



User Manual

P1402/P1503 set RF field coupling up to 3 GHz



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- Translation of the original user manual -

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1 Declaration of Conformity

Manufacturer:

Langer EMV-Technik GmbH

Nöthnitzer Hang 31
01728 Bannewitz
Germany



Langer EMV-Technik GmbH herewith declares that the

P1402 / P1503 set, RF field coupling up to 3 GHz

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

Katja Langer

Bannewitz, 2025-09-08

Signature:

A handwritten signature in black ink, appearing to be 'K. Langer', written over a horizontal line.

K. Langer, Managing Director

2 Safety instructions

Read and follow the operating instructions carefully and keep them in a safe place for later consultation. The devices may only be used by personnel who are qualified in the field of electromagnetic compatibility (EMC) and who are eligible to carry out this work.

When using a product from Langer EMV Technik GmbH, please observe the following safety instructions to protect yourself from electric shocks or the risk of injuries and to protect the devices used and the test IC from destruction.

- Use a power amplifier that is stable under open-circuit conditions and short-circuit proof.
- Use the probe lock to lock the probes during the test, because of high RF field strength



- Observe the operating and safety instructions for all devices used in the set-up.
- Never use any damaged or defective devices.
- Carry out a visual check before using a measurement set-up with a Langer EMV-Technik GmbH product. Replace any damaged connecting cables before starting the product.
- Never leave a product from Langer EMV-Technik GmbH unattended whilst this is in operation.
- The Langer EMV-Technik GmbH product may only be used for its intended purpose. Any other use is forbidden.
- People with a pace-maker are not allowed to work with these devices.
- The test set-up should always be operated via a filtered power supply.

Attention! Functional interference emissions (near fields and far fields) may occur when the field sources from the P1402/P1503 set are operated. The user is responsible for taking appropriate measures to protect all electronic devices used in the course of the tests. In particular, the user is responsible for protecting the measuring devices used for the test set-up and all other electronic devices outside the test bench against interference emissions so that their intended function is not impaired. This can be achieved by:

- observing an appropriate safety distance
- use of shielded rooms or enclosures (e.g. shielded tents)

A disturbance field is generated in the field chamber of the field source when operating the test bench. Make sure that the field chamber is not opened under any circumstances during the test for safety reasons (hazard due to RF). The field source may only be operated with the field chamber closed and in accordance with the measurement set-up. The test bench has to be operated in a shielded room or enclosure.

We cannot assume any liability for damage due to improper use.

The disturbances that are injected into the modules can destroy the test IC (latch-up) if their intensity is too high. Protect the device under test by:

- connecting a protective resistor in the IC's incoming power supply
- increasing the disturbance gradually and stopping when a functional fault occurs
- interrupting the power supply to the test IC in the event of a latch-up.

Attention! Make sure that internal functional faults are visible from outside. The test IC may be destroyed due to an increase in the injection intensity if the faults are not visible from outside. Take the following precautions if necessary:

- monitoring representative signals in the test IC
- special test software
- visible reaction of the test IC to inputs (reaction test of the test IC)

We cannot assume any liability for the destruction of test ICs!

3 Description of the system

3.1 Use

The P1402/P1503 set can be used to measure the immunity of integrated circuits (ICs) to magnetic and electric fields in the frequency range of up to 3 GHz, respectively.

The P1402 field source is used to generate a magnetic test field and the P1503 field source to generate an electric test field. The respective field source is positioned above the test IC by using a spacer ring and its test field is then applied to the IC to measure its immunity to disturbances.

Figure 1 shows the basic set-up for immunity measurements with the P1503 field source as an example. The IC test system, the ICE1¹ IC test environment as well as different measuring and test devices¹ are required for the measurement set-up:

Note: The P1402 field source is operated under short-circuit conditions and the P1503 field source is operated under open-circuit conditions. Any power amplifier that is used to supply the field sources must be designed for this purpose, i.e. it must be stable under open-circuit conditions and short-circuit proof.

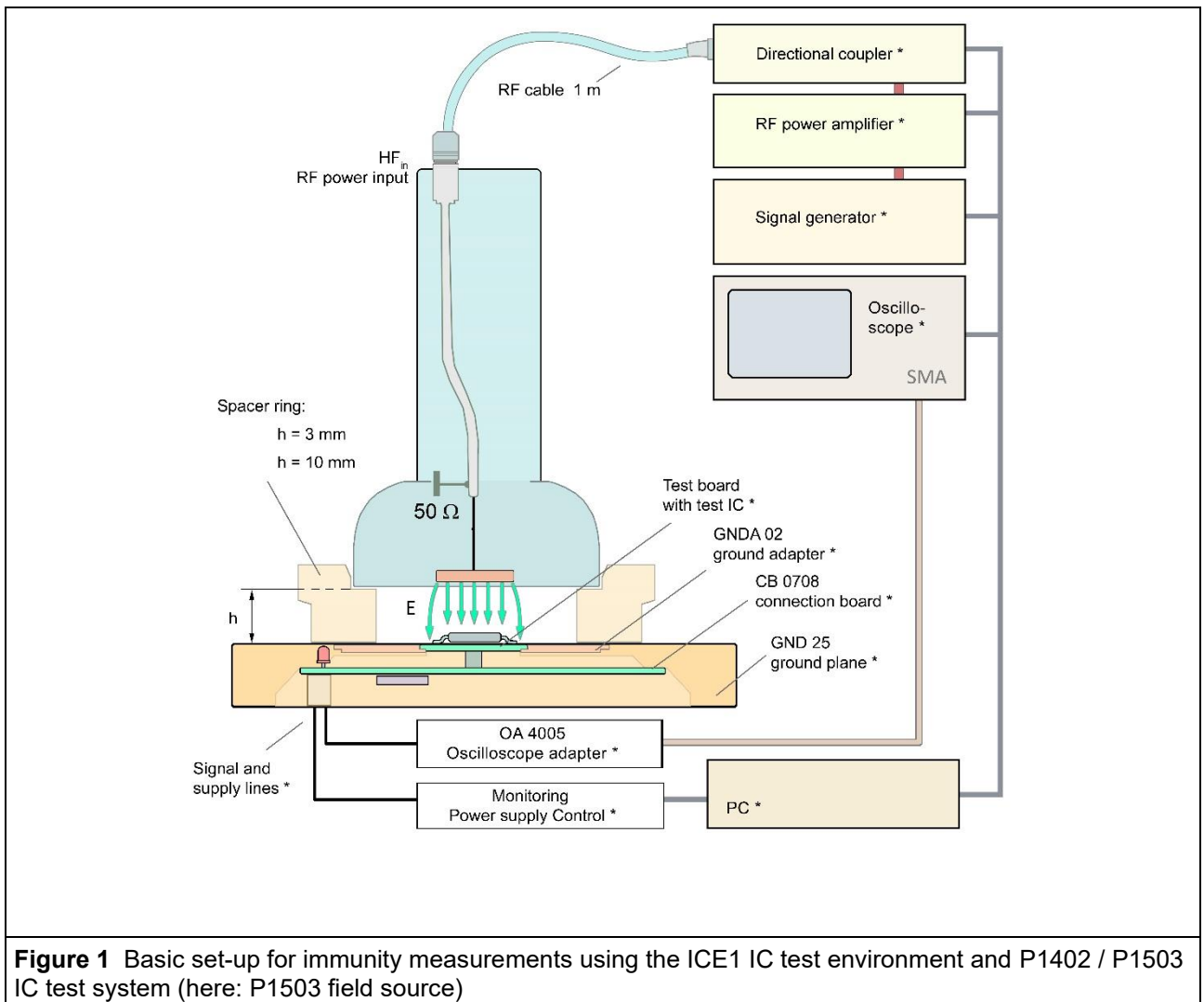


Figure 1 Basic set-up for immunity measurements using the ICE1 IC test environment and P1402 / P1503 IC test system (here: P1503 field source)

¹ not included in the scope of delivery

No.	Name	Description
1	P1402 (P1402/P1503 set)	RF field source to generate a magnetic test field
2	P1503 (P1402/P1503 set)	RF field source to generate an electric test field
3	FKE 30	Field chamber insert (only for P1402 with D70 h10)
4	D70 h03	Spacer ring, 3 mm
5	D70 h10	Spacer ring, 10 mm
6	SMA-SMB 1 m	Measuring cable

Table 1 Brief description of the P1402/P1503 set

The following components, not included in the scope of delivery, are also needed:

ICE1 set, IC Test Environment (Langer EMV-Technik GmbH)	<ul style="list-style-type: none"> - GND 25 ground plane - GND A 02 ground adapter - CB 0708 connection board - OA 4005 oscilloscope adapter
Measuring and test devices	<ul style="list-style-type: none"> - Directional coupler - RF power amplifier - Signal generator - PC - Oscilloscope - Test IC monitoring equipment
Other	<ul style="list-style-type: none"> - Test board for test IC

The test board together with the test IC is inserted into the ground plane of the measurement set-up. The field source (here P1503) is located above the test IC by using a spacer ring. A signal generator and an RF power amplifier are used to supply the field source. A directional coupler can be used to monitor the forward power.

An oscilloscope and PC are needed to monitor the equipment under test and/or control the measurement set-up. The current flowing through the electric conductor (P1402) can be monitored via the field sources' measurement output.

The principal measurement process corresponds to IEC 62132-2:2010.

3.2 P1402 field sources

Figure 2 show the P1402 field source which generates a magnetic test field. The field source has two plug connectors, an RF power input (N type) to power the field source and a measurement output (SMB type) at the top. The power input is marked RF_{in} and the measurement output is marked i_{out} .



On the inside of the field source, the RF power input is connected to the end of the electric conductor located at the bottom of the field source. The other end of the electric conductor is connected to ground of the field source and thus causes a short circuit in the RF current path. The resulting RF current i_p generates a magnetic field that develops around the electric conductor.

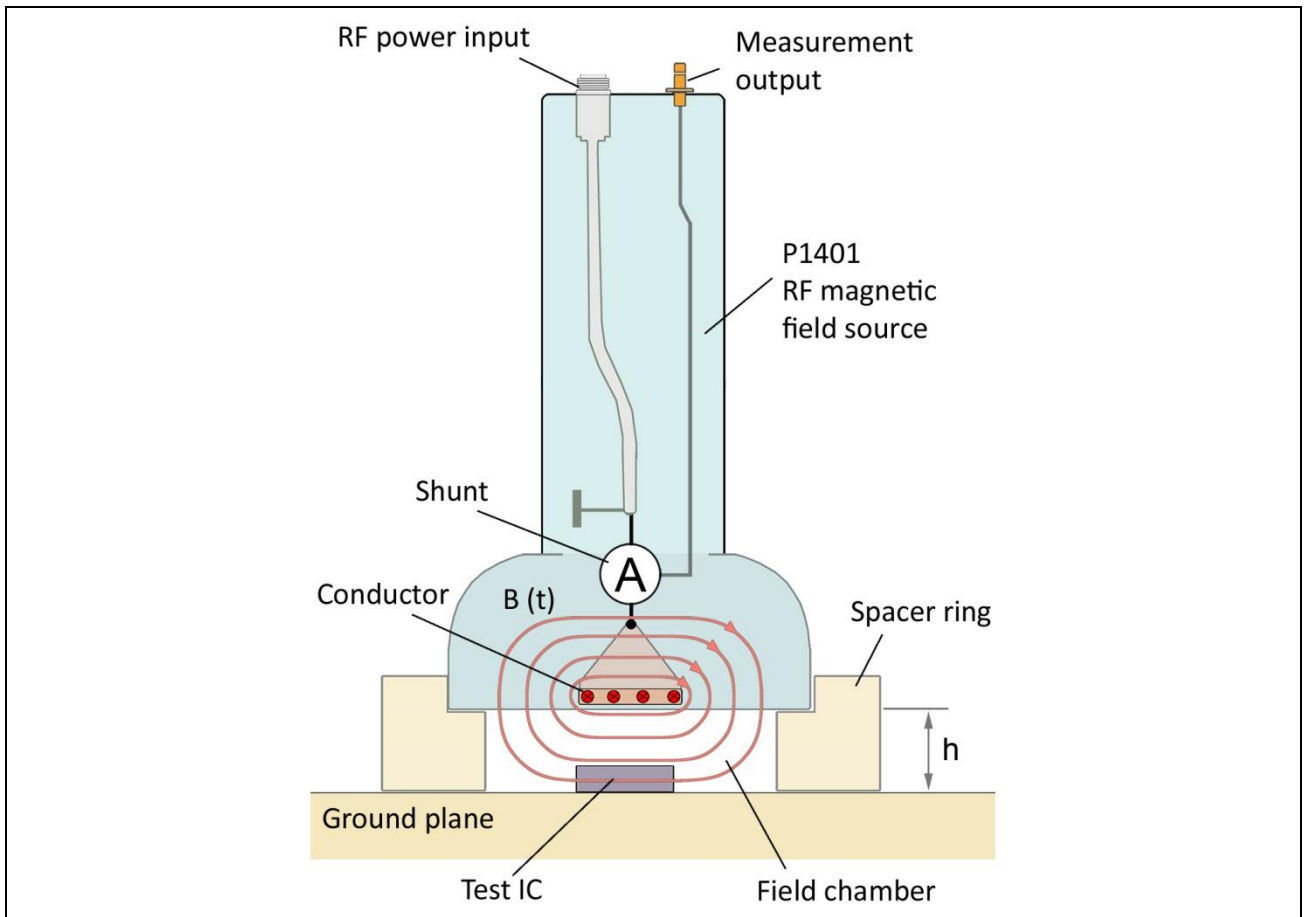


Figure 3 Principle of the immunity measurement using the P1402 field source (magnetic field)

Figure 3 shows the basic measurement principle. The field source, the spacer ring and the ground surface with the test board form a field chamber. This field chamber limits and shields the generated magnetic field. The FKE 30 field chamber insert has to be used in connection with the P1402 field source.



Figure 4 FKE 30 field chamber insert for P1402 field source

A current divider (shunt) is located in the current path of the field source to measure the field-generating current i_p . This current can be calculated from the voltage at the field source's measurement output (refer to section 0). The measurement output is terminated with 50Ω inside the field source.

3.3 P1503 field sources

Figure 5 show the P1503 field source which generates an electric test field. The electric field source has one plug connector, an RF power input (N type). The power input is marked RF_{in} .



Figure 5 P1503 field source

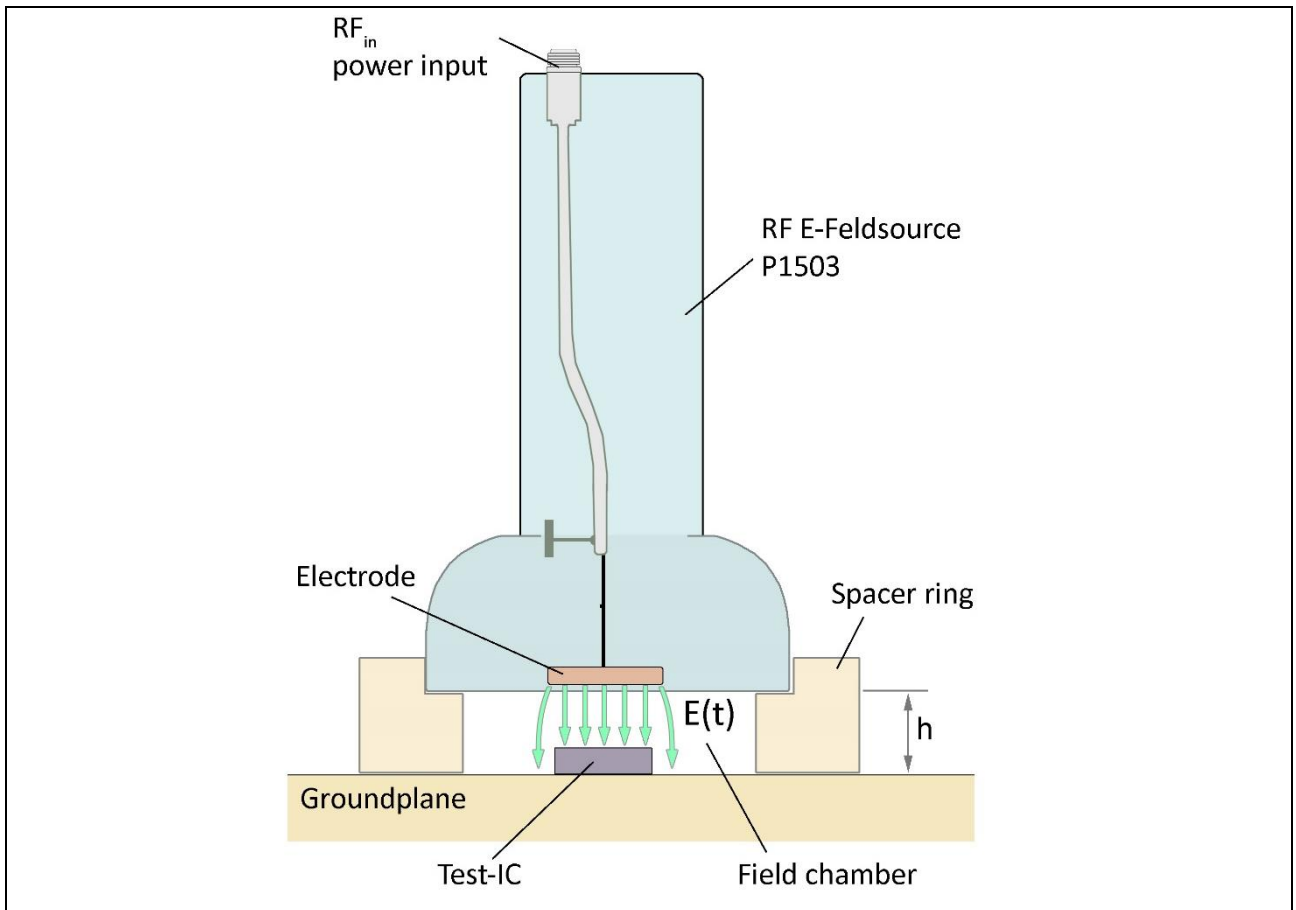


Figure 6 Principle of the immunity measurement using the P1503 field source (electric field)

On the inside of the field source, the RF power input is connected to the electrode located at the bottom of the field source. Due to the potential difference between the electrode and the ground surface, an electric field is generated which exits the electrode in the orthogonal direction. **Figure 6** shows the basic measurement principle. The field source, the spacer ring and the ground surface with the test board form a field chamber. This field chamber limits and shields the generated electric field.

3.4 Measurement outputs of the field source

The magnetic field source measurement output can be used to calculate the magnetic flux density B generated by the field source at the position of the test IC. The voltage u_{out} has to be measured at the field sources' outputs for this purpose. The respective field quantities can then be calculated using the conversion factors defined in **Table 2**.

P1402
$B = K1 \cdot i_p$ $i_p = K4 \cdot u_{out}$
Table 2 Conversion factors of the field sources to calculate the field quantities

Based on the transfer function of the P1503, it is possible to determine the test field strength using the forward power (see **Figure 18**).

3.5 D70 h10 and D70 h03 spacer rings

The D70 h10 and D70 h03 spacer rings are part of the P1402/P1503 IC test systems. The spacer rings have an inner diameter $d = 70$ mm and a height $h = 10$ mm or $h = 3$ mm. The spacer rings are used to position the field sources on the ground surface above the test IC. The height of the spacer ring determines the distance between the field source and the IC. The ground surface, the field source and the spacer ring form a field chamber in which the test field develops.

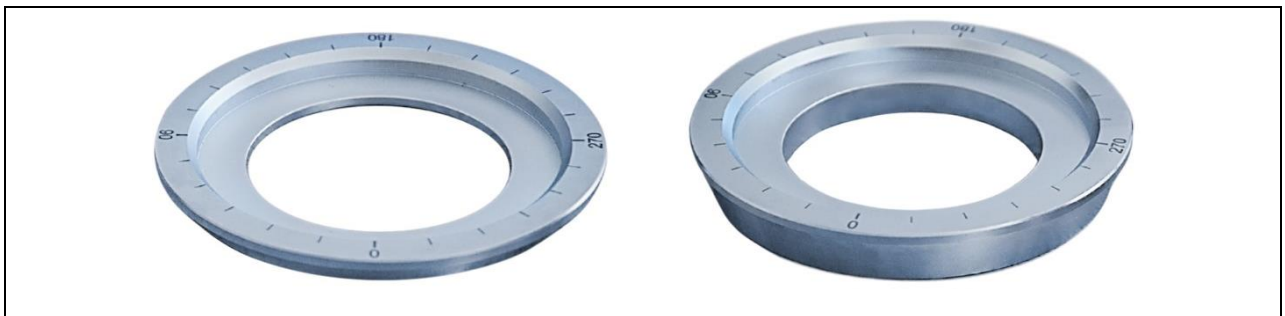


Figure 7 D70 h03 and D70 h10 spacer rings

3.6 FKE 30 field chamber insert

The FKE 30 field chamber insert is only used together with the P1402 field source and the D70 h10 spacer ring. When using the P1402 field source, the FKE 30 field chamber insert has to be installed at the bottom of the field source as shown in **Figure 8**. The field source can then be positioned on the spacer ring. The field chamber insert is now inside the spacer ring. The field chamber insert ensures a higher suppression of the field's electric component.

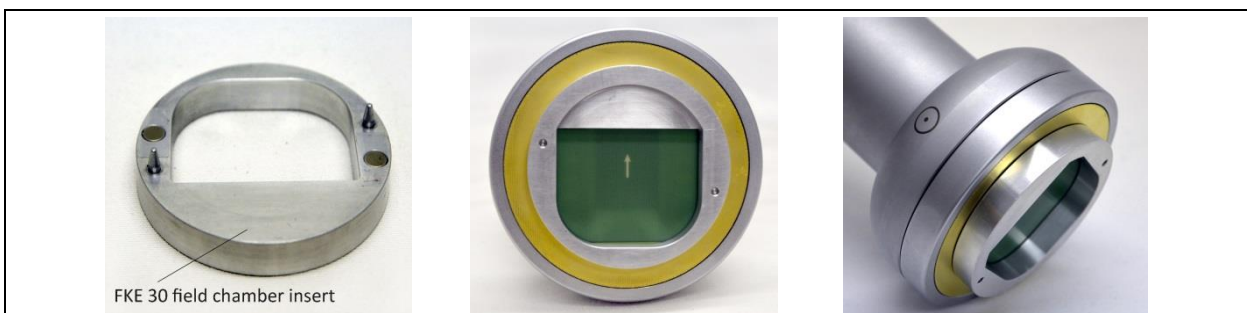


Figure 8 FKE 30 field chamber insert for use with P1402 field source

3.7 EPM 02 and BPM 02 field meters

The magnetic or electric field strength generated by the field sources at the position of the test IC can be measured with the BPM 02 and EPM 02 field meters. To do so, a field meter has to be inserted in the GND 25 ground plane using the GNDA 02 ground adapter. To calculate the magnetic flux density and the electric field strength based on the voltage u_{out} measured at the output of the respective field meter, the conversion factors defined in **Table 3** are used.



Figure 9 BPM 02 dE/dt field meter

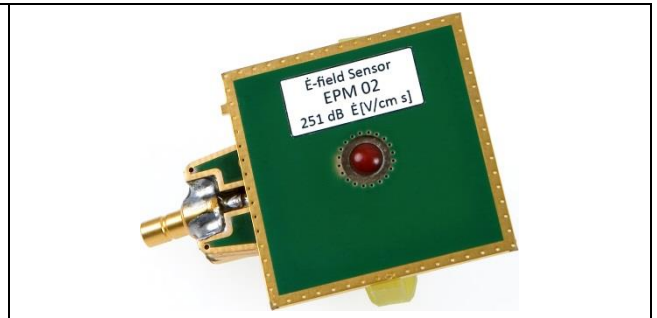


Figure 10 EPM 02 dB/dt field meter

BPM 02	EPM 02
$\dot{B} = K \cdot u_{out}$	$\dot{E} = K \cdot u_{out}$
$K = 122 \text{ dB} \left(\frac{\text{T}}{\text{V} \cdot \text{s}} \right)$	$K = 251 \text{ dB} \left(\frac{1}{\text{cm} \cdot \text{s}} \right)$
$B = (1/\omega) \dot{B}$	$E = (1/\omega) \dot{E}$
$B = \dot{B} - 20 \log_{10}(\omega)$	$E = \dot{E} - 20 \log_{10}(\omega)$
Table 3 Conversion factors of the BPM 02 und EPM 02 field meters	

EPM 02 and BPM 02 are not in the scope of delivery

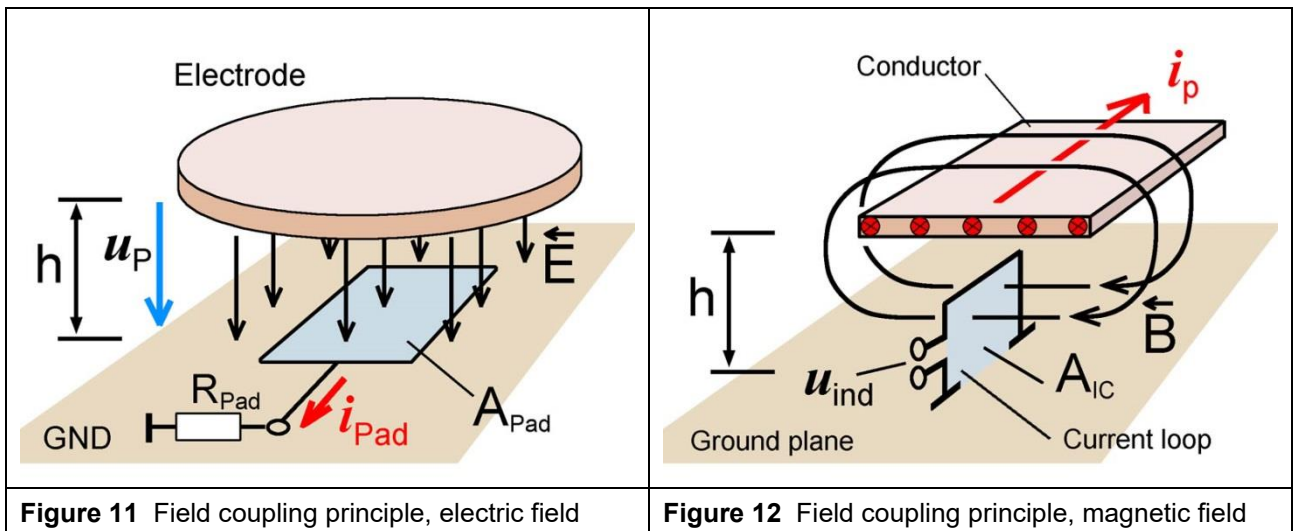
3.8 Orientation of the field sources

Electric field:

The electric field is orthogonal to the ground surface (surface of the test IC) in the area of the test IC (cf. **Figure 11**). Turning the field source on the spacer ring has no significant impact on the direction and the intensity of the electric field. However, we recommend that the orientation is selected for the measurement that was also used to calibrate the measurement set-up. Please refer to section 4.2 for further information on the calibration of the measurement set-up.

Magnetic field:

The magnetic field is oriented in a plane parallel to the ground surface in the area of the test IC (cf. **Figure 12**). Turning the field source on the spacer ring allows the user to vary the magnetic field's direction in this plane. The orientation of the electric conductor is marked at the bottom of the field source as an aid. In addition, there are two marks on the outer margin of the field source that show the orientation of the electric conductor. These is visible in **Figure 2** and can be used to adjust the orientation of the field source on the spacer ring. The electric conductor and the magnetic field are perpendicular to each other in the area of the test IC.



4 Start-up and measurement

The P1402/P1503 IC test system can be used to measure the immunity of integrated circuits (ICs) to magnetic and electric fields in the frequency range of up to 3 GHz, respectively. The immunity to electric fields and magnetic fields is measured separately. The basic measurement set-up, the measurement principle and a description of the individual components of the test systems can be found in section 3.

4.1 Measuring devices

The ICE1 test environment and P1402/P1503 IC test system from Langer EMV-Technik GmbH are used to carry out immunity measurements. In addition, the following devices are needed for the measurement set-up:

- **Signal generator** to generate a test signal
- **RF power amplifier** to generate the required power
- Directional coupler (optional) to measure the forward and reverse power
- Spectrum analyzer (optional) to monitor the signal at the measurement output of the field source
- **Oscilloscope** to monitor the functions and/or signals of the IC
- **PC** to automate the measurement

Note: Since the field sources are operated under short-circuit conditions or under open-circuit conditions, as described in section 2, the power amplifier is terminated and operated with the respective mismatch. The power amplifier used in this set-up must be designed for this purpose, i.e. it must be stable under open-circuit conditions and short-circuit proof.

4.2 Test board

The test IC must be put into operation for the measurement. A test board for the specific IC thus has to be manufactured for the following tasks:

- Provision of the signals and supply voltages required for test IC operation
- Provision of connections for devices such as an oscilloscope to monitor the operation condition and/or detect faults

For further information on manufacturing the test board, please refer to IEC 62132-1 and the "IC test instructions"².

² available on request (sales@langer-emv.de)

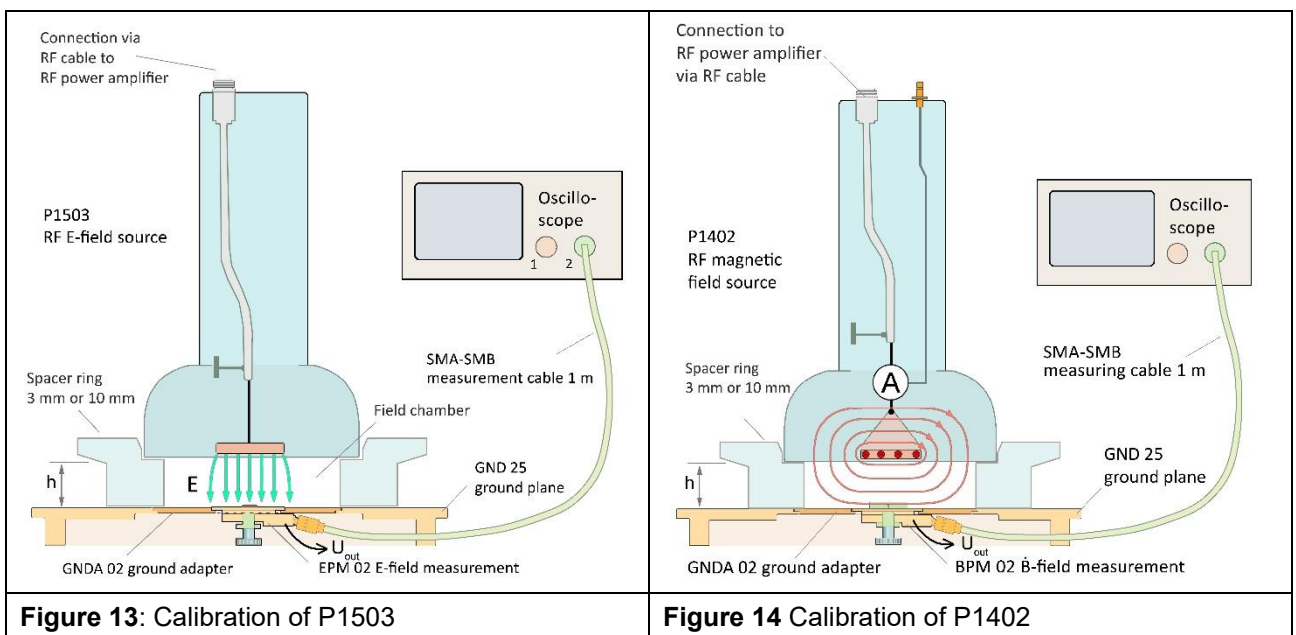
4.3 Calibration of the measurement set-up

The EPM 02 and/or BPM 02 are used to calibrate the measurement set-up. During calibration, the generated field strength is measured and adjusted via the power level of the signal generator to achieve the desired test field. The power level that is required depends on the frequency and has to be determined and stored for the respective frequency range during calibration. The stored values can then be used to measure the test IC's immunity. The field meters are removed and the test board with the IC is installed in the measurement set-up for this purpose.

As an alternative, the voltage can also be recorded at the measurement output of the field source during calibration. The recorded voltage values can then be compared with the values obtained from the ongoing immunity measurements. This comparison allows the user to check if the measurement set-up works correctly.

The EPM 02 is used to check the P1503 field source.

The BPM 02 is used to check the P1402 field source.



The basic measurement set-up corresponds to **Figure 1**. The respective field meter is inserted into the ground adapter instead of the test IC. The field strength that is generated by the field source can be determined on the basis of the relations described in section 0.

4.4 Measurement set-up

Note: The probes generate high electric and magnetic RF fields. It is therefore recommended that the probes are locked when the test is activated.
Please use our delivered probe locking device.

The probe lock consists of two parts:

PLO Probe-lock upper ring: for clamping the probe to the GND25

PLU Probe-lock lower ring: for centering the spacer rings over the middle of the GND25

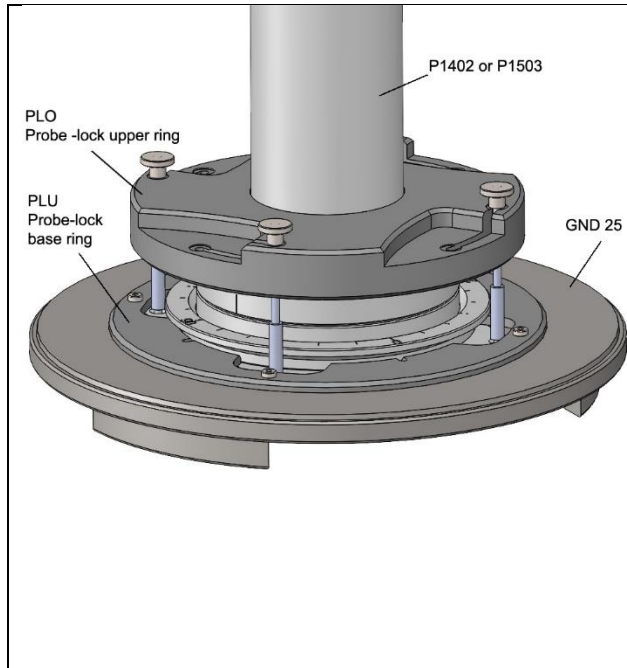


Figure 15 Setup of Probe lock mounted for the P1402 / P1503

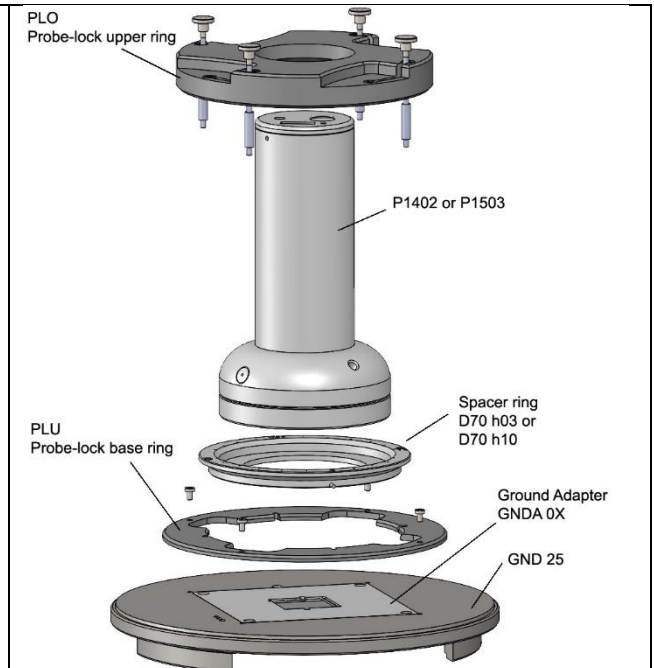


Figure 16 Setup of Probe lock stack up for the P1402 / P1503

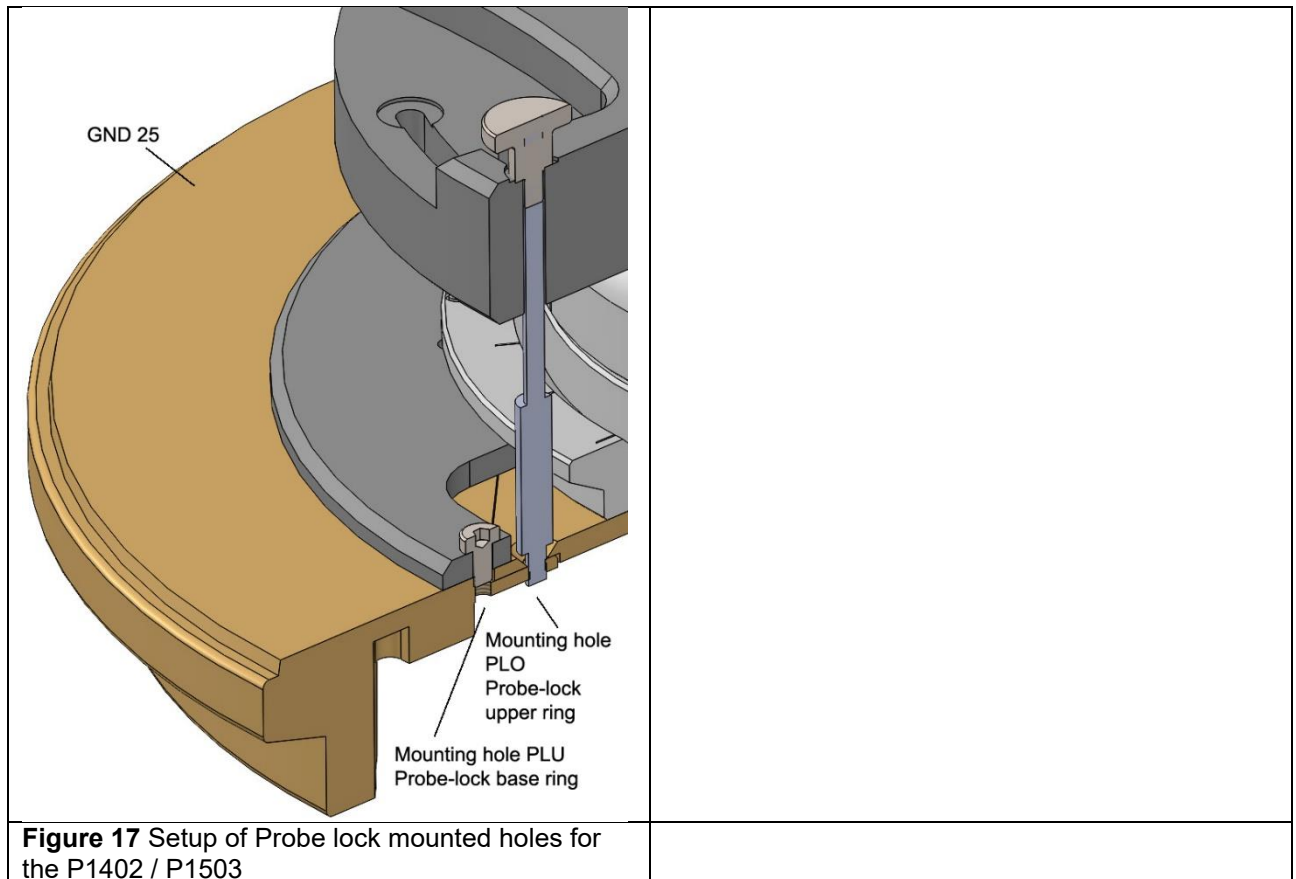


Figure 17 Setup of Probe lock mounted holes for the P1402 / P1503

1. Place the PLU Probe-lock lower ring on the ready to use GND 25 (with GNDA 0X) and mount it with the screws in the hole shown in **Figure 17**
2. Place the Space ring and the probe in the middle of the PLU Probe-lock lower ring - the GNDA 0X can be fixed with a pin in every 90° angle
3. Place the PLO Probe-lock upper ring on top and fix the 4 screws shown in **Figure 17**
4. For rotation of the probe, you have to open the screws a little

Figure 1 shows the basic set-up for immunity measurements with the IC test system and the ICE1 test environment.

The test board together with the test IC is initially inserted into the GND 25 ground plane and connected to the CB 0708 connection board. The IC is supplied with the required input signals via the connection board. At the same time, the test IC's output signals can be monitored during the measurement. Please refer to the user manual of the ICE1 test environment on how to use the connection board.

Use the spacer ring to position and align the respective field source above the test IC when measuring the IC's immunity to disturbances. The field source is then connected to the power amplifier and the signal generator. Additionally, a directional coupler and a power meter can be used to measure the forward and reverse power on the line between the power amplifier and the field source.

The signal generator generates the required test signal. This signal is amplified by the connected power amplifier and transmitted to the field source. The field source converts the input signal into the respective field quantity, in other words into an electric or magnetic field.

4.5 Measurement

The basic measurement can be carried out in accordance with IEC 62132-2:2010, for example:

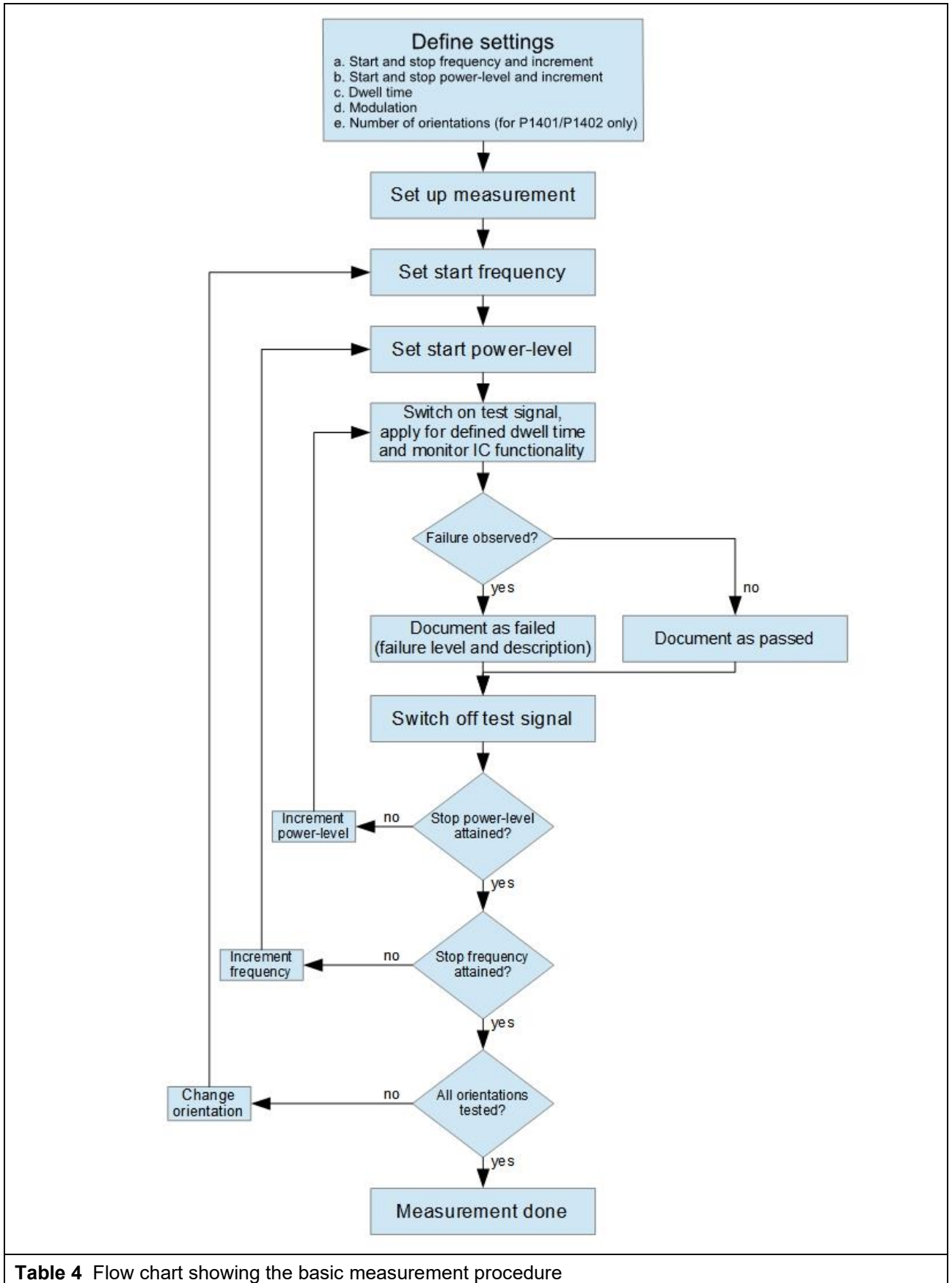


Table 4 Flow chart showing the basic measurement procedure

5 Warranty

Langer EMV-Technik GmbH will remedy any fault caused by defective materials or defective manufacture during the statutory warranty period, either by repair or replacement.

This warranty is only granted on condition that:

- the information and instructions in the user manual have been observed.

The warranty will be forfeited if:

- an unauthorized repair is performed on the product,
- the product is modified,
- the product is not used for its intended purpose,
- the product has been opened.

6 Technical Parameters

6.1 P1402/P1503

P1402 and P1503 field sources	
Dimensions (height/width/depth)	(180 x 95 x 95) mm
Weight of P1402/P1503	750 g / 700 g
Frequency range	(0 – 3) GHz
Maximum forward power P_{vor} (P1402)	100 W
Maximum forward power P_{vor} (P1503)	200 W (see Table 9)
Maximum probe current i_p (P1402)	2.8 A
Maximum probe voltage u_p (P1503)	200 V
Internal resistance, P1402 / P1503 power input	Operation under short-circuit / open-circuit conditions
Internal resistance, P1402 measurement output	50 Ω
Table 5 P1402 and P1503 field sources – General parameters	

P1402 field source – Magnetic flux density B								
P_{vor} in W	0.1	0.5	1	5	10	20	50	100
i_p in A	0.06	0.14	0.20	0.45	0.63	0.89	1.41	2.0
D70 h03 spacer, height h = 3 mm								
B in μT	1.5	3.5	4.9	10.9	15.4	21.8	34.5	48.8
D70 h10 spacer, height h = 10 mm								
B in μT	0.8	1.8	2.5	5.5	7.8	11.1	17.5	24.8
Table 6 P1401 field source – Magnetic flux density generated depending on the forward power P_{vor} and probe current i_p^3								

Bandwidth	3 GHz
Measurement error	approx. 10 %
Attenuator settings	x 20 A / V \rightarrow 26 dB
Deskew B to v_{out} at measurement output	1 ns
Table 7 Shunt 0.1 Ohm P1402	

³ The values for i_p have to be determined for each measurement set-up (see section 0).

P1503 field source – Electric field strength								
P_{vor} in W	0.1	0.5	1	5	10	20	50	100
u_p in V	3.2	7.1	10	22.3	31,6	44,7	70,7	100
D70 h03 spacer, height $h = 3$ mm								
E in V /cm	10.5	23.6	33.3	74.5	105	149	236	333
D70 h10 spacer, height $h = 10$ mm								
E in V /cm	3.2	7.1	10	22.3	31,6	44,7	70,7	100

Table 8 P1503 field source – Electric field strength generated depending on the forward power P_{vor} and probe voltage u_p ⁴

P1503 field source – Maximum input Power		
Frequency in GHz	Up to 1	For 1 – 3
P_{forward} in W	200	100

Table 9 P1503 field source – Classification of the maximum max forward power P_{forward} ⁵ depending on the frequency

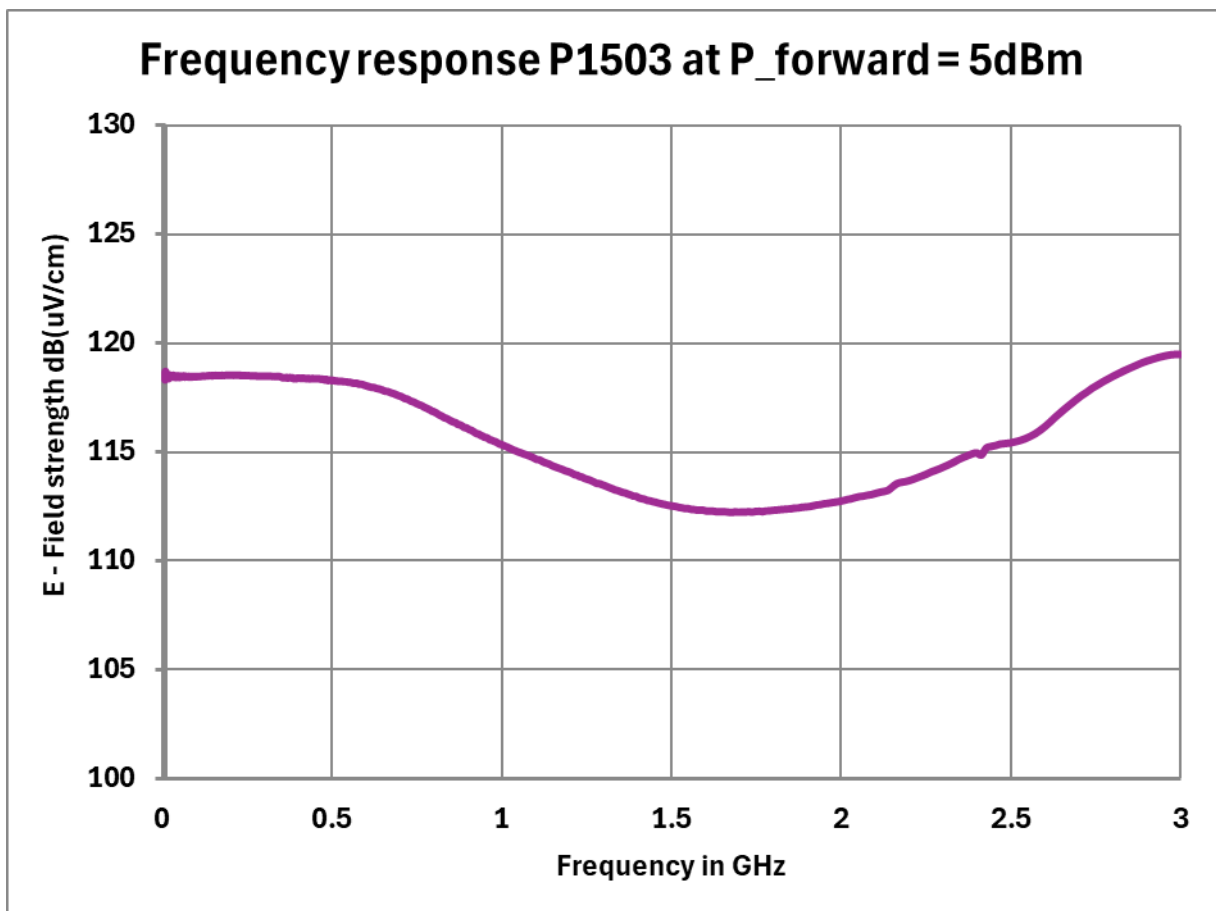


Figure 18: Frequency response P1503

⁴ The values for u_p have to be determined for each measurement set-up (see Section 0).

⁵ The values for u_p have to be determined for each measurement set-up (see Section 0).

6.2 EPM 02 / BPM 02 field meters

BPM 02 dB/dt field meter	
Frequency range	500 kHz - 3 GHz
Magnetic flux density B calculated based on the voltage u_{out} at the measurement output	$\dot{B} = K \cdot u_{out}$ $K = 122 \text{ dB} \left(\frac{\text{T}}{\text{V} \cdot \text{s}} \right)$ $B = (1/\omega) \dot{B}$ $B = \dot{B} - 20 \log_{10}(\omega)$
EPM 02 dE/dt field meter	
Frequency range	500 kHz - 3 GHz
Electric field strength E calculated based on the voltage u_{out} at the measurement output	$\dot{E} = K \cdot u_{out}$ $K = 251 \text{ dB} \left(\frac{1}{\text{cm} \cdot \text{s}} \right)$ $E = (1/\omega) \dot{E}$ $E = \dot{E} - 20 \log_{10}(\omega)$
Table 10 Conversion factors of BPM 02 and EPM 02	

Not in scope of delivery

7 Scope of delivery of the P1402/P1503 set⁶

Item	Designation	Type	Qty.
1	RF Magnetic Field Source	P1402	1
2	RF E-Field Source	P1503	1
3	Spacer Ring, 3 mm	D70 h03	1
4	Spacer Ring, 10 mm	D70 h10	1
5	Measuring Cable	SMA-SMB 1 m	1
6	Field Chamber Insert	FKE 30	1
7	System Case		1
8	Quick Guide		1
9	User Manual		1
10	CD with conversion factors		1
11	Probe-lock upper ring	PLO	1
12	Probe-lock base ring	PLU	1



Figure 19 Case of P1402/P1503 set

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⁶ The scope of delivery may differ depending on the respective order.

8 Information on Recycling and Disposal



DE 80567526

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.

9 Customer service

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

You can contact us:

Monday – Friday

8:00 Uhr bis 15 Uhr (CET)

Contact us at:

Address:Langer EMV-Technik GmbH

Nöthnitzer Hang 31

01728 Bannewitz

Germany

Internet: <https://www.langer-emv.com/>

E-mail: mail@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 distributor.

10 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

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