

Application Note

Using AtaiTec “In Situ De-Embedding” (ISD) Software to Create a Differential S4P Probe De-embedding File

The AtaiTec “In Situ De-Embedding” (ISD) software is a premier probe and fixture extraction software. It is employed to create a differential S4P (Touchstone) de-embedding file that includes modeling the differential cross-talk. The AtaiTec software is sold as an option for the DVT Solutions, LLC true odd mode differential probes. Once you receive your probe system, below is the process for installing the ISD software on the PC that will be used to create the differential probe model. The 2-month license includes technical support to generate your custom probe de-embedding file for any of the probes listed in Fig. 1.

AtaiTec ISD Software Installation and Support Information

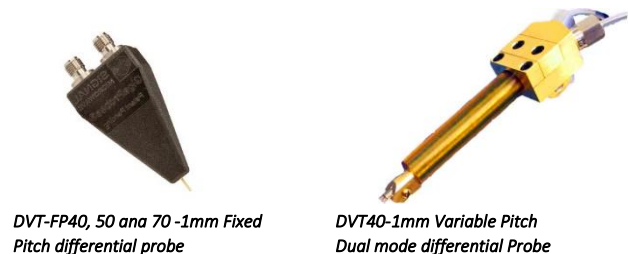
In order to issue the ISD software license after the probe system components are delivered, the customer must provide their computer’s MAC address to AtaiTec where the ISD software will be installed. After the software is installed, it is active for two months, including technical support and upgrades. The ISD license can be extended by contacting AtaiTec.

- a) Type “command prompt” in the Start menu, then type “getmac.”
- b) The physical address of the computer is the MAC address, which consists of six sets of alphanumeric characters separated by hyphens (e.g., 4B-BB-6B-94-DF-16). The Ethernet MAC address is preferred but any set will work.
- c) Email the MAC address to Ching-Chao Huang at huang@ataitec.com.
- d) You will receive a license for the ISD software via email.
- e) Follow instructions to install the software and license.
- f) **Support:** Two months of technical support and software updates.
- g) **Contact Information:** Contact Ching-Chao Huang at huang@ataitec.com for technical support.

Once the ISD software and license are installed on the computer, this application note demonstrates how to create an S4P de-embedding file for the supported differential probes in **Fig. 1**.

(Fig. 1) AtaiTec-supported Differential Probes

- DVT-FP70-1MM, fixed pitch 70 GHz differential probe
- DVT-FP50-1MM, fixed pitch 50 GHz differential probe
- DVT-FP40-1MM, fixed pitch 40 GHz differential probe
 - All DVT-FP40, 50 and 70-1mm probes are protected by “Patent 10852322 and other patents “
- DVT40-1MM variable pitch (0.3–1.8 mm) 26.5 GHz, 4.5 ps differential probe



In this application note, we will create a custom 70 GHz de-embedding file for the DVT-FP70-1MM, 70 GHz differential probe. This process can be applied to any of the probes in **Fig. 1**. DVT Solutions, LLC uses AtaiTec ISD software to create the differential probe de-embedding file since they are classified as a true odd mode differential probe. These differential probes use internal coupling so no ground pins are required, only signal-signal probe tips. With no ground referencing at the signal probe tips, it is essential that the ISD software model differential probes crosstalk, which is a patented feature of this software. The S-parameter measurements in **Figs. 2, 3 and 4** are used to create the S4P differential probe model. The Anritsu 70 GHz, 4-port VectorStar VNA and the DVT-FP70-1MM, 70 GHz differential probe will be used to acquire these measurements. These measurements are imported to the ISD software to produce the probe de-embedding file. When used as a probe de-embedding file with a VNA, the probe loss is accurately removed from the insertion loss measurement.

Probe measurements required by the ISD software for S4P network extraction:

- Probe_OPEN.S2P (Fig. 2), Probe_SHORT.S2P (Fig. 3) and Probe_In_Situ.S4P (Fig. 4)

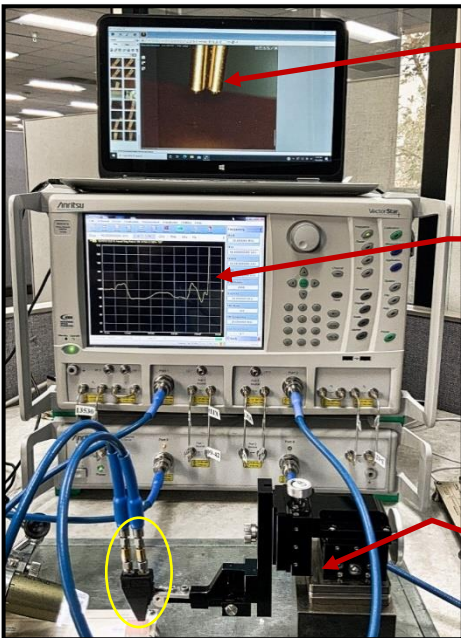
Once the differential probe de-embedding file is created by the ISD software, the accuracy of the de-embedding file can be verified. This is done by measuring the insertion loss of the 70 GHz differential “connector to probe” trace on the DB70-002 70 GHz broadband test verification board. The insertion loss measurement can be plotted on the VNA with and without the probe de-embedding file being enabled. The difference between the two measurements is equivalent to the known loss of the DVT-FP70-1MM probe.

Detailed procedure for measuring, extracting, and verifying the probe de-embedding files

Perform a harmonic calibration of the Anritsu 70 GHz 4-port VNA (or equivalent instrument) using the Short-Open-Load-Thru (SOLT) method. A harmonic calibration requires the start frequency to equal the step size of the sweep so that every frequency point in the sweep is harmonically related to the first. Configure the VNA for Low Pass Time Domain and display the impedance waveform as a Step Response (TDR equivalent). Connect VNA ports 1 and 2 to the probe and acquire the Probe_OPEN.S2P measurement (as shown in Fig. 2). Next, acquire the Probe_SHORT.S2P measurement by probing a copper plate as shown in Fig. 3. Finally, set-up the 4-port VNA as shown in Fig. 4. Connect VNA ports 2 and 4 to the probe and ports 1 and 3 to the connectors on the differential “connector to probe” trace located on the DB70-002 70 GHz broadband test verification board. Verify that the ports 1 to 2 and 3 to 4 are connected via the differential “connector to probe” trace on the board. This setup is used to acquire the Probe_In_Situ.S4P data, which is required by the ISD software to create the probe model in Fig. 6. This setup can also be used to verify the probe model accuracy. The Low Pass Time Domain impedance plot, with Step Response enabled, allows for confirming that the probe tips are *not* making contact for the Probe_OPEN.S2P measurement in Fig. 2 and, additionally, to verify that both probe tips are touching the copper shorting block used to obtain the Probe_SHORT.S2P measurement in Fig. 3. Finally, the Time Domain plot is used to verify that the probe tips are making contact with the differential “connector to probe” trace to acquire the Probe_In_Situ.S4P measurement in Fig. 4. Later, the VNA is used to verify the probe model by measuring the insertion loss of the 70 GHz “connector to probe” trace and then de-embedding the DVT-FP70-1MM probe model in the same measurement. The difference between the two measurements is the additional insertion loss contributed by the DVT-FP70-1MM probe.

Making S-parameter Measurements for Probe Network Extraction using the ISD Software

(Fig. 2) Probe_OPEN.S2P Measurement

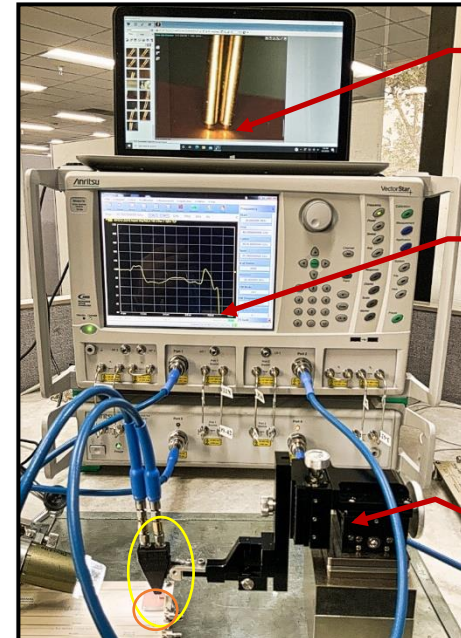


USB Camera shows Probe Tips not Connected

TDR Plot shows Probe Tips are Open

DVT-FP70-1MM 70 GHz Probe installed in DVT-FP250 Probe Positioner Arm
Process: Acquire Probe_OPEN.S2P Measurement File

(Fig. 3) Probe_SHORT.S2P Measurement



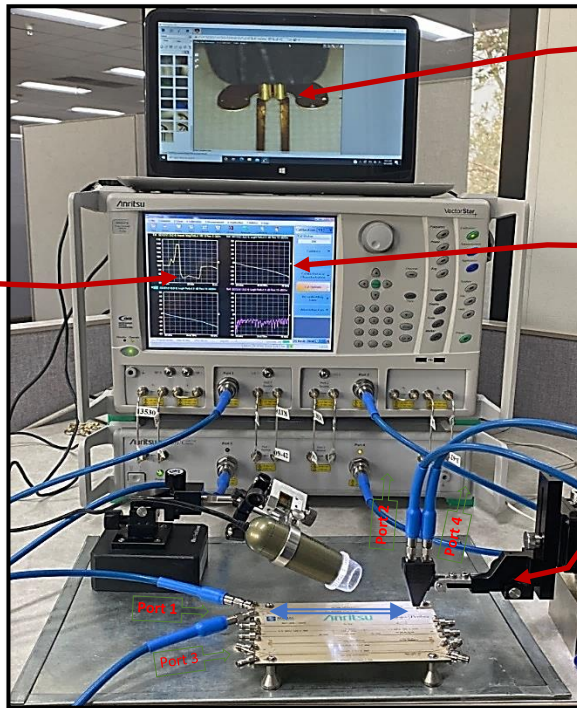
USB Camera shows Probe Tips Connected to a **Copper** Shorting Block

TDR Plot shows Probe Tips are **SHORTed**

DVT-FP70-1MM 70 GHz Probe Installed in DVT-FP250 Probe Positioner Arm
Process: Acquire Probe_SHORT.S2P Measurement File

(Fig. 4) Probe_In_Situ.S4P Measurement

TDR Plot shows Probe tips are Connected to Differential Trace



USB Camera shows the Probe Tips are Connected to the Differential "connector to probe" Trace on DB70-002 board

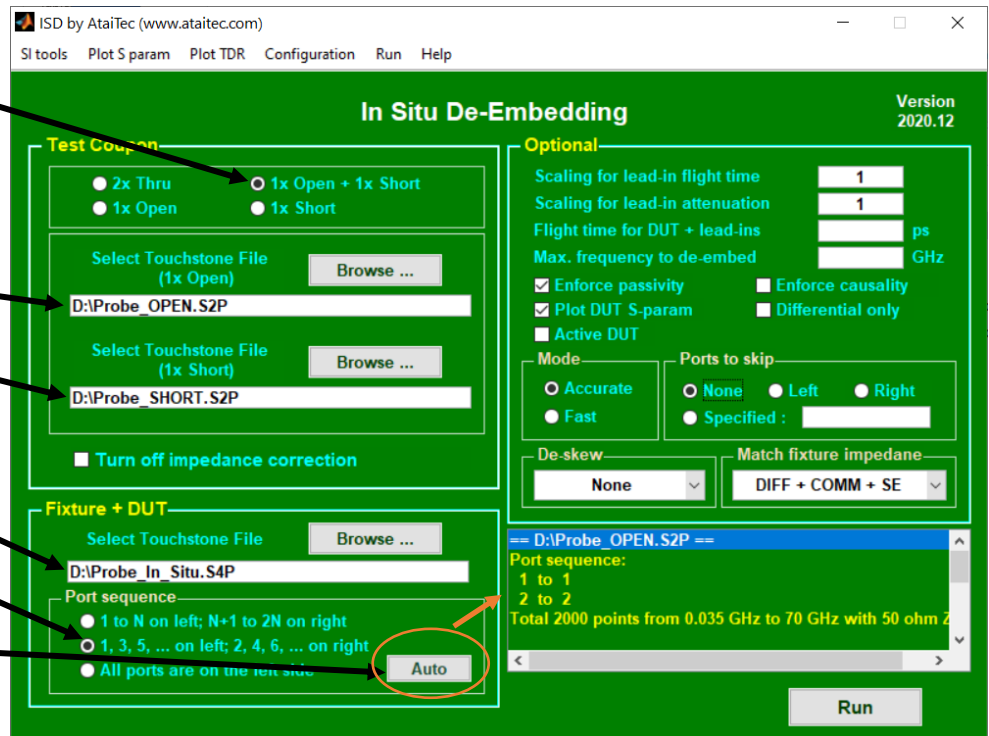
Insertion Loss Plot shows Probe In Situ "thru" S4P Measurement used to Create Probe Model in the ISD Software

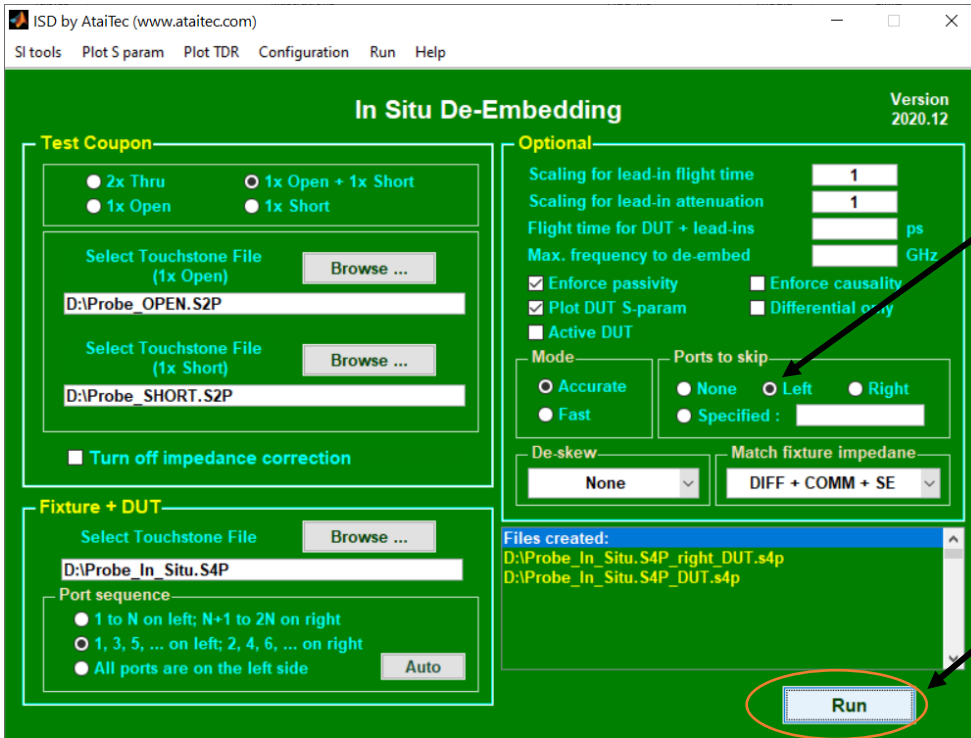
DVT-FP70-1MM 70 GHz Probe installed in the DVT-FP250 Probe Positioner Arm. Probe the Differential "connector to probe" Trace

Process: Acquire Probe_In_Situ.S4P Measurement File

(Fig. 5) Steps to Extract a Differential S4P Probe Model Using the ISD Software

- 1) Run the ISD software and select **1x Open + 1x Short**
- 2) Load the **Probe_OPEN.S2P** (Fig. 2) and **Probe_SHORT.S2P** (Fig. 3) measurements **Browse**
- 3) Load the **Probe_In_Situ.S4P** (Fig. 4) measurement.
- 4) Verify that the VNA ports are assigned correctly (1 and 3 on left, 2 and 4 on right). Click **Auto** to have port sequence assigned automatically and override if necessary. (Scroll down the box at lower right corner to see summary of Probe_In_Situ.S4P.)



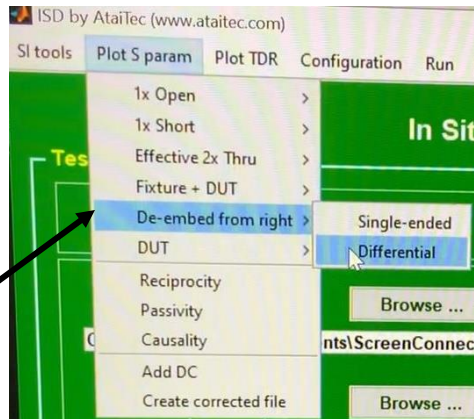


5) Under section **Optional** and “Ports to Skip” select **Left**. This option will skip the left port because the probe is on the right side of the differential trace. Refer to **Fig. 4** (and **Fig. 9**).

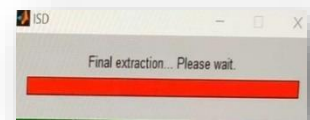
6) Select **Run** to start the network extraction process that will create the S4P model for the differential probe.

8) The differential probe model (i.e., the de-embedding model) is saved in Probe_In_Situ.S4P_right_DUT.s4p with Ports 1 and 3 at the probe tips and Ports 2 and 4 at the connector in this case. To view the differential probe S4P model, use the following menu sequence:

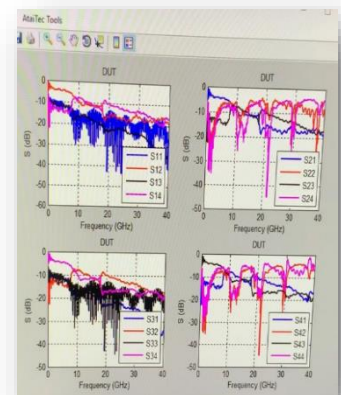
Select “Plot S param,” then “De-embed from right” and select “Differential.”



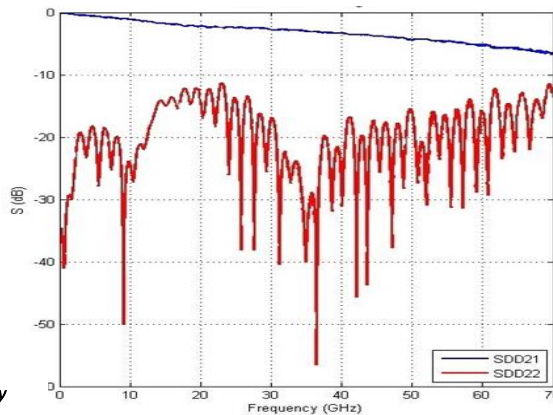
7A) The progress bar briefly appears showing that the network extraction is in progress.



7B) Once the extraction is complete, the ISD software will plot the DUT’s single-ended S-parameter results.



DVT-FP70-1MM 70GHz Differential Probe
All DVT-FP40, 50 and 70-1mm probes designs are protected by “Patent 10852322 and other patents”

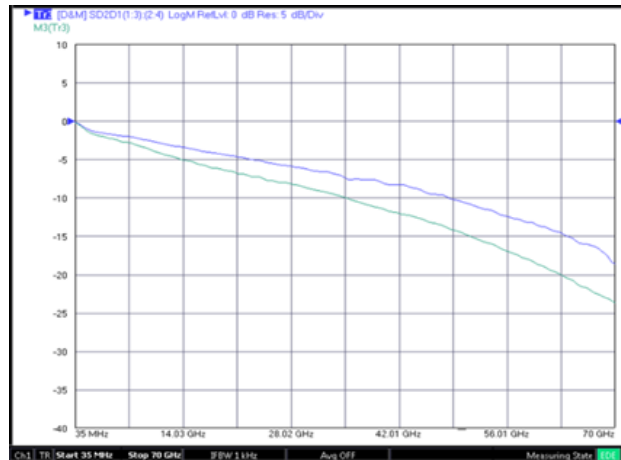


(Fig. 6) The AtaiTec ISD software plots the DVT-FP70-1MM differential S-parameters and shows the probe loss and its bandwidth. The software creates an S4P file, which is then used to de-embed the probe loss from the insertion loss measurement.

Verifying the AtaiTec ISD Extracted Differential Probe Model

Begin with the **Probe_In_Situ.S4P** measurement set-up on the VNA (as shown in **Fig. 4**). This represents the differential insertion loss of the differential PCB trace plus the probe to 70 GHz. Store this insertion loss trace to memory. In this example, it is the (green trace) in **Fig. 7** below. To verify the differential probe model, apply the extracted model shown in **Fig. 6** as the de-embedded file in the VNA. This results in the (blue trace) in **Fig. 7** below. The traces in **Fig. 7** show an -8 dB difference between the two insertion loss measurements at 70 GHz with and without the probe loss. To order a 40GHz, 50GHz or 70GHz ISD In-situ development and verification board refer to **Fig10** below.

Fig. 7



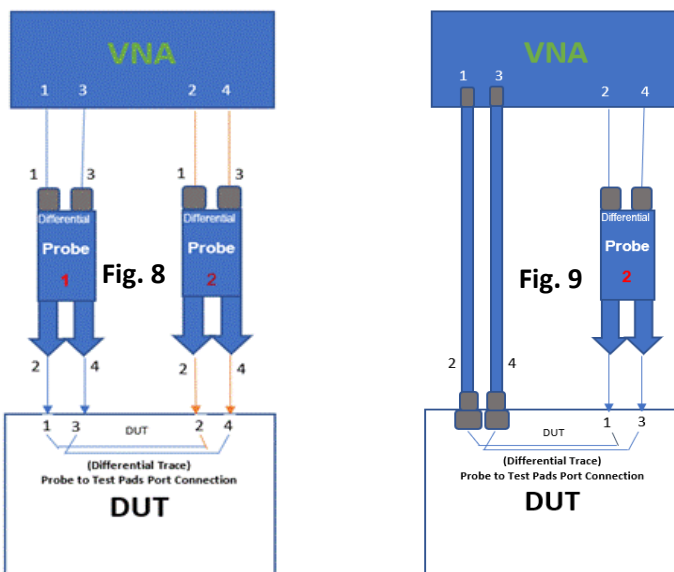
Insertion loss measurement with probe de-embedded

Insertion loss measurement with no probe de-embedded

VNA De-Embedding Port Assignment Examples

Below are two common probing applications where in **Fig. 8**, a connector cannot be placed on the PCB to connect to the VNA using a cable. Thus, two probes are required to make a probe-to-probe insertion loss measurement using a 4-port VNA. In **Fig. 9**, a connector can be installed on the PCB edge in a “probe-to-connector” measurement configuration. A common example is an I/O test pad connected, via a differential trace, to a set of edge launch RF connectors on a semiconductor device test board.

The VNA’s measurement ports are user defined, but in this example, VNA ports 1 to 2 and 3 to 4 are the “thru” measurements. If you follow the connections through the differential traces in **Figs. 8** and **9**, the differential trace paths are assigned to the VNA “thru” measurement paths.



Part#	BW	Connector
ISB40:	40GHz	2.92mm
ISB50:	50GHz	2.4mm
ISB70:	70GHz	1.85mm

Choose board that matches probe bandwidth

Fig 10) ISBXX (XX=BW) part numbers for the ISD in situ board used to make the probe to connector (probe in-situ) measurements required to develop and verify the accuracy of AtaiTec ISD software probe models as see in the above VNA plots.

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