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 TBWA1/20dB and TBWA1/40db wideband amplifiers are connected between EMC probe and Spectrum Analyzer to increase the dynamic range of the measurements.

Picture 1 – from top, H20, H5, H10, E5; TBWA1 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: 3GHz, though they can be used well beyond

SMB connectors to avoid twisting the RF cable when scanning DUTs

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Insulated with rubber coating

Wideband amplifiers with 20dB and 40dB gain

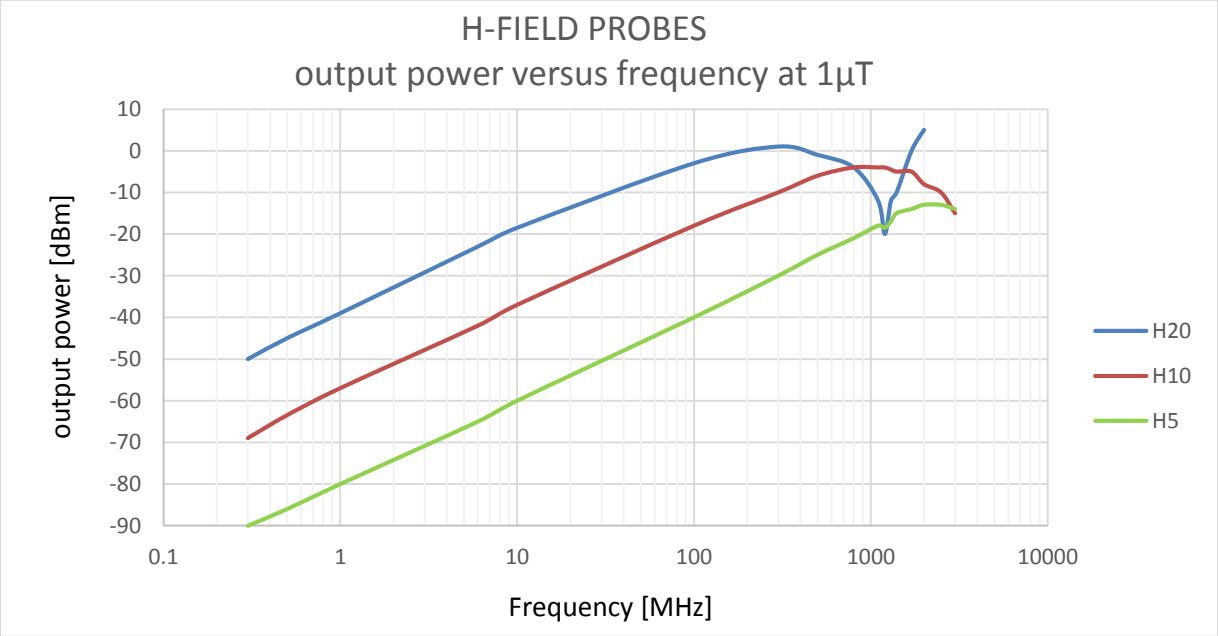
3 Dimensions

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

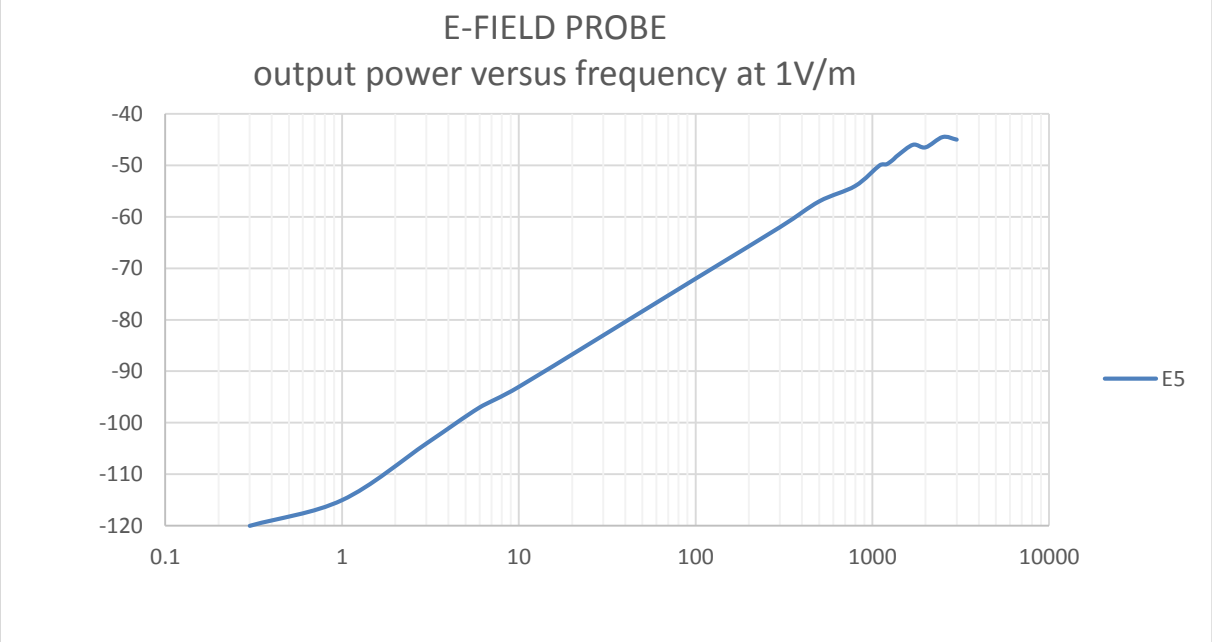
Wideband amplifiers:

TBWA1/20dB: 48 mm x 63mm x 20mm TBWA1/40dB: 48 mm x 63mm x 20mm

4 Frequency Response



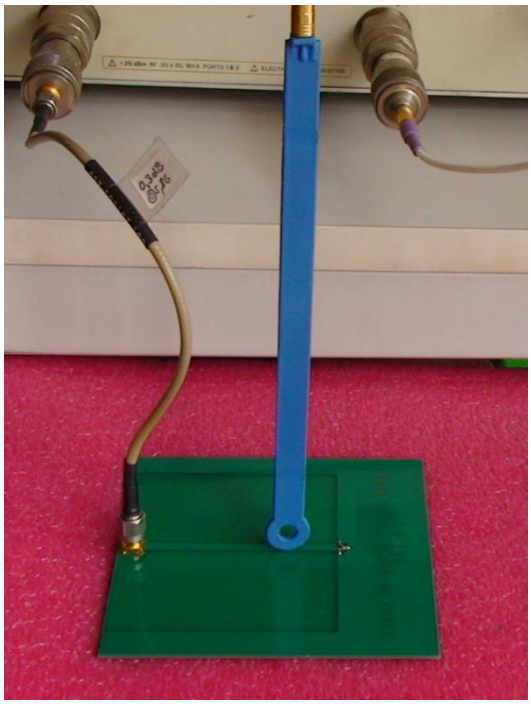
Picture 2 – frequency response, H-field probes



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, 300kHz – 3GHz

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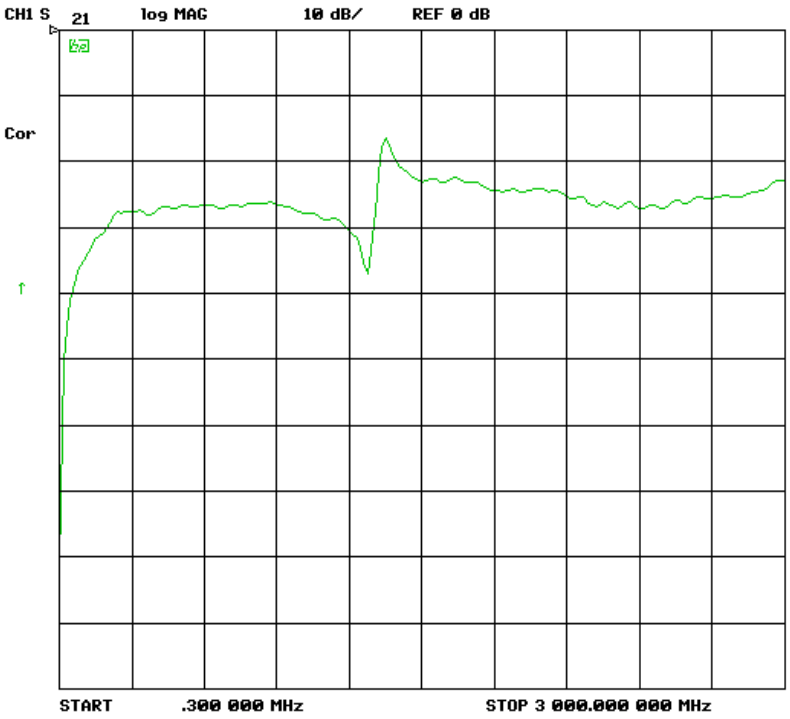
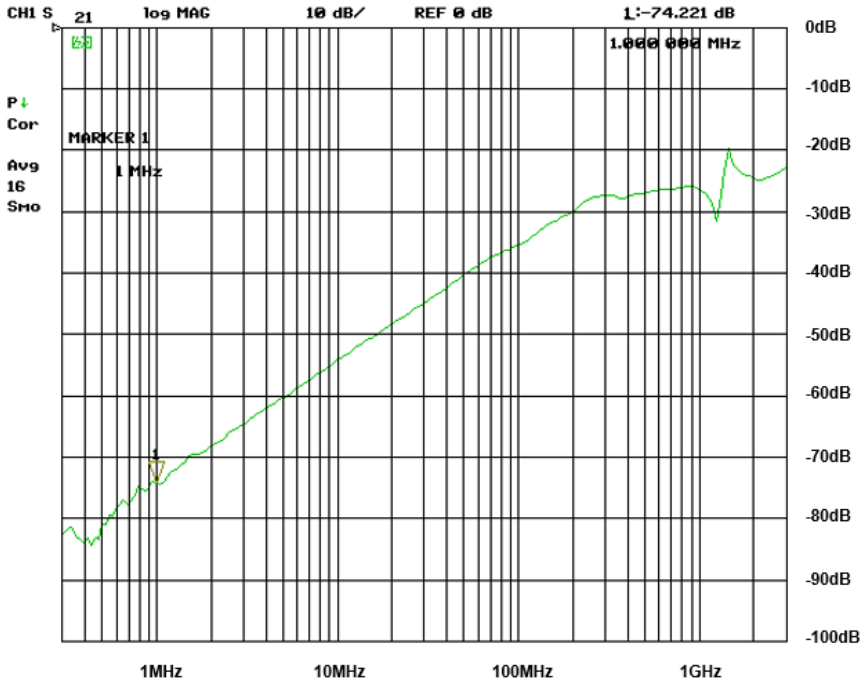
H20



Picture 5 – H20, coupling loss, 300 kHz – 3 GHz, lin.



Picture 6 – H20, coupling loss, 300 kHz – 3 GHz, log.

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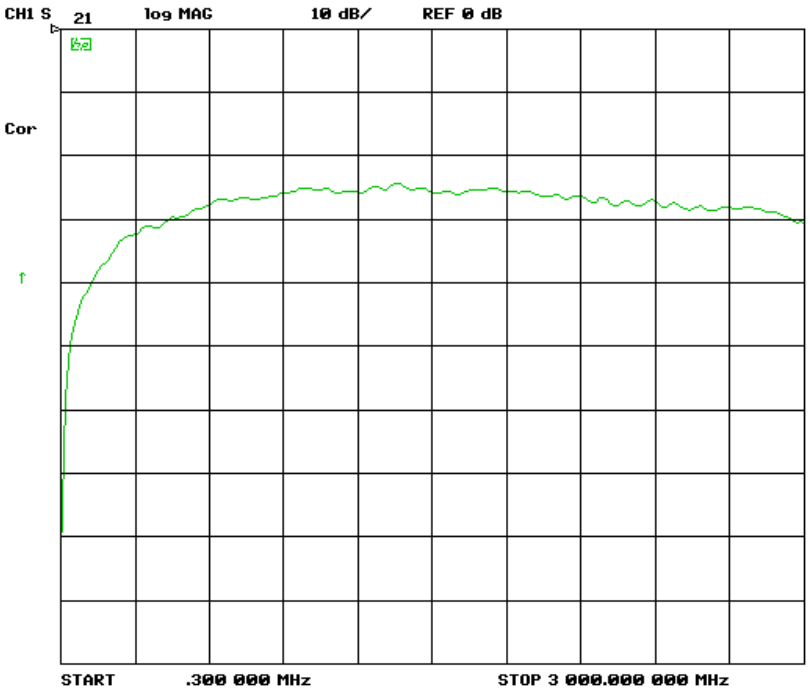
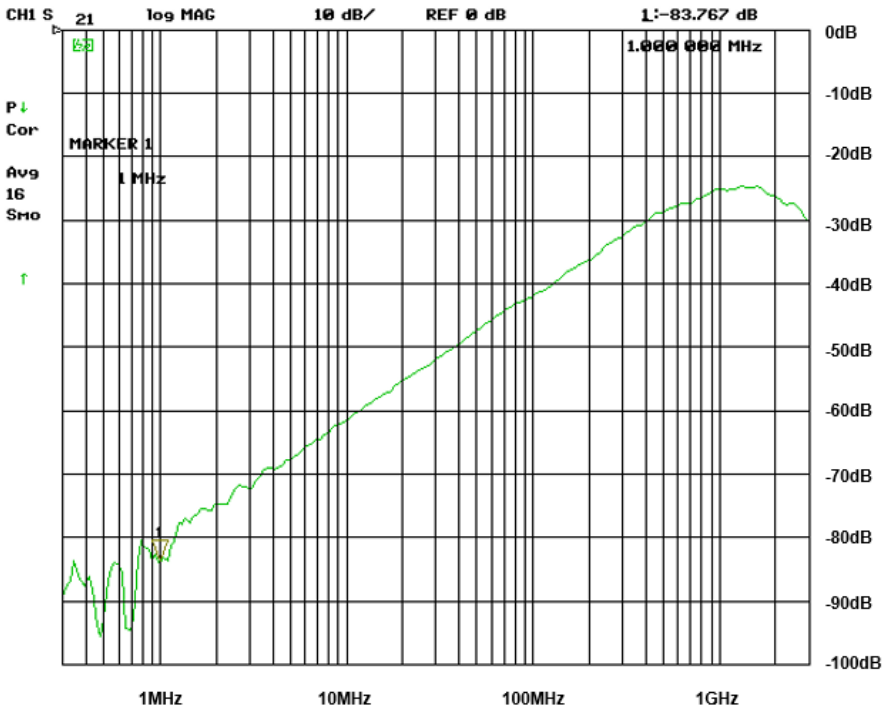
H10



Picture 7 – H10, coupling loss, 300 kHz – 3 GHz, lin.



Picture 8 – H10, coupling loss, 300 kHz – 3 GHz, log.

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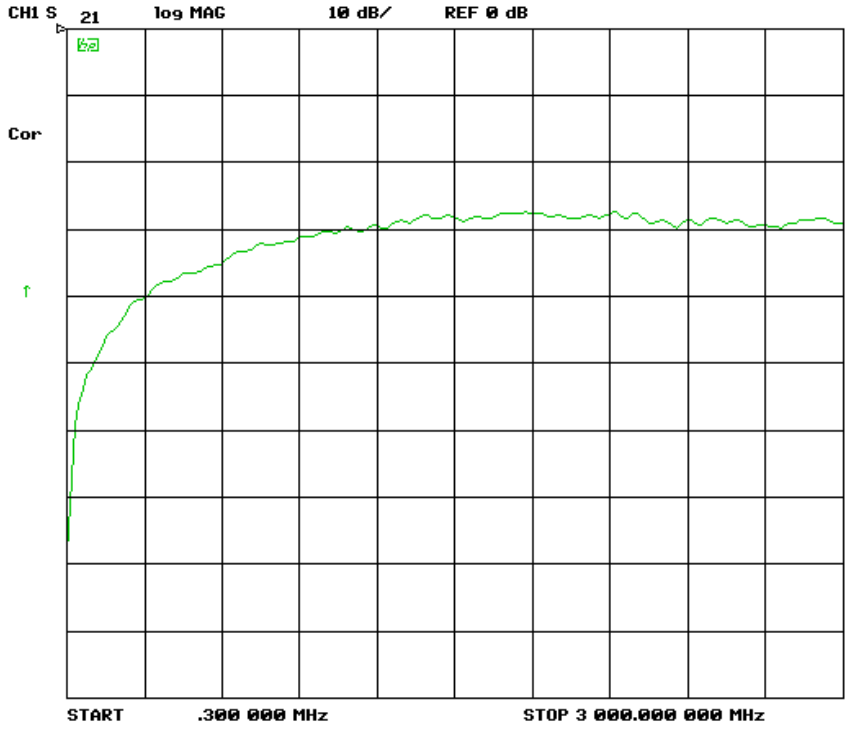
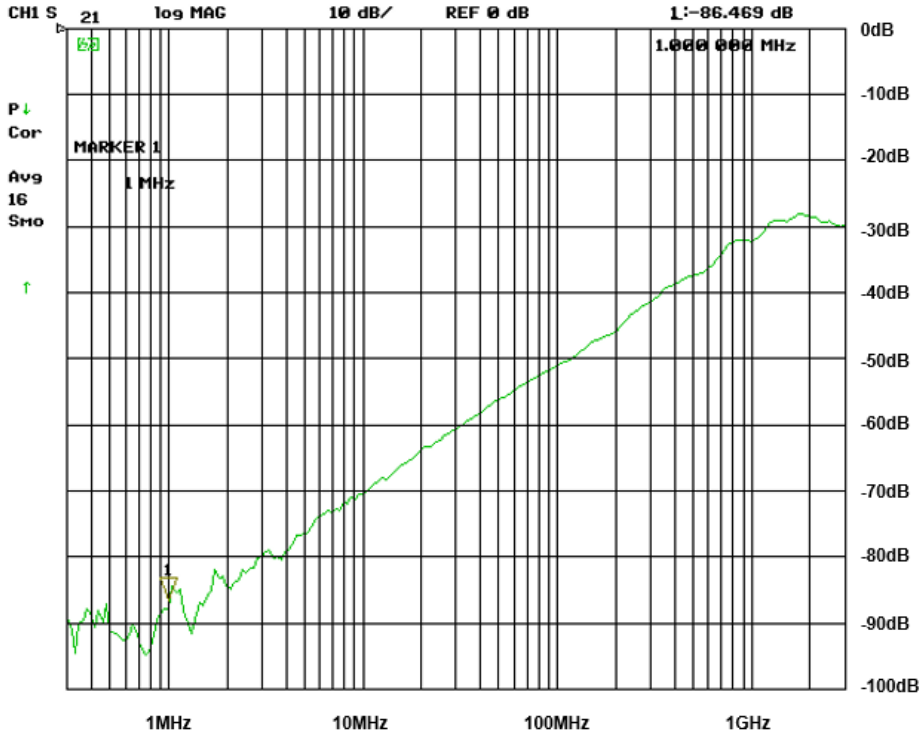
H5



Picture 9 – H5, coupling loss, 300 kHz – 3 GHz



Picture 10 – H5, coupling loss, 300 kHz – 3 GHz, log.

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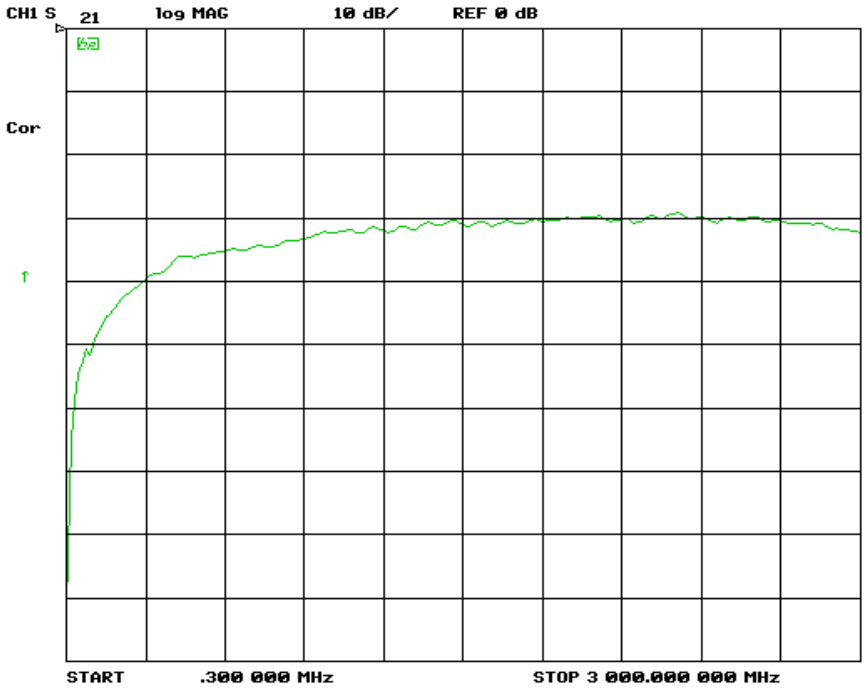
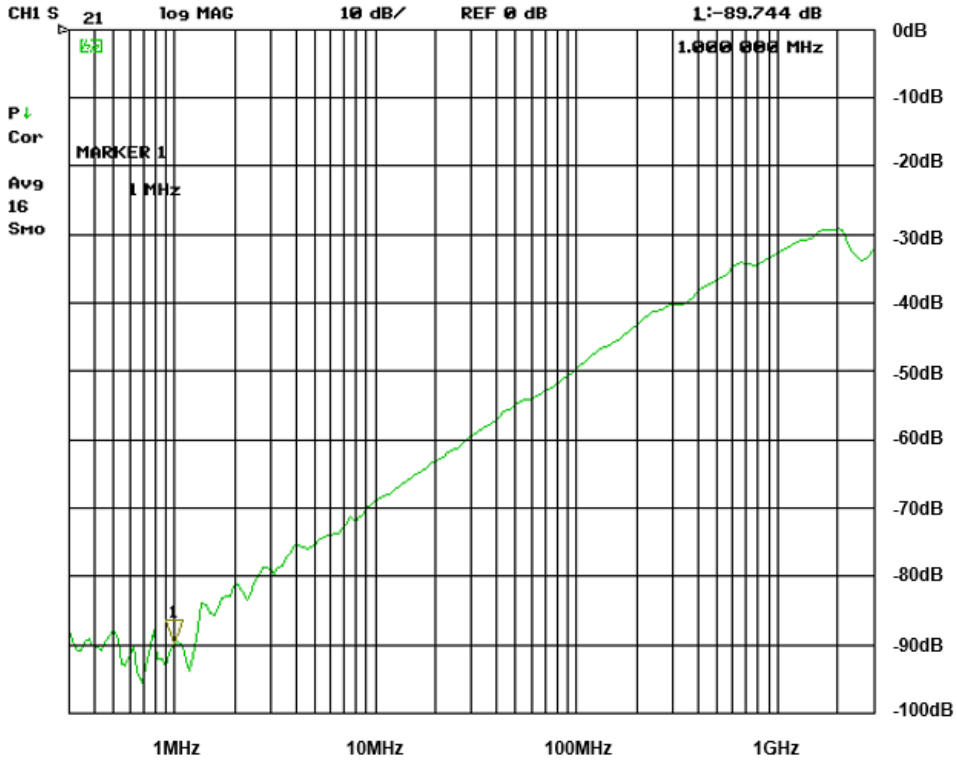
E5



Picture 11 – E5, coupling loss, 300 kHz – 3 GHz, lin.



Picture 12 – E5, coupling loss, 300 kHz – 3 GHz, log.

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 a resonance in the range of 1.3GHz.

The smaller the loop, the better the spatial response.

6 Wideband Amplifiers

6.1 TBWA1/20dB

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, Δf = 10MHz: +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	1.5 GHz	2 GHz	3 GHz
16.5 dB	20.2 dB	20.2 dB	20 dB	19.4 dB	18.6 dB	18.6dB	16.9 dB

Table 1 – TBWA1/20dB gain

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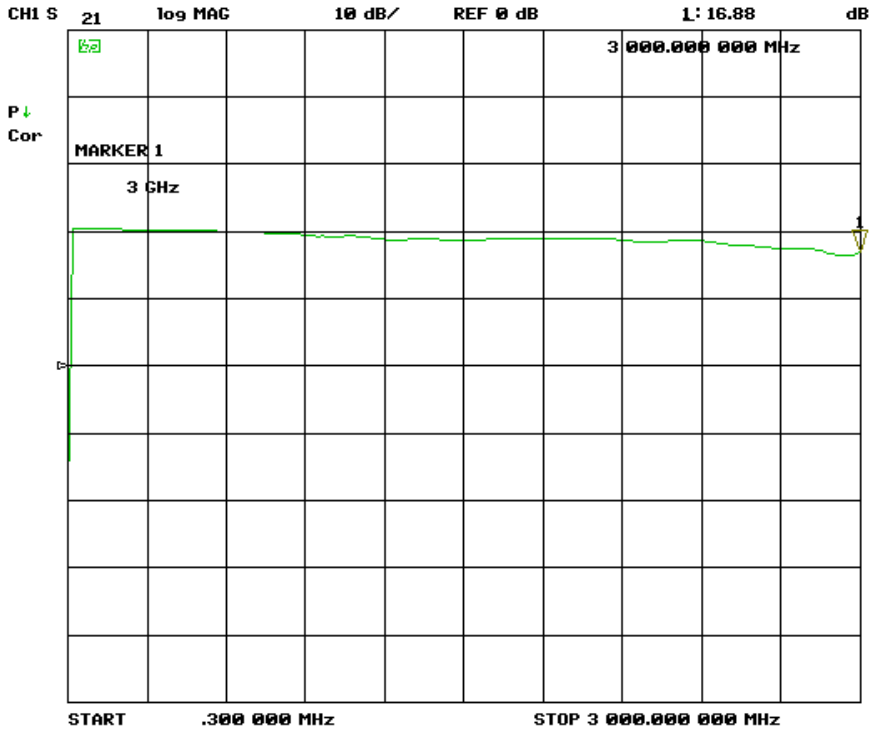
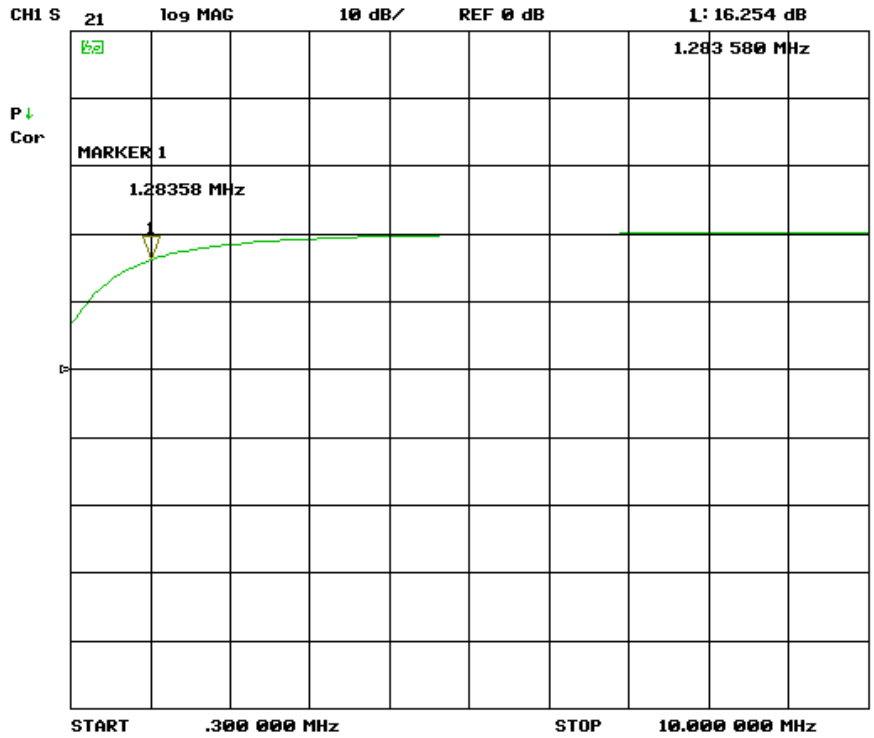
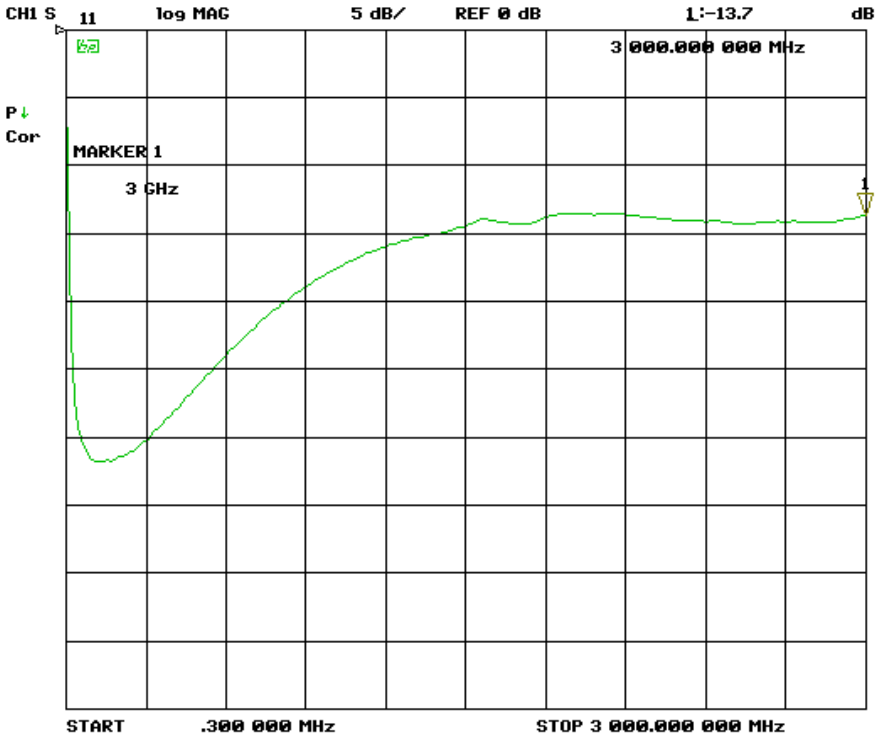


Picture 13 – TBWA1/20dB, gain, 300 kHz – 3 GHz, lin.

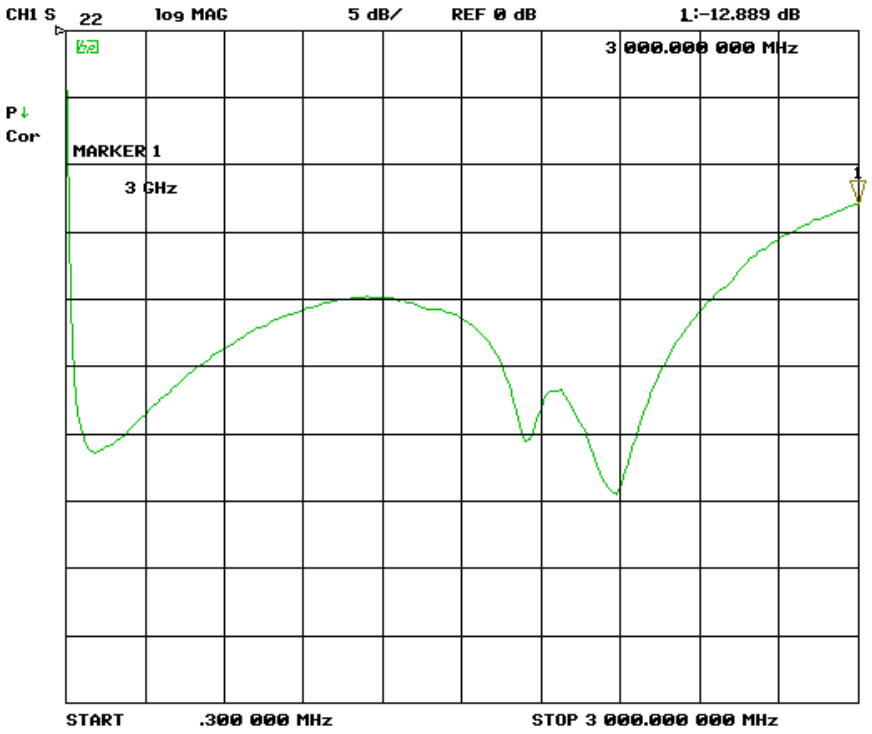


Picture 14 – TBWA1/20dB, gain, 300 kHz – 10 MHz, lin.

EMC Near-field Probes + Wideband Amplifier



Picture 15 – TBWA1/20dB, input return loss, IS11I, 300 kHz – 3 GHz, lin.



Picture 16 – TBWA1/20dB, output return loss, IS22I, 300 kHz – 3 GHz, lin.

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6.2 TBWA1/40dB

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

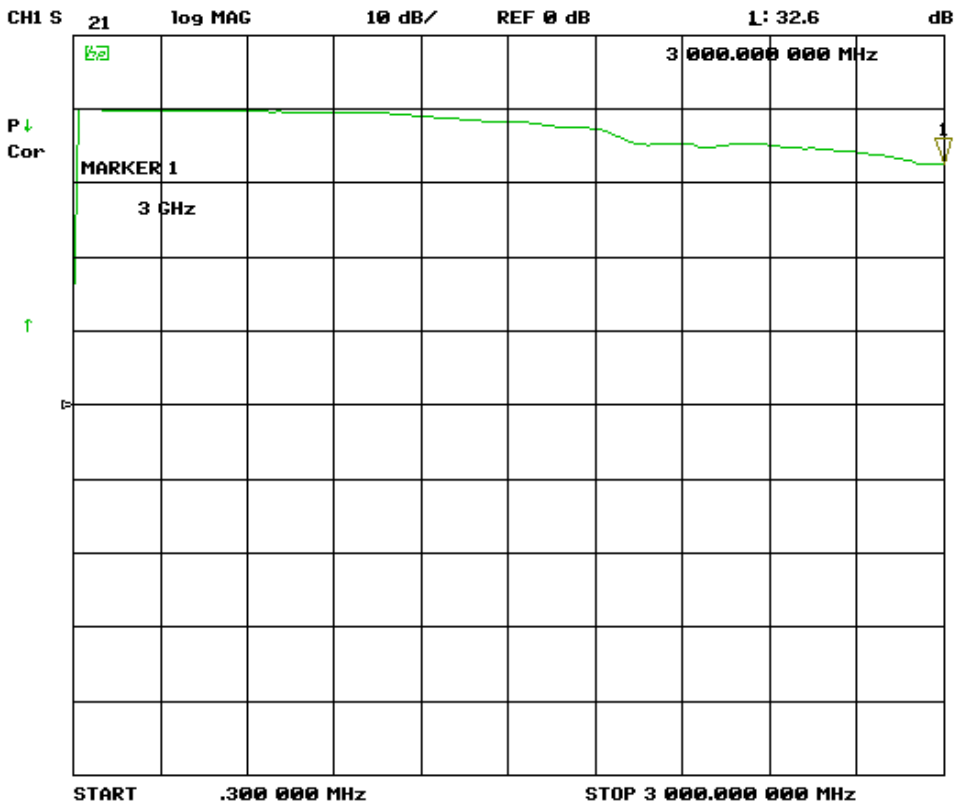
Reverse isolation S12, 0.1 …6GHz: 40dB

Noise Figure @ 2GHz: 5 dB

Gain:

1 MHz	10 MHz	100 MHz	500 MHz	1 GHz	1.5 GHz	2 GHz	3 GHz
33.5 dB	40.2 dB	40.2 dB	40 dB	39.8 dB	38.6 dB	34.5dB	32.6 dB

Table 2 – TBWA1/40dB gain



Picture 17 – TBWA1/40dB, gain, 300 kHz – 3 GHz, lin.

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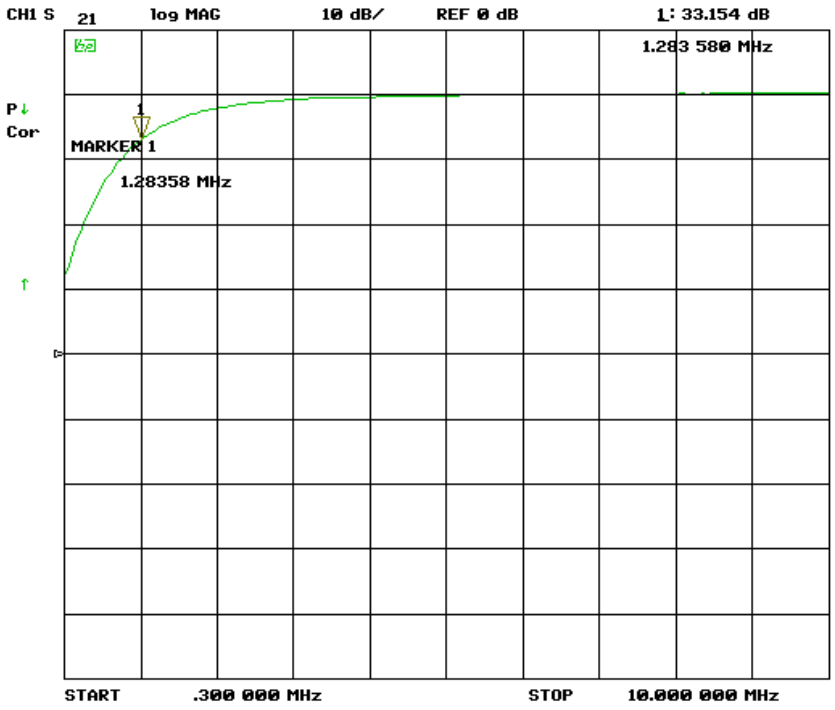
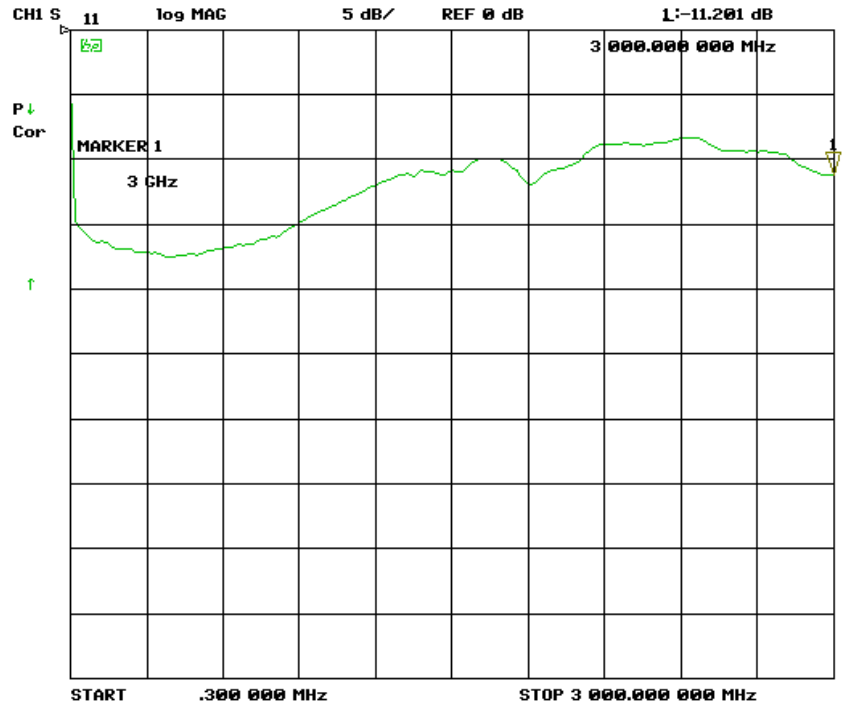
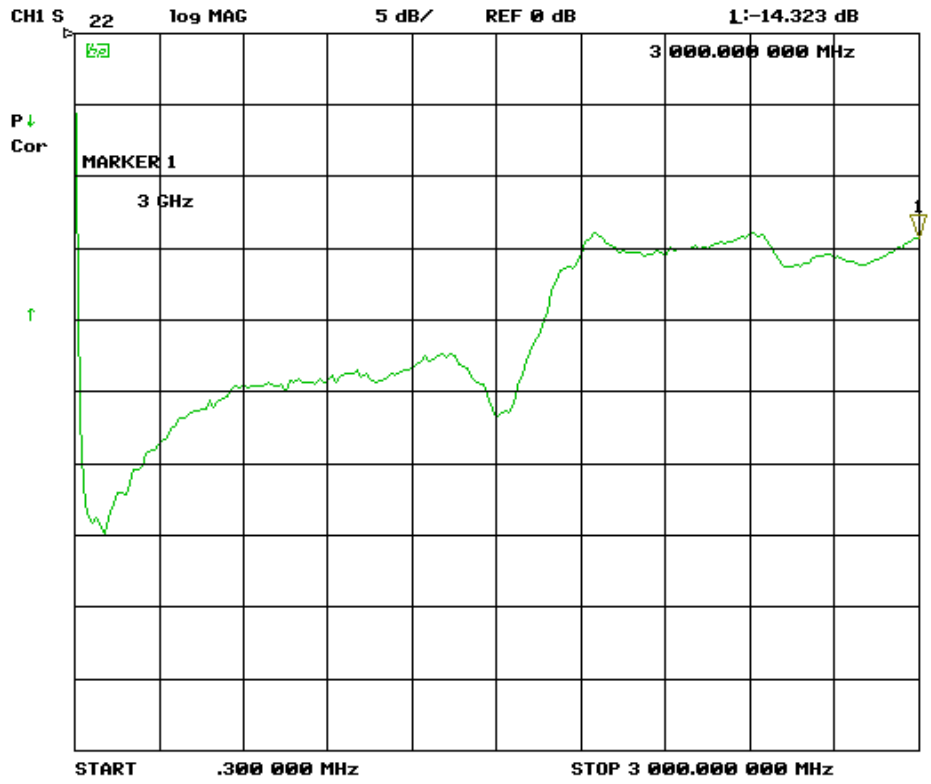


Picture 18 – TBWA1/40dB, gain, 300 kHz – 10 MHz, lin.



Picture 19 – TBWA1/40dB, input return loss, IS11I, 300 kHz – 3 GHz, lin.

EMC Near-field Probes + Wideband Amplifier



Picture 20 – TBWA1/40dB, 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

Set the input attenuation to 0dB and turn on the preamplifier, if available on your analyzer. Furthermore you can increase the dynamic range and sensitivity by reducing frequency span, resolution bandwidth and video bandwidth.

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.

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.

11 Ordering Information

Part Number	Description
TBPS01	EMC probe set consisting of H20, H10, H5, E5, 75cm SMB to SMA cable, measurement plots
TBP1WA1/20	EMC probe set consisting of H20, H10, H5, E5, TBSPA/20dB wideband amplifier, 75cm SMB to SMA cable, 75cm SMA to N cable, USB cable, wooden case, measurement plots
TBPS1WA1/40	EMC probe set consisting of H20, H10, H5, E5, TBSPA/40dB 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

Table 4 – History