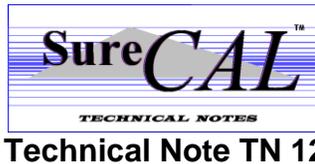


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Technical Note TN 12

## **Vector Network Analyzer upgrade to SureCAL RF Components Package**

### Overview:

This Technical Note describes the addition of Vector Network Analyzer (VNA) measurement capabilities to the RF Components Packages.

Topics covered in this technical note:

- Measurement Format
- Devices Supported
- New and Extended Support Device Profile Structure
- Supported VNA's
- VNA Test Set and Calibration Kit Descriptions and Capabilities
- VNA Test Set Definition Files
- VNA Calibration Kit Definition Files
- Supported Calibration Kit Types
- Supported Calibration Types
- Calibration Sequence
- Sliding Load Sequence
- Saving Calibrations
- Adapter Techniques

### Measurement Format:

The VNA addition provides the RF Component Package the ability to now support both 1 and 2 port measurement standards. The VNA upgrade is designed to be transparent to RF Component Package users. Except where new measurements are added as a result of expanded capabilities, the format of both current and new calibration procedures adhere to all previously defined structures. The ability of the user to freely manipulate, save and assign modified profiles developed from default parameters remains unchanged.

### Devices Supported:

Support for the following new devices has been added.

- Filters
- Power Splitters
- Power Dividers
- Isolators
- Mismatches

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Support has been extended to the following devices.

- Fixed, Decade, Programmable Attenuators
- Directional Couplers
- Terminations
- Power Sensors

#### New and Extended Support Device Profile Structure:

New device profiles appear in the profile pick list with a Type “Default” and a Status “Assigned”. To avoid profile index conflicts, extended support device profiles appear in the profile pick list with a Type “Default” and a Status “Floating”. To automatically recall these extended support profiles the Status will need to be reassigned by the operator using the Assign function.

#### VNA Support:

The VNA’s are addressed in the Flexible Standards table as integrated systems. Identification of system components such, as VNA sources, within the Flexible Standards table is not required. Since VNA configurations between manufacturers and model numbers can vary, care must be taken to verify VNA primary and secondary as well as pass through addresses do not conflict with other devices within the table.

#### VNA Test Set and Calibration Kit Descriptions and Capabilities:

Identification of both the test set and calibration kit being used is critical to determining measurement capabilities and uncertainties. The process of identifying the specific model numbers is provided via a pick list. The operator is queried at the start of a new procedure or whenever a profile parameter is altered.

#### VNA Test Set Definition Files:

Each VNA requires the use of an internal or external S Parameter Test Set to perform “error corrected” S-Parameter measurements. The Test Set Definition Files contains performance values derived from both simple specifications tables and calculations simulating combined performance of test set, VNA and calibration kit components. These values are based on theoretical performance and not actual measured values. They are not serial number specific. The test set files are stored in the SureCAL DATA folder and are identified by manufacturer/model number with an extension of .TSD.

The test set information is read from the .TSD file and used to optimize VNA performance as an “error corrected” system. In the “error corrected” mode, the VNA’s performance parameters have been optimized to the defined limits of the calibration kit, VNA configuration and skill of the operator.

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## Test Set (.TSD) file example for the Agilent/HP 8514A

```
.50-18GHz TEST SET
8514A
18 GHz
DETENORB;
ERROR TERMS
ERROR TERM      FREQUENCY (GHz)      ERROR TERM VALUE (LINEAR)
=====
REFL TRACKING   .5 TO 2              -    .0070000
                2 TO 8              -    .0070000
                8 TO 18            -    .0070000
TRAN TRACKING   .5 TO 2              -    .0139000
                2 TO 8              -    .0139000
                8 TO 18            -    .0139000
ISOLATION       .5 TO 2              -    .0000060
                2 TO 8              -    .0000018
                8 TO 18            -    .0000028
NOISE FLOOR     .5 TO 2              -    .0001400
                2 TO 8              -    .0000428
                8 TO 18            -    .0000530
=====
REFL & TRAN TRACKING ERROR TERMS ARE TAKEN FROM THE
HP85131F CABLE SET MAGNITUDE STABILITY SPECIFICATION.
(0.12dB = 0.0139 LIN MAG)
NOTE REFL TRACKING IS SIMPLY HALF THE TRAN TRACKING
```

### VNA Calibration Kit Definition Files:

Each VNA also requires the use of a calibration kit to perform “error corrected” measurements. The purpose of the cal kit definition file is to provide electrical and mechanical definitions of the calibration kit components. These definitions are based on kit/device specifications and not actual measured values. They are not serial number specific. The calibration kit files are stored in the SureCAL DATA folder and identified by manufacturer/model number with an extension of .CKD.

The calibration kit information is read from the data file and inputted to the VNA. This information is used when performing the VNA calibration function. The device specific information ultimately allows the characterization of the VNA to perform measurements in the “error corrected” mode. In the “error corrected” mode, the VNA’s performance parameters have been optimized to the defined limits of the calibration kit and skill of the operator.

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## Calibration Kit (.CKD ) file example for the Agilent/HP 85054D

N CAL KIT				
85054D				
18 GHz				
18 GHz FIXED TERM				
ERROR TERMS & CAL COEFFICIENTS				
ERROR TERM	FREQUENCY (GHz)		ERROR TERM VALUE (LINEAR)	
=====				
DIRECTIVITY	0 TO 2	-	.0100000	
	2 TO 8	-	.0158000	
	8 TO 18	-	.0200000	
LOAD MATCH	0 TO 2	-	.0100000	
	2 TO 8	-	.0158000	
	8 TO 18	-	.0200000	
SOURCE MATCH	0 TO 2	-	.0119000	
	2 TO 8	-	.0232000	
	8 TO 18	-	.0367000	
*****				
STANDARD				
(TEST PORT SEX)	LENGTH	STRAY C/L	LOSS	
=====				
FEMALE OPEN	57.993 (E-12)	* 89.939 (E-15)	.93	
	.0173860	* 2536.8 (E-27)		
* -264.99 (E-36)				
* 13.4 (E-45)				
MALE OPEN	22.905 (E-12)	* 104.13 (E-15)	.93	
	.0068667	* -1943.4 (E-27)		
* 144.62 (E-36)				
* 2.2258 (E-45)				
FEMALE SHORT	63.078 (E-12)	* 0.7563 (E-12)	1.1273	
	.0189100	* 459.88 (E-24)		
* -52.429 (E-33)				
* 1.5846 (E-42)				
MALE SHORT	27.990 (E-12)	* -0.1315 (E-12)	1.3651	
	.0083912	* 606.21 (E-24)		
* -68.405 (E-33)				
* 2.0206 (E-42)				
M-M ADAPTER	196.00 (E-12)		2.2	
	.0587590			

### Supported Calibration Kit Types:

Since Calibration Kits are identified and quantified through .CKD files, there are no restrictions between VNA and Calibration Kit manufacturers. Requirements are based on compatibility between frequency, connector and calibration type.

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### Supported Calibration Types:

Support is provided for several types of Short, Open, Load and Thru (SOLT) 1 and 2 port calibrations. Selection of Calibration Types is available through the Standards Profile function.

Calibration types are labeled as follows:

- Broadband Load
- Fixed/Sliding Load
- Waveguide
- E-Cal (Support for Agilent PNA E-Series and PNA N-Series only)

### Calibration Sequence:

Calibrations are guided with graphic instructions for each step. The contrasting sequence of the calibration devices (i.e. Open/Short, Short/Open...) is a result of two factors, elimination of the possibility of requiring two of the same sex calibration devices and deference to the most limiting VNA within the support list.

### Sliding Load Sequence:

The sliding load is measured at five unequally spaced positions. The measured data at each frequency point is used to calculate the vector sum of the directivity error and load reflection. Five unequally spaced points represents the best compromise for determining a complete 360 degree change in phase while remaining compatible with the largest possible number of calibration kits.

### Saving Calibrations:

The most current calibration is saved and can be recalled for a 24 hour period. The saved calibration details are compared to the current requirement using discriminators of connector type, calibration type and number of frequency points. If in agreement, the option of using this saved calibration is presented to the operator. The operator can decline the saved calibration and select a new calibration at this time.

### Adapter Techniques:

For ease of operation and limited capability within some supported VNA's, the initial release of the RF Components VNA Update supports adapter substitution techniques. This method will yield successful results when calibration kit, metrology grade, equal electrical length adapters are used.