

# A NEW 3.5mm TRL/LRL CALIBRATION KIT

A new type of calibration kit for Vector Network Analyzers (VNA) has been introduced that takes advantage of the full measurement capabilities of the VNA. The Tri-Kit calibration kit is designed for three types of calibration methods rather than just one. Most calibration kits in the past have been designed for one of two methods: Open-Short-Load-Thru (OSLT) or Thru-Reflect-Line (TRL). The Tri-Kit performs both methods as well as another very powerful, but usually overlooked, method called air line gating. Air line gating is more accurate than OSLT and much faster than TRL.



**Model 8060A14**

## The Three Calibration Methods

In this calibration application, TRL is a general term used to mean Thru-Reflect-Match (TRM), TRL or Line-Reflect-Line (LRL). In practice, TRM is used for low frequencies where a very long air line is required for the line standard. TRL is used at mid-frequencies and LRL is used for frequencies where air line standards become too short to be practical. The Tri-Kit is equipped with four air lines for TRL/LRL calibrations. **Table 1** lists the type of calibration required as a function of frequency. A VNA may be calibrated over a range of frequencies to 34 GHz using a combination of these techniques. TRL-type calibrations result in the best directivity and source match and are recommended for the highest degree of accuracy.

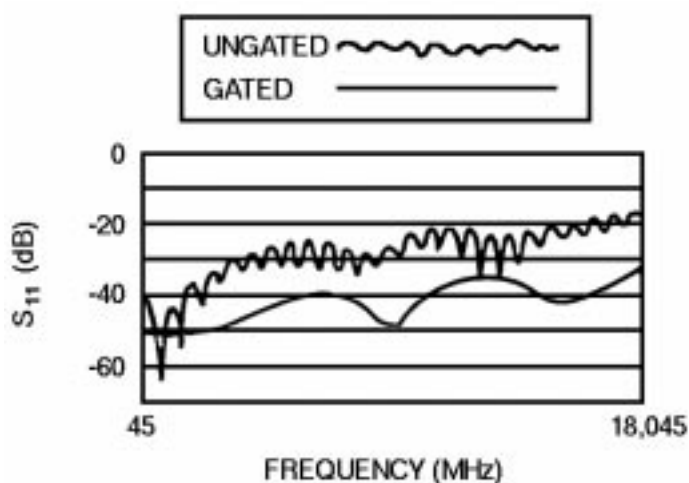
OSLT is often referred to as SOLT (Short-Open-Load-Thru); both terms refer to the same calibration method. When employing OSLT calibration, a fixed load is

generally used below 2 GHz and a sliding load is used above 2 GHz. The Tri-Kits are designed for fixed-load calibration using fixed terminations that are well matched up to 34 GHz. OSLT fixed-load calibrations are quick and easy to perform and are best suited for devices that exhibit moderate SWR. If greater accuracy is required, the supplied 15cm air line may be used with air line gating.

Air line gating is a time domain calibration used to selectively remove reflection time domain responses from the calibration. Using the supplied 15cm line, a very accurate one-port calibration can be achieved on a VNA using the Open-Short-Load technique. The 15cm line is terminated with a fixed load to provide an accurate impedance standard for calibration over the entire frequency range up to 34 GHz. By using air line gating, the reflections from the fixed termination are eliminated and the impedance of the air line becomes the standard. **Figure 1** shows the frequency response of a 7mm to 3.5mm adapter. The smoother trace is the gated frequency domain response of the adapter only. The effects of the fixed load on the measurement are removed. Air line gating calibrations are faster than TRL/LRL calibrations and provide much higher directiv-

**TABLE 1**  
Calibration Methods vs. Frequency

Frequency Range	Type of Calibration	Calibration Standards
DC — 800 MHz	TRM	Fixed termination
160 MHz — 800 MHz	TRL	15cm air line
800 MHz — 2.5 GHz	TRL	5cm air line
2.5 GHz — 12.5 GHz	LRL	5cm and 6cm air lines
8.5 GHz — 34 GHz	LRL	5cm and 5.3cm air lines



**Figure 1:** The gated frequency response of a 7mm to 3.5mm adapter

ity than fixed load calibrations, but do not allow accurate measurement of devices longer than the air line.

### A Typical TRM/TRL/LRL Calibration

The 3.5mm Tri-Kit calibration kit comprises the items listed in [Table 2](#). Performing a typical network analyzer calibration over the entire 40 MHz to 34 GHz frequency range with the highest degree of accuracy requires several steps. First, a TRM calibration is performed from the lowest network analyzer frequency to 160 MHz using the fixed termination, thru connection and short circuit termination. Next, a TRL calibration is performed from 160 to 800 MHz using the thru connection and 15cm air line. A TRL calibration then is performed from 800 MHz to 2.5 GHz using the thru connection and 5cm air line, and an LRL calibration from 2.5 to 12.5 GHz is accomplished with the 5cm air line (as the thru reference) and the 6cm air line. Finally, an LRL calibration is completed from 12.5 to 34 GHz using the 5cm air line (as the thru reference) and the 5.3cm air line. Narrower bandwidths only require the standards outlined previously rather than the entire complement of components required for full bandwidth use.

Specifications for the calibration kit include operation over the DC to 34 GHz frequency range, a 50  $\Omega$  impedance, a minimum return loss of 48 dB and an electrical length accuracy of 0.0025cm. The short circuits feature a reflection coefficient of 0.98 (mini-

mum) and a 50  $\Omega$  impedance (standard); the open circuits feature a reflection coefficient of 0.99 (minimum) and 1.5° phase accuracy. Both cover the full DC to 34 GHz frequency range. The 50  $\Omega$  fixed terminations handle 0.5 W CW power and 0.25 kW peak power. The 3.5mm adapters have SWR specifications of 1.05, 1.08, and 1.15 for the DC to 18, 18 to 26.5, and 26.5 to 34 GHz frequency ranges, respectively.

**TABLE 2**  
3.5mm Calibration Kit Contents

Model	Description	Quantity
8043S15	3.5mm Female to male air line	1
8043S5	3.5mm Female to male air line	1
8043S6	3.5mm Female to male air line	1
8043S53	3.5mm Female to male air line	1
8046F	3.5mm Female fixed short	1
8047F	3.5mm Male fixed short	1
8048A1	3.5mm Female open circuit	1
8048B1	3.5mm Male open circuit	1
8031A5	3.5mm Female fixed termination	1
8031B5	3.5mm Male fixed termination	1
8021A2	3.5mm Female to female Adapter	1
8021B2	3.5mm Female to male adapter	1
8021C2	3.5mm Male to male adapter	1
—	5/16" Double-end wrench	2
8021S14A	Calibration constants disk	1
—	Instrument case	1
—	Operating instructions	1

### Conclusion

Fast and accurate 3.5mm calibration of VNAs is now possible from DC to 34 GHz using the Tri-Kit calibration kit, which takes advantage of the full measurement capabilities of the analyzer. Additional information on the calibration kit may be obtained from the company's web site at [www.maurymw.com](http://www.maurymw.com).

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