User Manual

PT4 set

EFT Generator Set

The PT4 burst transformer is used for immunity tests during development.
In combination with an EFT/burst generator it provides potential-free burst pulses.

Noethnitzer Hang 31
01728 Bannewitz
February 2017

Content

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1 Declaration of Conformity

Manufacturer:

Langer EMV-Technik GmbH
Noethnitzer Hang 31
01728 Bannewitz
Germany

Langer EMV-Technik GmbH hereby affirms, that the product specified below

PT4 set, EFT Generator set
with PT4, BS 04DB-h, ES 05D-h

agrees with the regulations of EC guidelines:

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

Applied standards and technical specifications:

- DIN EN 61000-6-3:2011-09 EMC - Emission
- DIN EN 61000-6-1:2007-10 EMC - Immunity
- DIN EN 50581:2013-02 (Restrictions of hazardous substances)

Person authorized to compile the technical file:

Gunter Langer

Bannewitz, 2020-02-12

(Signature)
G. Langer, Executive Director

2 General Information

2.1 Storing the User Manual

This user manual provides the basis for the safe and efficient use of the PT4 set. It must be kept handy and easily accessible for the user.

2.2 Reading and Understanding the Manual

Read and understand the manual and observe the instructions carefully before using the PT4 set. Please consult Langer EMV-Technik GmbH if you have any questions or comments.

The user manual must be kept readily available in the immediate vicinity of the product.

2.3 Local Safety and Accident Prevention Regulations

The applicable local general safety and accident prevention regulations must be adhered to.

2.4 Images

Images in this manual facilitate a better understanding, but can deviate from the actual execution.

2.5 Limitations of Liability

The Langer EMV-Technik GmbH is not liable for personal injury or damage to material, if

- the instructions in this user manual were not followed.
- the product was used by personnel who are not qualified in the field of EMC and who are not fit to work under the influence of disturbance voltages and electric and magnetic fields.
- the product was not used as intended.
- the product was arbitrarily modified or technically altered.
- spare parts or accessories were used, that were not authorized by Langer EMV-Technik GmbH.

The actual scope of delivery can deviate from the texts and images in this manual in the case of individual adjustments to the order or recent technical changes.

2.6 Errors and Omissions

The information in this user manual has been checked very carefully and found to be correct to the best of our knowledge; however, Langer EMV-Technik GmbH can assume no responsibility for spelling, typographical or proofreading errors.

2.7 Copyright

The content of this user manual is protected by copyright and may only be used in connection with the PT4 set. This user manual may not be used for other purposes without the prior consent of Langer EMV-Technik GmbH.

3 Scope of Delivery

Item	Designation		Type	Qty.
01	Burst Transformer		**PT4**	1
02	Magnetic Field Source		**BS 04DB-h**	1
03	E-Field Source		**ES 05D-h**	1
04	High-Voltage Cable		HV SHV-SMB 1 m	1
		or	HV FI-SMB 1 m	1
05	Micro Kleps		Micro Kleps	2
06	Alligator Clip		Alligator Clip	2
07	Measuring Cable for PT4		BTK 40 cm	2
08	System Case		PT4 case	1
09	Quick guide		PT4 qg	1
10	User Manual		PT4 m	1

Important: The scope of delivery may differ depending on the respective order.

Figure 1: System case PT4 set

4 Technical Parameters

4.1 PT4

Max. burst voltage	4.5 kV
Transformation ratio	1:1
Dielectric strength of outputs	500 V / DC, AC 50 Hz

Table 1: PT4 technical parameters

4.2 Field Sources

Max. burst voltage	4.5 kV
Connector	SMB

Table 2: Technical parameters of field sources

5 Safety Instructions

5.1 General Safety Instructions

When using a Langer EMV Technik GmbH product, please observe the following safety instructions to protect yourself against electric shock or the risk of injury.

The use of the device must be carried out by personnel who are experts in the field of EMC and who are suitable for this work under the influence of interference voltages and burst fields (electrical and magnetic).

- The operating and safety instructions of all devices used must be observed.
- Damaged or defective devices must not be used.
- Before operating a measuring station with a product of Langer EMV-Technik GmbH, carry out a visual inspection. Damaged connecting cables must be replaced before operation.
- The product of Langer EMV-Technik GmbH may only be used for applications for which it is intended. Any other use is not permitted.

5.2 Intended Use

The PT4 set is used to analyze the immunity of assemblies and devices. The PT4 burst transformer converts the pulses of a EFT/burst generator into potential free burst pulses. These are injected into individual sections of the device under test. The set includes a magnetic and an electric field source which are also supplied by a EFT/burst generator. The field, which emerges from the head of the field source, is used to scan the surface of the device under test.

The PT4 is built according to its specified use therefore it should be used only for the following purposes:

- injection of burst pulses into assemblies and devices

The field sources are built according to their specified use therefore they should be used only for the following purposes:

- scanning of the surface of PCBs

5.3 Reasonably foreseeable Misuse

Reasonably foreseeable misuses of the PT4 set are:

- Use of the product outside of the given specifications.
- Modification or changing of the product without consent of Langer EMV-Technik GmbH.
- Operating the product with a technical fault.

6 Principle of Operation

Burst generators generate burst pulses related to their housing. For standard-compliant measurements, the housing is connected to a metal plate below the DUT. This results in a measurement set-up as shown in **Figure 2**.

Interference current is fed into the DUT via a network simulation or coupling clamp. This current flows on largely unknown paths through the DUT and then couples capacitively into the metal plate. If functional errors occur, the exact coupling mechanisms and coupling locations must be found as quickly as possible.

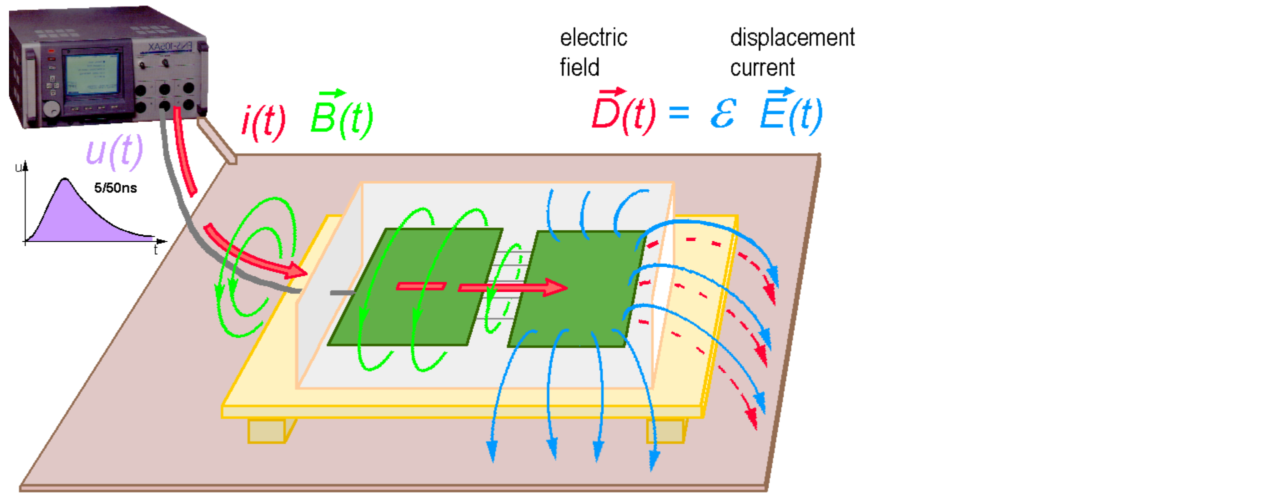


Figure 2: Typical measurement set-up with a burst generator

In addition to the use of field sources for troubleshooting, there are two other options available to the developer:

a) feed interference current through the DUT section by section and thus limit the fault location step by step,

b) measure signals from the DUT during the interference and thus prove the cause of the functional fault.

Both methods are limited in practice by the burst voltage applied to the generator housing:

to a) If interference current is fed into one point of the DUT and a second point is connected to the housing of the generator, a burst current flows between these two points as desired. In addition, however, a secondary burst current flows between the input coupling point and the generator housing via parasitic coupling paths (e.g. capacitive connection GND-PE in the DUT and via PE back to the burst generator). In this way, the burst current can also generate functional errors and cause an incorrect measurement result.

to b) If a measurement is made during the interference and a probe of an oscilloscope is connected to the DUT, a portion of the interference current flows parallel to the actual interference current path via the GND connection of the probe to the oscilloscope (**Figure 3**). This changes the interference current in the DUT, generates a voltage drop on the screen of the probe and the test line, which is also measured, and possibly influences the oscilloscope.

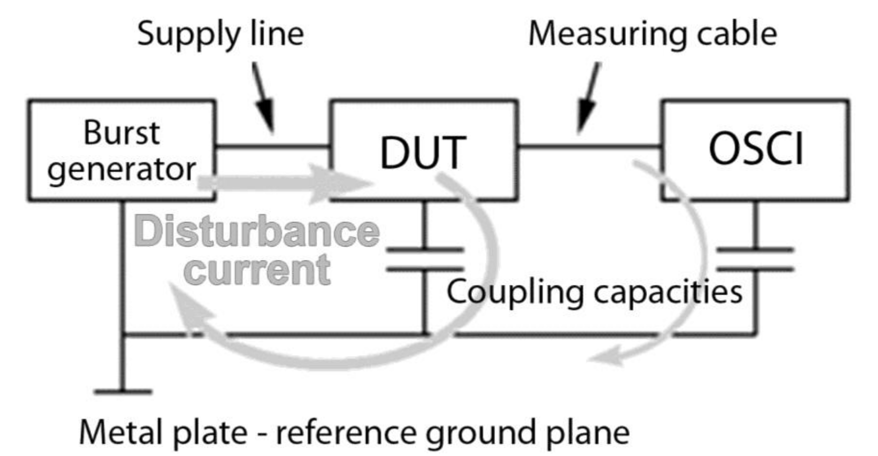


Figure 3: Part of the interference current affects the oscilloscope

With the PT4 the output pulse of the burst generator is galvanically isolated from the burst generator itself. In the connection cable of the PT4 there are damping elements which also largely prevent high-frequency common-mode currents from the generator into the DUT. This makes it possible to carry out the measurements described under a) and b) without the interfering parasitic currents.

7 Application

7.1 General Notes

The high-voltage plug of the PT4 burst transformer is connected to the burst output socket of a burst generator. The maximum supply voltage is 4.5 kV (peak value). The generator setting "Burst voltage positive" corresponds to a positive voltage pulse at the red or negative voltage pulse at the blue output socket of the PT4.
Both outputs of the PT4 are capacitively decoupled. This makes it possible, for example, to couple interference current in Vcc in and out again via GND.

7.2 Product Safety

- Always start the measurements with the smallest generator setting.
- Provide possibilities to quickly switch off the DUT as well as the generator in case of a fault.
- Connect or disconnect the PT4 only when it is disconnected from the power supply.
- Operate the PT4 or the field sources only with burst generators according to EN 61000-4-4.
- Apply the PT4 or the field sources only to electronic devices or modules, which are defined as Devices under test (DUTs).
- Always operate the test set-up via a filtered power supply.

It is the user's task to take measures to ensure that products installed outside the operational EMC environment are not impaired in their intended function (in particular by emitted interference).

This can be done by:
- maintaining an appropriate safety distance,
- use of shielded or screened rooms.

The fields generated by the PT4 or the field sources can, due to their function, lead to the destruction of IC if they affect the DUT too strongly (latch-up). Protection is provided by:

- no further increase of the generator voltage in case of functional errors,
- quick interruption of the power supply of the DUT in case of latch-up.

7.3 Feeding in Interference Current (Functional Fault Comparison)

Coupling can be made to GND/Vcc conductors, cable shields, shield connections, auxiliary power supply lines and bypass capacitors. To do this, connect the outputs of the PT4 directly to the DUT using the miniature clamp-type test probes (micro kleps) supplied.
The following procedure is recommended when selecting the input coupling points:

- First of all you should try to reproduce the natural path of the interference current through the DUT. For this purpose, a galvanic coupling is made e.g. into the shield or the shield connection of a connected cable (**Figure 4** - left). The interference current flows through the DUT and is returned e.g. from the DUT housing back to the PT4.
- Instead of the cable shielding, it is also possible to feed directly into individual wires of a cable (**Figure 4** - middle).
- Alternatively, a shield can be simulated by a piece of aluminum foil (**Figure 4** - right).

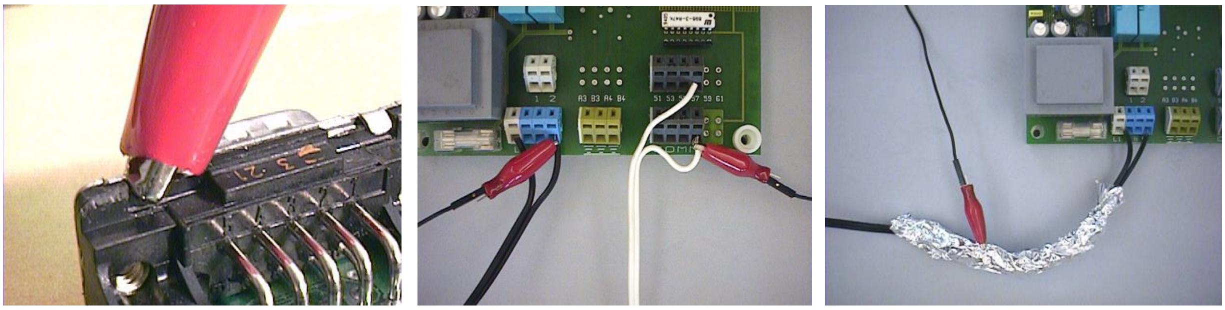


Figure 4: Examples for feeding in interference current

The aim of this investigation is to simulate the functional fault that occurs during a test according to the standard and to make statements about possible interference current paths in the device.

If functional errors have been caused, subsequent measurements will attempt to determine the location of the error more precisely by feeding into the DUT in sections.

Figure 5 shows some of the possibilities for feeding in interference current. For example, the properties of the ribbon cable between both PCBs are investigated by feeding into the GND positions of both PCBs in the immediate vicinity of the connectors.

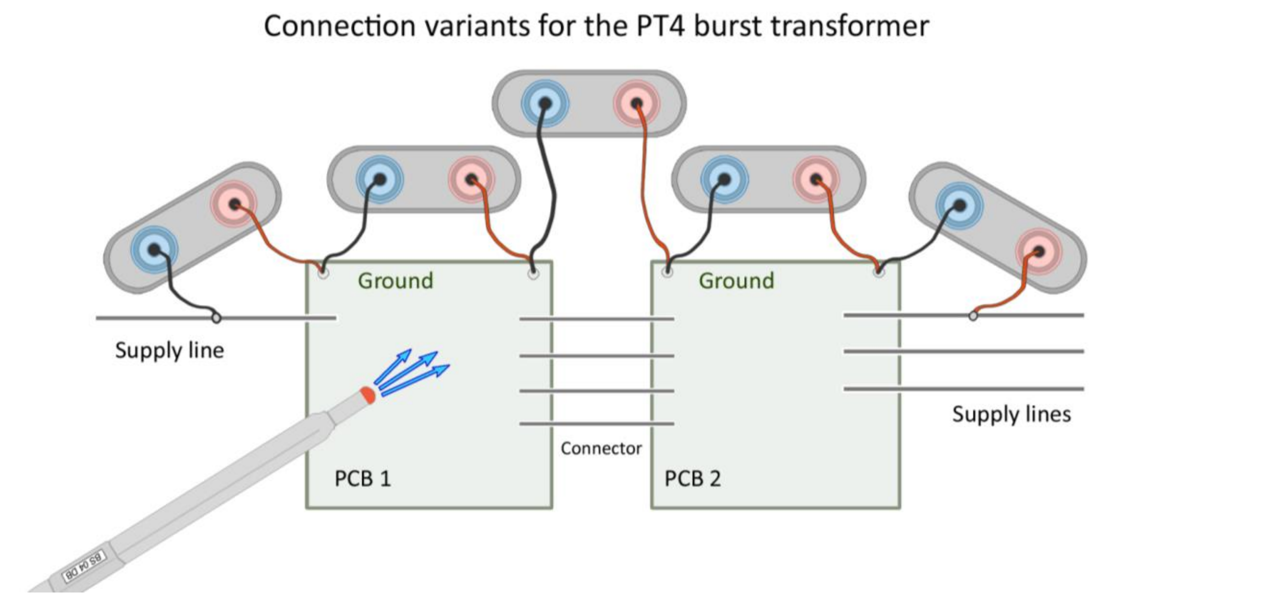


Figure 5: Connection variants of the PT4

7.4 Measuring Signals with an Oscilloscope

The following measurement set-up is recommended for the most error-free measurement of signals during the coupling of burst pulses:

- The burst generator is placed on a wooden table as far away from the DUT as possible. The complete length of the connecting cable of the PT4 (**Figure 6**) should be used.

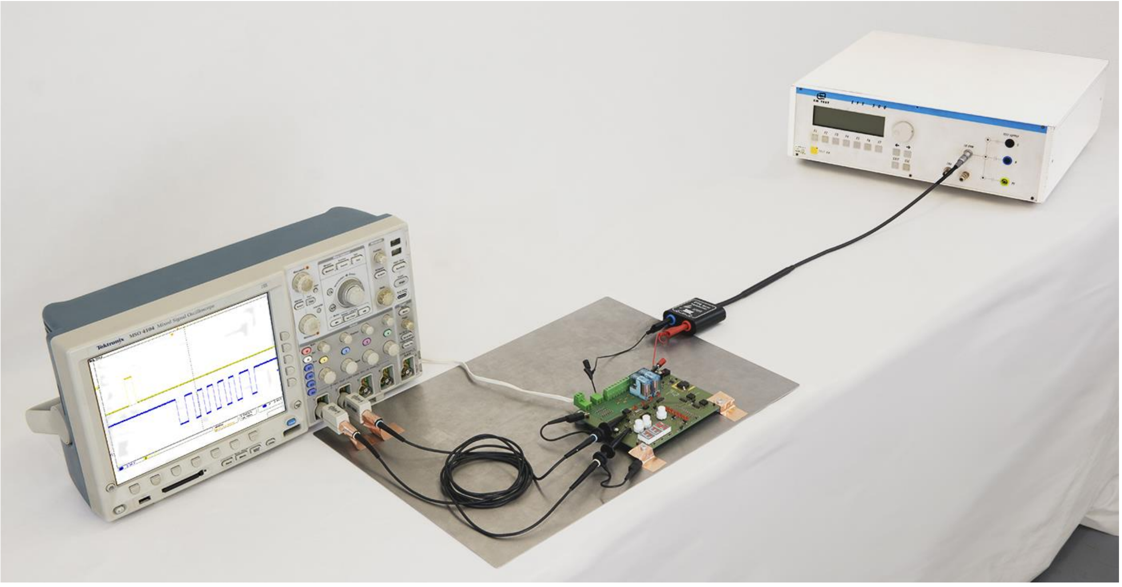
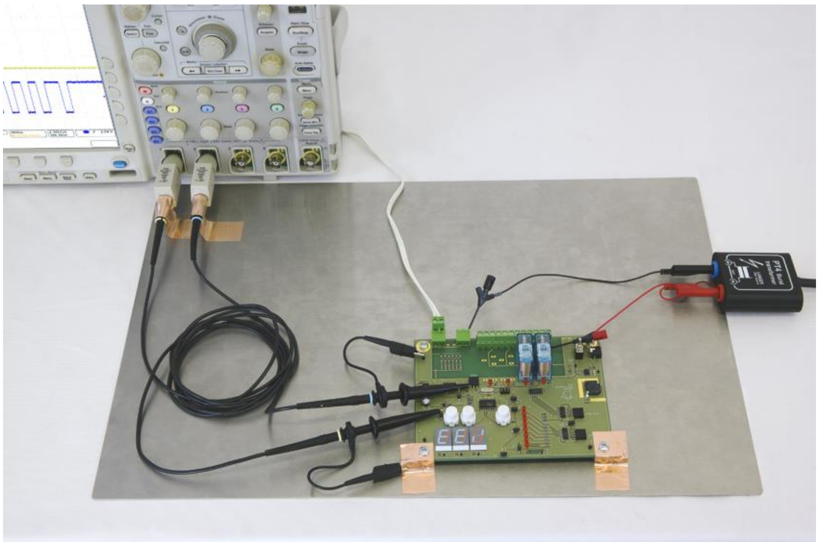


Figure 6: Measurement set-up with burst generator and oscilloscope

- To reduce magnetic coupling between cable and DUT, the cables can be twisted from the PT4 up to the DUT.

- The DUT is placed on a metallic surface. Both GND of the DUT and GND of the used measuring devices must be galvanically connected to this metal plate (**Figure 6**, **Figure 7**). In this way voltage differences and thus compensation currents between DUT and measuring devices can be reduced considerably.



This plate must NOT be connected to the burst generator!

Figure 7: Measurement set-up in detail

- To minimize magnetic coupling between the lines carrying interference current and the measuring lines, the measuring lines must be routed as close as possible to the metal surface.

If the DUT is very large or, for example, permanently installed in a switch cabinet, then the burst generator must also be set up at the maximum possible distance from the DUT. The lines from the PT4 to the DUT should be twisted as far as possible.
If the measurement errors are not sufficiently small in this case, an optical fiber system must be used for measurement (e.g. A100 set for analog or OSE 400 set for digital systems).

8 Interference Mechanisms

- Electronic assemblies have different immunity to interference depending on the layout and IC sensitivity.
- Precisely definable weak points are the cause of burst and ESD sensitivity. The development of the weak points depends largely on the GND/Vcc/signal conductor geometry and the type or manufacturer of the ICs used.
- Interference current **i** enters electronic modules either conductively or capacitively. Caused by the interference current, electrical interference fields (electrical field strength **E**) or magnetic interference fields (magnetic flux density **B**) act on the surface of the module.
- Magnetic pulse fields (**B**) or electric pulse fields (**E**) are the main physical quantities that trigger an influence on printed circuit boards.
- A weak point is usually only magnetically or only electrically sensitive.
- In practice, both types of vulnerability are relevant. For example, electric fields can occur during interference processes, which cause electrically sensitive weak points to respond. The currents driven by the electric field generate magnetic fields, which in turn address magnetically sensitive weak points (**Figure 8**).
- The interference effects of both mechanisms overlap and are difficult to separate. Each of the two types of weakness requires different EMC measures due to the different physical mechanisms. There are usually only a few immunity weak points on an assembly, which are often limited to small surface areas. Once the immunity weak points have been found and eliminated, the board is immune to interference.

8.1 Fields within the DUT using an Example

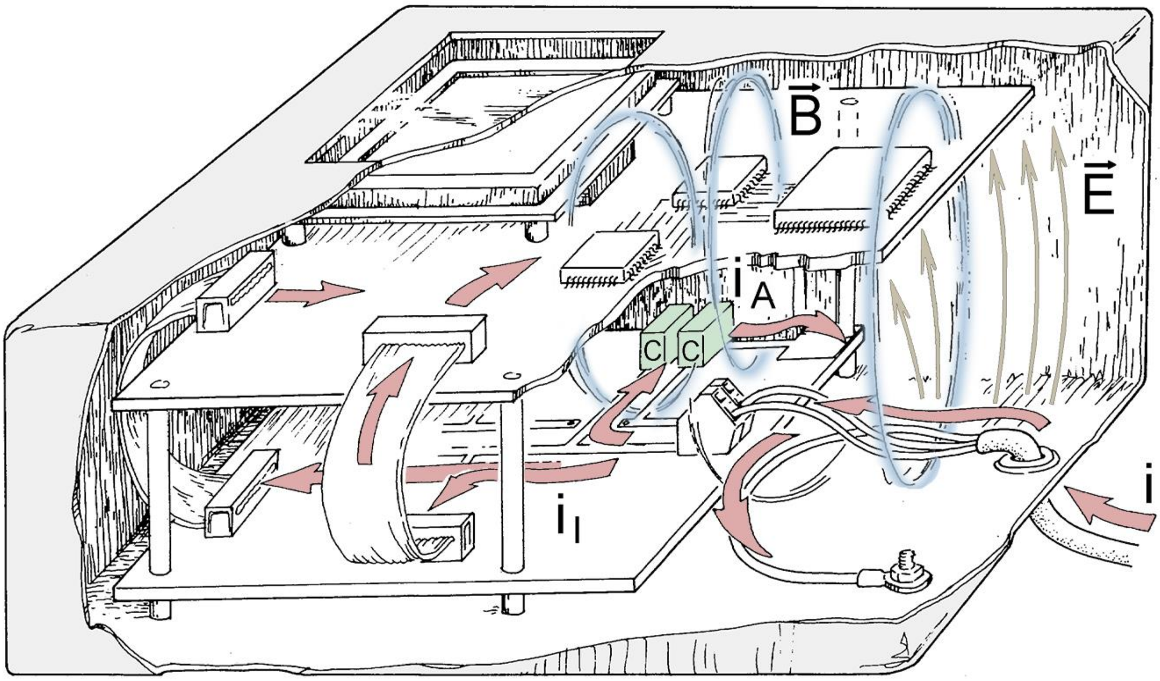


Figure 8: Example fields within a DUT

Interference current **i** in **Figure 7** enters the device conductively. Leakage current paths that run through capacitors C lead the portion i_A to the outside and reduce the interference current $\mathbf{i_I}$ for the internal areas. The magnetic fields **B** can affect electronic components located a few decimeters away. Not all magnetic fields that penetrate the surface of the assembly have an influencing effect. Usually only small areas are B-field sensitive. It should be noted that not only interference currents **i** in the vicinity of supply cables and PE connections generate magnetic fields. The leakage paths which run through leakage capacitors C and internal GND and Vcc connections are also heavily involved.

Electrical pulse fields **E** emanate from the lines carrying interference currents and essentially influence signal connections that have high-impedance signal sources.

9 Field Sources

9.1 Short Description

The field sources can be used to simulate fast transient electric and magnetic pulse fields in electronic devices and on electronic assemblies for immunity tests during development.
The aim of the application is to localize immunity weak points (burst, ESD) in electronic devices so that corrective measures can be applied in a targeted manner.
The field sources can only be used in conjunction with a burst generator according to IEC 61000-4-4.

9.2 Connection to Burst Generator

The field sources are fed with disturbance from a burst generator via the high-voltage cable contained in the PT4 set. Only burst generators according to IEC 61000-4-4 are to be used for this purpose. The maximum supply voltage of the field sources is 4.5 kV (peak value).
The high-voltage cable is only to be snapped onto the field source with the miniature connector (SMB) in a voltage-free state.
The high-voltage connector (SHV) is connected to the burst output socket of the burst generator.

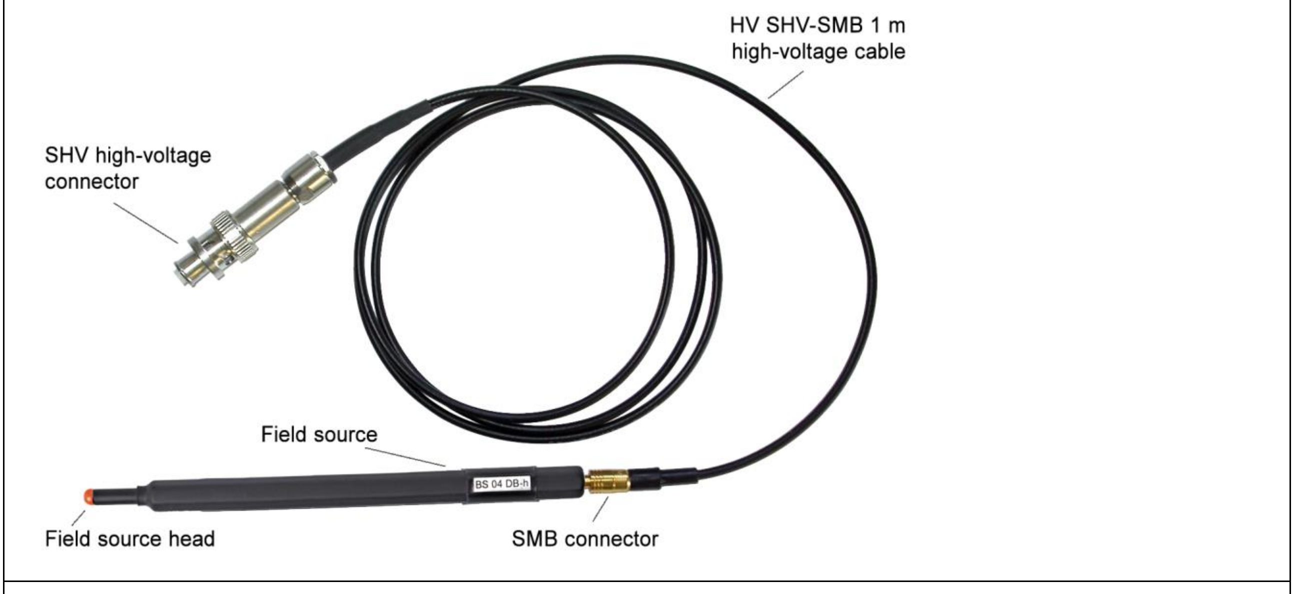


Figure 9: Field source connected to high-voltage cable

9.3 Principle of Operation – Magnetic Field Source

The burst generator drives a pulse current through the high-voltage cable and the induction coil located in the field source head (source of magnetic field). A pulse magnetic field is generated in the induction coil. This pulsed magnetic field emerges from the magnetic field source and acts on the DUT when approached accordingly.

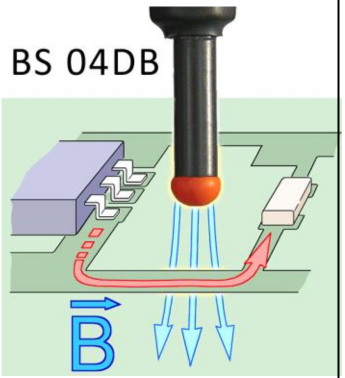
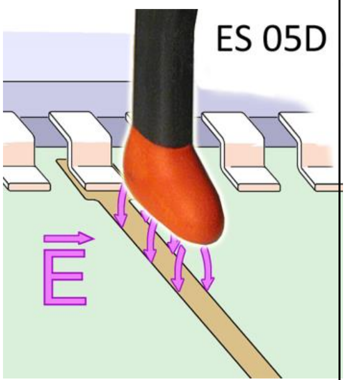
9.4 Principle of Operation – Electric Field Source

The burst generator feeds pulse voltage via the high voltage cable to the coupling electrode located in the field source head. The potential jump at the field source head generates a pulse-shaped electrical field. The ES 05D-h field source has its own field counterpole.

9.5 Handling

The field sources are guided over the DUT by hand. Depending on the size and distance of the field sources, pulse fields act on the surface of the DUT.
Conductors and components are selectively applied if handled appropriately.
Functional errors of the DUT indicate immunity weak points. The DUT can be damaged if the application is too intensive (**Section 7.2**).

9.6 Types of Field Sources

Application	Description	Design
	**BS 04DB-h** The magnetic field source generates a B-field bundle in the millimeter range (> 3 mm). The field beam exiting at the front of the field source is used to scan the surface of printed circuit boards. This allows the resolution of magnetic weak points in the layout and assembly area. Critical conductor sections, components and component connections can be located.	
	**ES 05D-h** The E-field source has a narrow line-shaped field source head and is intended for weak-point detection in the conductor and component area of assemblies. It is suitable for E-field coupling on conductors, wires, component connections (pins) and components, especially on individual SMD components such as resistors and capaci-tors. For E-field coupling, the field source is placed with the head or the front tip on individual con-ductors, SMD or leaded components. Individual plug contacts or individual wires of flat ribbon cables can also be examined.	

9.7 Application

The field source is connected to the burst generator (**Figure 10**) by means of the connecting cable and guided over the printed circuit board (DUT). During this process the generator voltage is increased step by step.

Hints:

- Weak points are localized when known functional errors occur.
- Approaching or placing the probes increases the resolution and thus the selectivity with regard to sensitive components and conductor paths.
- The generator voltage makes it possible to classify the localized weak point.
- The effect of the E-field source is amplified if the generator ground is connected to GND of the DUT.

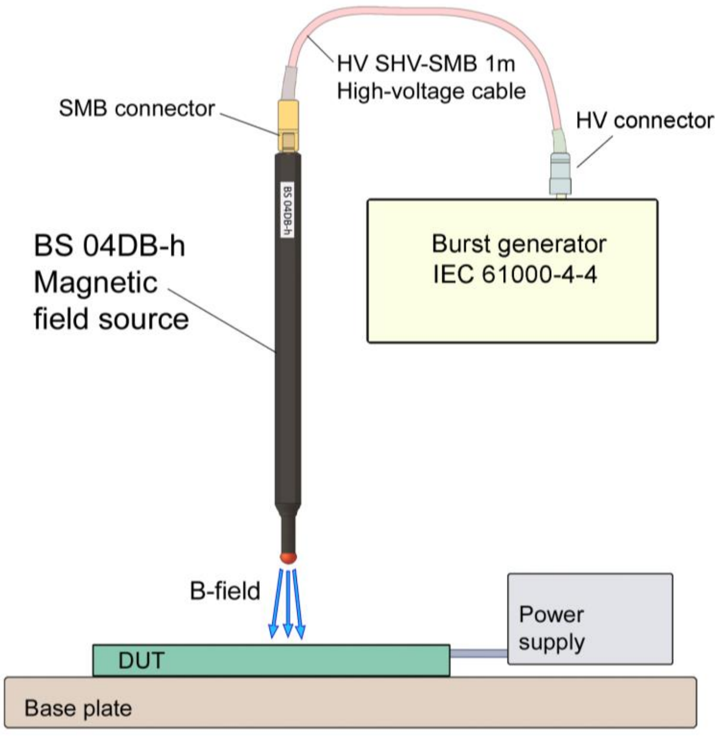


Figure 10: Schematic measurement set-up with field source and burst generator

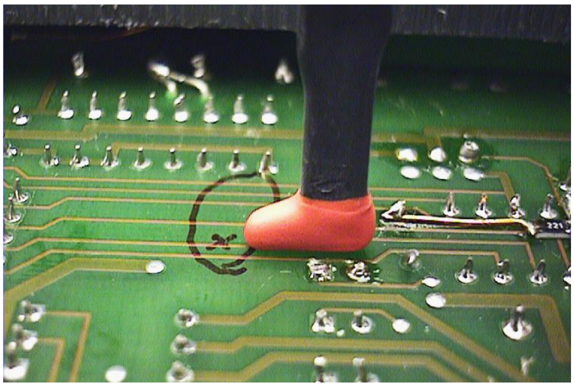


Figure 11 Application with E-field source

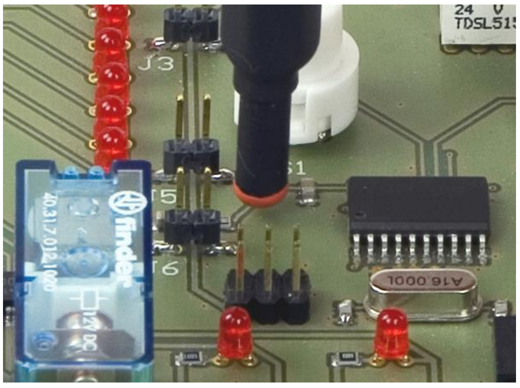


Figure 12: Application with magnetic field source

10 Warranty

Langer EMV-Technik GmbH will remedy any fault due to defective material or defective manufacture during the statutory warranty period.

Warranty is only granted on condition that:
- the operating instructions are observed,
- only original spare parts are used.
- external components such as power supply units, etc. have separate warranty terms and conditions which are applicable for the respective manufacturer.

The warranty will be forfeited if:
- unauthorized repairs have been made to the Langer EMV-Technik GmbH product,
- the product from Langer EMV-Technik GmbH has been modified,
- the product from Langer EMV-Technik GmbH has not been used correctly.

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