

EMC Near-field Probes + Wideband Amplifier

1 Introduction

The H20, H10, H5 and E5 are magnetic field (H) and electric field (E) probes for radiated emissions EMC pre-compliance measurements. The probes are used in the near field of sources of electromagnetic radiation. They serve to locate and identify potential sources of interference within the building blocks of electronic assemblies.

The probes act similar as wide bandwidth antennas, picking up radiated emissions from components, PCB traces, housing openings or gaps and from any other parts that could be emitting RF. The probes are usually connected to a spectrum analyser. Scanning the probe over the surface of a PCB assembly or housing quickly identifies locations which emit electromagnetic radiation. By changing to a probe with smaller size, the origination of the emissions can be further narrowed down.

Additional applications are RF immunity tests by feeding a RF signal into the probe and radiating it into potentially susceptible circuit sections: Furthermore the probes can be used in the field of repair or debugging to track down issues in RF signal chains by contactless measurement of RF signal levels. One more application is non-invasive measurement of RF building blocks such as modulators or oscillators. Frequency, phase noise and spectral components can be measured in conjunction with a low noise preamplifier.

The TBWA2/20dB and TBWA2/40db wideband amplifiers are connected between EMC probe and Spectrum Analyzer to increase the dynamic range of the measurements.



Picture 1 – from top, H20, H10, H5, E5; wideband amplifier

2 Features

Slim design for good access in between tightly spaced components

Shielded loops to avoid picking up common mode noise; insensitive to the human hand

Frequency range: up to 6GHz, see coupling plots of the respective probes

SMB connectors to avoid twisting the RF cable when scanning DUTs

EMC Near-field Probes + Wideband Amplifier

Insulated with rubber coating

Wideband amplifiers with 20dB and 40dB gain

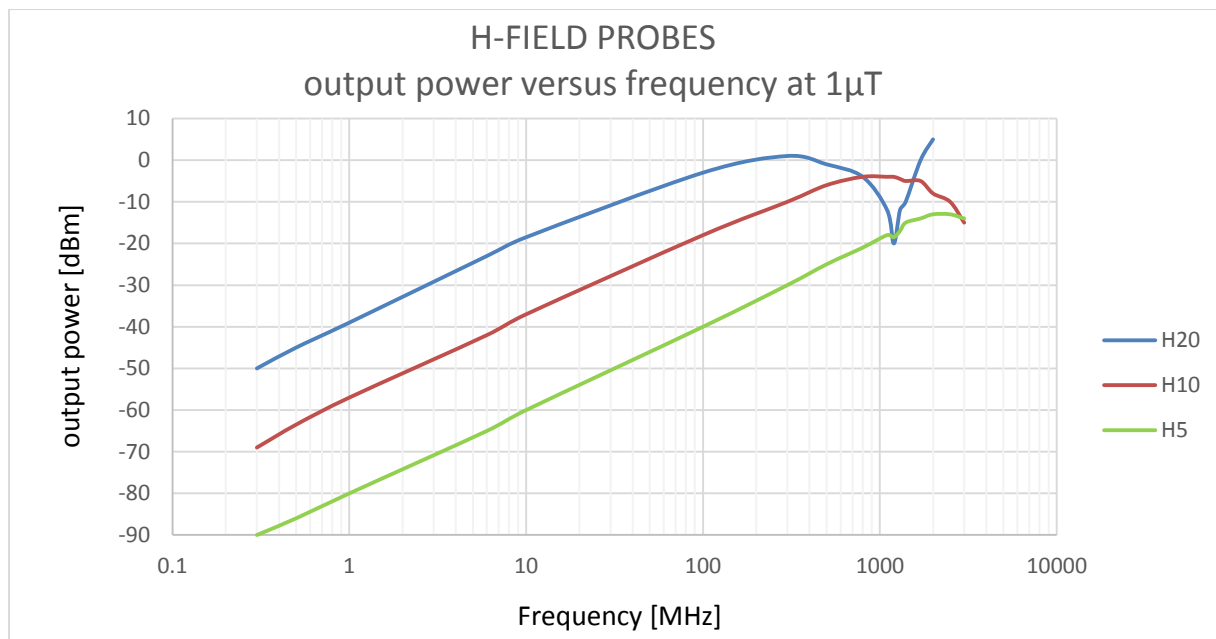
3 Dimensions

Probe		length	loop	tip
H20	H-Field	170 mm	20 mm	n.a.
H10	H-Field	170 mm	10 mm	n.a.
H5	H-Field	170 mm	5 mm	n.a.
E5	E-Field	170 mm	n.a.	5 mm

Wideband amplifiers:

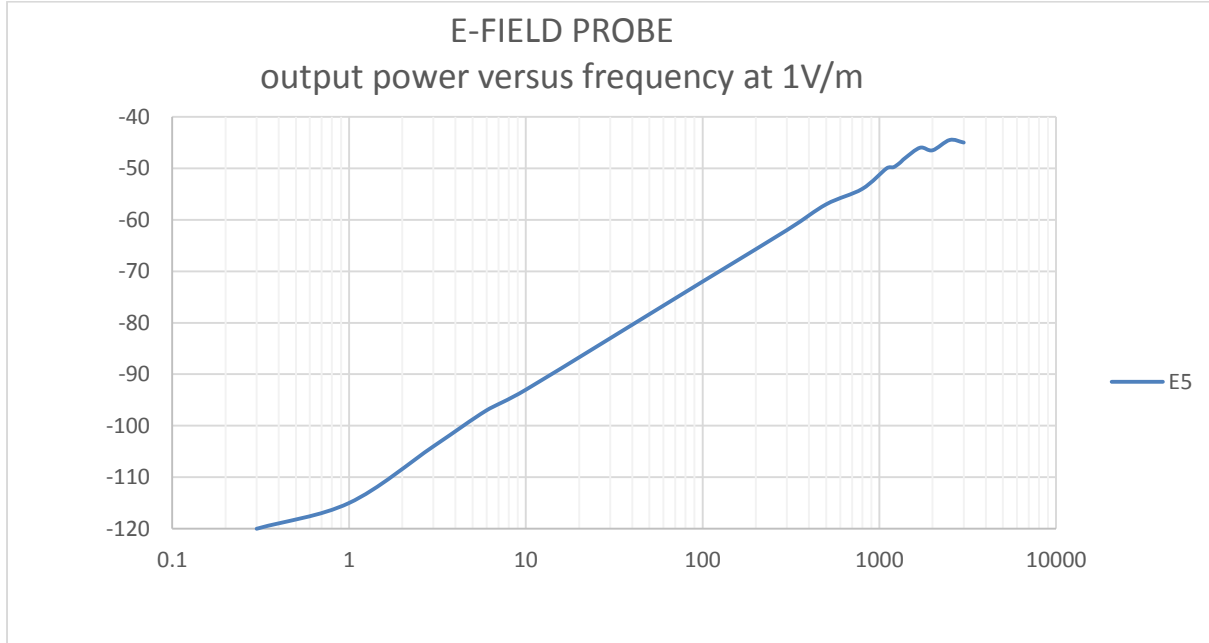
TBWA2/20dB: 48 mm x 63mm x 20mm TBWA2/40dB: 48 mm x 63mm x 20mm

4 Frequency Response



Picture 2 – frequency response, H-field probes

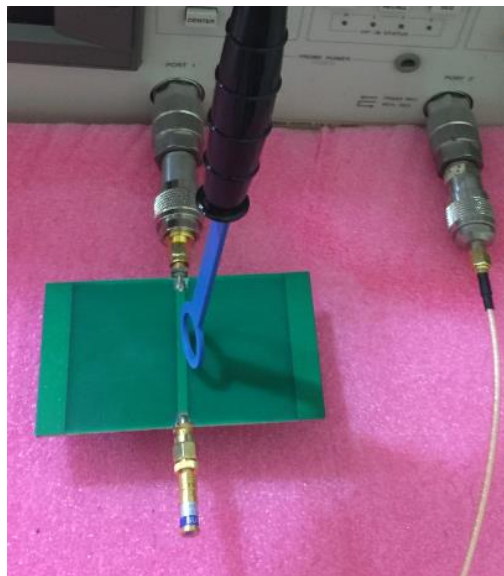
EMC Near-field Probes + Wideband Amplifier



Picture 3 – frequency response, E-field probe

5 Coupling loss

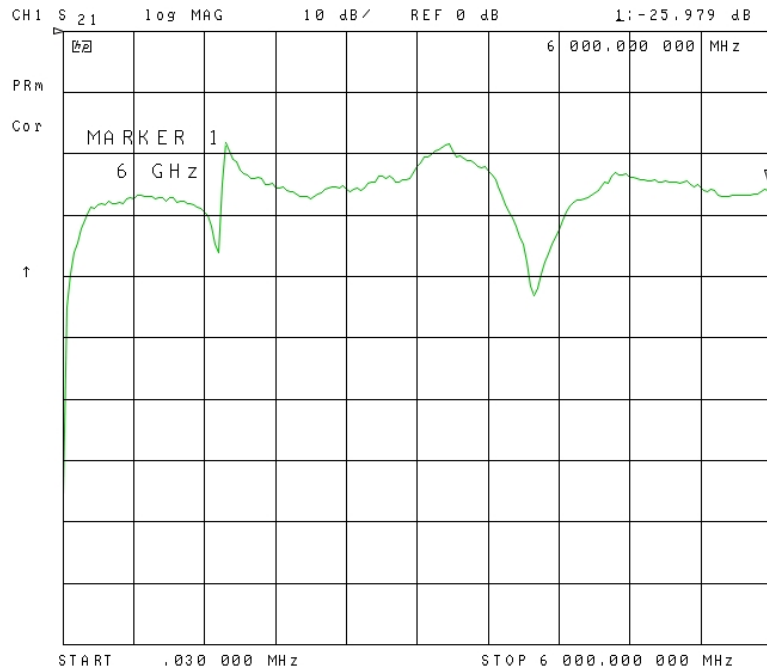
Coupling loss was measured on a terminated 50 Ohm stripline on a 1.6mm thickness FR4 board using a vector network analyzer.



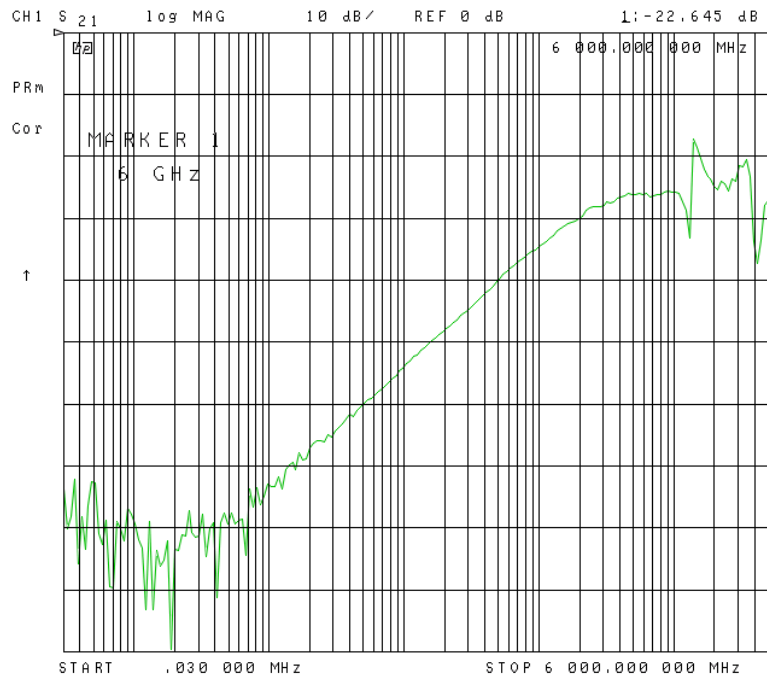
Picture 4 – measurement setup for coupling loss, 30kHz – 6GHz

EMC Near-field Probes + Wideband Amplifier

H20



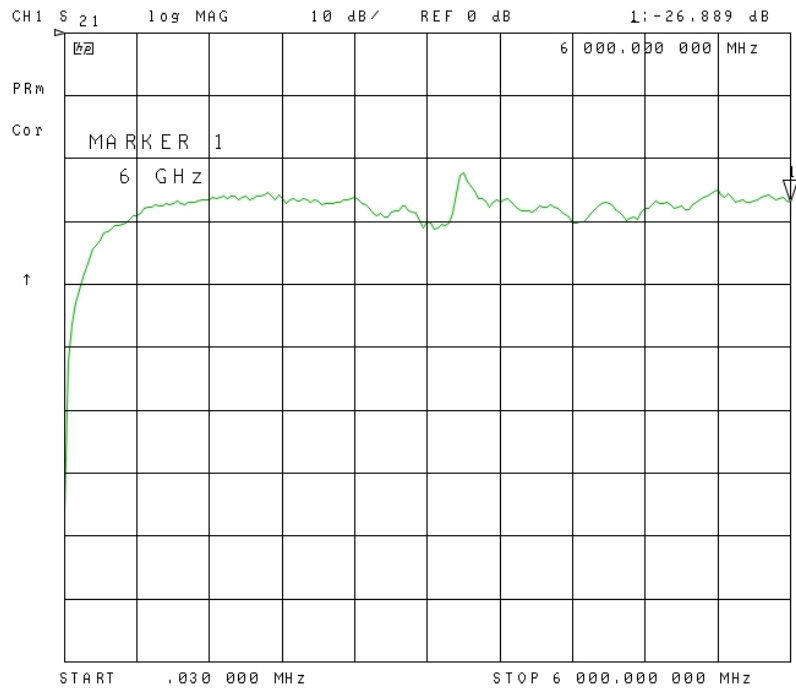
Picture 5 – H20, coupling loss, 30 kHz – 6 GHz, lin.



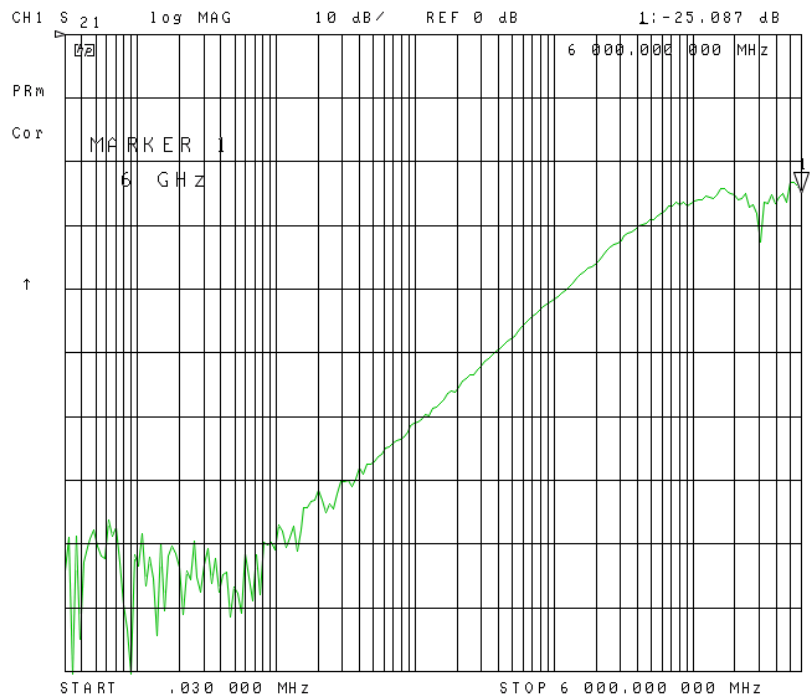
Picture 6 – H20, coupling loss, 30 kHz – 6 GHz, log.

EMC Near-field Probes + Wideband Amplifier

H10



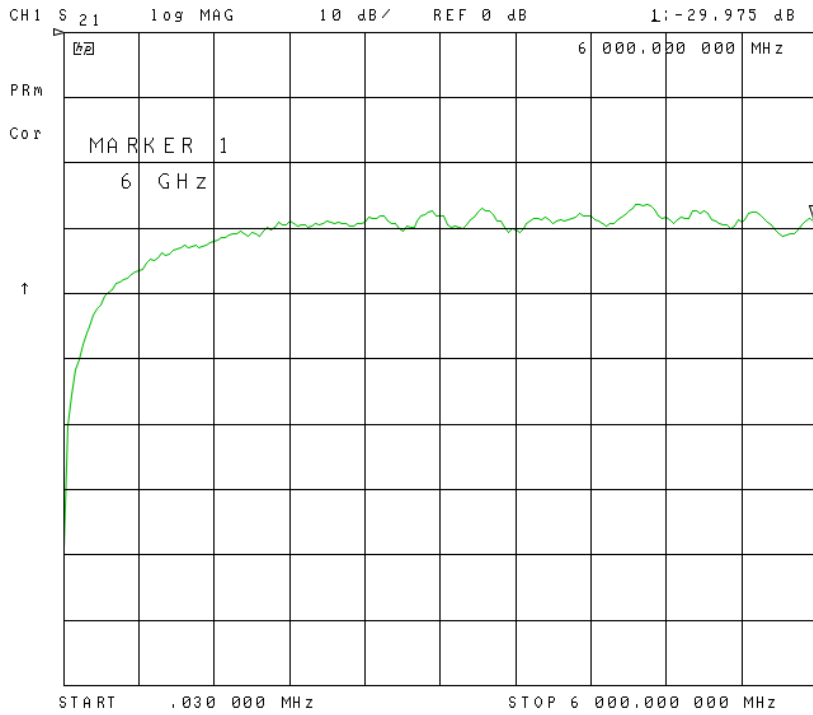
Picture 7 – H10, coupling loss, 30 kHz – 6 GHz, lin.



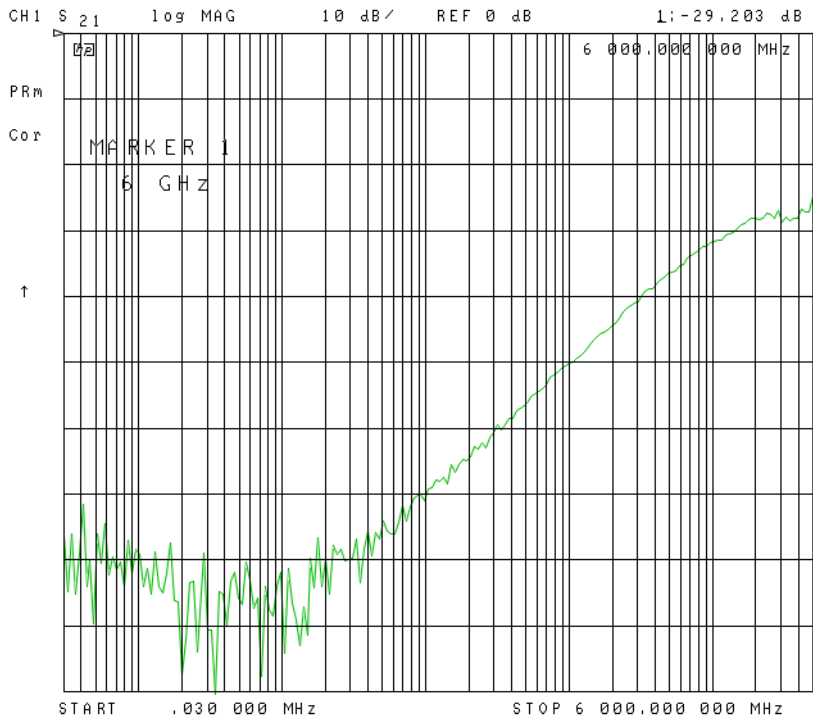
Picture 8 – H10, coupling loss, 30 kHz – 6 GHz, log.

H5

EMC Near-field Probes + Wideband Amplifier



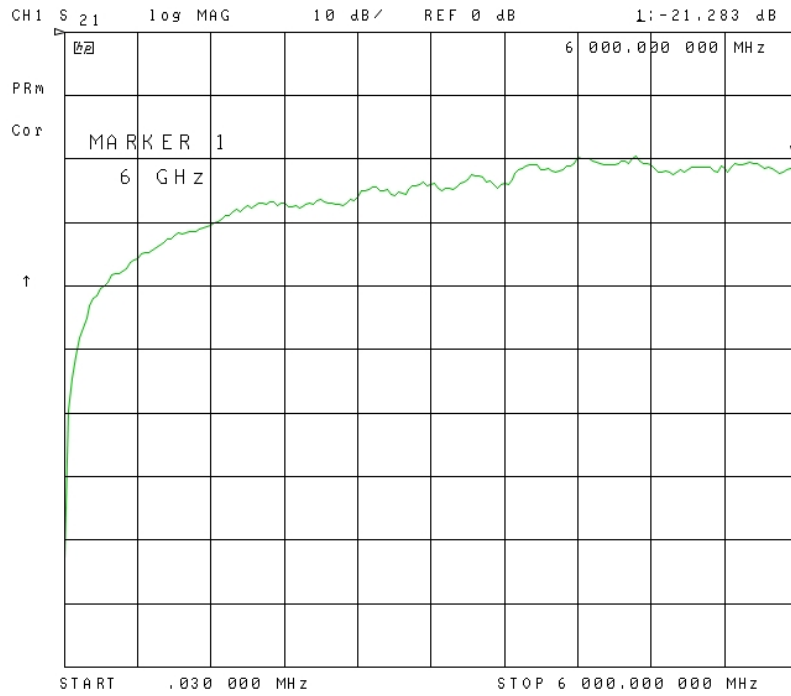
Picture 9 – H5, coupling loss, 30 kHz – 6 GHz



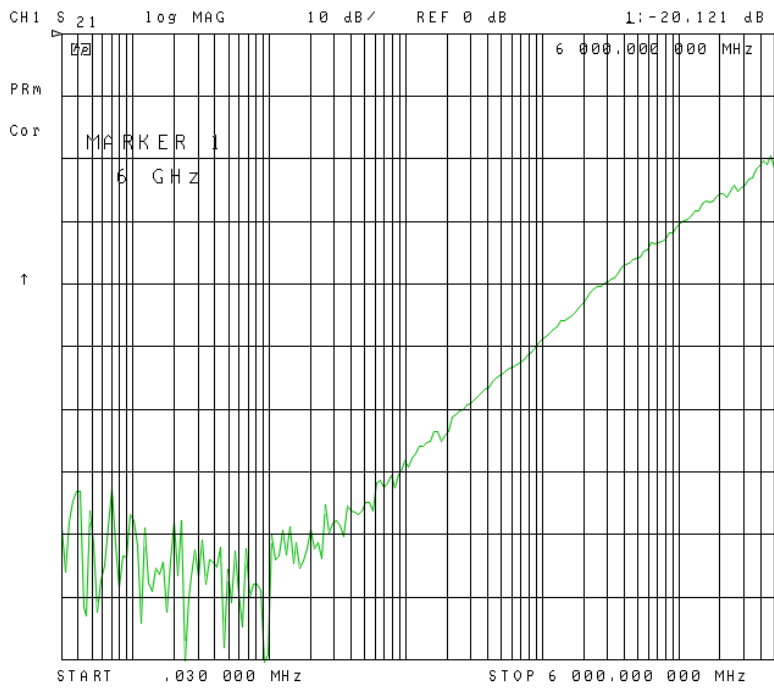
Picture 10 – H5, coupling loss, 30 kHz – 6 GHz, log.

EMC Near-field Probes + Wideband Amplifier

E5



Picture 11 – E5, coupling loss, 30 kHz – 6 GHz, lin.



Picture 12 – E5, coupling loss, 30 kHz – 6 GHz, log.

EMC Near-field Probes + Wideband Amplifier

5.1 Summary:

The larger the tip diameter, the lower the coupling loss at frequencies below 1GHz. At frequencies above 1GHz, the performance in terms of coupling loss of all probes is similar. The H20 has resonances in the range of 1.3GHz and 4GHz. The H10 has a resonance at 3.1GHz.

The smaller the loop, the better the spatial response.

6 Wideband Amplifiers

6.1 TBWA2/20dB

Technical Data:

Input: 50 Ohm, SMA

Output: 50 Ohm, SMA

Nominal supply Voltage: 4.5 - 5V, typ. 110mA, Mini-USB-B connector

Maximum supply voltage: 5.5V

Maximum input power: +10dBm

1dB output compression point @ 2GHz: +20dBm

3rd order output intercept point @ 2GHz, Pin = 0dBm/tone, $\Delta f = 10\text{MHz}$: +35dBm

Reverse isolation S12, 0.1 ... 6GHz: 23dB

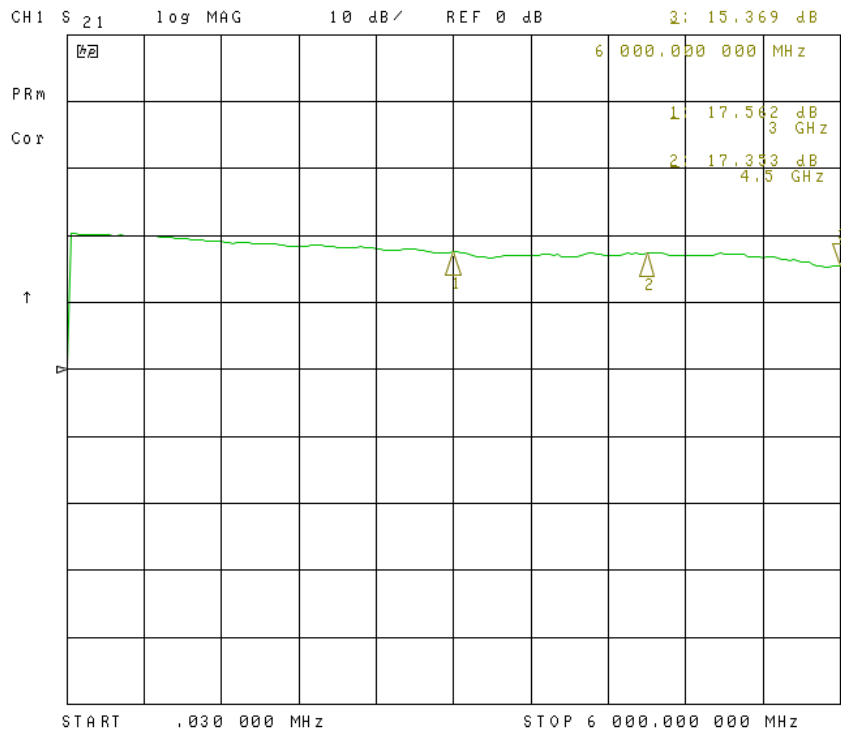
Noise Figure @ 2GHz: 4.5 ... 5 dB

Gain:

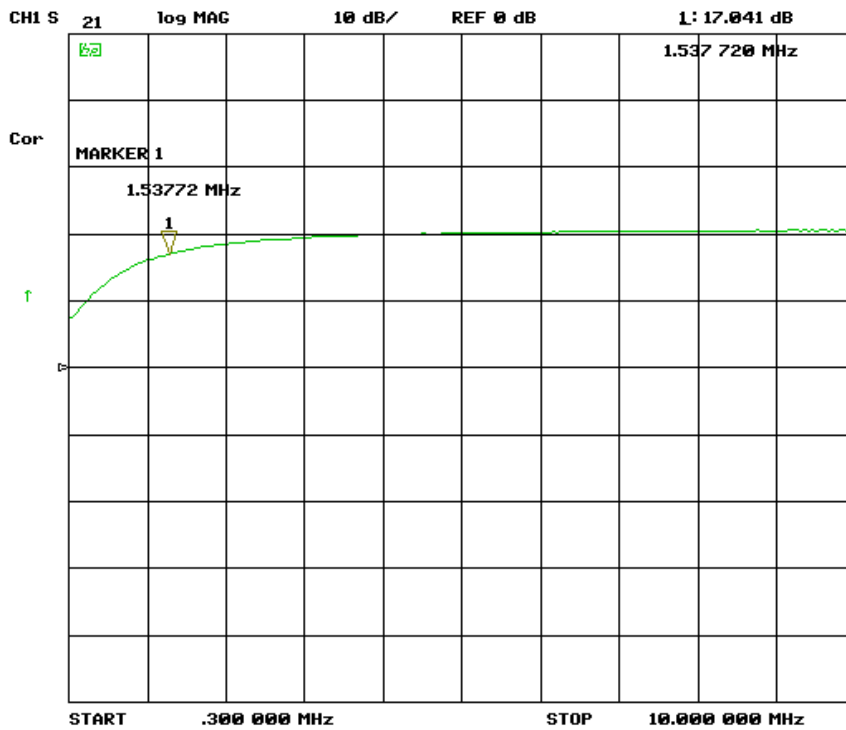
1 MHz	10 MHz	100 MHz	500 MHz	1 GHz	2 GHz	3 GHz	4.5 GHz	6 GHz
14.8 dB	20.2 dB	20.2 dB	20 dB	19.8 dB	19 dB	17.6 dB	17.4 dB	15.4 dB

Table 1 – TBWA2/20dB gain

EMC Near-field Probes + Wideband Amplifier

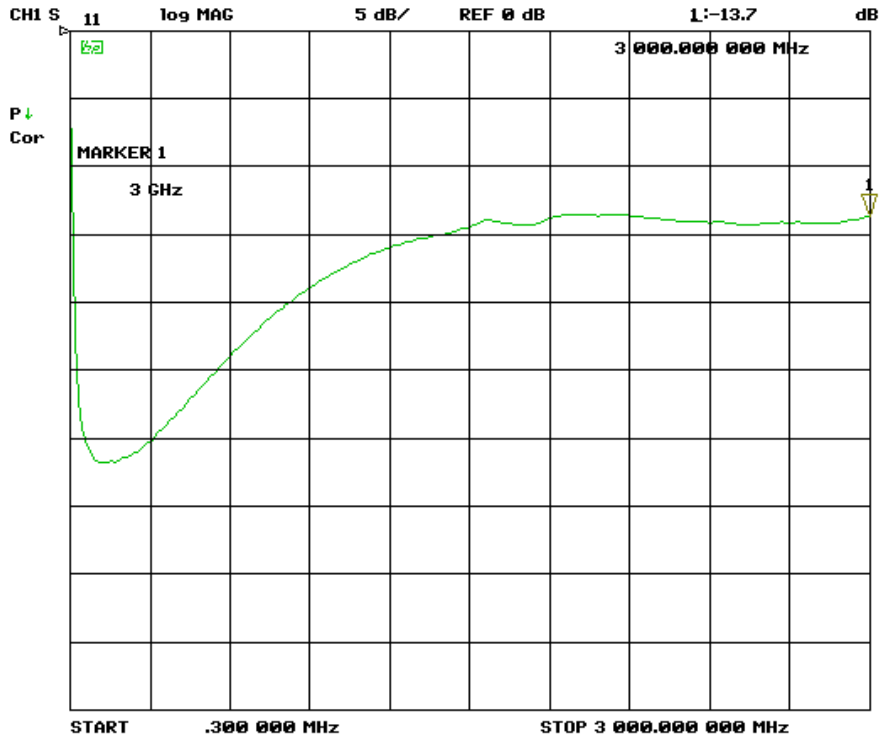


Picture 13 – TBWA2/20dB, gain, 30 kHz – 6 GHz, lin.

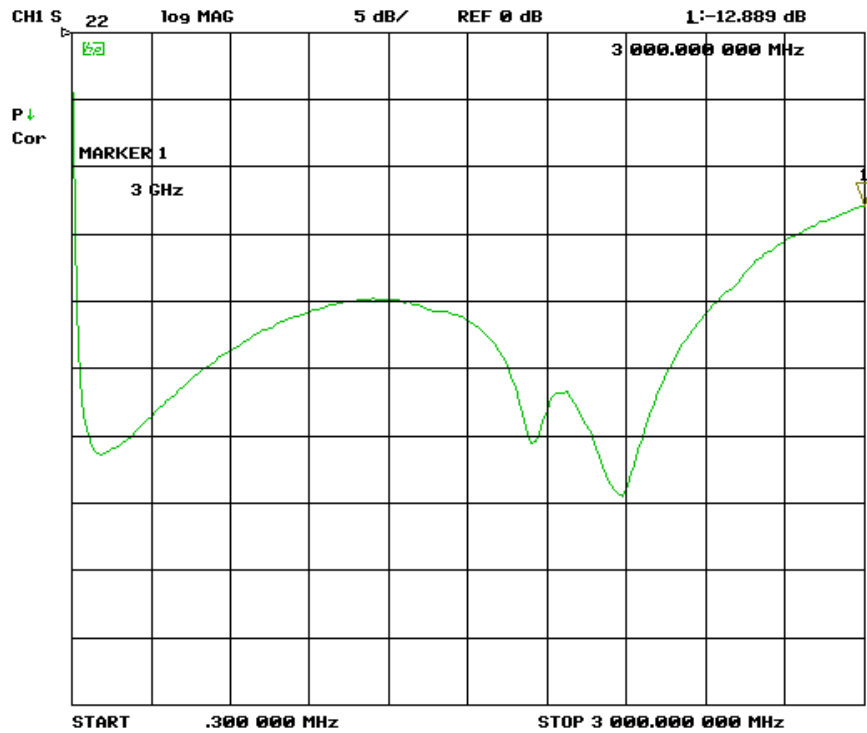


EMC Near-field Probes + Wideband Amplifier

Picture 14 – TBWA2/20dB, gain, 300 kHz – 10 MHz, lin.



Picture 15 – TBWA2/20dB, input return loss, IS111, 300 kHz – 3 GHz, lin.



Picture 16 – TBWA2/20dB, output return loss, IS221, 300 kHz – 3 GHz, lin.

EMC Near-field Probes + Wideband Amplifier

6.2 TBWA2/40dB

Technical Data:

Input: 50 Ohm, SMA

Output: 50 Ohm, SMA

Nominal supply Voltage: 4.5 - 5V, typ. 210mA, Mini-USB-B connector

Maximum supply voltage: 5.5V

Maximum input power: -10dBm

1dB output compression point @ 2GHz: +20dBm

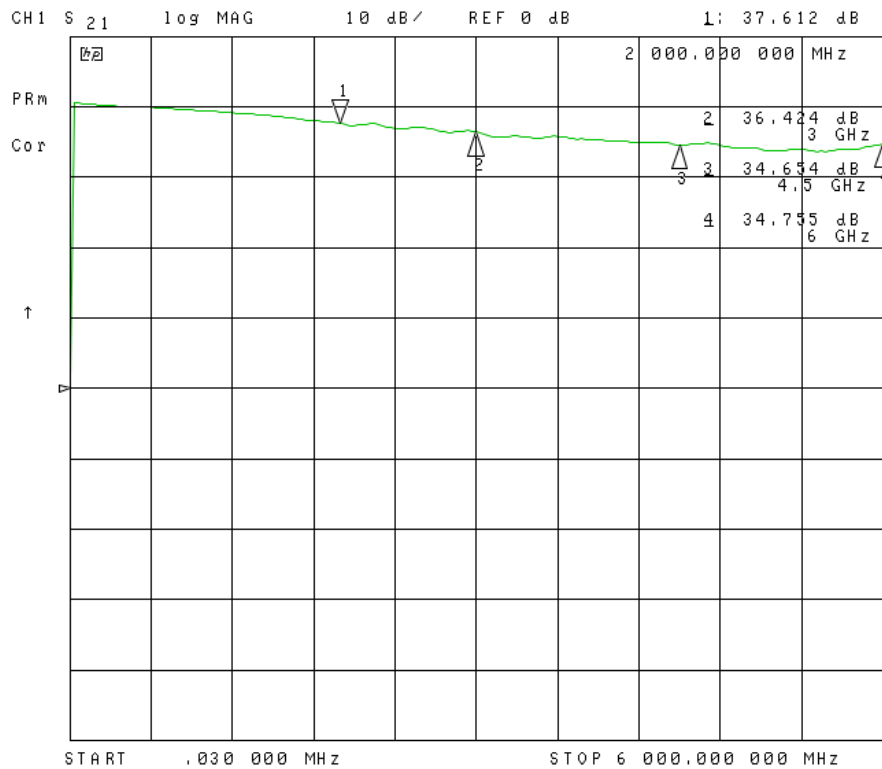
Reverse isolation S12, 0.1 ...6GHz: 40dB

Noise Figure @ 2GHz: 5 dB

Gain:

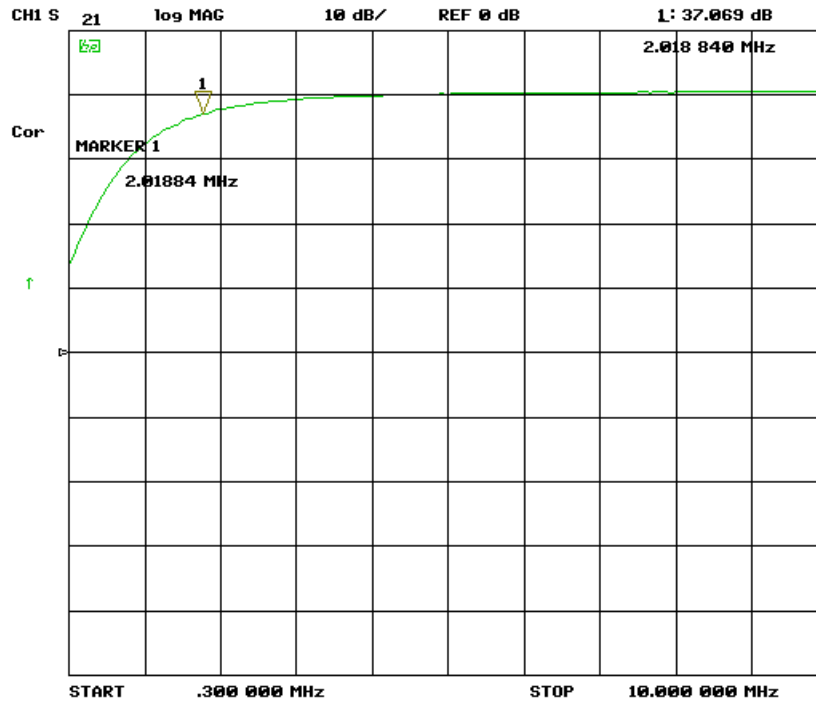
1 MHz	10 MHz	100 MHz	500 MHz	1 GHz	2 GHz	3 GHz	4.5 GHz	6 GHz
30 dB	40.2 dB	40.2 dB	40 dB	39.5 dB	37.6 dB	36.4 dB	34.6 dB	34.7 dB

Table 2 – TBWA2/40dB gain

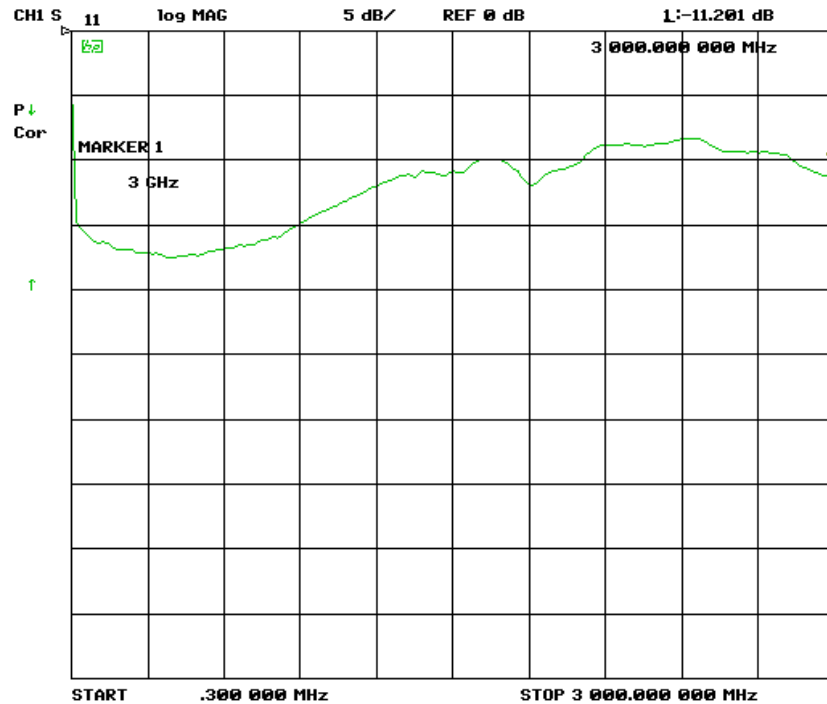


EMC Near-field Probes + Wideband Amplifier

Picture 17 – TBWA2/40dB, gain, 30 kHz – 6 GHz, lin.

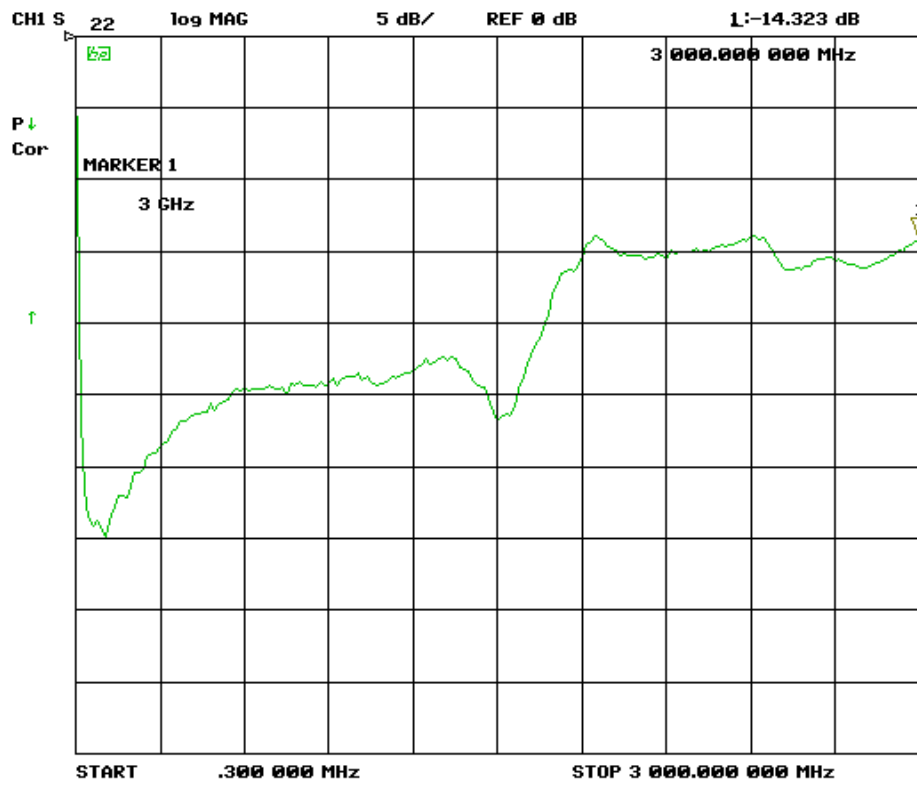


Picture 18 – TBWA2/40dB, gain, 300 kHz – 10 MHz, lin.



Picture 19 – TBWA2/40dB, input return loss, IS111, 300 kHz – 3 GHz, lin.

EMC Near-field Probes + Wideband Amplifier



Picture 20 – TBWA2/40dB, output return loss, IS22I, 300 kHz – 3 GHz, lin.

7 Application

Radiated EMC measurement

RF immunity testing

Contactless (load free) relative measurement of RF signal chains

Contactless (load free) relative measurement of oscillators, modulators, etc.

8 Spectrum analyzer settings

If the probes are used without wideband preamplifier, set the input attenuation to 0dB and turn on the internal preamplifier, if available on your spectrum analyzer. Furthermore you can increase the dynamic range and sensitivity by reducing frequency span, resolution bandwidth and video bandwidth.

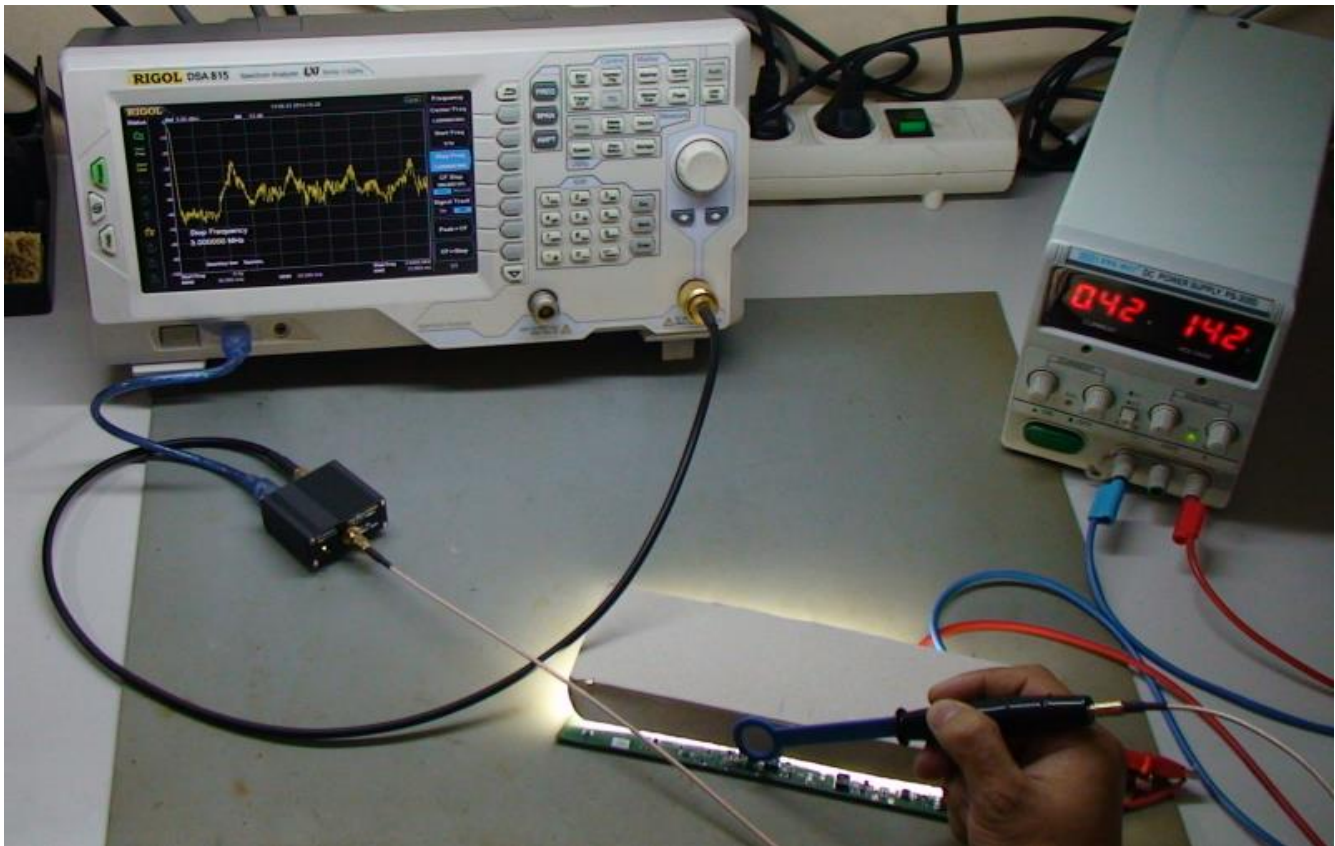
EMC Near-field Probes + Wideband Amplifier

9 Connection of the wideband amplifier

Use the SMB to SMA cable to connect the EMC probe to the input of the wideband amplifier.

Use the SMA to N cable to connect the output of the wideband amplifier with the input of the spectrum analyzer.

Use the USB cable to supply the wideband amplifier from the USB interface of the spectrum analyzer.



Picture 21 – measurement setup; probing the DC/DC converter of a LED lighting PCBA

10 Warning

Do not use the EMC probes to measure devices containing DC voltages higher than 75V or AC voltages higher than 50V_{eff}. Though the probes are insulated with solder mask, conformal coating and rubber coating, sharp metal edges may damage the insulation and cause lethal electrical shocks.

EMC Near-field Probes + Wideband Amplifier

11 Ordering Information

Part Number	Description
TBPS01	EMC probe set consisting of H20, H10, H5, E5, 75cm SMB to SMA cable, measurement plots, SMA-female to N-male coaxial adapter, wooden case
TBPS01-TBWA2/20dB	EMC probe set consisting of H20, H10, H5, E5, TBSPA2/20dB wideband amplifier, 75cm SMB to SMA cable, 75cm SMA to N cable, USB cable, wooden case, measurement plots
TBPS01-TBWA2/40dB	EMC probe set consisting of H20, H10, H5, E5, TBSPA/240dB wideband amplifier, 75cm SMB to SMA cable, 75cm SMA to N cable, USB cable, wooden case, measurement plots

Table 3 – Ordering Information

12 History

Version	Date	Author	Changes
V1.0	10.3.2014	Mayerhofer	Creation of the document
V1.1	18.7.2014	Mayerhofer	Chapter 6 added
V1.2	28.7.2014	Mayerhofer	Wideband amplifier details added
V1.3	24.10.2014	Mayerhofer	Frequency response updated
V1.4	29.10.2014	Mayerhofer	Chapter 9, picture added
V1.5	19.01.2015	Mayerhofer	TBWA1 amplifiers replaced by TBWA2 (new version)
V1.6	18.12.2015	Mayerhofer	Ordering information updated
V1.7	16.12.2016	Mayerhofer	Picture 1 – text corrected
V1.8	9.1.2017	Mayerhofer	Amplifier frequency response up to 6 GHz
V1.9	17.1.2017	Mayerhofer	Probe coupling loss plots up to 6 GHz
V2.0	29.10.2019	Mayerhofer	Chapter 11 updated

Table 4 – History