYY", "MM", "DD", "hh", "mm", "ss' and "SSS" denote E-Field Probe serial number, year, month, day, hour, minute, second and millisecond of log file creation with their respective number of digits. The number of digits used for the E-Field Probe serial number depends on the numeric value of the serial number.

The first line of all log files contains a header starting with a hash mark (#), which describes the contents of each column in the remainder of the file.

11.1.1 Basic Data Logger

The file format for all basic log files contains at least 13 columns described with their column headers and unit values in the table below.

Continuous logging will add one line for for every newly polled set of values. If more than one E-Field Probe are present one log file will be created for every E-Field Probe.

If a log file is created using the GUI's "Quick Save" button all presently displayed values of the active E-Field Probe will be saved to a newly created file.

Column	Header	Unit	Description
1	t	s	Timestamp expressed as a floating point number of seconds since 1904/01/01 00:00:00 UTC
2	Mode		Measurement mode, see Table 1, page 17
3	f	Hz	Compensation frequency
4	Ex	V/m	x-axis component of E-field
5	Ey	V/m	y-axis component of E-field
6	Ez	V/m	z-axis component of E-field

Column	Header	Unit	Description
7	Emag	V/m	E-field magnitude
8	fLpE	Hz	E-field low pass filter frequency
9	ACCx	gee	x-axis acceleration in multiples of 9.81 m/s^2
10	ACCy	gee	y-axis acceleration in multiples of 9.81 m/s^2
11	ACCz	gee	z-axis acceleration in multiples of 9.81 m/s^2
12	fLpACC	Hz	E-field low pass filter frequency
13	T	°C	Temperature inside the E-Field Probe
14	RSSIx	LSB	x-axis raw RSSI value, optional
15	RSSIy	LSB	y-axis raw RSSI value, optional
16	RSSIz	LSB	z-axis raw RSSI value, optional

EXAMPLE OF BASIC LOG FILE:

```
#t ⇥Mode ⇥f⇥Ex ⇥Ey ⇥Ez ⇥Emag ⇥fLpE ⇥ACCx ⇥ACCy ⇥ACCz ⇥fLpACC ⇥T⇥↙
   RSSIx⇥RSSIy⇥RSSIz↵
3569229678.874 ⇥0⇥100000000⇥0.155352 ⇥0.258098 ⇥0.204308 ⇥0.363993↙
    ⇥0⇥-0.02381 ⇥-0 ⇥0.916667 ⇥0⇥30.0625⇥2729 ⇥3131 ⇥2788↵
3569229678.910 ⇥0⇥100000000⇥0.172794 ⇥0.23228⇥0.230869 ⇥0.370287 ⇥0↙
   ⇥-0.011905⇥-0 ⇥0.952381 ⇥0⇥30.0625⇥2790 ⇥3042 ⇥2881↵
```

11.1.2 Field Scope Data Logger

The file format for all field scope log files contains at least seven columns described with their column headers and unit values in the table below.

Continuous logging will create a new log file for every newly recorded set of waveforms. If more than one E-Field Probe are present one log file will be created for every E-Field Probe.

If a log file is created using the GUI's "Quick Save" button all presently displayed values of the active E-Field Probe will be saved to a newly created file.

Column	Header	Unit	Description
1	Mode		Measurement mode, see Table 1, page 17
2	f	Hz	Compensation frequency
3	Ex	V/m	x-axis component of E-field
4	Ey	V/m	y-axis component of E-field
5	Ez	V/m	z-axis component of E-field

Column	Header	Unit	Description
6	Emag	V/m	E-field magnitude
7	Frame		Frame indicator, Frame is identical for waveform values belonging to the same burst frame, valid values are 0 and 1
8	RSSIx	LSB	x-axis raw RSSI value, optional
9	RSSIy	LSB	y-axis raw RSSI value, optional
10	RSSIz	LSB	z-axis raw RSSI value, optional

EXAMPLE OF FIELD SCOPE LOG FILE:

```
#Mode⊣f⊣Ex ⊣Ey ⊣Ez ⊣Emag ⊣Frame⊣RSSIx⊣RSSIy⊣RSSIz↵
0⊣100000000⊣1.355152 ⊣3.119291 ⊣0.228687 ⊣3.408623 ⊣1⊣5020 ⊣6064 ⊣↙
    2873↵
0⊣100000000⊣1.367466 ⊣3.141975 ⊣0.19829⊣3.432389 ⊣1⊣5031 ⊣6073 ⊣↙
    2767↵
```

11.1.3 Radar Data Logger

The file format for all radar log files contains at least 13 columns described with their column headers and unit values in the table below. The number of columns is dependent on the number of detected pulses for all component and magnitude E-field values. For every pulse a pair of columns consisting of the sample index of the start of the pulse and maximum E-field value for the pulse will be added to the radar log file. First, Nx value pairs for the x-axis component values will be added, followed by Ny, Nz and Nmag value pairs for the other component's and magnitude's values. The pulse counts Nx, Ny, Nz and Nmag are given in columns 10 through 13.

Continuous logging will create a new line in the log file for every newly recorded set of waveforms. If more than one E-Field Probe are present one log file will be created for every E-Field Probe.

If a log file is created using the GUI's "Quick Save" button all presently displayed values of the active E-Field Probe will be saved to a newly created file.

Column	Header	Unit	Description
1	t	s	Timestamp expressed as a floating point number of seconds since 1904/01/01 00:00:00 UTC
2	Mode		Measurement mode, see Table 1, page 17
3	f	Hz	Compensation frequency
4	Ex	V/m	Arithmetic mean of all pulses' x-axis component E-field maximums
5	Ey	V/m	Arithmetic mean of all pulses' y-axis component E-field maximums

Column	Header	Unit	Description
6	Ez	V/m	Arithmetic mean of all pulses' z-axis component E-field maximums
7	Emag	V/m	Arithmetic mean of all pulses' E-field magnitude maximums
8	Samp		Number of samples in waveforms evaluated for radar detection
9	Th	V/m	Threshold value for radar pulse detection, set to zero for automatic detection threshold
10	CNTx		Number of pulses detected for x-axis component of E-field
11	CNTy		Number of pulses detected for y-axis component of E-field
12	CNTz		Number of pulses detected for z-axis component of E-field
13	CNTmag		Number of pulses detected for E-field magnitude
14...	IDXxN		Sample index of N^{th} x-axis pulse
15...	ExN	V/m	N^{th} x-axis pulse's maximum E-field strength
14...	IDXyN		Sample index of y-axis pulse number Py
15...	EyN	V/m	N^{th} y-axis pulse's maximum E-field strength
14...	IDXzN		Sample index of z-axis pulse number Pz
15...	EzN	V/m	N^{th} z-axis pulse's maximum E-field strength
14...	IDXmagN		Sample index of magnitude pulse number Pmag
15...	EmagN	V/m	N^{th} E-field magnitude pulse's maximum E-field strength

EXAMPLE OF RADAR LOG FILE:

```
#t ⇥Mode ⇥f⇥Ex ⇥Ey ⇥Ez ⇥Emag ⇥Samp ⇥Th ⇥CNTx ⇥CNTy ⇥CNTz ⇥CNTmag ⇥↙
   IDXxN⇥ExN⇥IDXyN⇥EyN⇥IDXzN⇥EzN⇥IDXmagN⇥EmagN↵
3565256730.687 ⇥0⇥100000000⇥1.26726⇥1.30166⇥0.862018 ⇥1.84742⇥10000↙
   ⇥0⇥2⇥4⇥4⇥4⇥4752 ⇥1.2657 ⇥9752 ⇥1.26882⇥916⇥1.51021⇥4753 ⇥↙
   1.09146⇥5916 ⇥1.51268⇥9753 ⇥1.0923 ⇥916⇥1.02893⇥4753 ⇥0.694609↙
    ⇥5916 ⇥1.03234⇥9753 ⇥0.69219⇥916⇥1.90582⇥4752 ⇥1.78684⇥5916 ⇥↙
   1.90704⇥9752 ⇥1.78999↵
3565256753.101 ⇥0⇥100000000⇥1.26726⇥1.30166⇥1.01822⇥1.84742⇥10000⇥1↙
   ⇥2⇥4⇥19 ⇥4⇥4753 ⇥1.2657 ⇥9753 ⇥1.26882⇥917⇥1.51021⇥4754 ⇥↙
   1.09146⇥5917 ⇥1.51268⇥9754 ⇥1.0923 ⇥917⇥1.02129⇥925⇥1.01203⇥931↙
   ⇥1.00951⇥933⇥1.02808⇥949⇥1.00368⇥951⇥1.02298⇥955⇥1.00202⇥957⇥↙
   1.02893⇥964⇥1.01035⇥5917 ⇥1.03234⇥5924 ⇥1.02298⇥5933 ⇥1.02978⇥↙
   5936 ⇥1.01707⇥5940 ⇥1.02638⇥5950 ⇥1.00868⇥5952 ⇥1.02553⇥5958 ⇥↙
   1.02298⇥5961 ⇥1.01454⇥5966 ⇥1.00701⇥916⇥1.90582⇥4752 ⇥1.78684⇥↙
   5916 ⇥1.90704⇥9752 ⇥1.78999↵
```

11.1.4 Statistics Data Logger

The file format for all statistics log files contains at least 32 columns described with their column headers and unit values in the table below. The number of columns is dependent on the number of E-field strength bins in the recorded histogram, there is at least one bin in the histogram. For every bin four columns consisting of the number of x-, y-, z-axis and magnitude samples detected for the corresponding bin will be added to the radar log file. The number of bins is specified in column number 28.

Continuous logging will add a new line to the log file for every newly recorded statistics snapshot. If more than one E-Field Probe are present one log file will be created for every E-Field Probe.

If a log file is created using the GUI's "Quick Save" button all presently displayed values of the active E-Field Probe will be saved to a newly created file.

Column	Header	Unit	Description
1	t	s	Timestamp expressed as a floating point number of seconds since 1904/01/01 00:00:00 UTC
2	Mode		Measurement mode, see Table 1, page 17
3	f	Hz	Compensation frequency
4	Type		Statistics type, 0 for continuous statistics, 1 for triggered statistics
5	MINx	V/m	E-field x-axis component minimum
6	MINy	V/m	E-field y-axis component minimum
7	MINz	V/m	E-field z-axis component minimum
8	MINmag	V/m	E-field magnitude minimum
9	MAXx	V/m	E-field x-axis component maximum
10	MAXy	V/m	E-field y-axis component maximum
11	MAXz	V/m	E-field z-axis component maximum
12	MAXmag	V/m	E-field magnitude maximum
13	MEANx	V/m	E-field x-axis component arithmetic mean
14	MEANy	V/m	E-field y-axis component arithmetic mean
15	MEANz	V/m	E-field z-axis component arithmetic mean
16	MEANmag	V/m	E-field magnitude arithmetic mean
17	RMSx	V/m	E-field x-axis component root mean square
18	RMSy	V/m	E-field y-axis component root mean square
19	RMSz	V/m	E-field z-axis component root mean square
20	RMSmag	V/m	E-field magnitude root mean square
21	SDEVx	V/m	E-field x-axis component standard deviation

Column	Header	Unit	Description
22	SDEVy	V/m	E-field y-axis component standard deviation
23	SDEVz	V/m	E-field z-axis component standard deviation
24	SDEVmag	V/m	E-field magnitude standard deviation
25	Samp		Number of samples used for statistics evaluation
26	Res	V/m	E-field resolution for histogram output
27	Offs	V/m	E-field offset of minimum bin in histogram
28	Bins		Number of bins in E-field value histogram
29...	CNTxN		Number of x-axis E-field values in N^{th} bin of histogram
30...	CNTyN		Number of y-axis E-field values in N^{th} bin of histogram
31...	CNTzN		Number of z-axis E-field values in N^{th} bin of histogram
32...	CNTmagN		Number of E-field magnitude values in N^{th} bin of histogram

EXAMPLE OF STATISTICS LOG FILE:

```
#t ⊣Mode ⊣f⊣Type ⊣MINx ⊣MINy ⊣MINz ⊣MINmag ⊣MAXx ⊣MAXy ⊣MAXz ⊣↙
   MAXmag ⊣MEANx⊣MEANy⊣MEANz⊣MEANmag⊣RMSx ⊣RMSy ⊣RMSz ⊣RMSmag ⊣↙
   SDEVx⊣SDEVy⊣SDEVz⊣SDEVmag⊣Samp ⊣Res⊣Offs ⊣Bins ⊣CNTxN⊣CNTyN⊣↙
   CNTzN⊣CNTmagN↵
3565261205.605 ⊣0⊣100000000⊣0⊣0.13693⊣0.016042 ⊣0.117557 ⊣0.213673↙
    ⊣141.416473 ⊣38.725765⊣11.891866⊣146.639175 ⊣1.415222 ⊣↙
   0.447755 ⊣0.304661 ⊣1.572223 ⊣12.207644⊣3.499163 ⊣0.887066 ⊣↙
   12.730366⊣12.125352⊣3.470403 ⊣0.833109 ⊣12.632927⊣317452 ⊣30 ⊣↙
   -1 ⊣3⊣1125 ⊣313385 ⊣2942 ⊣305436 ⊣9099 ⊣2917 ⊣29281⊣285640 ⊣↙
   2531 ⊣0⊣314510 ⊣2942↵
3565261228.359 ⊣0⊣100000000⊣1⊣0.161065 ⊣0.016042 ⊣0.127204 ⊣↙
   0.234153 ⊣126.76519⊣36.919006⊣10.40519 ⊣132.357941 ⊣1.396783 ⊣↙
   0.441806 ⊣0.304875 ⊣1.54563⊣11.939714⊣3.483666 ⊣0.986952 ⊣↙
   12.476414⊣11.858323⊣3.45571⊣0.93873⊣12.380923⊣10000⊣30 ⊣-1 ⊣3⊣↙
   29 ⊣9877 ⊣94 ⊣9843 ⊣63 ⊣94 ⊣1005 ⊣8903 ⊣92 ⊣0⊣9906 ⊣94↵
```

11.1.5 Multiprobe Data Logger

The file format for all statistics log files contains at least 19 columns described with their column headers and unit values in the table below. The number of columns is dependent on the number of E-Field Probes in a Multiprobe system. The system ID is stored in column number 18. The serial numbers of all E-Field Probes in a Multiprobe system are stored in column 19 onward. There is at least one E-Field Probe in a Multiprobe system.

Continuous logging will add a new line for every newly recorded set of Multiprobe statistics.

If a log file is created using the GUI's "Quick Save" button all presently displayed values will be saved to a newly created file.

Column	Header	Unit	Description
1	t	s	Timestamp expressed as a floating point number of seconds since 1904/01/01 00:00:00 UTC
2	Mode		Measurement mode, see Table 1, page 17
3	f	Hz	Compensation frequency
4	Type		Multiprobe Statistics type, 0 for continuous statistics, 1 for triggered statistics
5	AvgMag	V/m	Arithmetic mean of the arithmetic mean of all magnitude values for all E-Field Probes in a Multiprobe system
6	MEANx	V/m	Arithmetic mean of E-field x-axis component maximum values for all E-Field Probes in a Multiprobe system
7	MEANy	V/m	Arithmetic mean of E-field y-axis component maximum values for all E-Field Probes in a Multiprobe system
8	MEANz	V/m	Arithmetic mean of E-field z-axis component maximum values for all E-Field Probes in a Multiprobe system
9	MEANxyz	V/m	Arithmetic mean of E-field x-axis, y-axis and z-axis component maximum values for all E-Field Probes in a Multiprobe system
10	SDEVx	V/m	Standard deviation of E-field x-axis component maximum values for all E-Field Probes in a Multiprobe system
11	SDEVy	V/m	Standard deviation of E-field y-axis component maximum values for all E-Field Probes in a Multiprobe system
12	SDEVz	V/m	Standard deviation of E-field z-axis component maximum values for all E-Field Probes in a Multiprobe system
13	SDEVxyz	V/m	Standard deviation of E-field x-axis, y-axis and z-axis component maximum values for all E-Field Probes in a Multiprobe system
14	SDdBx	V/m	Standard deviation in dB of E-field x-axis component maximum values for all E-Field Probes in a Multiprobe system
15	SDdBy	V/m	Standard deviation in dB of E-field y-axis component maximum values for all E-Field Probes in a Multiprobe system
16	SDdBz	V/m	Standard deviation in dB of E-field z-axis component maximum values for all E-Field Probes in a Multiprobe system
17	SDdBxyz	V/m	Standard deviation in dB of E-field x-axis, y-axis and z-axis component maximum values for all E-Field Probes in a Multiprobe system

Column	Header	Unit	Description
18	ID		Multiprobe system ID
19...	SernoN		E-Field Probe serial number of Nth E-Field Probes in a Multiprobe system

EXAMPLE OF MULTIPROBE LOG FILE:

```
#t ¬Mode ¬f¬Type ¬AvgMag ¬MEANx¬MEANy¬MEANz¬MEANxyz¬SDEVx¬SDEVy¬↙
   SDEVz¬SDEVxyz¬SDdBx¬SDdBy¬SDdBz¬SDdBxyz¬ID ¬SernoN↵
3565261973.621 ¬0¬100000000¬0¬0.659498 ¬8.16582¬29.7167¬19.8838¬↙
   19.2554¬0¬0¬0¬10.7892¬0¬0¬0¬3.86426¬1¬5↵
3565261973.621 ¬0¬100000000¬0¬1.59676¬0.659498 ¬0.659498 ¬52.5014¬↙
   32.742 ¬17.0175¬34.087 ¬76.7914¬5.24005¬4.96456¬41.5254¬7.82807↙
   ¬1.28946¬2.22345¬6.92008¬3¬7¬5¬5↵
3565261973.621 ¬0¬100000000¬0¬1.12813¬74.6691¬34.2547¬15.5844¬↙
   41.5027¬76.7914¬5.24005¬4.96456¬47.8105¬6.14317¬1.23639¬2.402¬↙
   6.65678¬4¬5¬7¬5¬7↵
3565261973.621 ¬0¬100000000¬0¬0.893814 ¬1.59676¬0.659498 ¬52.5014¬↙
   32.742 ¬17.0175¬34.087 ¬68.6843¬4.68685¬4.44044¬40.2855¬7.26562↙
   ¬1.16202¬2.01384¬6.77648¬6¬5¬5¬5¬7¬7¬5↵
3565261973.621 ¬0¬100000000¬0¬1.12813¬74.6691¬34.2547¬15.5844¬↙
   41.5027¬71.095 ¬4.85135¬4.59629¬46.7596¬5.81019¬1.15048¬2.24492↙
   ¬6.55397¬8¬5¬7¬5¬7¬5¬7¬5¬7↵
3565261973.621 ¬0¬100000000¬0¬1.12813¬74.6691¬34.2547¬15.5844¬↙
   41.5027¬71.095 ¬4.85135¬4.59629¬46.7596¬5.81019¬1.15048¬2.24492↙
   ¬6.55397¬48 ¬5¬5¬5¬5¬7¬7¬7¬7↵
3565262010.792 ¬0¬100000000¬1¬0.697771 ¬8.30329¬29.2079¬19.7129¬↙
   19.0747¬0¬0¬0¬10.4669¬0¬0¬0¬3.79953¬1¬5↵
3565262010.792 ¬0¬100000000¬1¬1.54563¬0.697771 ¬0.697771 ¬47.7906¬↙
   31.7783¬16.6103¬32.0597¬68.394 ¬4.45202¬5.3738 ¬36.9316¬7.71612↙
   ¬1.13883¬2.43462¬6.6567 ¬3¬7¬5¬5↵
3565262010.792 ¬0¬100000000¬1¬1.1217 ¬67.5342¬33.0634¬15.059 ¬↙
   38.5522¬68.394 ¬4.45202¬5.3738 ¬42.4985¬6.07571¬1.09725¬2.65063↙
   ¬6.45415¬4¬5¬7¬5¬7↵
3565262010.792 ¬0¬100000000¬1¬0.909735 ¬1.54563¬0.697771 ¬47.7906¬↙
   31.7783¬16.6103¬32.0597¬61.1735¬3.98201¬4.80647¬35.8289¬7.15882↙
   ¬1.02541¬2.20753¬6.51675¬6¬5¬5¬5¬7¬7¬5↵
3565262010.792 ¬0¬100000000¬1¬1.1217 ¬67.5342¬33.0634¬15.059 ¬↙
   38.5522¬63.3205¬4.12177¬4.97517¬41.5644¬5.74531¬1.02044¬2.4795↙
    ¬6.35346¬8¬5¬7¬5¬7¬5¬7¬5¬7↵
3565262010.792 ¬0¬100000000¬1¬1.1217 ¬67.5342¬33.0634¬15.059 ¬↙
   38.5522¬63.3205¬4.12177¬4.97517¬41.5644¬5.74531¬1.02044¬2.4795↙
```

```
⊣6.35346⊣48  ⊣5⊣5⊣5⊣5⊣7⊣7⊣7⊣7↵
```

11.1.6 48 Probe Statistics Data Log

The file format for 48 probe setups all statistics log files contains 25 columns described with their column headers and unit values in the table below.

When a log file is created using the GUI's "Quick Save" button up to 48 lines with the statistics values of the respective E-Field Probe will be saved to a newly created file.

Column	Header	Unit	Description
1	t	s	Timestamp expressed as a floating point number of seconds since 1904/01/01 00:00:00 UTC
2	Mode		Measurement mode, see Table 1, page 17
3	f	Hz	Compensation frequency
4	Type		Statistics type, 0 for continuous statistics, 1 for triggered statistics
5	MINx	V/m	E-field x-axis component minimum
6	MINy	V/m	E-field y-axis component minimum
7	MINz	V/m	E-field z-axis component minimum
8	MINmag	V/m	E-field magnitude minimum
9	MAXx	V/m	E-field x-axis component maximum
10	MAXy	V/m	E-field y-axis component maximum
11	MAXz	V/m	E-field z-axis component maximum
12	MAXmag	V/m	E-field magnitude maximum
13	MEANx	V/m	E-field x-axis component arithmetic mean
14	MEANy	V/m	E-field y-axis component arithmetic mean
15	MEANz	V/m	E-field z-axis component arithmetic mean
16	MEANmag	V/m	E-field magnitude arithmetic mean
17	RMSx	V/m	E-field x-axis component root mean square
18	RMSy	V/m	E-field y-axis component root mean square
19	RMSz	V/m	E-field z-axis component root mean square
20	RMSmag	V/m	E-field magnitude root mean square
21	SDEVx	V/m	E-field x-axis component standard deviation
22	SDEVy	V/m	E-field y-axis component standard deviation
23	SDEVz	V/m	E-field z-axis component standard deviation

Column	Header	Unit	Description
24	SDEVmag	V/m	E-field magnitude standard deviation
25	Samp		Number of samples used for statistics evaluation
26	Serno		E-Field Probe serial number

EXAMPLE OF 48 PROBE STATISTICS LOG FILE:

```
#t ⊣Mode ⊣f⊣Type ⊣MINx ⊣MINy ⊣MINz ⊣MINmag ⊣MAXx ⊣MAXy ⊣MAXz ⊣↙
   MAXmag ⊣MEANx⊣MEANy⊣MEANz⊣MEANmag⊣RMSx ⊣RMSy ⊣RMSz ⊣RMSmag ⊣↙
   SDEVx⊣SDEVy⊣SDEVz⊣SDEVmag⊣Samp ⊣SernoN↵
3569467865.941 ⊣0⊣100000000⊣0⊣0.01382⊣0.016042 ⊣0.014314 ⊣0.030832↙
    ⊣2.390562 ⊣12.669224⊣2.645453 ⊣13.137115⊣0.113764 ⊣0.209428 ⊣↙
   0.102401 ⊣0.268618 ⊣0.241519 ⊣0.938516 ⊣0.237296 ⊣0.997701 ⊣↙
   0.213048 ⊣0.914852 ⊣0.214065 ⊣0.960861 ⊣467021 ⊣68↵
3569467865.941 ⊣0⊣100000000⊣0⊣0.267147 ⊣0.043752 ⊣0.030252 ⊣↙
   0.310814 ⊣46.69281 ⊣20.582588⊣39.445728⊣62.301716⊣0.577217 ⊣↙
   0.348229 ⊣0.510458 ⊣0.932523 ⊣2.709211 ⊣1.555824 ⊣3.601982 ⊣↙
   4.76812⊣2.647009 ⊣1.516354 ⊣3.565633 ⊣4.676047 ⊣467023 ⊣5↵
```

11.2 Calibration Files

Each LSProbe E-Field Probe comes with a detailed set of in-house calibration files used for linearity compensation, frequency compensation, temperature compensation and E-field strength calibration. Optionally, an external E-field strength calibration file can be added. Calibration files are stored in one directory per E-Field Probe, directory names consist of »sn« followed by the decimally coded E-Field Probe serial number without leading zeros. Calibration directories are stored in the directory specified via the `LSPROBE_CAL_PATH` environment variable. The CSV file conventions detailed in section 11 apply to all calibration files.

The contents of all calibration files are protected against inadvertent modification by means of a decimally coded integer checksum in the last column of each calibration files's line. The checksum is calculated by adding all ASCII code values of the calibration file starting with the first character of the second line of the respective calibration file.

11.2.1 In-House Linearity, Frequency and Temperature Compensation Files

One in-house linearity, frequency and temperature compensation file, or short LFT file, exists for every in-house calibrated frequency and E-Field Probe mode. LFT file names consist of »sn« followed by the decimally coded E-Field Probe serial number, »m« followed by the decimally coded mode number, »f« followed by the decimally coded frequency value in Hertz, followed by ».csv«.

The first line of LFT files starts with a hash mark character (#) and gives context information for the LFT file, it does not give column names for the data in the remainder of the CSV file. The first line's columns have the following contents:

Column	Unit	Description
1		E-Field Probe serial number as decimally coded integer value
2		Measurement mode, see Table 1, page 17
3	Hz	Measurement frequency
4		Time stamp of first calibration temperature for given frequency and mode
5	°C	Ambient temperature of first calibration temperature for given frequency and mode
6	LSB	E-Field Probe internal temperature ADC value of first calibration temperature for given frequency and mode
7		Time stamp of second calibration temperature for given frequency and mode
8	°C	Ambient temperature of second calibration temperature for given frequency and mode
9	LSB	E-Field Probe internal temperature ADC value of second calibration temperature for given frequency and mode
10		Time stamp of third calibration temperature for given frequency and mode
11	°C	Ambient temperature of third calibration temperature for given frequency and mode
12	LSB	E-Field Probe internal temperature ADC value of third calibration temperature for given frequency and mode
13		Time stamp of fourth calibration temperature for given frequency and mode
14	°C	Ambient temperature of fourth calibration temperature for given frequency and mode
15	LSB	E-Field Probe internal temperature ADC value of fourth calibration temperature for given frequency and mode
16		Checksum for rest of file as described in Section 11.2

The following lines of LFT files have the following contents:

Column	Unit	Description
1	dBm	Power level used for given mode, frequency and all temperatures given in the first line of the file
2	LSB	x-axis RSSI value for first calibration temperature for given frequency, mode and power value in first column

Column	Unit	Description
3	LSB	y-axis RSSI value for first calibration temperature for given frequency, mode and power value in first column
4	LSB	z-axis RSSI value for first calibration temperature for given frequency, mode and power value in first column
5	LSB	x-axis RSSI value for second calibration temperature for given frequency, mode and power value in first column
6	LSB	y-axis RSSI value for second calibration temperature for given frequency, mode and power value in first column
7	LSB	z-axis RSSI value for second calibration temperature for given frequency, mode and power value in first column
8	LSB	x-axis RSSI value for third calibration temperature for given frequency, mode and power value in first column
9	LSB	y-axis RSSI value for third calibration temperature for given frequency, mode and power value in first column
10	LSB	z-axis RSSI value for third calibration temperature for given frequency, mode and power value in first column
11	LSB	x-axis RSSI value for fourth calibration temperature for given frequency, mode and power value in first column
12	LSB	y-axis RSSI value for fourth calibration temperature for given frequency, mode and power value in first column
13	LSB	z-axis RSSI value for fourth calibration temperature for given frequency, mode and power value in first column

11.2.2 In-House Field Strength Calibration Files

One in-house E-field calibration file or short IE file, exists for every in-house calibrated E-Field Probe mode. IE file names consist of »sn« followed by the decimally coded E-Field Probe serial number, »m« followed by the decimally coded mode number, followed by ».csv«.

The first line of IE files starts with a hash mark character (#) and gives context information for the IE file, it does not give column names for the data in the remainder of the CSV file. The first line's columns have the following contents:

Column	Unit	Description
1		E-Field Probe serial number as decimally coded integer value
2		Measurement mode, see Table 1, page 17
3	V/m	E-field strength during calibration of given mode

Column	Unit	Description
4	LSB	E-Field Probe internal temperature ADC value during calibration of given mode
5		Time stamp during calibration of given mode
6		Checksum for rest of file as described in Section 11.2

The following lines of IE files have the following contents:

Column	Unit	Description
1	Hz	Frequency for given mode and ambient temperature
2	LSB	x-axis RSSI value for given E-field strength and mode in first column
3	LSB	y-axis RSSI value for given E-field strength and mode in first column
4	LSB	z-axis RSSI value for given E-field strength and mode in first column

11.2.3 External Field Strength Calibration Files

One external E-field calibration file or short EE file, exists for every externally calibrated E-Field Probe. An EE file contains correction factors expressed in Decibels, the correction factor will be applied to the base E-field derived from the supplied internal calibration data. A value greater than zero will make the output E-field value larger, values smaller than zero make the output E-field value. The EE file name consists of »sn« followed by the decimally coded E-Field Probe serial number followed by ».csv«.

The first line of an EE file starts with a hash mark character (#) and gives context information for the EE file, it does not give column names for the data in the remainder of the CSV file. The first line's columns have the following contents:

Column	Unit	Description
1		E-Field Probe serial number as decimally coded integer value
2	°C	Average E-Field Probe internal temperature during calibration
3		Maximum time stamp during calibration
4		Checksum for rest of file as described in Section 11.2

The second line of EE files starts with a hash mark character (#) and contains a calibration certificate string that extends to the end if the second line. The following lines of an EE file have the following contents:

Column	Unit	Description
1	Hz	Frequency for external E-field calibration

Column	Unit	Description
2	dB	x-axis correction value for the given frequency
3	dB	y-axis correction value for the given frequency
4	dB	z-axis correction value for the given frequency

11.2.4 Stream Files in Binary Format

The format "PREFIX_FP_YYYYMMDD_hhmmss.bin" containing the following information is used for all binary stream files.

PREFIX
: File prefix set by the user, its default value is 'stream',

FP
: Serial number of the E-Field Probe which recorded the stream data.

YYYYMMDD_hhmmss
: Year, month, day of the month, hour, minute and second of the start of the stream file.

Stream files are optimized for small file size and low processor load. Their binary format contains E-field lookup-tables and raw, unsigned integer RSSI values for all axes, including frame indicators as well es auxiliary information about mode, frequency, temperature and skip count. E-field lookup-tables can be used off-line for converting RSSI values to E-field strength values.

All stream files start with a lookup-table block containing three-axis E-field lookup-tables and auxiliary information. Field strength information is stored in the form of RSSI data blocks. Lookup-table blocks start with a single byte set to a value of 255. They have a size of 196,623 bytes and the following structure:

Data	Offset	Size	Description
Identifier	0	1	Single byte set to 255
Mode	1	2	E-Field Probe mode, 16 bit, little endian, unsigned integer
Frequency	3	4	E-Field Probe frequency in Hertz, 32 bit, single precision, little-endian floating point value
Temperature	7	4	E-Field Probe temperature in °C, 32 bit, single precision, little-endian floating point value
Skip Count	11	4	Stream recording skip count, 32 bit, little endian, unsigned integer value
x-axis[0]	15	4	x-axis E-field strength for RSSI=0, 32 bit, single precision, little-endian floating point value
y-axis[0]	19	4	y-axis E-field strength for RSSI=0
z-axis[0]	23	4	z-axis E-field strength for RSSI=0

Data	Offset	Size	Description
x-axis[1]	27	4	x-axis E-field strength for RSSI=1
...	...	4	...
z-axis[16383]	196,619	4	z-axis E-field strength for RSSI=16383

Lookup-table blocks are followed by an arbitrary number of RSSI data blocks. Each block contains simultaneous x-, y- and z-axis RSSI values and the frame indicator for one sampling instant. Each block has a a size of seven bytes and the following structure:

Data	Size	Description
frame	1	frame information for the current sample, alternating between zero and one, 8 bit unsigned integer
x-axis RSSI	2	x-axis RSSI value, 16 bit unsigned integer little-endian format
y-axis RSSI	2	y-axis RSSI value
z-axis RSSI	2	z-axis RSSI value

RSSI data blocks are followed by a lookup-table indicated by the header described above when the lookup table is modified, e.g. in response to a significant temperature change of the E-Field Probe.

11.2.5 Stream Files in CSV Format

The Bin2Csv.exe program which is part of the LSProbe Installer can be used to generate CSV files from binary stream files described in the previous section. CSV output files have the following format:

Column	Header	Unit	Description
1	Mode		Measurement mode, see Table 1, page 17, optional
2	f	Hz	Compensation frequency, optional
3	Ex	V/m	x-axis component of E-field
4	Ey	V/m	y-axis component of E-field
5	Ez	V/m	z-axis component of E-field
6	Emag	V/m	E-field magnitude, optional
7	Frame		frame indicator
8	RSSIx	LSB	x-axis raw RSSI value, optional
9	RSSIy	LSB	y-axis raw RSSI value, optional
10	RSSIz	LSB	z-axis raw RSSI value, optional

Column	Header	Unit	Description
11	T	°C	Temperature inside the E-Field Probe
12	Skip		Skip count used during stream recording

The Bin2Csv.exe program accepts an arbitrary number of command line switches followed by the file name(s) of one or more binary stream files. One CSV file will be generated for every bin file, replacing the extension "bin" by "csv". The following command line switches are supported:

-h
: display usage information and quit program,

-m
: enable optional E-field magnitude column,

-s
: set sample index for the start of binary to CSV conversion, default is zero,

-e
: set sample index for the end of binary to CSV conversion, default is last sample in bin file,

-l
: set number of samples to be converted to CSV format, relative to start sample index if specified, defaults to all samples in bin file,

-M
: enable optional mode column,

-F
: enable optional frequency column,

-T
: enable optional temperature column,

-r
: enable optional RSSI value columns,

-S
: enable optional skip count column.

12 Specifications

12.1 E-Field Probe

Table 19: *LSProbe Field Probe specifications*

Frequency Range	10 kHz ... 6 GHz
Analog Rise Time	
Low Band, low bandwidth	1.9 ms
Low Band, high bandwidth	770 ns
High Band	330 ns
Minimum Pulse Width	
Burst Mode	500 ns
Streaming Mode	2 µs
Resolution	<0.01 dB
Sampling Rate	
Burst Mode	2 MSample/s
Streaming Mode	500 kSample/s
Field Strength	
Low Band	<1 V/m ... >10 kV/m
High Band	<0.1 V/m ... >1 kV/m
Damage Level	>25 kV/m
Dynamic Range (typical)	
Low Band	>100 dB
High Band up to 4 GHz	>90 dB
High Band above 4 GHz	>80 dB
Isotropy @ 900 MHz	<1 dB
Amplitude Accuracy @ 10 V/m	
10 kHz ... 10 MHz	1.3 dB
>10 MHz ... 1 GHz	1.5 dB
>1 GHz ... 8 GHz	1.0 dB
Linearity Error	<0.1 dB
Temperature Stability	0.1 dB
Fiber Optic Connector	FC / ST
Fiber Optic Cable Length	5 m permanently attached, 15 m extension included
Max. Fiber Optic Cable Length	1,000 m (sold on request)
Minimal Fiber Optic Cable Bending Radius	30 mm
Ambient Temperature	10°C ... 40 °C
Dimensions (W x D x H)	46 x 46 x 114 mm^3

12.1.1 Typical Isotropy

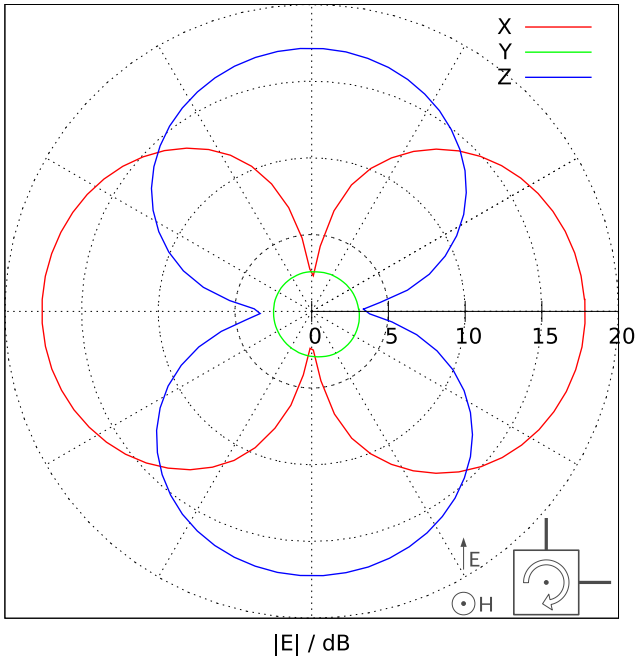


Figure 58: *Isotropy at 900 MHz, rotating around magnetic field vector*

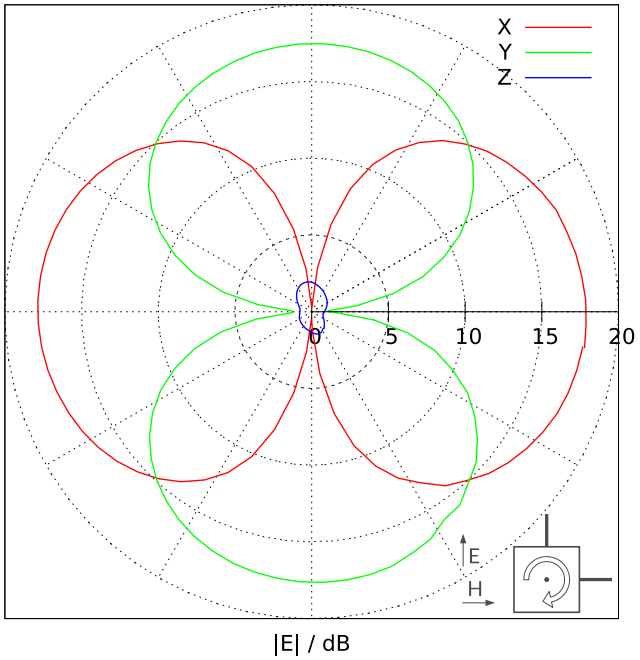


Figure 59: *Isotropy at 900 MHz, rotating in E-H-Plane*

12.1.2 Typical Dynamic Range

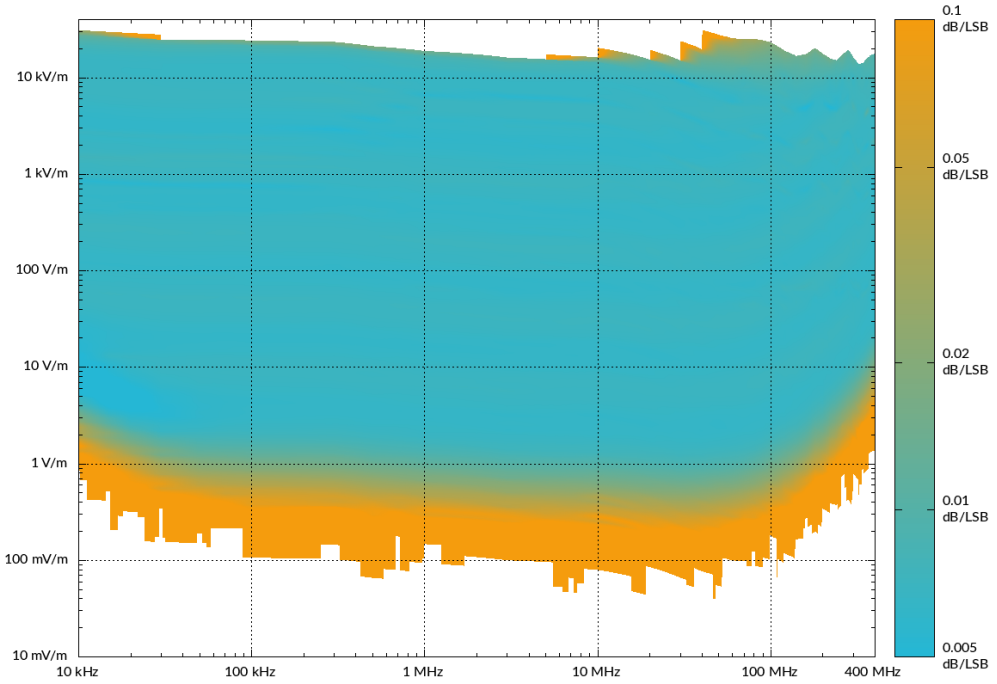


Figure 60: *Typical dynamic range, low band*

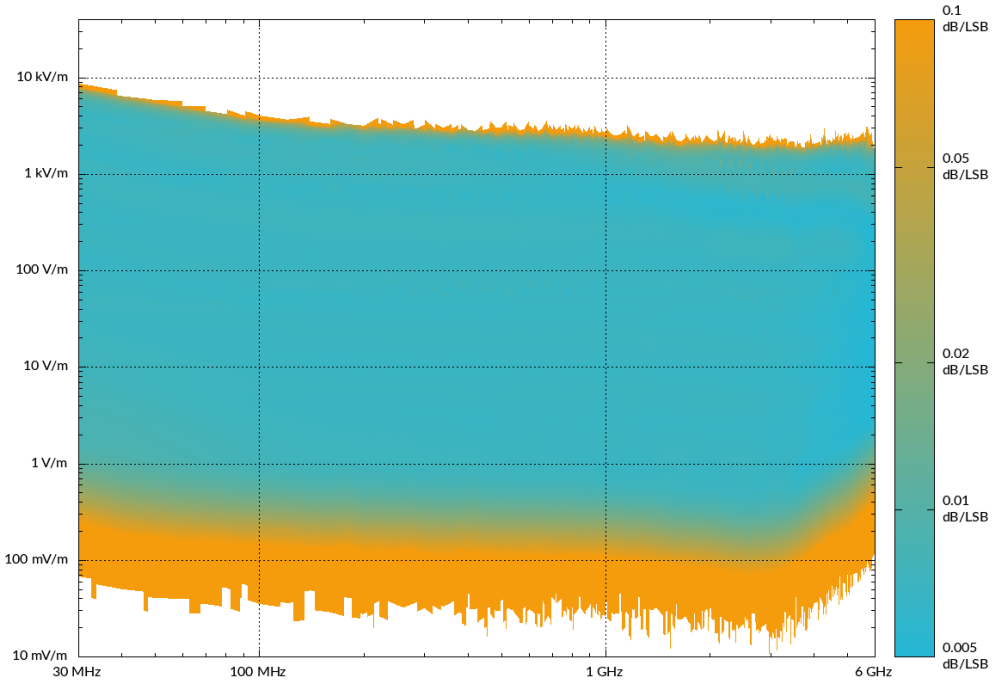
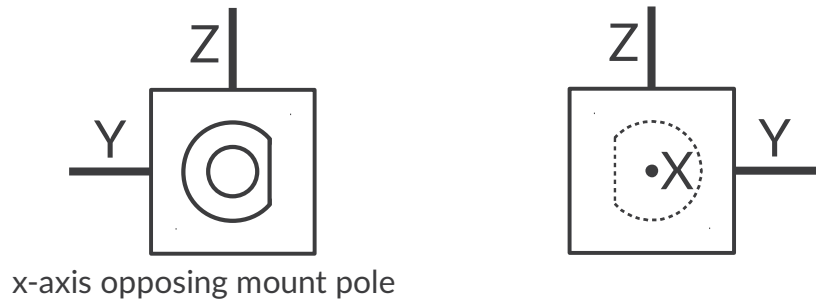


Figure 61: *Typical dynamic range, high band*

12.1.3 Mechanical orientation

For rough orientation, the direction of the antennas is marked on the protective cover of the E-Field probe. A flat on the bottom of the mounting pole helps to achieve an exact orientation of the probe. The y-axis antenna opposes this flat.



(a) LSProbe, view from bottom

(b) LSProbe, view from top

Figure 62: *Mechanical orientation of the antennas*

By acquiring data of the built-in acceleration sensor, the orientation of the field probe can also be checked by software.

12.2 Computer Interface

Table 20: *Computer Interface specification*

PC Interface	USB 2.0
Application Software	LSProbe TCP Server, LSProbe GUI
Burst Trigger Level	5 V
Burst Trigger Connector	BNC
Laser - Wavelength	850 nm
Laser - Max. Output Power	1,000 mW
Laser Class	1M
Laser - Shutdown Time	1 ms
Fiber Optic Connector	FC / ST
Minimum number of optical couplers	6
Input Voltage*	5 V ± 5 %
Input Current	<3 A
Ambient Temperature	10 °C ... 40 °C
Dimensions (W x D x H)	135 x 38 x 120 mm^3
Certifications	CE, IEC 60825-1:2014

* power supply included

13 Warranty Conditions

1. The period of warranty shall start from the date of delivery of the product to the customer and shall cover a period of 24 months.
2. These warranty conditions apply to devices purchased in Germany. These conditions of warranty also apply if these devices are exported abroad and meet the technical requirements (e.g. voltage, frequency) for the respective country and which are suitable for the respective climatic and environmental conditions.
3. Every and all parts of the product are under LUMILOOP's warranty coverage against any defect that may occur during production, assembly and/or defective parts.
4. In case of repair within warranty period, the time spent on the repair work is added to the warranty period. Repair time of the product is maximum 20 (twenty) working days. A warranty event does not lead to a new warranty period. The warranty period for built-in spare parts ends with the warranty period for the entire device.
5. In case of failure of the product during warranty period, the producer or reseller company has to assign another product to the customer with similar features until completion of repair of the product.
6. Within the warranty period, if the product fails because of general material and workmanship, or mounting faults, it will be repaired without demanding any charge.
7. In case of any failure in the product, occurring at least four times in one year or six times within the warranty period, product replacement or refund is mandatory depending on the choice of the customer.
8. Free repair and product exchange obligations will be annulled under the following conditions:
   a) If the product becomes faulty due to use contrary to the terms or conditions stated in the user's manual,
   b) If the product has been opened, used, or previously repaired by unauthorized persons,
   c) Use of the product by plugging into inappropriate voltages or with faulty electric installation,
   d) If the product serial number has been altered or removed,
   e) If the fault or damage to the product occurred during the transportation outside of the responsibility of LUMILOOP GmbH,
   f) A break or scratch to the product's exterior while in the customer's possession,
   g) Damage from chemical and electrochemical effects of water
   h) When our product is damaged due to use with spare parts, accessories or devices purchased from other companies which are not original parts.
   i) Those damages caused by natural disasters such as fire, lightning, flood, earthquake, etc.
9. A short report prepared by the LUMILOOP GmbH will determine whether the damage was caused by improper use.

10. Customers are required to initially report any conflicts between themselves and an authorized reseller to the address below:

    LUMILOOP GmbH
    Topfmarkt 1
    01936 Königsbrück
    Germany
    E-mail: info@lumiloop.de

EC DECLARATION OF CONFORMITY

We, LUMILOOP GmbH,
Topfmarkt 1,
01936 Königsbrück,
GERMANY,

declare under sole responsibility that the:

Model / Part Number: LSProbe 1.2 / CI-250 1v2
Model / Part Name: Electric Field Probe / Computer Interface
Date of Declaration: July 7, 2017

to which this declaration relates, meets the requirements and is in conformity with the relevant EC Directives listed below using the relevant section(s) of the following EC harmonized standards and other normative documents:

Applicable Directives:

2014/35/EU (Low Voltage Directive)

2014/30/EU (EMC Directive)

2011/65/EU (RoHS)

Applicable harmonized standards and/or other normative documents:

EN 61010-1:2010	Safety requirements for electrical equipment for measurement, control, and laboratory use Part 1: General requirements
EN 61326-1:2013	Electrical equipment for measurement, control and laboratory use – EMC requirements Part 1: General requirements
EN 60825-1:2014	Safety of laser products Part 1: Equipment classification and requirements

Authorized Signatories:

LUMILOOP GmbH
Eike Suthau, Technical Director

This declaration attests the compliance with the stated directives. It does not imply any assurance of characteristics.

15 Revision History

2016/06/24

- Initial release.

2016/06/28

- Sacrificial optical cable assembly added.
- Analog rise time values corrected.

2016/07/11

- Radar measurements added.

2017/02/09

- Statistical evaluation for continuous and triggered measurement, SCPI commands and GUI support added.
- Multiprobe mode, SCPI commands and GUI support added.
- MProbe parameter added for almost all SCPI commands.
- Make ":syst:reg:get?" return NAN when requesting invalid register.
- Reference field strength for E-field calibration changed to 10 V/m.
- In-house and external calibration timestamp query using »:CALibration:TStamp? [<MProbe>]« command added.
- External calibration data can be disabled using SCPI command. New SCPI commands: »:CALibration:EXTernal? [<MProbe>]« and »:CALibration:EXTernal <Value>[,<MProbe>]«.
- Firmware-Update command requires revision number as to avoid inadvertent flashing.
- TCP-Server status messages for laser and E-Field Probe status added.
- At startup TCP-Server prints table of available calibration data.
- At startup TCP-Server prints table of connected CIs and firmware revision numbers.
- Reduced memory footprint by using dynamic trigger buffer size.
- GUI log files extended and corrected.
- GUI "Quick Save" button added.
- GUI shows notification during firmware updates.
- GUI shows difference between TCP Server and last GUI setting.
- Ext1 RJ45 external trigger added to Computer Interface, TCP Server and GUI.
- GUI shows laser current and received signal strength in "Laser Status" tool tip.
- GUI shows calibration dates and certificate number in tool-tips.
- GUI shows number of radar pulses.
- GUI can control multiple Computer Interfaces using "All" button.
- TCP Server no longer accepts frequencies outside the calibrated range.
- Alignment of E-field axis and acceleration sensor axis.
- External trigger documentation in manual added.
- Add documentation and support files for EMC32.

- Installer includes FTDI USB driver.
- Installer sets system environment variables instead of user environment variables.
- Documentation of calibration CSV file format added.
- Documentation of sacrificial cable kit added.
- Introduce support for mode 1 and 5 for systems newer than February 2017.
- Remove "Auto" button from GUI for consistency with TCP Server.
- Add optional RSSI value logging for basic and scope logs.
- Allow input and output of SCPI commands via standard IO of TCP Server.
- Support dynamic adding and removing of CIs.
- Use previously defined environment variables during installation.
- Add Start menu entry for all users during installation.
- Terminate TCP Server on receiving Ctrl-C.
- Fix TCP Server parsing of commands using both semicolon and new-line.
- Check decimal separator in calibration CSV files.
- Add support for serial protocol emulation in mode 1.
- Add virtual Computer Interface and Field Probe support.
- Documentation for RadiMation.
- Documentation and support files for Win6000.

2017/07/24

- Section "Warranty Conditions" added.
- EC Declaration of Conformity added.
- Radar Measurement: improved detection of very short pulses (2 µs).
- Application of temperature compensated calibration improved.
- :SYSTem:FREQuency <Frequency>[,<MProbe>] SCPI command Bug fixed: RSSI value corresponding to highest calibrated E-field value correctly adapted to new set frequency.
- Statistics: Enable bin sizes of over 2 billion samples.
- Computer Interface Firmware with support for stream recording included.
- Support for stream recording in TCP Server and GUI added.
- Debug flags for stream recording, triggering and interpolation added.
- Bin2Csv executable for converting binary stream files to CSV format added.
- :TRIGger:DONE? [<Timeout>,<MProbe>] SCPI command to check state of trigger system added.
- :TRIGger[:WAVeform]:RADar:COUnt? [<Threshold>][,<MProbe>] SCPI command to query number of radar pulses added.
- Documentation and support files for BAT-EMC.
- Support for arbitrary order of columns in CSV file for virtual probes read-in added in GUI.
- Better visibility of current mode and mode changes in GUI.
- Connection tab moved to leftmost position in GUI.