

## Creating SDD11 Return loss SDD21 Insertion loss using two GigaProbes™

Measuring the impedance of a passive interconnect (i.e. backplane, cable, connector & package) in the time domain does not provide the full picture as to if the transmission lines have adequate bandwidth to pass signal integrity testing once you have a functioning design so the bandwidth of the passive interconnect(s) must be determined. This can be done with a VNA but a TDR with Frequency domain analysis capability like the Tektronix DSA8200 and IConnect® provide both time and frequency domain analysis that is more than adequate for most digital designs. With this system we can measure the time domain impedance and frequency (S-parameters) to capture the full signal integrity picture of our interconnect system before we assemble the active components.

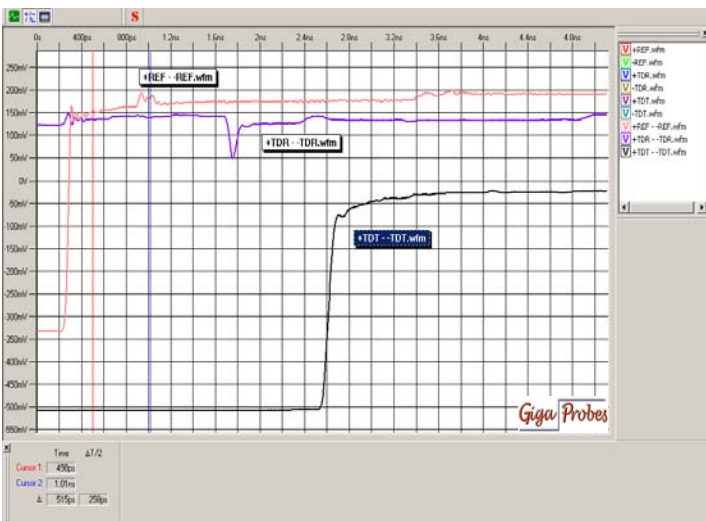
Generating S-parameters in IConnect® once the voltage waveforms have been acquired is an easy process. In this example, we chose a PCB differential test coupon for our S-parameter analysis. We place GigaProbes™ on the near and far end of our coupon using the Tektronix articulating arm to hold the probes in place, freeing our hands to operate the TDR and IConnect® software (Fig 1 or 2). Using IConnect® we acquire the odd mode differential voltages for the Reference (red), TDR (purple) and TDT (black) and add each set (i.e. +TDR- - TDR) together within IConnect® resulting in differential waveforms shown in (Fig 3). Using IConnect® S-parameters “operator function” we convert the differential TDR waveform to a SDD11 return loss plot. The reflected signal should be less than 10% the incident signal. A common spec for the return loss of a connector is less than -20 dB, up to the full bandwidth of the application. Using the S-parameter operator on the differential TDT waveform we create a SDD 21 insertion loss plot (Fig 4). As a rough rule of thumb, the amplitude of the signal transmitted through the interconnect must be at least 70% the amplitude going in for it to be large enough to be useful. Transmitted amplitude of 70% is -3 dB. We use the frequency at which the magnitude of S21 has dropped to below - 3 dB as a measure of the bandwidth of the interconnect. We usually refer to this as the “3 dB bandwidth.”Our return loss waveform should be at least -20db and the insertion loss -3db. By placing cursors on the S-parameters we can read the frequency vs. db values to determine if our design meets expected or simulated bandwidth requirements.



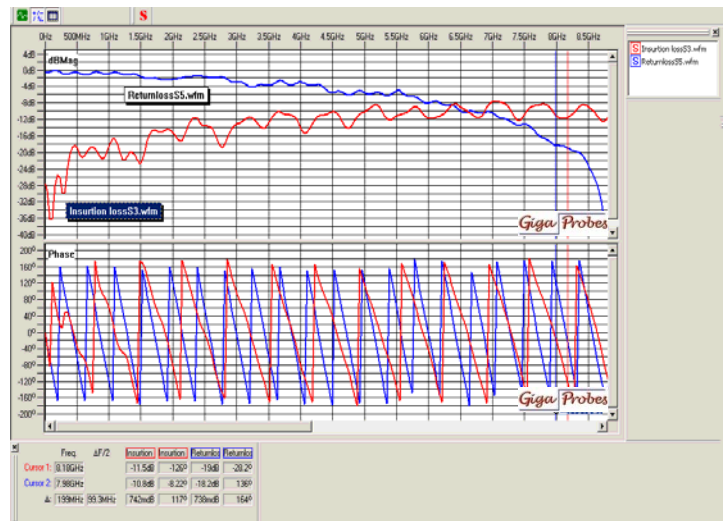
**Fig. 1)** Two GigaProbes™ connected through SMA cables and to the TDR heads are used to acquire the differential Reference (Open), TDR, TDT Waveforms and ported into IConnect® for processing.



**Fig 2)** For a faster TDR pulse, remove the cable and directly connect the GigaProbes™ directly to the TD sampling head via a high speed coupler.



**Fig 3)** each waveform set are converted to a differential waveform leaving you with three differential Reference (Open), TDR and TDT Waveforms shown in the IConnect® waveform viewer.



**Fig 4)** Employ the “S-parameters” operator to create the SDD11 return-loss from the TDR waveform and create the SDD21 insertion-loss from the TDT Waveform. Use the waveform cursors to measure the db vs. Frequency response.