GGB Picoprobe Model 10 Frequency Response

Advanced TLP/HMM Solutions

1 Picoprobe Model 10

A close up image of a Picoprobe with integrated dividing resistor is shown in Fig. 1, after removal of the covering mould compound and the signal pin.

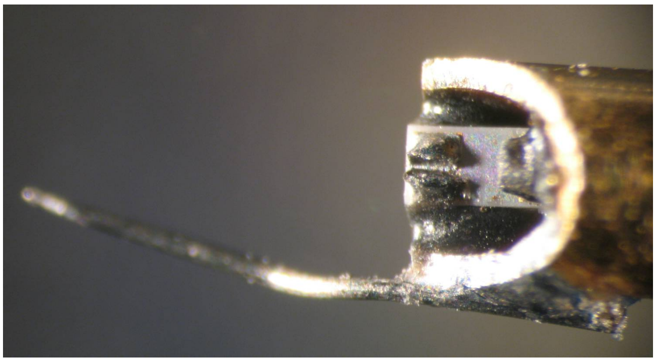

Figure 1: Mechanical construction of a Picoprobe Model 10 with integrated 5k resistor. The signal pin is normally soldered to the resistor but has been removed in this picture.

Ideally, the probe provides a voltage division given by the series resistor R_{div} and the 50 Ω termination of the coaxial cable. The voltage measured by the oscilloscope V_{meas} is:

$$V_{meas} = V_{DUT}\frac{50}{R_{div} + 50} \qquad (1)$$

However, there is no such thing as an ideal resistor. All real resistors have intrinsic capacitance and inductance. The inductance is in series with the resistor and depends on the size and layout of the resistive element. The capacitance is simply the stray capacitance between the terminals of the resistor, and is thus dependent on the terminal size and the distance between them. A small resistor like the one shown in Fig. 1, generally has a very low inductance due to its short resistive element. On the other hand the terminals are quite close, which gives rise to a considerable capacitance. Hence, the frequency dependent impedance of the resistor must be considered.

A lumped model of the model 10 probe is shown in Fig. 2. R_{div} is the voltage dividing resistor, $C_{parasitic}$ the parasitic stray capacitance between the resistor terminals, L_R the inductance of the resistor and L_{tip} tip the inductance of the two probe tips.

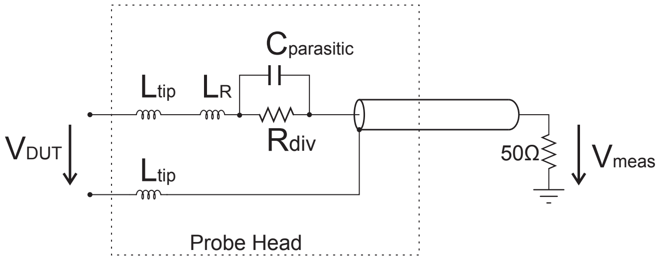

Figure 2: Electric schematic of a Picoprobe Model-10 probe. R_{div} is the integrated dividing resistor in the probe head. Its parasitic capacitance $C_{parasitic}$ is the most important cause of non-flat frequency response.

1.1 Picoprobe Model 10 with pulse robust 0502 resistor

A standard Model-10 with 5 kΩ resistor can handle about 500V @ 100ns pulse width. Higher voltages will cause the small resistor to fuse open. To overcome this limit a special model with a more robust resistor has been developed by GGB and HPPI. The new model has been tested up to 1500 V with 1500 ns pulse width. Due to the larger dimensions of the reistor element, the probe also offers less capacitive coupling, and hence higher bandwidth. The order number for the enhanced Model-10 is obtained by adding "(0502)" in the standard order number (e.g. 10-5K(0502)-125-W-2-L-100 for a 5k probe).

1.2 Picoprobe Model 10 frequency response

In Fig. 3 the measured transfer function and phase has been plotted for various models of the picoprobe model 10.

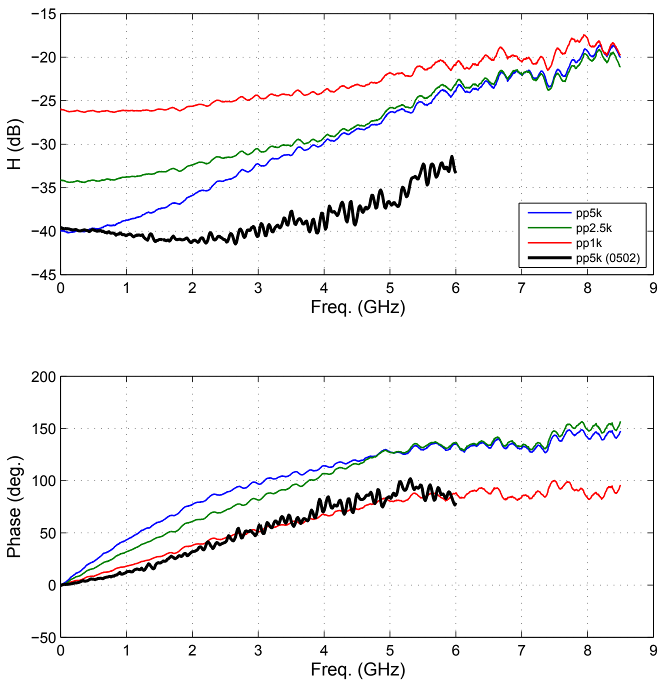

Figure 3: Amplitude and phase response of model-10 picoprobes with various dividing resistors.

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1.3 Picoprobe Model 10 Modeling

To enhance the accuracy of the sense probes, models have been fitted to the frequency as shown in Fig. 4. Several measurements of different samples shows a quite good reproducibility of the measurements. The models are available in the TLP-Tester and can be selected to apply inverse filtering.

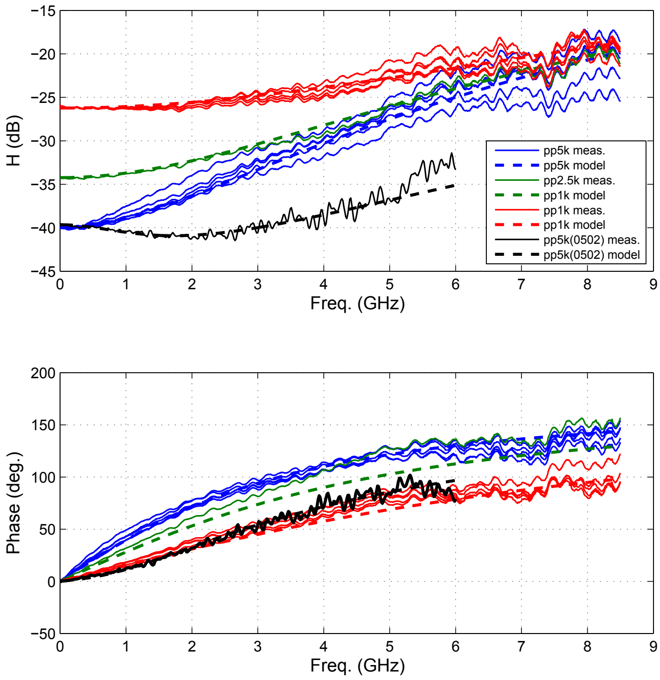

Figure 4: Fitted models of the various Model-10 Picoprobes

2 Inverse filtering

Fig. 5 shows an example of a measured voltage waveform that has been corrected with a digital inverse filter. This correction is available in the HPPI TLP Tester Software for the various Model-10 Picoprobes.

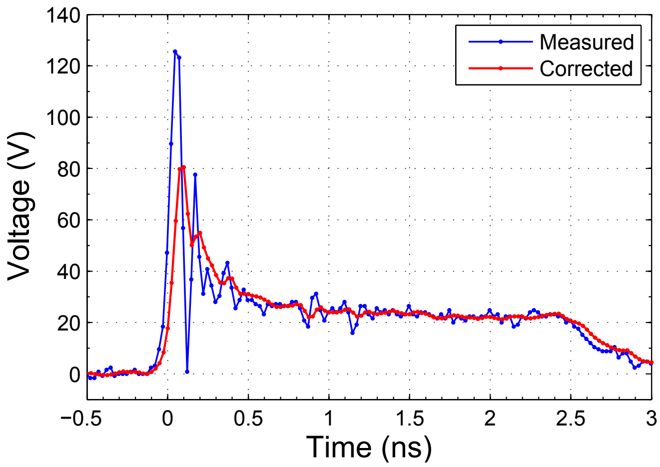

Figure 5: Transient response of a device measured with a standard 5k Picoprobe. On the red curve the inverse model for a 5k probe has been applied.

3 References

This application note describes investigation of the frequency response of GGB's Picoprobe Model 10 replacement probe tips. Please refer to http://ggb.com/10.html for the model 10 probe tip holder and description of replacement probe tips: http://ggb.com/PdfIndex_files/mod10.pdf