

## TRL Calibration Procedure for MABA-011082-TB

Rev. V1

This document details how to accurately measure the MABA-011082-TB.

A TRL (Thru, Reflect, Line) calibration normally requires two transmission standards and one reflection standard. Examples of sub sets of TRL are, TRM (Thru, Reflect, Match), LRL (Line, Reflect, Line), LRM (Line, Reflect, Match). The traditional SOLT (Open, Short, Load, Thru) calibration requires one transmission standard (T) and three reflection standards (S, O, L). A single TRL calibration covers a 1:8 frequency range. It is possible to combine the TRM for low bands with multiple TRLs to achieve a wide band measurement. The extended standards needed for a TRL calibration are relatively easy to construct accurately in microstrip or grounded coplanar waveguide.

TRM and TRL calibration is used here to de-embed the DUT from the test board. This yields an accurate measurement of the DUT's performance. By combining the TRM and TRL a wide frequency range is measured. For this calibration a TRM is used 5-1000 MHz, a TRL 11 mm for 1-3 GHz and a TRL 6 mm for 3-8 GHz. The steps below have been implemented on a typical Keysight ENA, so on other test equipment the menu options may be slightly different.

This TRL de-embedded measurement works out more accurate than a custom de-embedded SOLT measurement. As the extended L standard becomes inaccurate above 1 or 2 GHz, when a shunt 50  $\Omega$  0402 load resistor is used at the end of a transmission line for the L standard.

MABA-011082-TB calibration procedure:

1. Set up the calibration coefficients.
  - a. Copy the <PT-0019995 TRL.CKX> file from the MACOM webpage into the ENA.
  - b. Press **CAL**, [Cal Kit User](#) → [Modify Cal Kit](#) → [Import Cal Kit](#)
  - c. upload the "PT-0019995 TRL" file to an unused calibration coefficient memory location.
2. Connect 3x 50 Ohm cables to the ENA. Use cables with N-Type to SMA connectors.
3. Manually step through the TRL calibration using the following steps.
4. THRU
  - a. On the ENA click the **CAL** button and then [Calibrate](#) on screen button.
  - b. Click on [3-Port TRL Cal](#)
  - c. Connect the zero length thru "THRU" between cables 1-2.  
Click on [Thru/Line](#) → [1-2 Thru/Line Thru](#)
  - d. Move the THRU to cables 1-3. Click on [Thru/Line](#) → [1-3 Thru/Line Thru](#)
  - e. Move the THRU to cables 2-3. Click on [Thru/Line](#) → [2-3 Thru/Line Thru](#)
5. Reflect
  - a. Connect SHORT to cable 1. Click on [Reflect](#) → [Port1 Reflect short](#)
  - b. Move the SHORT to cable 2. Click on [Port2 Reflect short](#)
  - c. Move the SHORT to cable 3. Click on [Port3 Reflect short](#)
6. MATCH1
  - a. Connect the 3x loads to cable 1, 2 & 3 at the same time.
  - b. Click on [1-2 Line/Match](#) → [Line/Match1](#)
  - c. Click on [1-3 Line/Match](#) → [Line/Match1](#)
  - d. Click on [2-3 Line/Match](#) → [Line/Match1](#)

<p><b>Key</b>  <a href="#">Soft Key on ENA</a>  <b>Hard Key on</b></p>
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### 7. MATCH2

- Connect the “11 mm LINE” between cables 1&2
- Click on **1-2 Line/Match** → **Line/Match2 Line 11 mm 1-3 GHz**
- Move the “11 mm LINE” to cables 1-3. Click on **1-3 Line/Match** → **Line/Match2 Line 11 mm 1-3 GHz**
- Move the “11 mm LINE” to cables 2-3. Click on **2-3 Line/Match** → **Line/Match2 Line 11 mm 1-3 GHz**

### 8. MATCH3

- Connect the 6mm LINE between cables 1&2
- Click on **1-2 Line/Match** → **Line/Match3 Line 6 mm-3>GHz**
- Move 6 mm LINE to cables 1-3. **Click on 1-3 Line/Match** → **Line/Match3 Line 6 mm-3>GHz**
- Move 6 mm LINE to cables 2-3. **Click on 2-3 Line/Match** → **Line/Match3 Line 6 mm-3>GHz**

9. Press **DONE** to complete TRL calibration

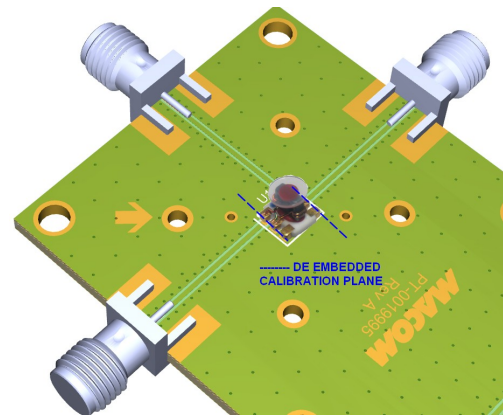
10. Press **AVG** → **Smoothing on** → set smoothing to **1.5%**

11. Connect test board with DUT.

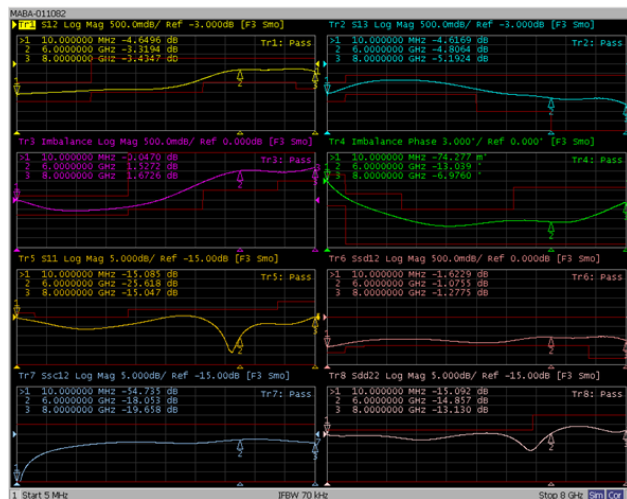
12. Use fixture simulator to set the port impedances

- Port 1 = 50 Ω
- Port 1 = 25 Ω
- Port 1 = 25 Ω

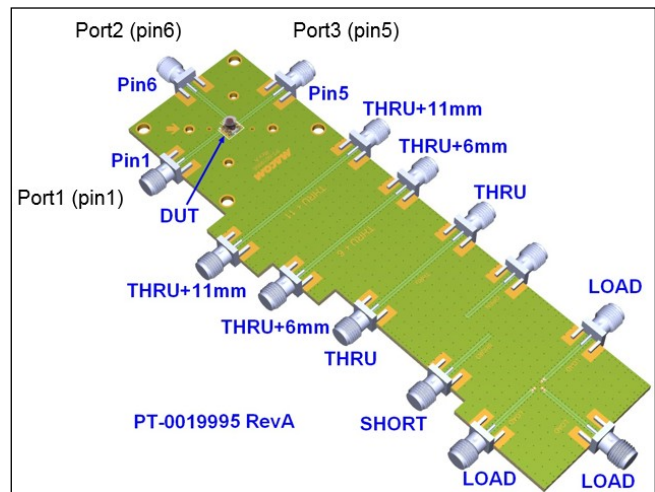
13. Now the ENA will display s-parameters that pass



Calibration de embedded to DUT



ENA test screen



MABA-011082-TB TRL calibration and test board

Application Note

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