In Situ De-embedding (ISD)
Accurate fixture de-embedding to reduce hardware cost

Almost all component and system manufacturers need to do fixture de-embedding to characterize the electrical performance of a component, ranging from chip to package, printed circuit board (PCB), connector and cable. In the past, vector network analyzer (VNA) with thru-reflect-line (TRL) or 2x thru calibration was often used. In order to reduce impedance variation between calibration structure and actual fixture, expensive hardware with high-quality connectors, PCB material and tight etching tolerance is required. Even so, PCB traces see different fiber weave and therefore impedance at every location, resulting in causality error in the de-embedded device-under-test (DUT) data that makes correlation with simulation difficult. A cost effective and accurate de-embedding solution is highly desired.

In Situ De-embedding (ISD)

AtaiTec introduces In Situ De-embedding (ISD) to solve the impedance variation problem in de-embedding through software instead of hardware. ISD is the first in the industry to use the fixture's impedance, instead of calibration structure's impedance, for de-embedding. Cost saving is achieved because inexpensive hardware with larger impedance variation between calibration structure and fixture can now be used. De-embedding accuracy is improved because the results are inherently causal. The improved accuracy makes correlation easier and reduces time for design refinement. Such applications as compliance testing and material property extraction all benefit from more accurate de-embedding.

Inputs and outputs

Configured like mobile apps, ISD is as easy to use as 1-2-3. The user inputs two Touchstone files (one for Test Coupon and one for Fixture+DUT) and clicks "Run". ISD then separates Fixture and DUT and outputs their corresponding Touchstone files.
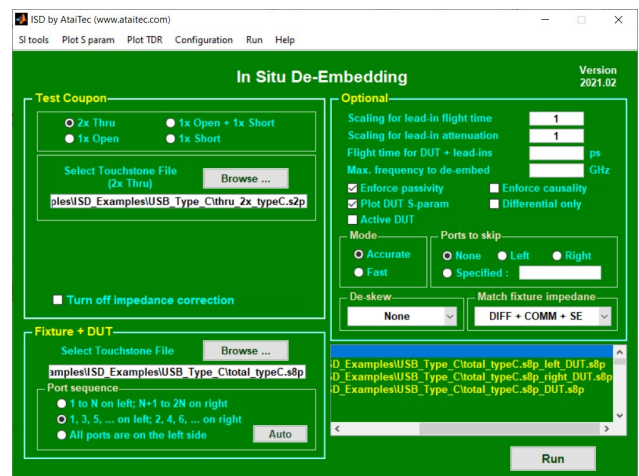

Figure 1. In Situ De-embedding (ISD) de-embeds fixture and extracts accurate data for device-under-test (DUT) in a mobile-apps-like easy-to-use package.

Test Coupon

Test coupon (or calibration structure) can be in 2x thru, 1x open + 1x short, 1x open or 1x short. The 2x thru Test Coupon corresponds to 2x length of Fixture to either the left side or right side of DUT. When the Fixture is symmetric (i.e., the left and right sides have similar delay and attenuation), only one set of 2x thru is needed and ISD is run once to de-embed the left and right Fixture simultaneously .

When the Fixture is asymmetric (i.e., the left and right sides have different delay and/or attenuation), two sets of 2x thru are needed and ISD is run twice to de-embed the left and right Fixture separately. The 2x thru Test Coupon does not need to have the same impedance as Fixture. However, the 2x thru Test Coupon should have similar delay and attenuation as Fixture, so the 2x thru Test Coupon is typically fabricated together with the Fixture. Similarly, 1x open (or short) corresponds to one side of Fixture with one end close to DUT being left open (or short). The 1x open (or short) Test Coupon can be either the Fixture itself without DUT or fabricated together with the Fixture. The 2x thru Touchstone file must be in either .s2p or .s4p and the 1x open (or short) Touchstone file must be in either .s1p or .s2p.
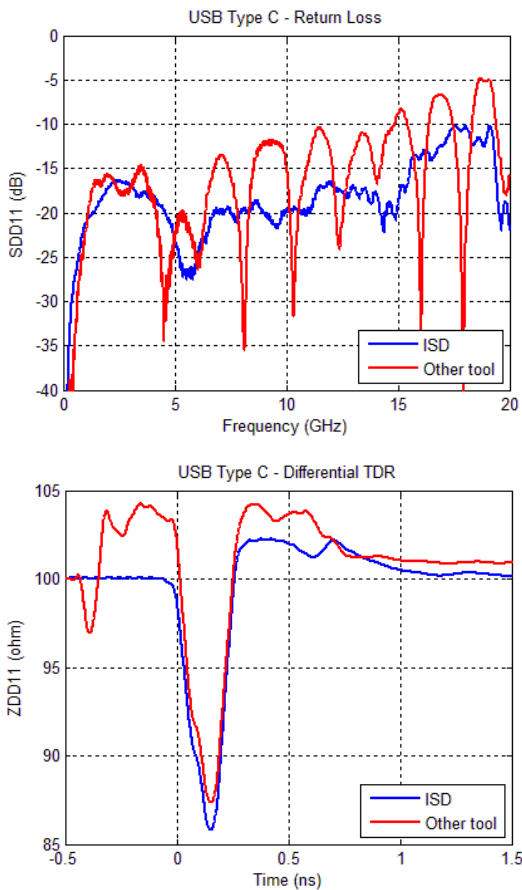

Figure 2. In this USB Type C example, ISD gives causal DUT results while other tool gives many artificial ripples in SDD11 and non-physical TDR response before time 0.

Fixture + DUT

Fixture + DUT Touchstone file can be in any .snp (e.g., s1p, s2p, …, s99p, …). A wild card (*) can be specified in the file name to de-embed multiple files with the same Test Coupon. The user can click an "Auto" button to identify the port sequence and output such information as # points, min/max frequency and reference impedance of Touchstone file.

Features

Turn off impedance correction

Split 2x thru directly to mimic other de-embedding tools.

Scaling for lead-in flight time and/or attenuation

Scaling Test Coupon allows slightly smaller or larger Fixture (vias before DUT, for example) to be de-embedded.

Skip ports for de-embedding

For asymmetric Fixture, the user can run ISD twice and select appropriate ports to skip de-embedding each time.

SI tools

Convenient SI tools are available to re-order port sequence, check S-parameter quality and correct passivity and reciprocity.

Plot S param and TDR

Single-ended and differential S parameters and TDR are plotted for Test Coupon, Fixture + DUT and de-embedded Fixture and DUT.

Configuration

The same setup can be saved and reused for de-embedding.

Batch mode

Multiple ISD jobs can be stacked together and run in batch.

Applications

There are many ways to run ISD for various applications (Figure 3).

Split 2x thru only

2x thru Test Coupon can be split into two halves. The DUT in this case is a straight thru.

Calculate 1x thru from 1x open/short

The complete S-parameter matrix of 1x thru can be recreated from the return loss of 1x open and/or 1x short.

Delta-L (Eigenvalue) method

The eigenvalue method can be used for quick calculation of PCB trace attenuation when a shorter trace is entered for 2x thru and a longer trace is entered for Fixture + DUT. The DUT in this case is trace only that corresponds to the center portion of longer trace.

Compare ISD with Delta-L method

The user can easily compare PCB trace attenuation calculated by direct division, Eigenvalue and ISD. Figure 4 shows that ISD with automatically renormalized impedance gives the smoothest curve with minimal ripples or spikes.
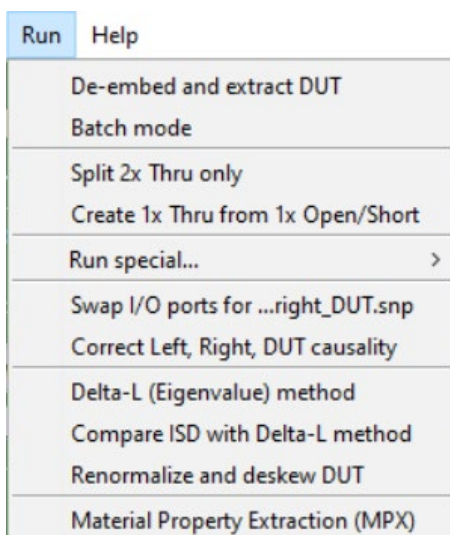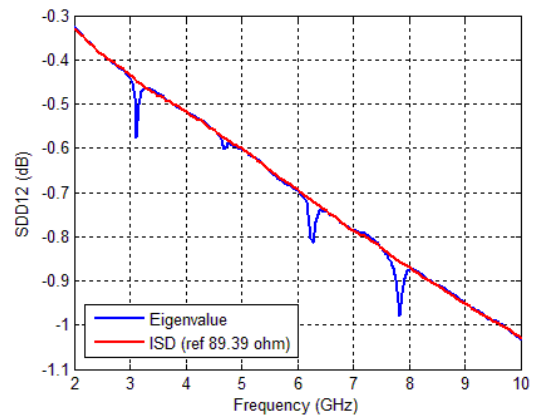

Figure 3. Many ways to run ISD.

Figure 4. In this 2" PCB trace only extraction, ISD with automatically renormalized impedance gives the smoothest attenuation curve with minimal ripples or spikes.

Material Property Extraction (MPX) option

The MPX option, which requires ADK and X2D2 licenses, allows the user to extract PCB's dielectric property (DK, DF) and metal roughness from trace-only DUT results.

OS and software licensing

ISD software license is available for all Windows in any combination of node-locked or floating, time-based or permanent and with or without a dongle. To obtain a trial license, send your computer's MAC address to info@ataitec.com

Sales and technical support

For sales and technical support, contact our partner or local distributor or email: info@ataitec.com

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