LANGER
EMV-Technik

# IC TEST SYSTEM

User Manual

## ICI L-EFT set

IC EM fault injection Langer Pulse




- Translation of the original German user manual into English -

**Content:** **Page**

# 1 Declaration of Conformity

Manufacturer:
Langer EMV-Technik GmbH

Nöthnitzer Hang 31
01728 Bannewitz
Germany

Langer EMV-Technik GmbH herewith declares that the

**ICI "xxx" L-EFT set,** IC EM Pulse Injection Langer Pulse set including the products:

- **BPS 202,** Burst Power Station and
- **ICI HH1000-15 L-EFT,** Pulse Magnetic Field Source and/or
- **ICI HH500-15 L-EFT,** Pulse Magnetic Field Source and/or
- **ICI HH250-15 L-EFT,** Pulse Magnetic Field Source and/or
- **ICI E450 L-EFT,** Pulse E-Field Source and/or
- **ICI I900 L-EFT,** Pulse Current Source and/or

conforms with the following relevant regulations:

- EMC Directive 2014/30/EU
- Low-Voltage Directive 2014/35/EU
- Restriction of certain Hazardous Substances 2011/65/EU

The following applicable standards were used to implement the requirements specified by the a forementioned directives:

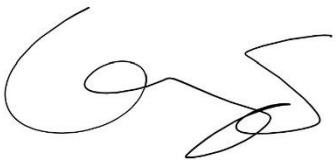
- DIN EN IEC 61000-6-1:2019-11 (EMC immunity)
- DIN EN IEC 61000-6-3:2022-06 (EMC emission)
- DIN EN 61010-1:2020-03 (Safety)
- DIN EN IEC 63000:2019-05 (Restriction of hazardous substances)

Name of the person authorized to compile the technical documentation

Katja Langer

Bannewitz, 2025-09-08

Signature:



K. Langer, Managing Director

# 2 General Information

## 2.1 Storage of the User Manual

This user manual enables the safe and efficient use of the ICI L-EFT set. It must be kept close at hand and accessible to the user.

## 2.2 Reading and Understanding the Manual

Read the user manual carefully, observe the safety information (Chapter 3) and follow the instructions given in this manual before putting the device into service.

## 2.3 Local Safety and Accident Prevention Regulations

The local accident prevention and general safety regulations also apply to ensure that the ICI L-EFT set is used for its intended purpose.

## 2.4 Images

Figures and images have been included in this user manual to assist the reader's understanding but may differ from the device's actual version.

## 2.5 Limitations of Liability

In the following cases, Langer EMV-Technik GmbH can assume no liability for damage to property and personal injury if:

- The information given in this user manual has not been observed.
- The ICI L-EFT set was operated by staff not qualified in the field of EMC.
- The ICI L-EFT set was subjected to unauthorized modifications or technical changes.
- The ICI L-EFT set was not used according to its intended purpose.
- Spare parts or accessories were used that had not been approved by Langer EMV-Technik GmbH.

## 2.6 Errors or Omissions

The information in this user manual has been carefully checked and is believed to be accurate; however, the Langer EMV-Technik GmbH assumes no responsibility for any clerical, typographical, or proofreading errors, or omissions.

## 2.7 Copyright

# 3 Safety

## 3.1 Labels and Signs

| | | |
|---|---|---|
|  |  |  |
| General warning sign | Warning; Electricity | Prohibition sign; No access for people with active implanted cardiac devices. |
| Table 1: Safety signs | | |

Safety instructions in this user manual are marked by symbols (**Table** 1). Observe the safety precautions and act cautiously to avoid accidents as well as personal and material damages.

## 3.2 Intended Use

The ICI L-EFT set is used to couple fast transient pulses into devices under tests with high precision and high spacial resolution. This allows for electromagnetic fault injection or body-bias injection e.g. to test security-critical circuits.

The ICI L-EFT set consists of up to three different ICI probes. The ICI E450 emits an electric field, the ICI HH-probes emits a magnetic field and the ICI I900 emits current pulses.

The ICI probes come with high resolution probe tips which allow for the testing of extremely small areas and a very low trigger to pulse jitter which allows for the disruption of very specific points in the program sequence of the tested IC.

The ICI probes are connected to the BPS 202 burst power station, which provides high voltage and control signals. The BPS 202 is connected to a computer[1] via USB interface and is controlled by BPS 202-Client software or the included DLL functions.

Areas of application (a selection):

- EM fault injection and analysis (EMFI)
- EM pulse coupling

The user must follow all information and instructions in this user manual.

The ICI L-EFT set may only be used in an environment with a temperature of 10 to 30 degrees Celsius and a humidity of 20 to 85 per cent without condensation.

[1] Not included in the scope of delivery.

## 3.3 Reasonably Foreseeable Misuse

| | |
|---|---|
|  Warning! | **Danger resulting from misuse!**<br><br>**Misuse of the ICI L-EFT set can lead to dangerous situations!** |

Incorrect applications of the sets include:

- Use of the product outside of the given specifications.
- Modification or changes to the product without the consent of Langer EMV Technik GmbH.
- Operation of the product with a technical defect.

## 3.4 Staff Requisition

Only qualified staff with training, knowledge, and experience in the field of EMC is allowed to operate the ICI L-EFT set.

Persons whose ability to perform is influenced or impaired by alcohol, drugs, or pharmaceuticals, are not allowed to operate the ICI L-EFT set.

## 3.5 Safety Instructions

| | |
|---|---|
|  Warning; Electricity! | **Danger resulting from electricity!**<br><br>**Risk of injury by electrocution!**<br>**Risk of burns due to heat!** |

High voltage can cause irreversible damage to the body, therefore the following safety instructions must be observed.

- All cable connections must be closed before operating the ICI L-EFT set.
- Do not touch the probe tip of the ICI L-EFT when it is in operation.
- If the insulation is damaged (e.g. cables), the power supply must be disconnected immediately.
- Damaged parts must be replaced with undamaged parts before commissioning. Contact Langer EMV-Technik GmbH to obtain a replacement.
- Protect conducting parts from moisture to avoid short circuits.
- Never leave a Langer EMV-Technik GmbH product unattended while it is in operation.

Always check all attachments, measuring devices, cables and probes before using the ICI L-EFT set. Never use damaged or defective devices.

Only employees of Langer EMV-Technik GmbH may open the ICI L-EFT probes or the BPS 202 and work on the electrical components and electrical cables.

If you notice any damage to lines, cables or electrical components, switch off the device immediately, pull out the mains plug, secure the ICI L-EFT set against being switched on again and contact Langer EMV-Technik GmbH!

| | |
|---|---|
|  | **Danger resulting from electro-magnetic fields!**<br><br>**Risk of affecting a cardiac device!** |
| Prohibition; No access for people with active implanted cardiac devices | |

Electromagnetic near fields are generated on the probe due to its function. For this reason, persons with a cardiac device, such as a pacemaker, must not work on or approach the ICI L-EFT set during operation.

# 4 Scope of Delivery

| Item | Designation | Type | Qty. |
|---|---|---|---|
| 1 | Burst Power Station | BPS 202 | 1 |
| 2 | Pulse Magnetic Field Source | ICI HHxxx-15 | 0-3 |
| | Pulse E-Field Source | ICI E-450 | 0-1 |
| | Pulse Current Source (FBBI) | ICI I900 | 0-1 |
| 3 | Control Cable, Fischer-Fischer | SK FI-FI 7p 1 m | 1 |
| 4 | SMA-SSMB Measuring Cable | SMA-SSMB 1 m | 1 |
| 5 | USB Cable | USB-A / USB-B | 1 |
| 6 | Power Supply Unit | 12 V / 1 A | 1 |
| 7 | USB Stick with BPS 202-Client | | 1 |
| 8 | User Manual | ICI L-EFT m | 1 |
| 9 | ICI Case | System Case | 1 |

* The scope of delivery may deviate depending on the respective order.


Figure 1: ICI 03 L-EFT set scope of delivery

# 5 Overview of the ICI L-EFT set

## 5.1 ICI L-EFT Set

The ICI L-EFT set is used to couple fast transient pulses into ICs. The probes are optimised for high spatial and temporal resolution. This allows individual areas of ICs to be tested in a targeted manner.
Depending on the scope of delivery, the set consists of one or more ICI L-EFT probes, a high-voltage generator (BPS 202), a power supply and the connection cables. The BPS 202 is connected to a PC via USB and controlled using the supplied BPS 202-Client software or the included DLL file.


Figure 2: ICI L-EFT set with BPS 202 and one possible ICI probe.

## 5.2 BPS 202 Burst Power Station


Figure 3: BPS 202

The BPS 202 burst power station is used as power supply and control unit for the ICI probes.

The BPS 202 is connected to a computer via the USB interface and connected to an ICI probe via control cable. The provided software includes the standalone BPS 202-Client and a DLL for implementing automated systems.

The sync TTL input allows for the synchronization of the pulse generation to external events, e.g. operation sequences of ICs.

Features are:

- Adjustment of the pulse frequency and pulse voltage
- Single pulse or pulse sequence
- External triggering possible
- Adjustable trigger delay
- Synchronization output

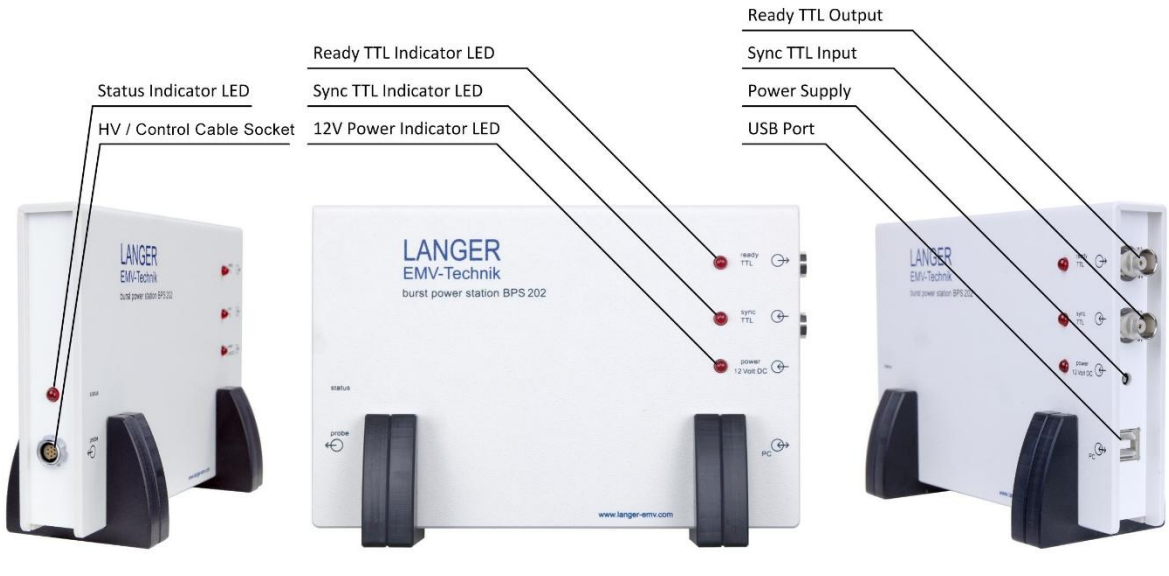



Figure 4: BPS 202 features

| Connectors | Description |
|---|---|
| HV / Control Cable socket | High-voltage power supply and probe communication |
| Ready TTL Output | - BNC connector<br>- used for external trigger<br>- high state indicates that the BPS 202 has finished building up high voltage and is ready to start the pulse |
| Sync TTL Input | - BNC connector<br>- used for external trigger<br>- the trigger impulse is sent from external to the BPS 202 to start the disturbance pulse<br>- the BPS 202 reacts on the rising or falling edge (adjustable in software) |
| Power Supply | Connector for power supply unit to power the BPS 204 and the connected probe. |
| USB-B Port | USB Type-B port to connect BPS 202 to a computer |

Table 2: BPS 202 connectors

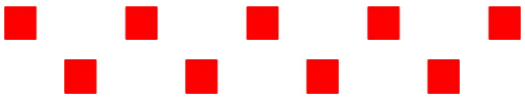
| LED | State | | Description |
|---|---|---|---|
| Status |  | 10 Hz | Fault: Probe is not connected or is incorrectly connected |
| |  | 2 Hz | Probe is ready |
| |  | 2 Hz | Pulse operation |
| Ready TTL<br>Sync TTL |  | 2 Hz | Bootloader state<br>(during firmware update) |
| Ready TTL |  | - | External trigger is ready to initiate (start pulse) |
| Sync TTL |  | - | External trigger pulse received |
| 12 V Power |  | - | BPS 202 is powered |

Table 3: BPS 202 states (indicator LEDs)

Figure 5 shows the block diagram of the BPS 202. The internal logic is controlled by the BPS 202-Client or the DLL.

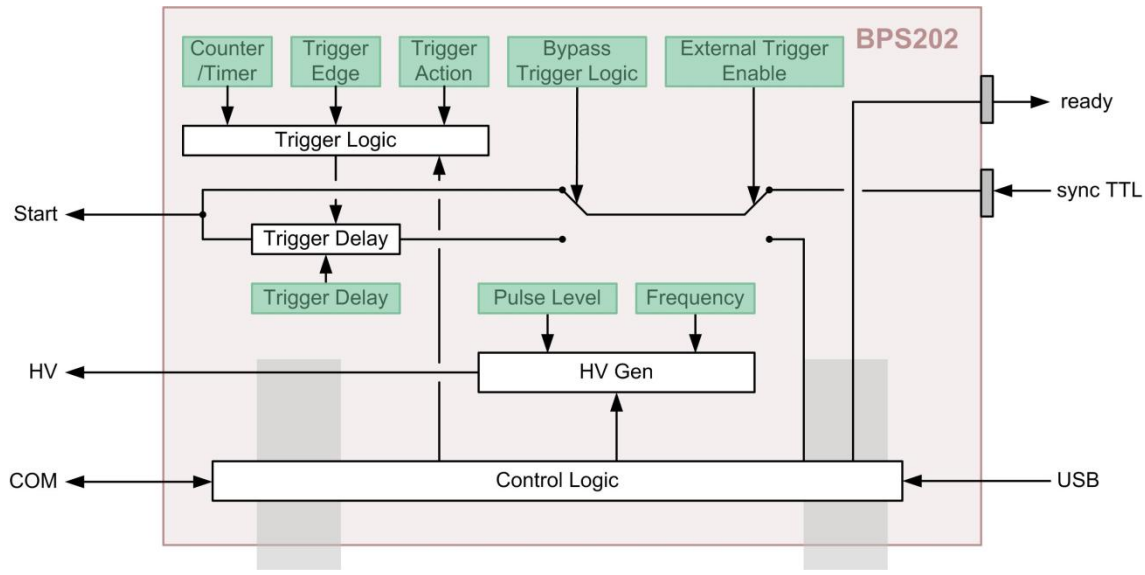



Figure 5: Block diagram of the BPS 202

## 5.3 ICI Probes

### 5.3.1 Overview


Figure 6: The three different ICI probes ICI HH500-15, ICI E450 and ICI I900 (from left to right)

The ICI HHxxx-15 probes emit a magnetic field, the ICI E450 emits an electric field and the ICI I900 emits current pulses.
A single ICI probe is connected with the control cable to the BPS 202 burst power station. The internal probe current (Figure 8) can be monitored by connecting the SSMB measurement output of the ICI probe to an oscilloscope with the provided SMA-SSMB measuring cable (see Chapter 8).

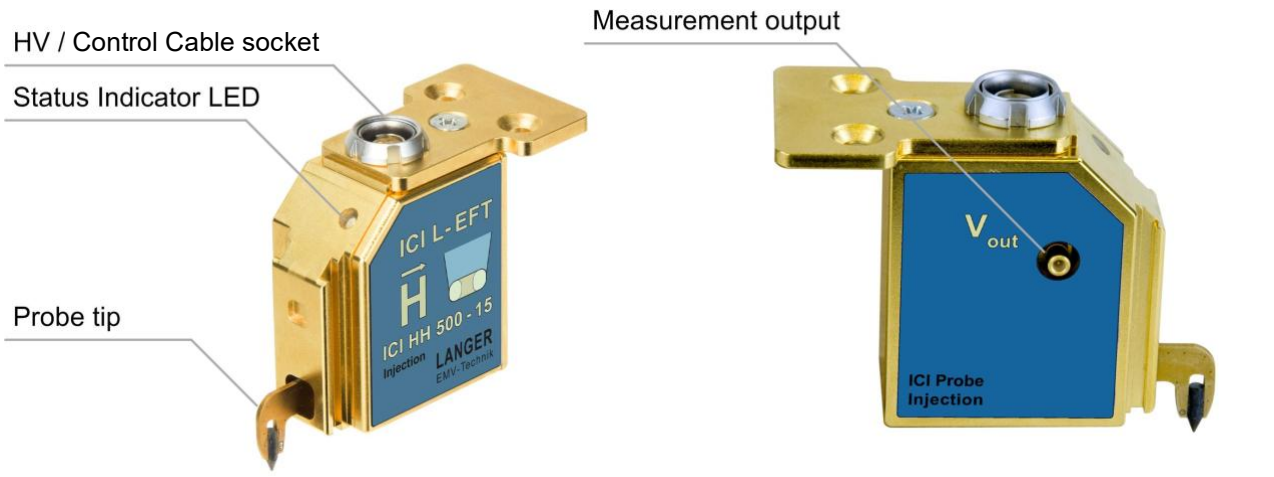



Figure 7: ICI probe features (ICI HH500-15 as an example)

| Socket | Description |
|---|---|
| HV / Control cable connector | High-voltage power supply / control signals |
| Measurement output | 50 Ω (5 Ω shunt), SSMB |

Table 4: ICI probe connectors

The current operational state of the ICI probes is indicated by the multicolor status indicator LED. The possible states are listed in Table 5.

| LED state | | Description |
|---|---|---|
| | strobe | System start |
| | continuous | Probe is ready |
| | 2 Hz | Pulse operation |
| | 2 Hz | Delay Line Error |
| | 2 Hz | Bootloader state (during firmware update) |

Table 5: Operational states of the ICI probes

All ICI probes are equipped with an additional pulse delay with a low trigger to pulse jitter (see Section 8.8). This feature allows the device under test to be disturbed with the same signal-triggered pulse at well-defined points in time. The delay can be defined within the BPS 202-Client or by the corresponding DLL function call.

Figure 8 shows the block diagram of the ICI probes. The internal logic is controlled by the BPS 202-Client or the DLL. The current $I_{pulse}$ can be measured by the integrated shunt. The measured voltage $V_{out}$ is positive independent of the pulse polarity settings.

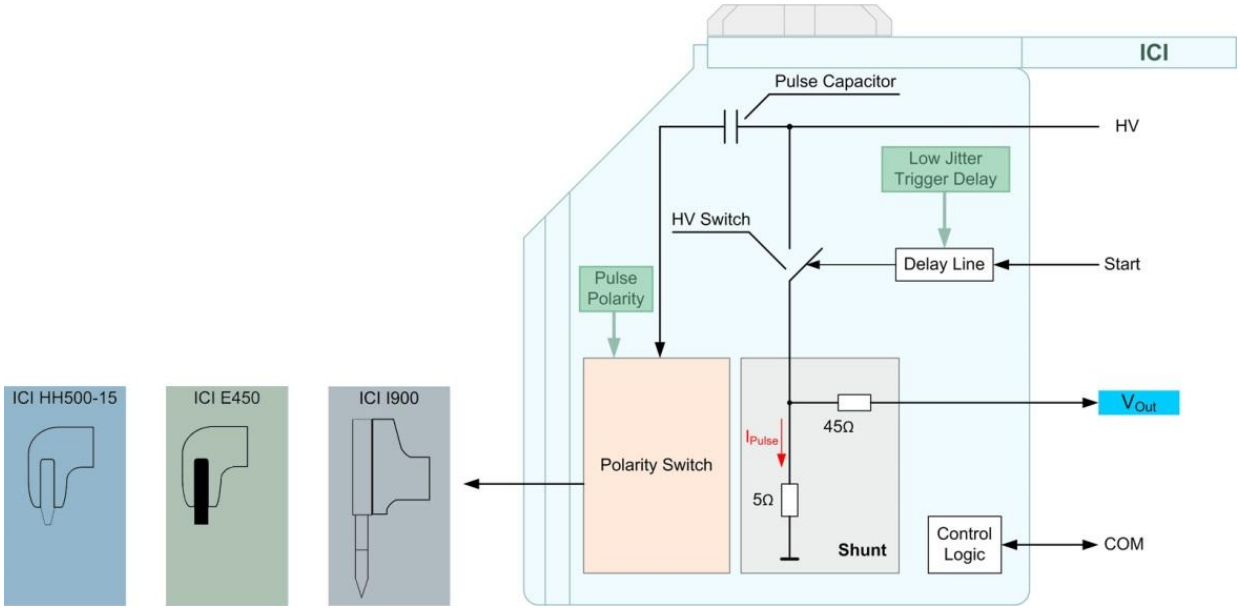



Figure 8: Block diagram of the ICI probes

### 5.3.2 ICI HH500-15 Pulse Magnetic Field Source


The ICI HH500-15 L-EFT pulse magnetic field source couples fast transient pulses into an IC (open die) via a magnetic field. Side-channel attacks can be simulated to test security-critical circuits. Special features include a very high-resolution 500 µm probe tip (allowing for the testing of extremely small areas) and a very low trigger-pulse jitter (allowing for the disruption of very specific points in the program sequence). This allows for the immunity of individual areas of the IC to be tested.

### 5.3.3 ICI E450 Pulse E-Field Source


The ICI E450 L-EFT pulse electric field source couples fast transient pulses into an IC (open die) via an electric field. Side-channel attacks can be simulated to test security-critical circuits. Special features include a very high-resolution 450 µm electrode diameter (allowing for the testing of extremely small areas) and a very low trigger-pulse jitter (allowing for the disruption of very specific points in the program sequence). This allows for the immunity of individual areas of the IC to be tested.

### 5.3.4 ICI I900 Pulse Current Source (FBBI)


The ICI I900 L-EFT is a pulse current source with a spring loaded tip. This allows for contacting the circuit substrate without damaging the probe tip or the device under test. This probe allows for body-bias injection (FBBI).

# 6 Pulse-Current Measurement

You can use the measurement output of the connected ICI probe to view the internally generated pulse current. The oscilloscope input has to be set to 50 Ω. Otherwise an external termination should be used.

⚠ Make sure you do not exceed the limits of your oscilloscope (Table 7). If required use an external attenuator[2] (Figure 39).

The appropriate attenuator settings for the oscilloscope (resulting from the shunt / external attenuator and 50 Ω termination) are found in Table 7. To get a proper pulse-current reading, the damping factor in the oscilloscope must be set according to the individual attenuator used. The transfer function is listed below.

$$I_{Pulse} = \left( \frac{50\Omega \cdot (5\Omega // 95\Omega)}{95\Omega} \cdot 10^{\frac{1}{20} \cdot \frac{a}{dB}} \right)^{-1} \cdot V_{Out} = \left( 2{,}5\Omega \cdot 10^{\frac{1}{20} \cdot \frac{a}{dB}} \right)^{-1} \cdot V_{Out} \qquad \text{Eq. 1}$$

**Example:** using a 30 dB attenuator (a = -30 dB)

$$I_{Pulse} = \left( 2{,}5\Omega \cdot 10^{-\frac{30}{20} \cdot} \right)^{-1} \cdot V_{Out} = 12{,}6 \frac{1}{\Omega} \cdot V_{Out} \qquad \text{Eq. 2}$$

$$\frac{I_{Pulse}}{dBA} = \frac{V_{Out}}{dBV} + 22$$

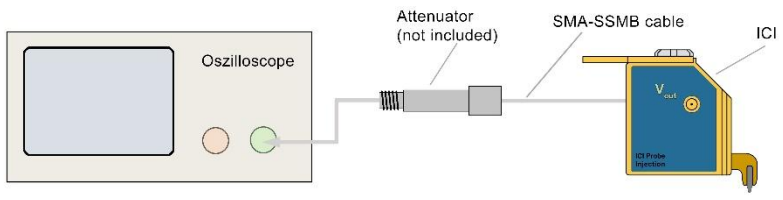



Figure 9: Set-up for pulse-current measurement with an oscilloscope

| **$V_{Out}$** (linear / log) | | **Attenuator** (linear / log) | | **Termination Oscilloscope** (termination / att.) | | **Total attenuation** (linear / log) | |
|---|---|---|---|---|---|---|---|
| 5 | 14 dB | 3.2 | -10 dB | 50 Ω | -6 dB | 1.3 | -2 dB |
| 5 | 14 dB | 10 | -20 dB | 50 Ω | -6 dB | 4 | -12 dB |
| 5 | 14 dB | 31.6 | -30 dB | 50 Ω | -6 dB | 12.6 | -22 dB |
| 5 | 14 dB | 100 | -40 dB | 50 Ω | -6 dB | 40 | -32 dB |

Table 6: Measurement output – oscilloscope settings

[2] Not in the scope of delivery. Attenuator with SMA connector recommended.

| Pulse level (HV) | Pulse current ($I_{Pulse}$) | Input voltage at oscilloscope (50 Ω) using different attenuators | | | |
|---|---|---|---|---|---|
| [V] | [A] | 10 dB [V] | 20 dB [V] | 30 dB [V] | 40 dB [V] |
| 50 V | 1 | 0.76 | 0.26 | 0.08 | 0.025 |
| 100 V | 2 | 1.54 | 0.50 | 0.16 | 0.050 |
| 150 V | 3 | 2.30 | 0.75 | 0.24 | 0.075 |
| 200 V | 4 | 3.08 | 1.00 | 0.32 | 0.100 |
| 260 V | 5 | 3.84 | 1.26 | 0.40 | 0.125 |
| 330 V | 6 | 4.62 | 1.50 | 0.48 | 0.150 |
| 400 V | 7 | 5.38 | 1.76 | 0.56 | 0.175 |
| 500 V | 8 | 6.16 | 2.00 | 0.64 | 0.200 |

Table 7: Input voltage present at oscilloscope using different attenuators. Settings which need an attenuator are marked in red.

# 7 Operating Modes Overview

## 7.1 Types of Pulses

The ICI L-EFT set can generate the following types of pulses:

- Single pulse (Figure 10)
- Continuous pulse
- Burst packets with a defined number of pulses and burst period (Figure 11)
- Defined number of pulses or burst packets

The type of pulse sequence is set by the control software BPS 202-Client or the included DLL.

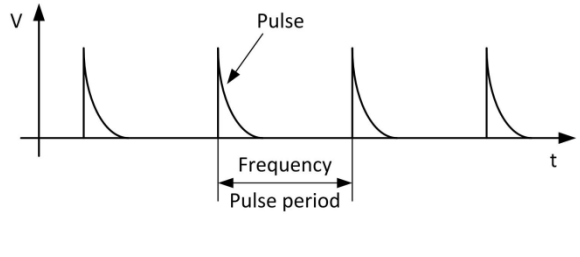



Figure 10: Pulse mode

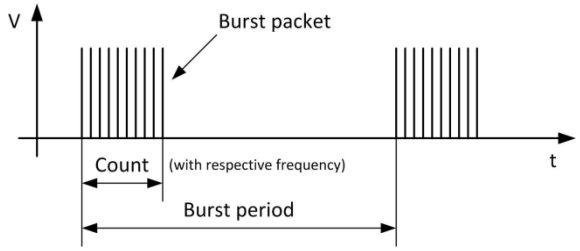



Figure 11: Burst mode

Furthermore, it is possible to synchronize the generated pulses to an external event by using the external trigger function.

## 7.2 Free-Running Mode (Pulses not Synchronized)

In free-running mode, the pulse generation is controlled by the BPS 202-Client (see Chapter 8). The pulse generation in this mode cannot be synchronized to external trigger signals.

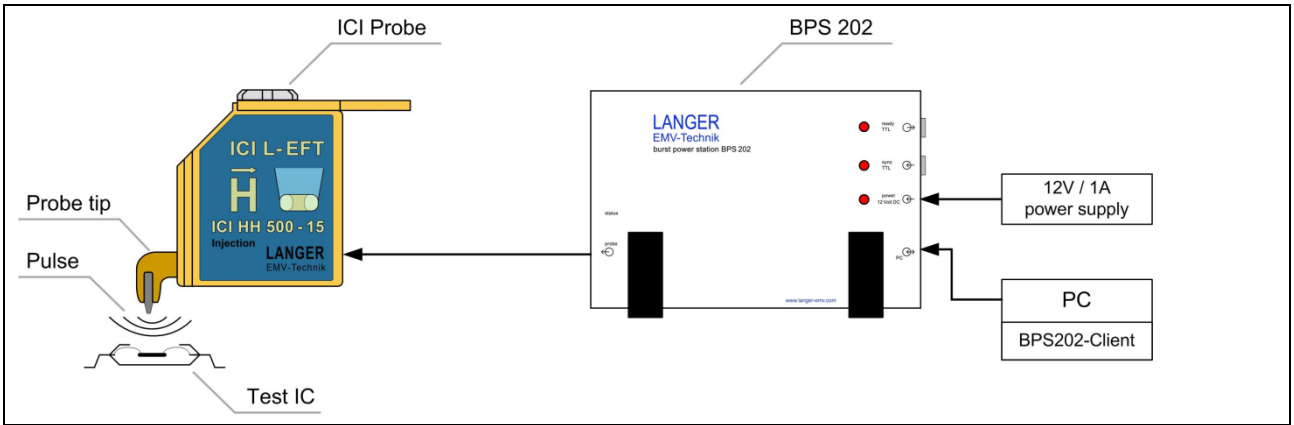



Figure 12: System set-up for free running mode

## 7.3 Synchronized Mode (Pulses Synchronized to External Events)

In the synchronized mode, the pulse can be triggered by an external signal source (Start Logic) e.g. a signal from the test IC (TTL max. 5 V).

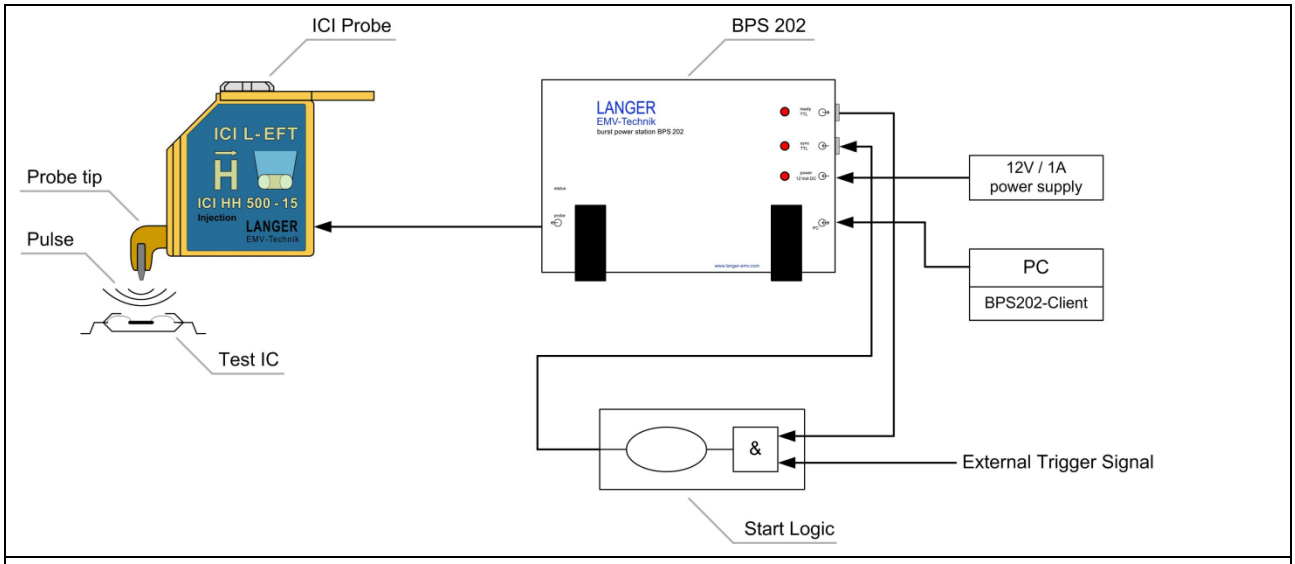



Figure 13: System set-up external trigger via BPS 202 *sync TTL* input

The *trigger to pulse delay* is set in the BPS 202-Client (see Figure 8 / Figure 5) by using either the delay timer in the BPS 202 or the low-jitter trigger delay line in the ICI probes (see Section 8.7 / 8.8).
The ready TTL output of the BPS 202 signals when the BPS 202 is ready to start a pulse. Figure 14 and Figure 15 show the sequence of control signals when the external trigger mode is used.

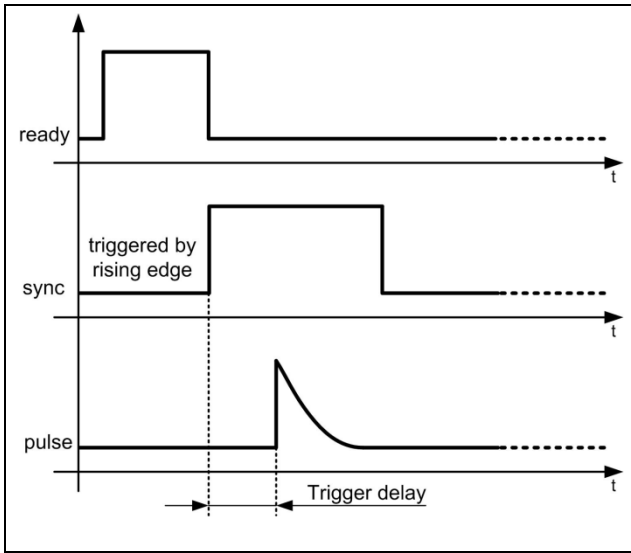



Figure 14: Signal sequence of external trigger mode, trigger on rising edge

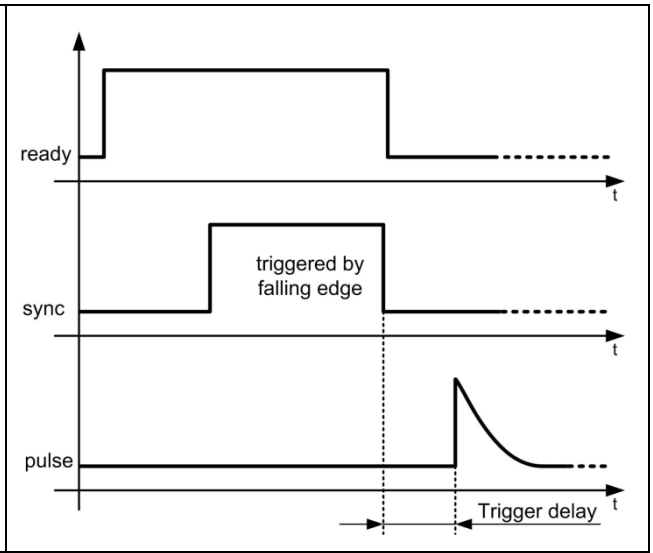



Figure 15: Signal sequence of external trigger mode, trigger on falling edge

Control signals:

**Ready:**
When the ready signal is driven high by the BPS 202, it accepts trigger signals to start pulses.

**Sync:**
The trigger signal for the pulse is fed into this port. The BPS 202 accepts rising or falling edges depending on the setting in the BPS 202-Client software.

**Pulse:**
The generated pulse can be emitted with a variable trigger to pulse delay.
Note: For the minimum delay refer to the provided parameter sheet.

Sequence:

a) The external trigger of the BPS 202 is set in the BPS 202-Client software (see Section 8.7 / 8.8).
b) The BPS 202 sets the ready TTL output to high, when the high voltage is built up and a pulse can be triggered.
c) The pulse is emitted on a rising or falling edge at the sync TTL input (Figure 15). This depends on the settings in the BPS 202-Client software (see Section 8.7).
d) The trigger to pulse delay between the trigger signal at the sync TTL input and pulse can be set in the BPS 202-Client software

# 8 BPS 202-Client Software

## 8.1 Installation

The provided USB flash drive contains:

- BPS 202-Client software
- BPS202 SDK with DLL- and so-file
- User manual
- Device driver

Important: The device driver can only be installed on a computer with administrator rights.

Installation sequence:

- Insert the USB stick into a USB port on the computer.
- Open the USB stick on the computer.
- Double-click the installer file BPS 202-Client-*.exe.
- Follow the instructions during the installation.
- Proceed with the device driver installation which follows automatically.

## 8.2 BPS 202-Client Overview

The BPS 202-Client software contains all control elements needed to operate the BPS 202 and the connected ICI probe in all its operating modes.

The graphical user interface (GUI) consists of:

- Pulse configuration
- Burst configuration (only in *Burst Mode*)
- Trigger control
- Start / stop pulsing or bursting
- Status bar

Settings are only possible if a valid BPS 202 and a valid ICI probe are detected by the software. This is displayed in the status bar (see Section 8.10).

After launching the software, the main dialog of the application always displays *Pulse Mode*, see Figure 16.

Note: In either operating mode only probe-specific values are displayed.

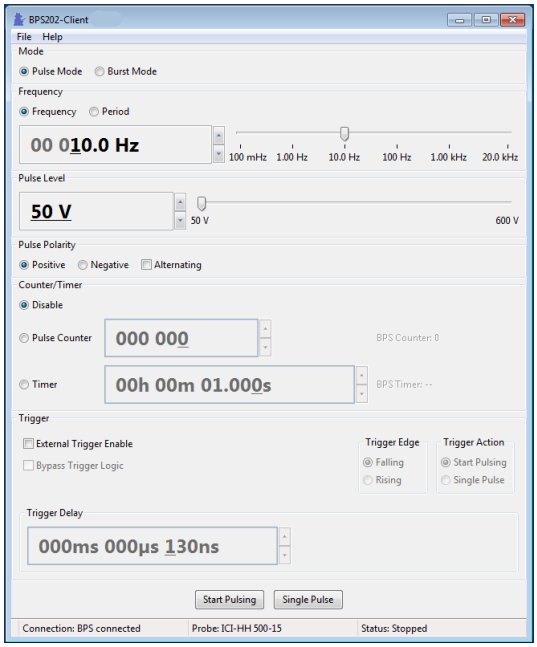



Figure 16: GUI with *Pulse Mode* selected

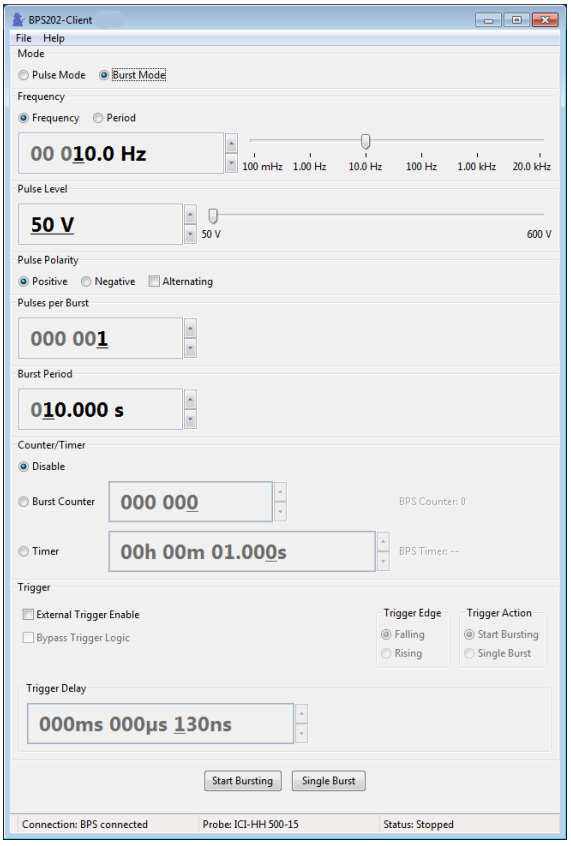



Figure 17: GUI with *Burst Mode* selected

## 8.3 Setting the Operating Mode

The operating modes *Pulse Mode* and *Burst Mode* can be chosen within the (operating) *Mode* section by clicking on the corresponding radio button. The GUI changes respectively, see Figure 16 (*Pulse Mode*) and Figure 17 (*Burst Mode*).

a) *Pulse Mode*: creates several pulses that are equidistant in time
b) *Burst Mode*: creates packets of pulses that are equidistant in time

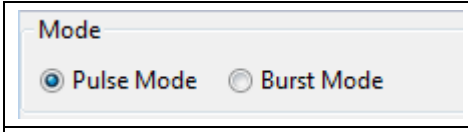



Figure 18: Radio buttons for operating mode selection

## 8.4 Pulse Configuration

### 8.4.1 Setting the Pulse Frequency or the Pulse Period

The frequency of the pulses is set in the GUI section *Frequency* (Figure 18) in the range from 0.1 Hz to 20 kHz (probe dependant). Alternatively, the *Pulse Period* can be set in a range from 50 µs to 10 s (probe dependant). *Pulse Frequency* or *Pulse Period* can be selected by activating the corresponding radio button.

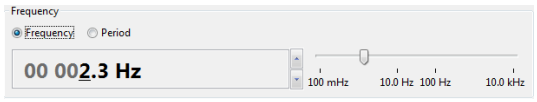



Figure 19: Setting of the pulse frequency

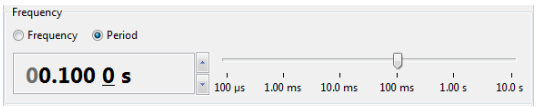



Figure 20: Setting of the pulse period

### 8.4.2 Setting the Pulse Level

The voltage amplitude of the pulses can be set in the GUI section *Pulse Level* (Figure 21). The pulse level slider allows a rough setting and the spin buttons allow a fine grain setting.

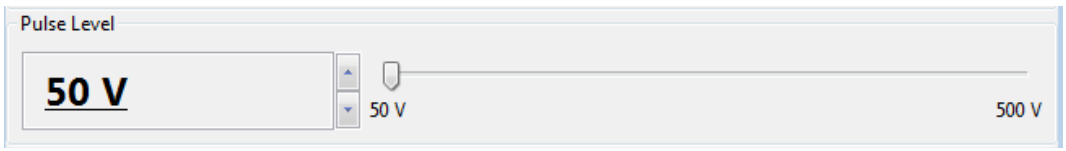



Figure 21: Setting of the pulse level

### 8.4.3 Setting the Pulse Polarity

The polarity of the created pulses can be set in the GUI section *Pulse Polarity*. Available options are:

- Positive (+)
- Negative (-)
- Alternating (+/-)

Alternating the polarity of the created pulses with the option *Alternating* activated takes effect in all operating modes of the BPS 202. The first pulse will have the selected polarity.

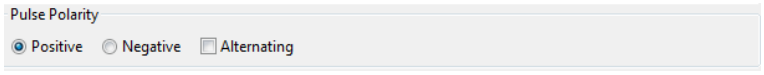



Figure 22: Setting of the pulse polarity

## 8.5 Burst Configuration

### 8.5.1 General Information

When *Burst Mode* is chosen, the burst configuration section is displayed in the GUI (Figure 17). In this operating mode, the *Burst Period* and the number of *Pulses per Burst* are additional parameters which must be set.

### 8.5.2 Setting the Number of Pulses per Burst

In this section the number of pulses per burst packet is set, see Figure 23.

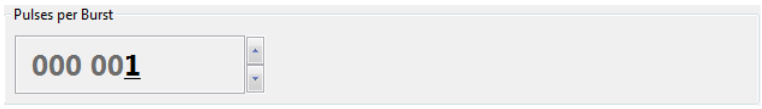



Figure 23: Setting of the number of pulses per burst packet

### 8.5.3 Setting the Burst Period

In this section, the *Burst Period* is set, which defines the time between two consecutive burst packets. The minimal value of the burst period is derived from the pulses in each burst and the pulse frequency.

$$BurstPeriod_{Min} = \frac{1}{Frequency} * Pulse\_per\_Burst \qquad \text{Eq. 3}$$

$$BurstPeriod_{Min} = Period * Pulse\_per\_Burst \qquad \text{Eq. 4}$$


Figure 24: Time between two consecutive burst packets

## 8.6 Setting a Defined Pulse Counter or Time

In the GUI section *Counter/Timer* a defined pulse or burst counter or a timer is set.
The following four modes can be selected:

*Disable*:
No pulse counter or timer is set → After starting, pulses are continuously generated.

*Pulse Counter* (*Pulse Mode*):
Pulse counter active → After starting, the set number of pulses is generated.

Burst Counter (*Burst Mode*):
Burst counter active → After starting, the set number of bursts is generated.

Timer:
Timer active → After starting, pulses or bursts packets will be generated for the length of the set timer.

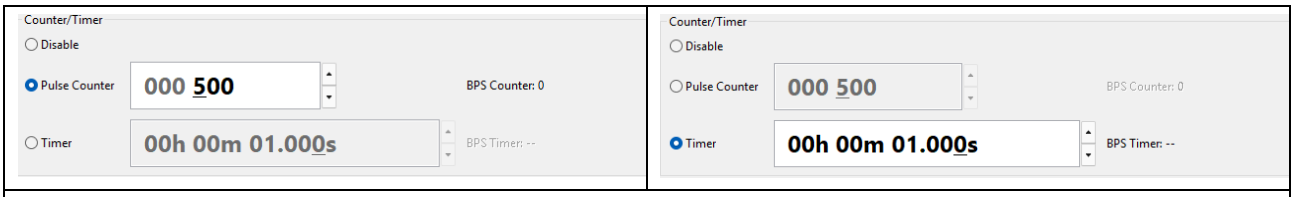



Figure 25: Setting of a pulse / burst counter or timer

## 8.7 Setting the External Trigger

The external trigger is configured in the *Trigger* section of the GUI. By enabling the box *External Trigger Enable*, the following options become selectable:

*Trigger Edge*:

a) *Falling*: Trigger activated at HIGH – LOW transition
b) *Rising*: Trigger activated at LOW – HIGH transition

*Trigger Action* for operating mode *Pulse Mode*:

a) *Start Pulsing*: generates test pulses with the set pulse parameters
b) *Single Pulse*: generates one test pulse with the set pulse parameters

*Trigger Action* for operating mode *Burst Mode*:

a) *Start Bursting*: generates burst packets with the set burst parameters
b) *Single Burst*: generates one burst packet with the set burst parameters

The Trigger Delay is set in steps of 10 ns (see Section 7.3).

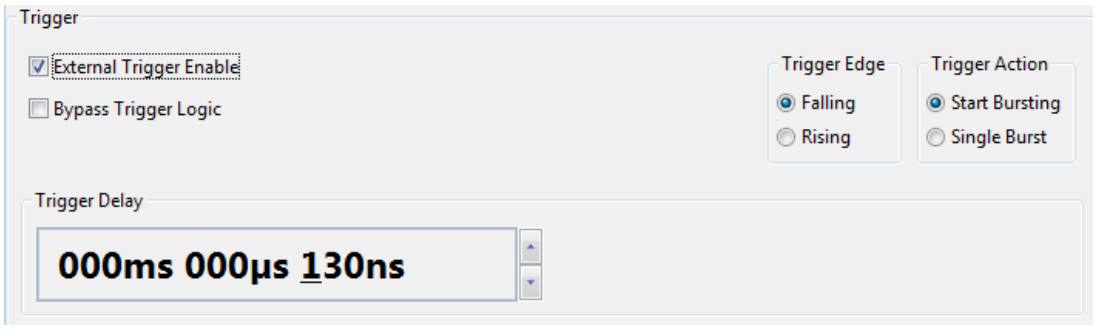



Figure 26: GUI section *Trigger* for operating mode *Burst Mode*

## 8.8 Setting the Low Jitter Trigger

In order to enable the low-jitter trigger delay line, the *Bypass Trigger Logic* box must be selected. The low-jitter trigger feature directly connects the pulse start signal and the signal applied to the sync input of the BPS 202. Since the external start signal is no longer processed by the BPS 202 the BPS delay option is no longer available. The *Trigger Delay* section changes to *Low Jitter Trigger Delay*.
In this mode only rising edge and single pulse / single burst operation modes are available.

This programmable delay is generated by the ICI probe (if available). The ICI probe features a programmable delay line (Figure 8). The programmable delay adds to the minimum propagation delay of the whole system (see provided parameter sheet).

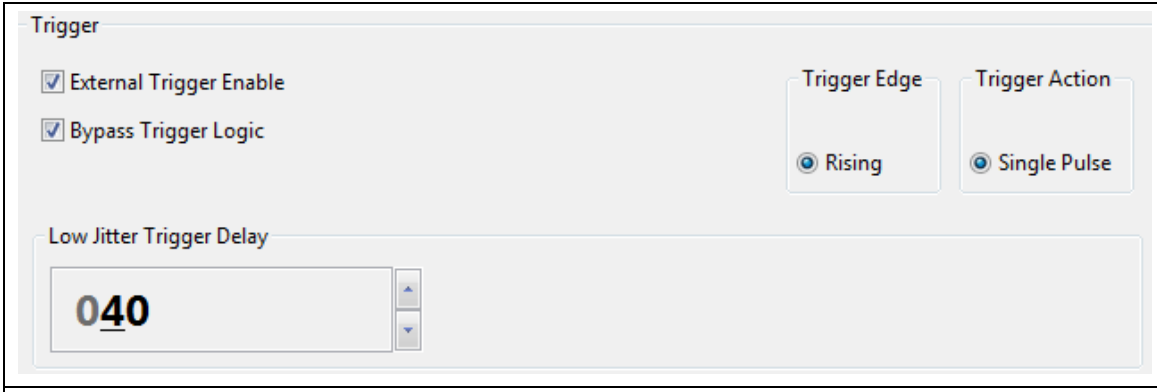



Figure 27: External trigger with bypass enabled

## 8.9 Operating Modes

### 8.9.1 Pulse Mode – Single Pulse

By pressing the *Single Pulse* button (Figure 28) the BPS 202 will generate a single pulse with the set *Pulse Level* and *Polarity*. The status LED of the BPS 202 and the LED of the connected ICI probe will blink one time, as described in Chapter 5. If the *Pulse Polarity* option *Alternating* is selected, the pulse polarity will alternate every time the *Single Pulse* button is pressed.

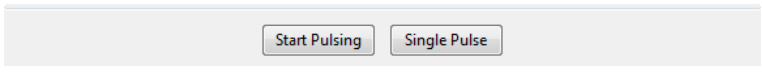



Figure 28: Active buttons: Start Pulsing and Single Pulse

### 8.9.2 Pulse Mode – Continuous Pulse

When the *Start Pulsing* button (Figure 28) is pressed, the BPS 202 will generate continuous pulses with the defined pulse parameters. Additionally the LED on the ICI probe and the status indicator LED on the BPS 202 will blink continuously, the software's status will display *Status: running* (see Section 8.10), and the *Start Pulsing* button is renamed to *Stop Pulsing*. The pulse frequency and voltage can be changed at any time. The pulse polarity can be set to alternate after each pulse by activating the *Pulse Polarity* option *Alternating* (which must be set before the *Start Pulsing* button is pressed). The continuous pulses can be stopped at any time by pressing the *Stop Pulsing* button.

Depending on the *Counter / Timer* settings, the pulses generated by the BPS 202 can be defined by time (also unlimited) or number.
The pulses or the time remaining is displayed next to the set value and is updated continuously.

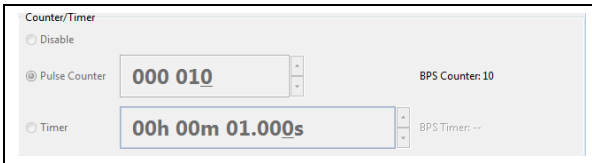



Figure 29: Pulse option counter


Figure 30: Pulse option timer

### 8.9.3 Burst Mode – Single Burst

By pressing the button *Single Burst* (Figure 31) the BPS 202 will generate a single burst packet with the defined burst parameters. Additionally, the status indicator LED and the ICI probe's LED will blink as described in Chapter 5. If the *Pulse Polarity* option *Alternating* is selected, the pulse polarity will alternate every time the *Single Burst* button is pressed.

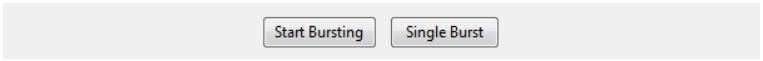



Figure 31: Active buttons: Start Bursting and Single Burst

### 8.9.4 Burst Mode – Continuous Burst

When the *Start Bursting* button (Figure 31) is pressed, the BPS 202 will generate continuous bursts with the defined burst parameters. Additionally the LED on the ICI probe and the status indicator LED on the BPS 202 will blink continuously, the software's status will display *Status: running* (see Section 8.10), and the *Start Bursting* button is renamed to *Stop Bursting*. The burst frequency and voltage can be changed at any time. The pulse polarity can be set to alternate after each burst by activating the *Pulse Polarity* option *Alternating* (which must be set before the *Start Bursting* button is pressed). The continuously generated bursts can be stopped at any time by pressing the *Stop Bursting* button.

Depending on the *Counter / Timer* settings, the bursts generated by the BPS 202 can be defined by time (also unlimited) or number.
The bursts or the time remaining is displayed next to the set value and is updated continuously.

### 8.9.5 Externally Triggered Pulses or Bursts

If the option *External Trigger Enable* is activated, the generated pulses or bursts can be synchronized with an external event.

When the *Start Pulsing / Start Bursting* button is pressed then:

- the button *Start Pulsing / Start Bursting* changes to *Stop Pulsing / Stop Bursting* and stops the generation of pulses / bursts if pressed.
- the ready TTL LED of the BPS 202 lights up.
- the BPS 202 waits for a trigger event at its input sync TTL.
- the status bar of the BPS 202-Client displays the status message *Status: Waiting for Trigger*.

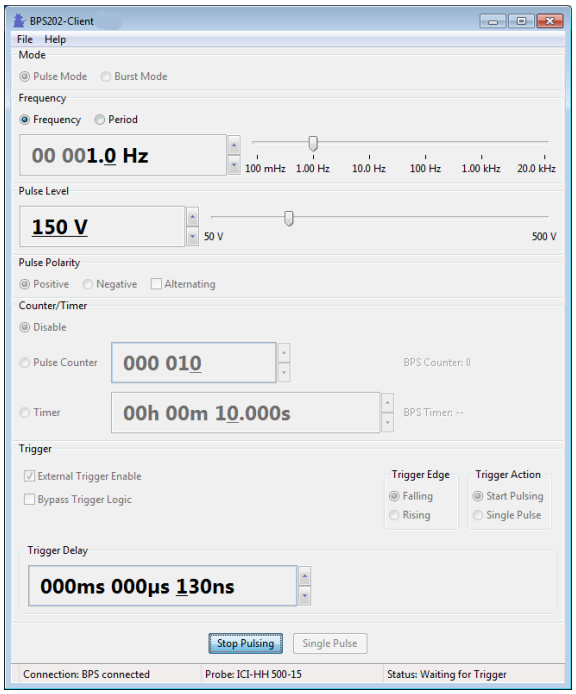



Figure 32: Trigger for Pulse Mode

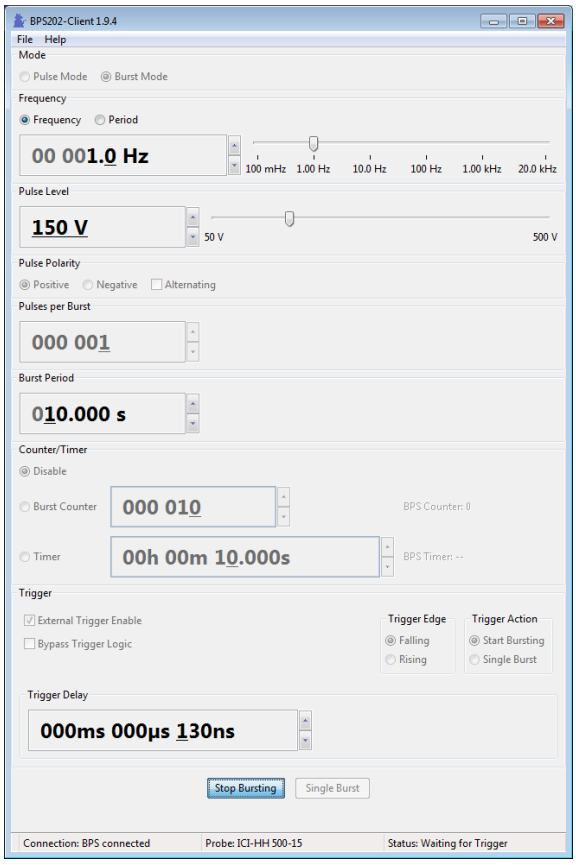



Figure 33: Trigger for Burst Mode

The *Trigger Edge* and the reaction of the BPS 202 to a trigger event can be set in the section *Trigger* for both operating modes. If a trigger event is recognized at the sync TTL input of the BPS 202 the defined trigger action is executed and the status indicator LED and the connected ICI probe's LED blink in accordance to the parameters.

If the options *Counter* and *Start Pulsing* are activated, every trigger event leads to the execution of the set number of pulses or bursts depending on the operating mode.

Important: The minimum delay relates only to the signal propagation delay in the BPS 202. The total delay varies depending on the attached ICI probe, pulse voltage and polarity (see provided parameter sheet).

## 8.10 Status Bar Messages

The status bar of the BPS 202-Client shows different status messages depending on the situation:

1) Status of the USB connection between BPS 202 and computer
   a) *Connection: BPS not connected*
   b) *Connection: BPS connected*


Figure 34: No USB connection to BPS 202

2) Status of the automatic probe recognition

a) *Probe: no Probe*

b) *Probe: "Probe name"*

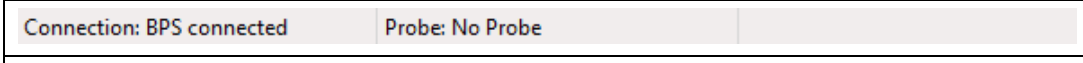



Figure 35: BPS 202 connected but no valid Probe detected

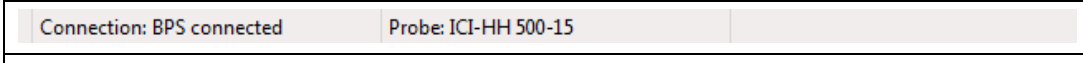



Figure 36: BPS 202 connected and an ICI probe detected

3) Operating mode of the BPS 202

a) *Status: stopped* – no generation of pulses or bursts

b) *Status: running* – generating pulses or bursts

c) *Status: Waiting for Trigger – BPS 202* – waits for an external trigger event

## 8.11 Menus

### 8.11.1 File Menu

*File -> Exit* Shuts down the BPS 202-Client software

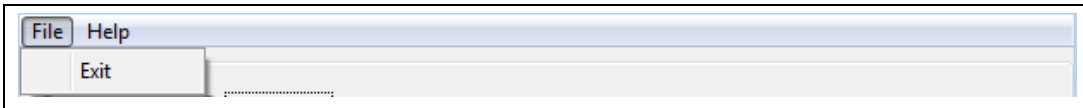



Figure 37: File Menu

### 8.11.2 Help Menu

*Help -> Hardware Info …* Display hardware information about the connected BPS 202 and ICI probe

*Help -> About …* Software information / Link to www.langer-emv.de

*Help -> Update BPS Firmware…* Open the BPS 202 firmware update dialog

*Help -> Update Probe Firmware…* Open the probe firmware update dialog

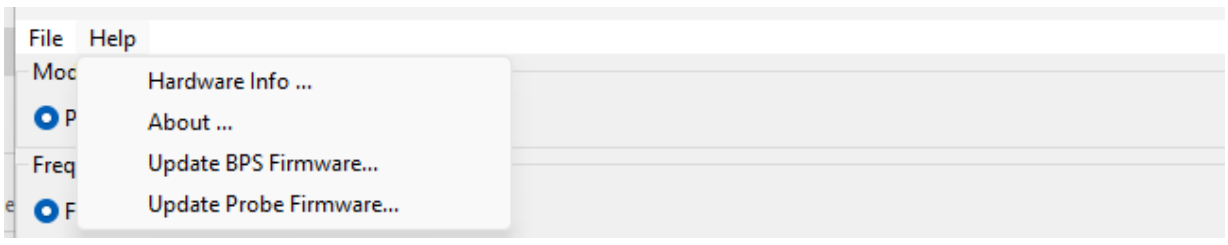



Figure 38: Help Menu

# 9 SDK

In addition to the BPS 202-Client software, the SDK for remote control of the BPS 202 is included on the supplied USB stick. Using this SDK, the BPS 202 can be controlled from both Windows and Linux systems. A detailed description of the SDK and its functions can be found in the BPS 202 Programming Manual.

To get started quickly, the package includes programming examples in Python and C++ that introduce the remote control functions.

# 10 Measurement setup

Figure 39 shows a possible test setup using the ICI L-EFT set. The ICI HH500-15 probe is placed above the device under test (DUT). An automatic positioning system (e.g., the ICS 105) is used to ensure controlled and repeatable probe positioning. The ICI and the BPS 202 are configured and controlled via a PC, while the measurement data is analyzed using an oscilloscope.
Optionally, the BPS 202 can be synchronized with the DUT.

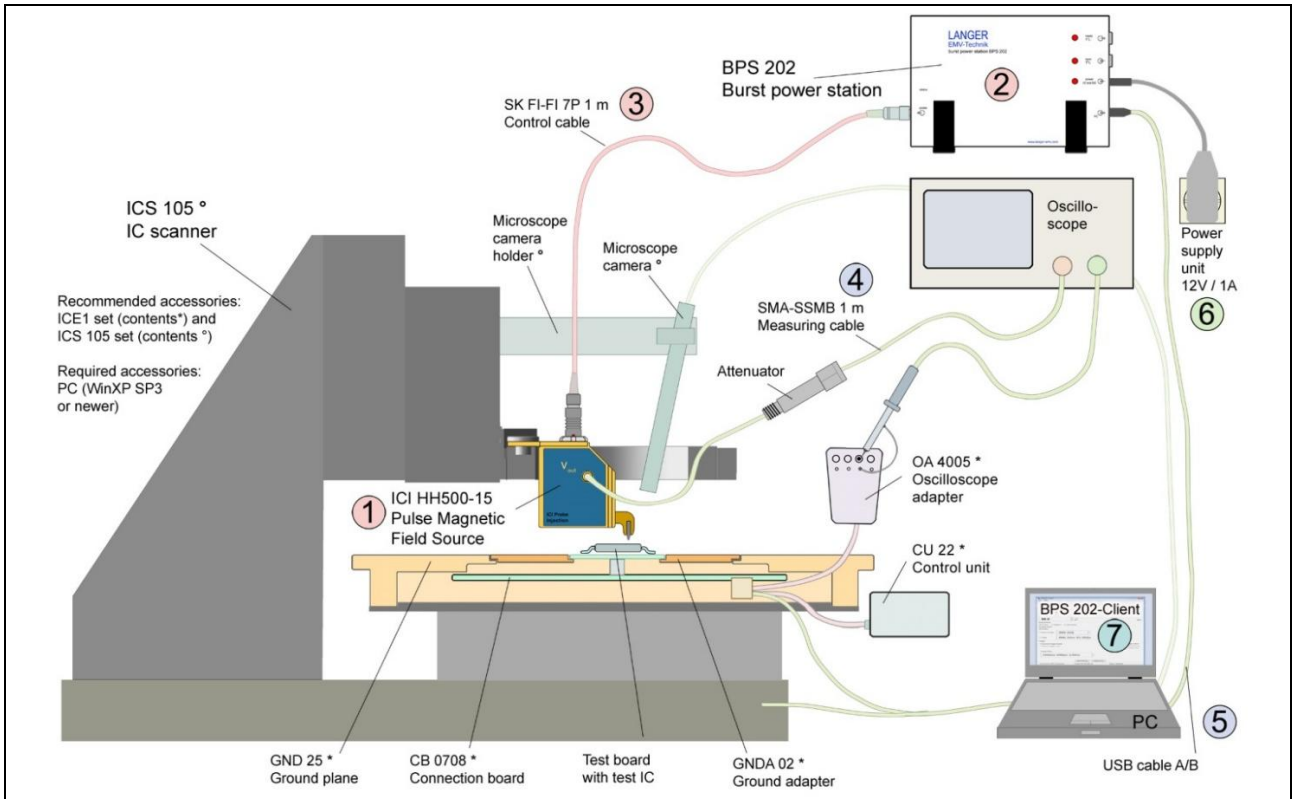



Figure 39: Set-up of ICI L-EFT set with ICI HH500-15 probe. All elements which are included in the scope of delivery are marked with a with a circled number according to table 8.

| No | Name | Description |
|---|---|---|
| ① | ICI HHxxx-15 L-EFT | Generates the H-Field injected into the DUT |
| | ICI E450 L-EFT | Generates the E-Field injected into the DUT |
| | ICI I900 L-EFT | Generates the current pulse injected into the DUT |
| ② | BPS 202 | Supplies high voltage and control signals to the ICI probe |
| ③ | Control Cable | Connects ICI probes with the BPS 202; Fischer-Fischer |
| ④ | Measuring cable | SSMB to SMA cable to connect measurement output with an oscilloscope |
| ⑤ | USB cable | Connects the BPS 202 with a PC |
| ⑥ | Power supply unit | 12 V / 1 A power supply unit, used to power the ICI L-EFT set |
| ⑦ | BPS 202-Client | Computer software / DLL to control ICI probes |

Table 8: ICI L-EFT set short description

# 11 Quick Start

1 Check all components to be used. Only proceed if all components are undamaged.

2 Install the BPS 202-Client software onto a computer (Section 8.1).

3 Connect the ICI probe with the BPS 202 via the provided control cable (SK Fi-Fi 7p 1 m).

4 Connect the SSMB measurement output of the ICI probe to an oscilloscope via the provided SMA-SSMB cable.

⚠ Make sure you do not exceed the limits of your oscilloscope (Table 7). If required use an external attenuator[3] (Figure 39).

5 Connect the power supply unit to the BPS 202.

5.1 The status indicator LED of the ICI probe lights up green.

5.2 The status indicator LED of the BPS 202 flashes with 2 Hz.

6 Connect the BPS 202 to a computer via the provided USB A/B cable.

7 Start the BPS 202-Client software.

[3] Not in the scope of delivery

# 12 Technical Parameters

## 12.1 BPS 202 – Burst Power Station

| | |
|---|---|
| **Output voltage** | 50 V - 500 V |
| **External trigger input (sync TTL)** | TTL (max. 5V), BNC, max. 20 kHz |
| **Synchronization output (ready TTL)** | TTL (max. 5V), BNC |
| **Trigger-pulse delay (Bypass Mode, BPS only)** | |
| Min. trigger-pulse delay (typ.) | 30 ns |
| Max. jitter (typ.) | ± 1 ns |
| **Trigger-pulse delay (Timer Mode, BPS only)** | |
| Min. trigger-pulse delay (typ.) | 130 ns |
| Max. trigger-pulse delay (typ.) | 100 ms |
| Max. jitter (typ.) | ± 15 ns |
| Trigger delay, min. increment | 10 ns |
| **Control Interface** | USB Type-B |
| **Supply voltage** | 12 V / 1 A DC |
| **Size (L x W x H)** | (175 x 122 x 61) mm |
| **Weight** | 300 g |

Table 9: Technical parameters of BPS 202

## 12.2 ICI HH500-15

| | |
|---|---|
| **Supply / control** | via BPS 202 |
| **Diameter probe tip** | Ø 500 µm |
| **Max. flux density** | ca. 50mT[4] |
| **Measurement output** | SSMB, 50 Ω |
| **Puls parameters** | |
| repetition frequency | 0.1 Hz - 20 kHz |
| rise time | approx. 2 ns |
| polarity (via software) | + / - / alternating |
| **Pulse level voltage range** | 50V – 500V |
| **Trigger-to-pulse delay (bypass mode)** | |
| Trigger pulse delay | see parameter sheet |
| Trigger pulse jitter | ± 1 ns[5] |
| **Weight** | 70g |
| **Sizes (L x W x H)** | (26 x 43 x 53) mm |

Table 10: Technical parameters of ICI HH500-15

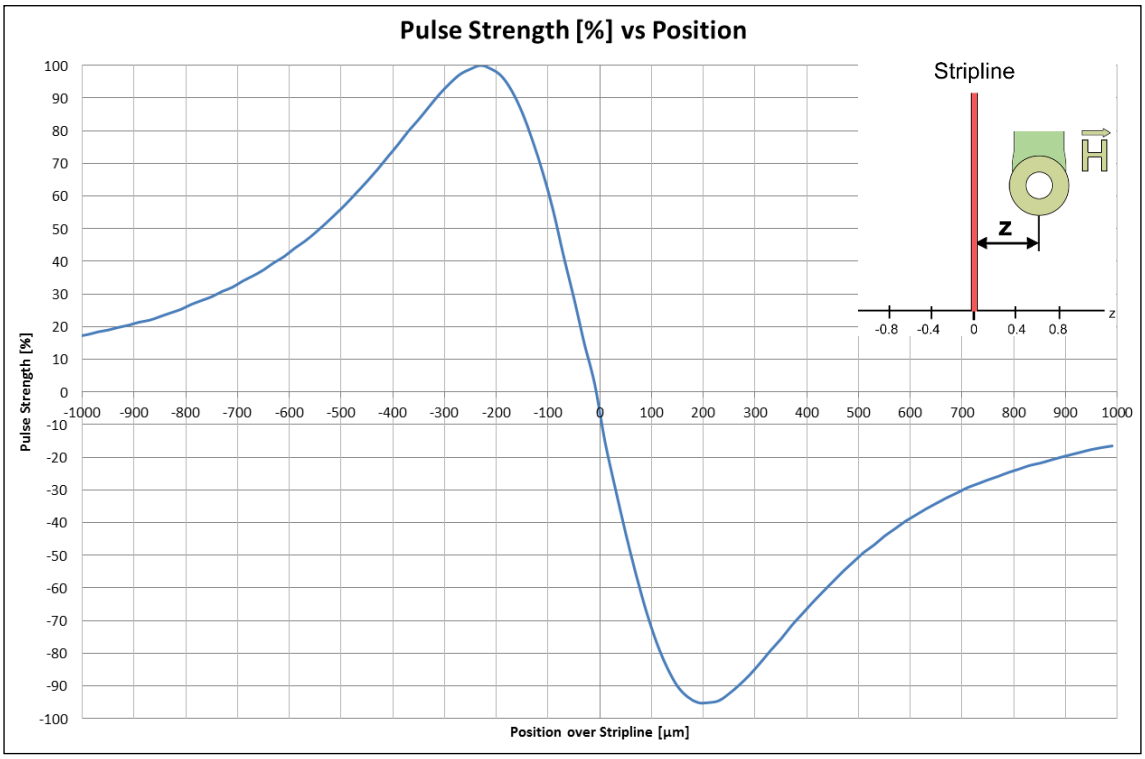



Figure 40: Relative pulse strength, scan across 100µm stripline

[4] Approximate value; for specific value refer to parameter sheet of the probe

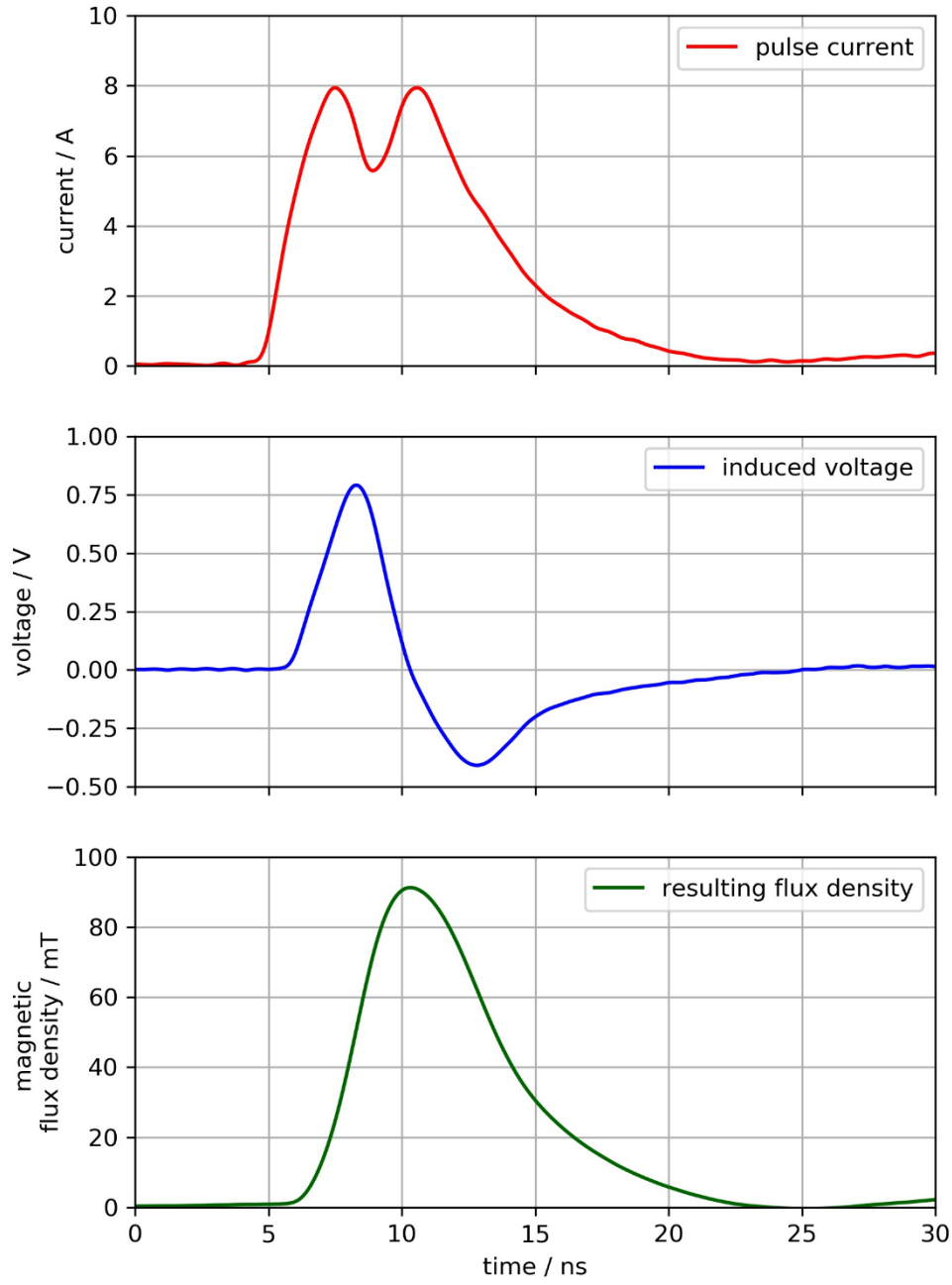



Figure 41: ICI HH500-15 typical waveform (reference setup, 500µm coil, 50Ω)

## 12.3 ICI E450

| | |
|---|---|
| **Supply / control** | via BPS 202 |
| **Probe head dimensions** | Ø 450 µm |
| **Max. displacement current (Stripline 100 µm)** | 7 mA[5] |
| **Measurement output** | SSMB, 50 Ω |
| **Puls parameters** | |
| repetition frequency | 0.1 Hz - 20 kHz |
| rise time | approx. 2 ns |
| polarity (via software) | + / - / alternating |
| **Pulse level voltage range** | 50V – 500V |
| **Trigger-to-pulse delay (bypass mode)** | |
| Trigger pulse delay | see parameter sheet |
| Trigger pulse jitter | ± 1 ns[5] |
| **Weight** | 70g |
| **Sizes (L x W x H)** | (26 x 43 x 53) mm |

Table 11: Technical parameters of ICI E450

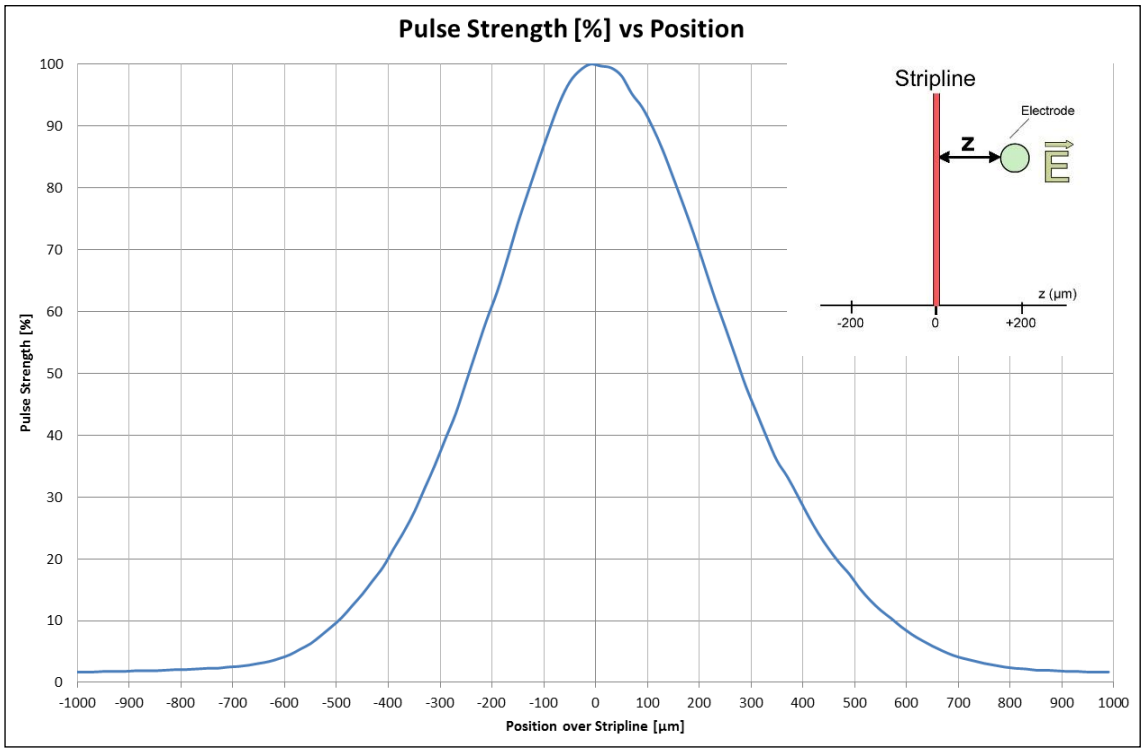



Figure 42: Relative pulse strength, scan across 100µm stripline

[5] Approximate value; for specific value refer to parameter sheet of the probe

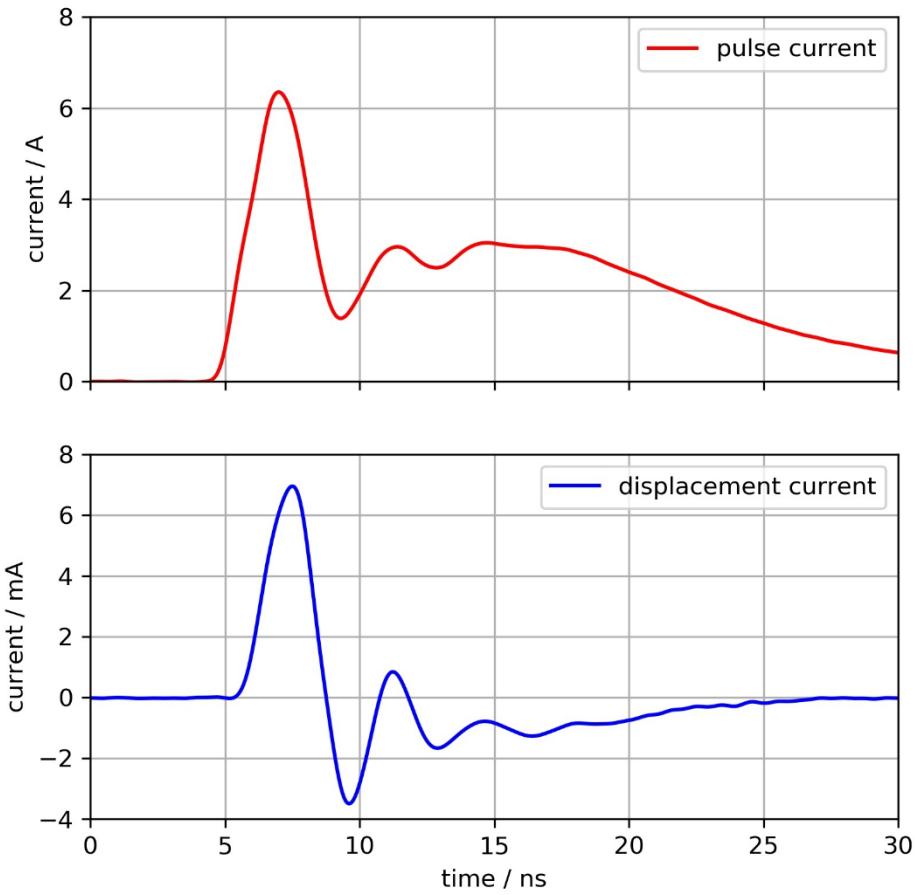



Figure 43: ICI E450 typical waveform (reference setup, 100µm stripline, 50Ω)

## 12.4 ICI I900

| | |
|---|---|
| **Supply / control** | via BPS 202 |
| **probe tip** | Spring Pin |
| **Max displacement current (1Ω load)** | approx. 4A[6] |
| **Measurement output** | SSMB, 50 Ω |
| **Puls parameters** | |
| repetition frequency | 0.1 Hz - 20 kHz |
| rise time | approx. 2 ns |
| polarity (via software) | + / - / alternating |
| **Pulse level voltage range** | 50V – 500V |
| **Trigger-to-pulse delay (bypass mode)** | |
| Trigger pulse delay | see parameter sheet |
| Trigger pulse jitter | ± 1 ns[5] |
| **Weight** | 70g |
| **Sizes (L x W x H)** | (26 x 43 x 53) mm |

Table 12: Technical parameters of ICI I900

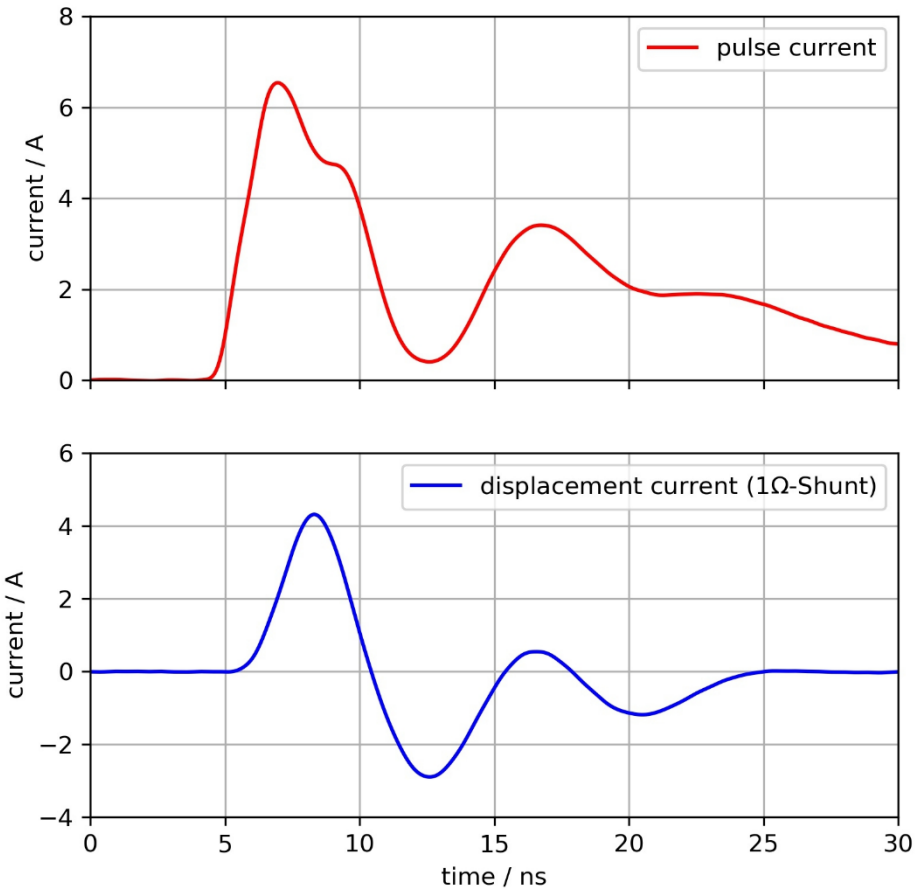



Figure 44: ICI I900 typical waveform (1Ω load, low-impedance ground connection)

[6] Approximate value; for specific value refer to parameter sheet of the probe

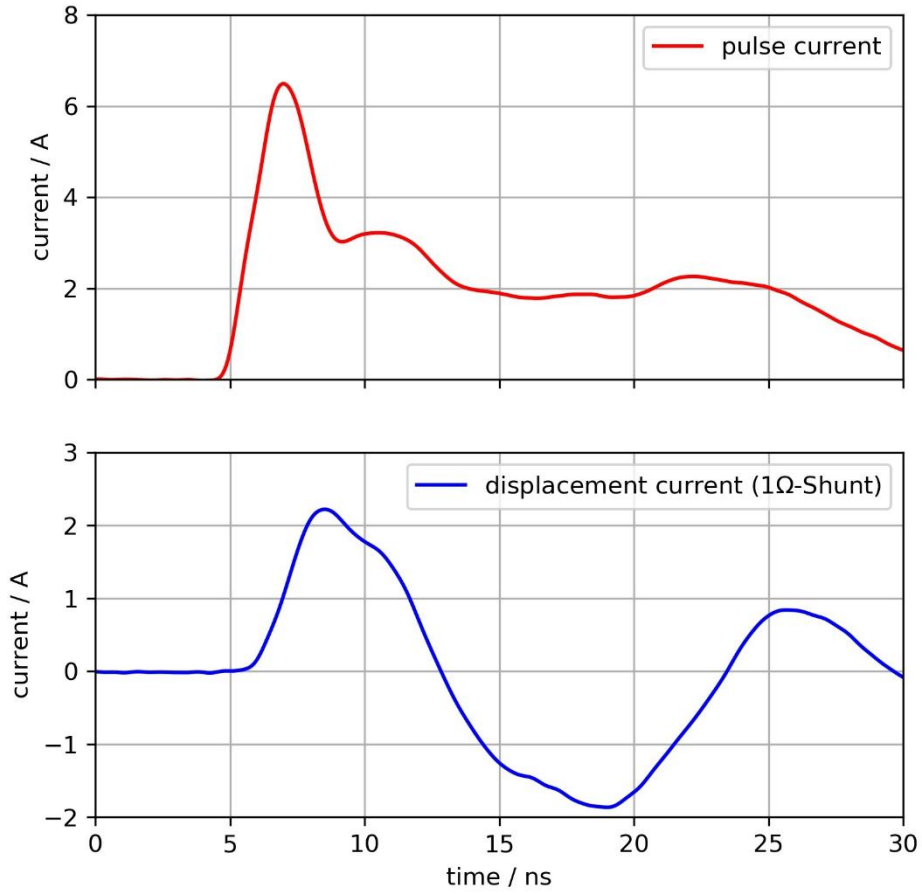



Figure 45: ICI I900 typical waveform (1Ω load, high-impedance ground connection)

## 12.5 BPS 202-Client and SDK

| | |
|---|---|
| **Operating system** | Windows 11 |
| **Monitor resolution** | 1024 x 768 or higher |
| **HD space** | 20 MB |
| **SDK** | dll- (Windows) and so-file (Linux) |

Table 13: System requirements for the BPS 202-Client software

## 12.6 Dimensions of ICI Probes

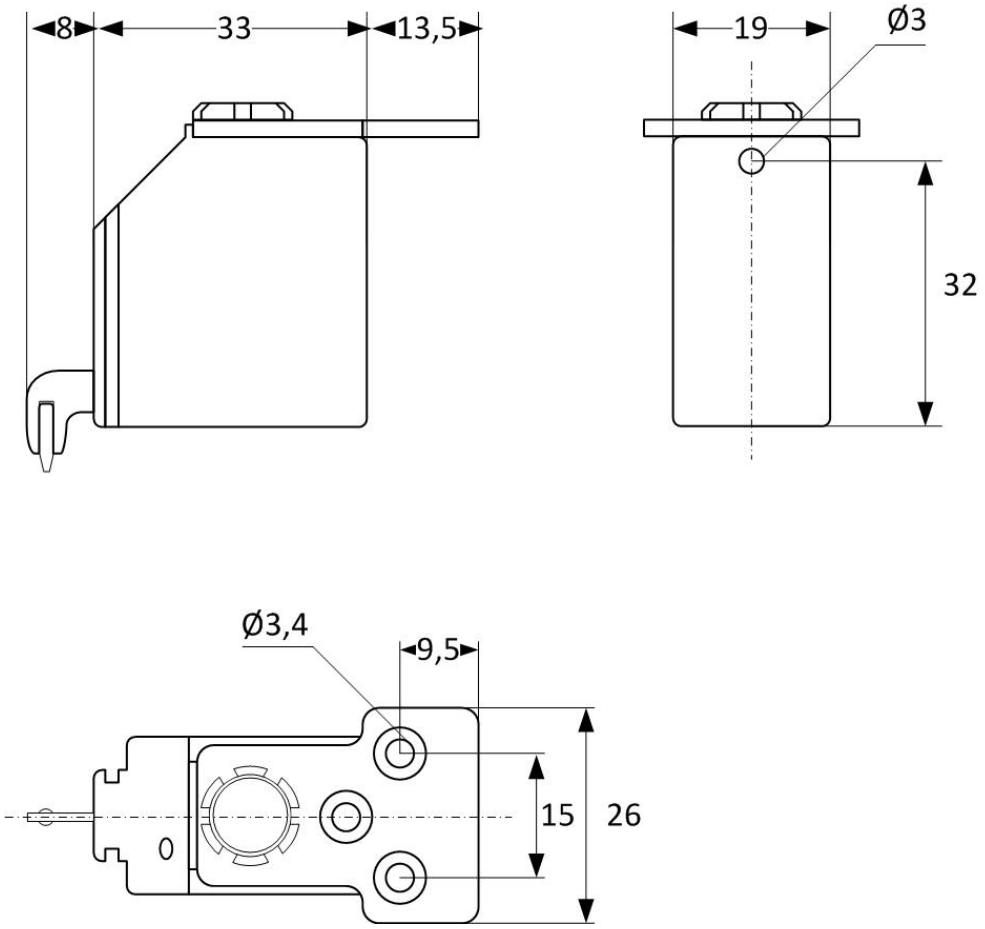



Figure 46: Dimensions of ICI probes in [mm]

## 12.7 Dimensions of Probe Tips of ICI Probes

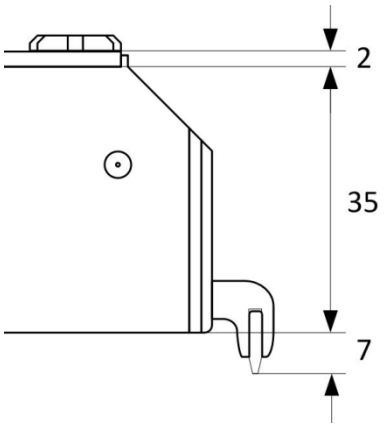
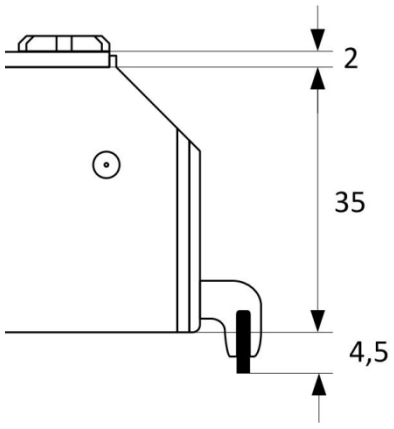
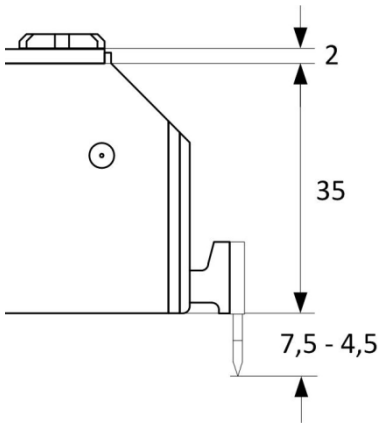
| ICI HH500-15 | ICI E450 | ICI I900 |
|---|---|---|
|  |  |  |



Figure 47: Dimensions of Probe Tips in [mm]

# 13 Information on Recycling and Disposal

In accordance with the WEEE Directive 2012/19/EU (Waste of Electrical and Electronic Equipment), the following must be observed:

At the end of its service life, this product should be taken to a suitable disposal facility for recycling and disposal. Do not dispose of with household waste.

# 14 Customer service

Please contact us if you have any questions, comments or suggestions.

You can contact us:

Monday – Friday
8:00 – 15:00 (CET)

Contact us at:

Address: Langer EMV-Technik GmbH
Nöthnitzer Hang 31
01728 Bannewitz
Germany

Internet: https://www.langer-emv.com/
E-mail: sales@langer-emv.de
Phone: +49 (0) 351-430093-0
Fax: +49 (0) 351-430093-22

**Calibration**

We recommend having the product calibrated every two years by the manufacturer Langer EMV-Technik GmbH or by a certified service partner.

# 15 Warranty

Langer EMV-Technik GmbH shall remedy all defects attributable to material or manufacturing faults within the statutory warranty period by repairing the product or supplying replacement parts.

**This guarantee is only granted on condition that:**

- the information and instructions in the operating instructions are observed.

**The guarantee expires if:**

- an unauthorized repair is carried out on the product
- the product is modified
- the product is not used as intended