# Thread: High Frequency Oscilloscope Measurements

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Replies: 5 - Pages: 1 - Last Post: Mar 13, 2013 6:07 AM Last Post By: algoss

SOLT_guy

Posts: 268
Registered: 05/30/09

**High Frequency Oscilloscope Measurements**
Posted: Mar 11, 2013 8:29 AM

Reply

Dear Sir:

I was wondering if you could tell me how Agilent makes accurate voltage measurements at high frequency.

Consider this question:

Generally, oscilloscopes make measurements with an internal impedance of 1 Megaohm or 50 ohms. I read that, in the past, that when an oscilloscope made a measurement when the internal impedance was set to 50 ohms, that 50 ohm resistance would be in placed parallel with the load. This is equivalent to using a 50 ohm feedthrough when scopes were fixed at a 1 Mega ohm input impedance. It follows logically, if one were measuring a the voltage across an external 50 ohm resistance, the equivalent resistance would be approximately 25 ohms. (I realize, the method I have just described is simplistic and cannot be practically applied after giving this some more thought). This would indicate, at this setting that one would measure the a voltage drop across a 25 ohm resistance. Can you tell me how this issue is resolved? Does Agilent use a correction factor (data processing) to obtain the correct result?

Next question:

When oscilloscopes make measurements at high frequencies, (Agilent has advertised a raw measurement bandwidth at its pre-amps at approximately 26 GHz), there are SWR issues that take place at the measurement point. Can you tell me how Agilent resolves this issue?

Edited by: SOLT_guy on Mar 11, 2013 10:43 AM

algoss

Posts: 602
Registered: 11/03/06

**Re: High Frequency Oscilloscope Measurements**
Posted: Mar 11, 2013 9:30 AM in response to: SOLT_guy
correction , infiniium , infiniisim , precisionprobe , precisioncable

Reply

Short answer, "Very Carefully".

- First Question - Input Impedance - 1MOhm inputs are only for lower frequency scopes. The BW is generally 500 MHz or below, since

there is also quite a bit of impedance.

When using a scope in 50 Ohm mode, you have 2 choices.

One is to connect the scope as if it were the load. In the case, the scope is providing the 50 Ohm termination and you will see what your DUT would see if it were connected, instead of the scope.

The other solution would be to use a good divider. In this case, if you use good cables with matched lengths, the DUT and the scope see the same signal, with a little more than 3dB loss. If everything was connected correctly, you only have to worry about the cable loss.

In neither case is the scope directly in "parallel" with the load, and you would never use anything like a Tee

- Second Question - Frequency correction - We have recognized, since we went over 1 GHz, that scope front-ends aren't perfect. Since we now have scopes with BW as high as 63GHz, and probes with BW up to 30GHz, this has become more of an issue. To address this, we have made a considerable number of changes to our internal architecture.

The A/D's used on our high BW scopes include a real-time FIR filter stage on the output. We make careful measurements of the S-Parameters of the scope inputs, and create FIR filters that provide correction out to the front panel of the scope. Note that the input impedance changes as the input attenuation changes, and we switch in different filters as necessary.

The Probe amplifiers individually have their S-Parameters tested at the factory, and the results are stored in EEPROM in each amplifier. When the amplifiers are connected to the scope, a new FIR filter is created for each channel/amplifier combination. At that point, correction is done to the end of the probe amp. If any of the probe adapters are used, then the user tells the scope what adapters are in use, and further correction is done.

There are additional capabilities available, depending on the specific configuration.

The InfiniiSim SW options allow all kinds of different configurations for correction, including adding and removing effects of external fixtures, assuming that you have S-Parameters for all fixtures and connectors. In this case all reflections are accounted for.

The PrecisionProbe/PrecisionCable products allow simpler, but less accurate, fixture removal. With these products, S21 removal is available, but no S-Parameters need to be available. In this case, we use the scope to make a TDT measurement, and use the results of that measurement to create the correction filters.

Additional information is available here: InfiniiSim and here: PrecisionProbe

Does this answer your question?

Al

SOLT_guy

Posts: 268
Registered: 05/30/09

**Re: High Frequency Oscilloscope Measurements**
Posted: Mar 11, 2013 11:25 AM in response to: algoss

Reply

Dear Sir:

I would like to thank you very much for replying to my question.

Can you please link me to pictorial diagram of how one would the measurement you referred to when you wrote:

" One is to connect the scope as if it were the load. In the case, the scope is providing the 50 Ohm termination and you will see what your DUT would see if it were connected, instead of the scope."

Also, when you wrote:

"The other solution would be to use a good divider. In this case, if you use good cables with matched lengths, the DUT and the scope see the same signal, with a little more than 3dB loss. If everything was connected correctly, you only have to worry about the cable loss."

There is so much incorrect information on the web and sometimes making a logical inference from incomplete information can still result in an erroneous determination. In an analogous example, you can obtain two mathematically valid roots from a polynomial equation but only one root is valid for the application that you use the equation for.

I am going to stop here because I want to obtain the rudimentary measurement information first before I focus on anything else. Please include the "divider" type (I am thinking "power splitter" but I could be wrong) if it is not set forth in the pictoral diagram.

Again, I want to thank you for your reply.

Again, thank you for your reply.

algoss

Posts: 602
Registered: 11/03/06

**Re: High Frequency Oscilloscope Measurements**
Posted: Mar 11, 2013 11:29 AM in response to: SOLT_guy

Reply

Tell me what you are trying to do and I'll help you make the measurement.

What are you trying to test?

Al

SOLT_guy

Posts: 268
Registered: 05/30/09

**Re: High Frequency Oscilloscope Measurements**
Posted: Mar 12, 2013 7:58 AM in response to: algoss

Reply

I am shopping for a new oscilloscope and when working with my oscilloscope at high frequency, I began to notice measurement anomolies which could be explained as SWR effects. I wanted to see the approach to this conundrum in the time domain and analyze the measurement accuracy.

When I purchase new equipment I tend to include what all my costs are going to be (in the case of an oscilloscpe I factor in the price of a new high frequency probe - I know that Agilent will give the customer a new probe when you buy the oscilloscope. This is just an example). When other devices are required to make measurements, I factor those prices in. I also look at accuracy and the cost to obtain that accuracy and the potential versatility of the system I am going to purchase.

When you mentioned the measurement methods you described, I believe you had an example in mind. I would like to know what you had in mind because somewhere along the line I will probably have to repeat your methods.

Can you please send me pictoral diagram of what you had in mind?

Edited by: SOLT_guy on Mar 12, 2013 7:58 AM

algoss

**Re: High Frequency Oscilloscope Measurements**
Posted: Mar 13, 2013 6:07 AM in response to: SOLT_guy

Reply

Posts: 602
Registered: 11/03/06

My answer is no different for an oscilloscope than it is for any of the other test equipment, such as a spectrum analyzers, that you have asked about in other forums.

If you are checking a source, then you connect the source to the test equipment. If you want to see the signal going to another device, then you need to split the signal, using appropriate HW, and expect that you will see lower amplitude at both the scope and on the other device.

Al

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