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Lightning™

Network Analysis Solutions for Design and Manufacturing

37000E

Vector Network Analyzers, 40 MHz to 65 GHz

Introduction

The Lightning E series microwave and millimeter-wave Vector Network Analyzers encompass a wide range of high performance component and system test tools designed to address the growing needs of defense, satellite, radar, broadband communication, and optoelectronic component markets. Complete measurements solutions to 20 GHz, 40 GHz and 65 GHz are available in microwave models 37x47E, 37x69E, and 37x97E, respectively.

Powerful Applications

Amplifier Testing – Automatically perform swept power gain compression or swept frequency gain compression.

Mixer Measurements – Directly measure frequency translation devices utilizing the NxN multiple device solution utility.

Multiport Testing – Add a multiport test set and perform balanced and differential tests on two or multiport devices.

Optoelectronic Devices – Measure E/O and O/E devices incorporating the de-embedding routine and photo detector transfer function.

Embedding/De-embedding – Manipulate S2P networks to automatically remove fixtures and devices or add effects of a known structure.

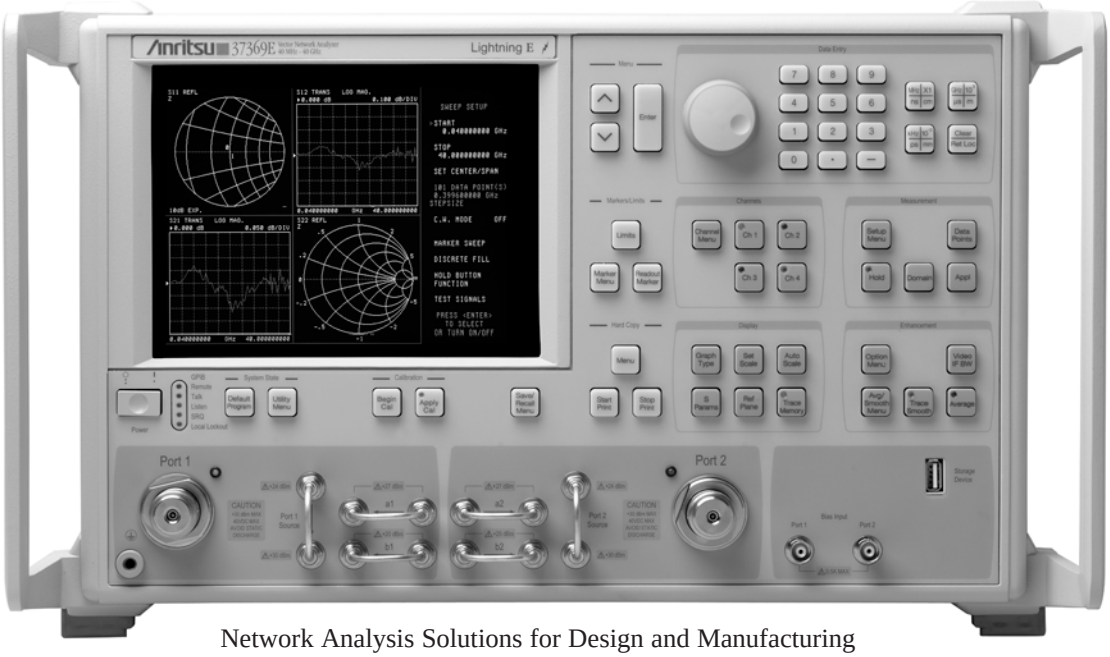
High Performance Features

Calibration Choices – A full range of calibration choices from SOLT, offset short, and waveguide to the first commercially available Multiple Line calibration kit for metrology-grade LRL/LRM calibrations.

Adapter Removal Calibration – Adapters used during calibration are later “removed” for accurate measurements of non-insertable devices.

Multiple Source Control – Independently control two sources for testing of mixers, multipliers and frequency-translated devices.

Power Meter Correction – Accurately calibrate the power output of the analyzer for flat, leveled power across the entire frequency sweep.



Network Analysis Solutions for Design and Manufacturing

Standard Features

Measurement Parameters: S11, S21, S22, S12
User-defined combinations of a1, a2, b1, and b2.

Domains: Frequency Domain, CW Draw, and optional High Speed Time (Distance) Domain.

Graph Types: Log Magnitude, Phase, Log Magnitude and Phase, Smith Chart (Impedance), Smith Chart (Admittance), Linear Polar, Log Polar, Group Delay, Linear Magnitude, Linear Magnitude and Phase, Real, Imaginary, Real and Imaginary, SWR, and Power Out.

Data Points: 1601 maximum or N discrete data points where $2 \leq N \leq 1601$.

Limits Lines: Either single or segmented limit lines can be displayed. Two limit lines are available for each trace.

Single Limit Readouts: Interpolation algorithm determines the exact intersection frequencies of test data and limit lines.

Segmented Limits: A total of 20 segments (10 upper and 10 lower) can be generated per data trace. Complete segmented traces can be offset in both frequency and amplitude.

Test Limits: Both single and segmented limits can be used for PASS/FAIL testing. The active channel's PASS or FAIL status is indicated on the display after each sweep. In addition, PASS/FAIL status is output through the rear panel I/O connector as selectable TTL levels (PASS = 0V, FAIL = +5V or PASS = +5V, FAIL = 0V).

Tune Mode: Tune Mode optimizes sweep speed in tuning applications by updating forward S-parameters more frequently than reverse ones. This mode allows the user to select the ratio of forward sweeps to reverse sweeps after a full 12-term calibration. The ratio of forward sweeps to reverse sweeps can be set anywhere between 1:1 and 10,000:1.

Data Averaging: Point-by-point (default) {up to 4096}, Sweep-by-Sweep

IF Bandwidth: 10 kHz to 10 Hz

Reference Plane: Can be entered in time or in distance (when the dielectric constant is entered). Automatic reference plane feature adds the correct electrical length (delay) compensation. Software compensation for the electrical length difference between reference and test is always accurate and stable since measurement frequencies are always synthesized. In addition, the system compensates reference phase delay for dispersive transmission media, such as waveguide and microstrip.

Measurement Frequency Range: Frequency range of the measurement can be narrowed within the calibration range without recalibration. CW mode permits single frequency measurements, also without recalibration.

Group Delay Aperture: Defined as the frequency span over which the phase change is computed at a given frequency point. The aperture can be changed without recalibration. The minimum aperture is the frequency range divided by the number of points in calibration and can be increased to 20% of the frequency range without recalibration.

Measurement Channels: Four independent channels are available to display any S-parameter or user defined parameter, in any format, with up to two traces per channel for a maximum of eight traces simultaneously. A single channel, two channels (1 and 3, or 2 and 4), or all four channels can be displayed simultaneously. Channels 1 and 3, or channels 2 and 4 can be overlaid.

Display: Color LCD, 8.5 in. diagonal.

Display Colors: The color of data traces, memory, text, markers and limit lines are all user definable.

Trace Overlay: Displays two data traces on the active channel's graticule simultaneously.

Trace Memory: A separate memory for each channel can be used to store measurement data for later display or subtraction, addition, multiplication or division with current measurement data.

Group Delay Range: The maximum delay range is limited to measuring no more than +180° of phase change within the aperture set by the number of frequency points.

Scale Resolution (minimum per division):

Log Magnitude	0.001 dB
Linear Magnitude	1 pU
Phase	0.01°
Group Delay	0.001 ps
Time	0.001 ms
Distance	0.1 µm
SWR	1 pU
Power	0.01 dB

Markers: Six independent markers can be used to read out measurement data.

Delta Marker: One marker can be selected as the reference for the other five.

Enhanced Markers: Marker search feature can be used for finding a level or bandwidth on the active channel.

Marker Sweep: Sweeps upward in frequency between any two markers. Recalibration is not required during the marker sweep.

Blank Frequency Information: Blanking function removes all references to frequencies on the display. Frequency references can only be restored through a system reset or GPIB command.

Vector Error Correction: There are six built-in methods of calibration:

Short-Open-Load-Thru (SOLT): This calibration method uses short circuits, open circuits, and terminations (fixed or sliding).

Offset-Short (waveguide): This calibration method uses short circuits and terminations.

LRL/LRM: The Line-Reflect-Line (LRL) or Line-Reflect-Match (LRM) calibration uses transmission lines and a reflective device or termination (LRM).

TRM: The Thru-Reflect-Match calibration uses short circuits and fixed termination.

Three Offset-Short (SSST): This calibration method uses three short circuits with different offset lengths to calculate all the calibration terms.

Autocal®: This calibration method uses an automatic calibrator module.

There are four vector error correction models available for calibration:

1) Full 12-Term
2) One Path/Two Port
3) Frequency Response
4) Reflection Only

Merged Calibrations: In addition, the Lightning E series VNAs have a Merged Calibration feature that allows the user to merge calibrations performed under different conditions (such as a low frequency SOLT with a band-limited LRL) to cover different frequency bands, provided the total number of points does not exceed 1601.

AutoCal: The VNA can internally control an external AutoCal module to perform a 2-port SOLT calibration. AutoCal is a single two port calibration module with built-in, switched, and characterized SOLT standards. AutoCal provides quick, reliable, and accurate calibrations that exceed the performance of a standard broadband load SOLT calibration.

Calibration Standards: For coaxial calibrations the user can select between SMA, 3.5 mm, GPC-7, Type N, 2.4 mm, TNC, K, V, W1 connector or special type from the calibration menu. Use of fixed or sliding loads can be selected for each connector type. User defined calibration standards allow for entry of open capacitance, load and short inductances, load impedance, and reflection standard offset lengths.

Reference Impedance: It is possible to modify the reference impedance of the measurement to other than 50 Ω (but not 0).

Adapter Removal Calibration: Built-in Adapter Removal application software accurately characterizes and "removes" any adapter used during calibration that will not be used for subsequent device measurements. This technique allows for accurate measurement of non-insertable devices.

Dispersion Compensation: Selectable as Coaxial (nondispersive), Waveguide, or Microstrip (dispersive).

NxN Multiple Device Solutions: The NxN application provides an accurate method of measuring frequency translated devices, such as mixers, providing both magnitude and phase information and the unique ability to measure absolute phase (group) delay. By measuring the response characteristics of device pairs, the Lightning VNA will solve for device pairs and de-embed the characteristics. The NxN application module for mixer measurements includes capabilities for characterizing the IF path of frequency translation device measurements. The result is a real-time display of the de-embedding characteristics of the device under test.

Power Meter Correction: Power meter correction is available at a user-selectable power level, if it is within the power adjustment range of the internal source. This is performed using an external power meter over the Dedicated GPIB port.

Multiple Source Control Capability: Multiple Source Control capability allows a user to independently control the frequencies of two sources and the receiver without the need for an external controller PC. The frequency sweep may be comprised of up to five separate bands, each with independent source and receiver settings, for convenient testing of mixers, multipliers and other frequency translated devices.

Set-On Receiver Mode: For applications that require Harmonics or Intermodulation measurement, the 37000E can be configured to measure the relative harmonic level of test devices with Set-On Receiver Mode capability. The 37000E's unique phase locking scheme allows it to operate as a tuned receiver by locking all of its local oscillators to its internal crystal reference oscillator.

Embedding/De-embedding: All 37000E are equipped with an Embedding/De-embedding feature. De-embedding is generally used for removal of test fixture contributions and other S2P networks from measurements. The de-embedding can be applied to a calibration and then stored for future measurements. Similarly, the Embedding function can be used to simulate matching circuits for optimizing amplifier designs or simply adding effects of a known structure to a measurement.

Electro-Optical Measurements

The 37000E series incorporates a de-embedding function that simplifies VNA calibration when measuring E/O and O/E devices. The Lightning E series characterize the transfer function, group delay, and return loss of optical modulators (E/O) and photoreceivers (O/E) using the built-in application.

E/O Measurements: The application menus guide the user through the entire calibration and setup. A characterized photodiode (O/E) reference and a laser source are required to complete the test setup. The internal VNA application de-embeds the response of the photodiode reference to allow direct measurement of the bandwidth and return loss of the modulator.

O/E Measurements: Photoreceiver measurements can be made by characterizing a modulator first and then using it as a transfer standard for the O/E measurement. The internal application de-embeds the response of the modulator to allow characterization of the photoreceiver.

Gain Compression Measurements (37300E models only)

The 37300E series provide a user-intuitive Gain Compression and AM/PM measurement application. The following two methods are available for making gain compression measurements.

Swept Power Gain Compression: The VNA displays traditional Power out vs. Power in or Phase vs. Power in, at one of up to 10 selectable CW frequencies. A separate screen will easily show Power out and Power in at 1 dB or selected Gain compression for all entered frequencies.

Swept Frequency Gain Compression: Once Gain is measured at the starting power, the user increments Power in, observing Normalized Gain vs. Frequency. This aids in analyzing the most critical compression frequencies of a broadband amplifier.

Connectivity

GPIB: 2 Ports, system GPIB and dedicated GPIB

System GPIB (IEEE-488.2): Connects to an external controller for use in remote programming of the network analyzer. Address can be set from the front panel and can range from 1 to 30.

Dedicated GPIB: Connects to external peripherals for network analyzer controlled operations (e.g., GPIB plotters, frequency counters, frequency synthesizers and power meters).

GPIB Data Transfer Formats: ASCII, 32-bit floating point, or 64-bit floating point. 32-bit and 64-bit floating point data can be transferred with LSB or MSB first.

Measurement Throughput: Measurement times are based on a single 40 MHz to 20 GHz sweep with 10 kHz IF bandwidth (no averages) after a full 12-term calibration. Sweep times include retrace and band switch times.

Measurement Time (ms) vs. 101 Data Points (typical)

Calibration Type	Data Points				
	3	51	101	401	1601
1 Port (3 Term)	75	270	350	920	3000
2 Port (12 Term)[1]	60	250	340	920	3000

1: Using Tune Mode Optimization

Measurement Time vs. Sweep Mode for 101 Data Points (typical)

Sweep Mode	Time (ms)
Linear	350
List	350
CW	190

Measurement Time vs. IF BW for 101 Data Points (uncorrected) (typical)

IF Bandwidth	Time (ms)
10 kHz	180
1kHz	270
100 Hz	1110
10 Hz	7300

Measurement Time vs. Span for 101 Data Points (typical)

Frequency Span	Time (ms)
40 MHz to 65 GHz	900
40 MHz to 40 GHz	450
20 GHz to 40 GHz	340
10 GHz to 11 GHz	220

GPIB Data Transfer Speed (with or without cal): 240 kB/sec

GPIB Data Throughput Time: Throughput measurements for both tables were made as follows: start the timer, trigger a sweep, wait for a full sweep, transfer data across the GPIB and stop the timer. Data throughput times are shown separately for measurements made without calibration and with full two-port, 12-Term calibration.

Measurement Conditions: 40 MHz to 20 GHz sweep, single channel, log magnitude display, 10 kHz IF bandwidth, and output final data.

Throughput Times (ms) without Correction (typical)

Data Format	3 Points[2]	101 Points	401 Points	1601 Points
32 Bit	40	400	1000	3000
64 Bit	40	400	1000	3000
ASCII	40	450	1200	3600

Throughput Times (ms) with 12-Term Correction (typical)

Data Format	3 Points[2]	101 Points	401 Points	1601 Points
32 Bit	80	800	1900	5800
64 Bit	80	800	1900	5800
ASCII	80	850	2100	6300

2: 3 data point sweeps taken at 2, 4, and 6 GHz.

Fast CW Operation: Fast CW is an ideal mode of operation for rapid data taking over GPIB. To achieve a fast measurement rate the display is not updated and only the raw S-parameter or user-defined parameter of the active channel is measured.

Fast CW Typical Performance

Trigger Mode	Measurement Speed (ms/point)
GPIB	1.5
External TTL	1.2
Internal	0.8

Internal Buffer Data Collection: Internal Buffer Data Collection is provided to allow saving active channel measurement data from multiple sweeps without having to synchronize and collect data at the end of each sweep. The 37000E can store up to 50,000 data point measurements, each consisting of two (real and imaginary) IEEE 754 4-byte floating point numbers. GPIB transfer speed for the 50,000 data points is typically 2.2 seconds.

Ethernet Port: 10/100 Base T

Ethernet Data transfer speed (with or without cal): 850 kB/s (typical)

Printer Port: Parallel port, 25 pin

Serial Port: Control Signals +5V TTL, also used for AutoCal control

External I/O: Connects to external test sets, 25 pin DSUB connector

Storage

SD Card Internal Disk: 8 GB, used to store and recall measurement and calibration data and front-panel setups. File names can be 1 to 8 characters long, and must begin with a character, not a number. Extensions are automatically assigned.

Internal Memory: Ten front panel states (no calibration) can be stored and recalled from non-volatile memory locations. The current front panel setup is automatically stored in non-volatile memory at instrument power-down. When power is applied, the instrument returns to its last front panel setup.

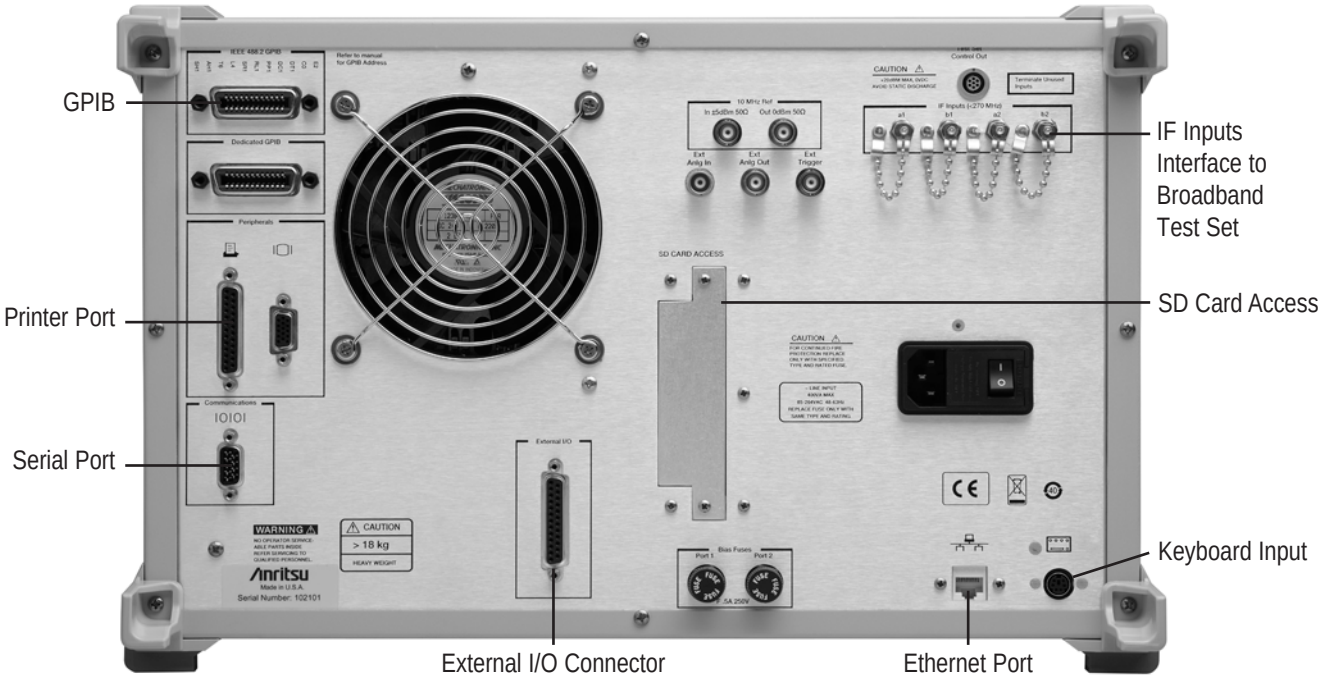
Secure Storage: Option 4A, Extra SD Card used to store secure data and operating system.

USB Storage: A USB Type A Storage Port accepts USB Memory Devices (USB Flash Drives) to load measurement programs and to store/recall measurements, calibration data, and front-panel setups. Measurement data can be stored in text, S2P or bitmap format. File names can be 1 to 8 characters long and must begin with a character, not a number. Extensions are automatically assigned.

Measurement Data: 102.8 kB per 1601 point S-parameter data file.

Calibration Data: 187.3 kB per 1601 point S-parameter data file (12-Term cal plus setup).

Trace Memory File: 12.8 kB per 1601 point channel.



Backpanel view

Interfaces

Front Panel Connectors and Controls:

USB Storage: A USB Type A Port accepts USB Memory Devices (USB Flash Drive) to store/recall measurements, calibration data, and front-panel setups.

Test Ports: Universal K male test ports are standard on the 37x47E and 37x69E models, and the Universal V male test ports are standard on the 37x97E model. For additional configurations check Test Port Converters (Option 7).

Bias Inputs, Port 1 and 2 (37300E): 0.5 amps maximum through BNC connectors. 40 VDC max

Option 15 ports: K-female provided on the 37x47E and 37x69E models, and V-female ports provided on the 37x97E model. Please refer to Flexible test set option section for power ratings of ports.

Rear Panel Connectors and Controls:

VGA Out: Provides VGA output of 37000E video display.

Serial: 9-Pin male D-SUB connector. Provides RS-232 serial port control for an AutoCal® module (3658 series).

10 MHz REF In: Connects to external reference frequency standard, 10 MHz, +5 dBm to –5 dBm, 50 Ω, BNC female.

10 MHz REF Out: Connects to internal reference frequency standard, 10 MHz, 0 dBm, 50 Ω, BNC female.

Ext Analog Out: –10 V to +10 V with 5 mV resolution, varying in proportion to user-selected data (e.g., frequency, amplitude). BNC female.

Ext Analog In: ± 50 V input for displaying external signals on the LCD. BNC female.

Line Selection: Power supply automatically senses 100 V, 120 V, 220 V or 240 V lines.

External Trigger: External TTL triggering for 37000E measurement. 10 kΩ input impedance, BNC female.

Printer Port: A standard parallel port interfaces to most printers for printing full screen graphical and tabular data.

Keyboard Input: Any PS-2 keyboard can be connected to the rear panel for navigating through front panel menus, annotation of data files and display labels, printing displays and pausing instrument sweeps.

SD Card Internal Disk: 8 GB, used to store/recall measurement, calibration data, and front-panel setups.

Options

Time (Distance) Domain Measurement Capability (Option 2A)

High Speed Time (Distance) Domain option allows the conversion of reflection or transmission measurements from the frequency domain to the time domain. Measured S-parameter data is converted to the time domain by application of a Fast Fourier Transform (FFT) using the Chirp Z-Transform technique. Prior to conversion, any one of several selectable windowing functions may be applied. Once the data is converted to the time domain, a gating function may be applied to select the data of interest. The processed data may then be displayed in the time domain with display start and stop times selected by the user or in the distance domain with display start and stop distance selected by the user. The data may also be converted back to the frequency domain with a time gate to view the frequency response of the gated data.

The following modes are available within the Time Domain option:

Lowpass Mode: This mode displays a response equivalent to the classic "TDR" (Time Domain Reflectometer) response of the device under test and provides the best resolution. Lowpass response may be displayed in either the Impulse or Step mode. This type of processing requires a sweep over a harmonic series of frequencies and an extrapolated or user-entered DC value.

Bandpass Mode: This mode displays a response equivalent to the time response of the device under test to a band limited impulse. This type of processing may be used with any arbitrary frequency sweep range, limited only by the test set range or device under test response.

Phasor Impulse Mode: This mode displays a response similar to the Lowpass impulse response, using data taken over an arbitrary (band limited) sweep range. Detailed information, similar to that contained in the lowpass impulse response may be used to identify the nature of impedance discontinuities in the device under test. Now, with Phasor Impulse, it is possible to characterize complex impedances on band-limited devices.

The following windows may be applied to the frequency data in the time domain mode.

Windowing: Any one of four window functions may be applied to the initial frequency data, to counteract the effects of processing data with a finite bandwidth. These windows provide a range of trade offs of main lobe width versus side lobe level (ringing). The general type of function used is the Blackman-Harris window with the number of terms being varied from one to four. Typical performance follows:

Type of Window (Number of Terms)	First Side Lobe Relative to Peak	Impulse Width[3]
Rectangle (1)	–13 dB	1.2 W
Nominal-Hamming (2)	–43 dB	1.8 W
Low Side Lobe, Blackman-Harris (3)	–67 dB	2.1 W
Minimum Side Lobe, Blackman-Harris (4)	–92 dB	2.7 W

3: W (Bin Width) = 1/2 Δf sweep width.

Gating: A selective gating function may be applied to the time domain data to remove unwanted responses, either in a pass-band or reject-band (mask). This gating function may be chosen as the convolution of any of the above window types with a rectangular gate of user defined position and width. The gate may be specified by entering start and stop times or center and span. The gated data may be displayed in the time domain, or converted back to the frequency domain.

Range:
The unaliased (non-repeating) time range is given by the formula:

$$\text{Unaliased Range (ns)} = \frac{\text{Number of Frequency Data Points}}{\text{Frequency Sweep Range (GHz)}}$$

The resolution is given by the formula:

$$\text{Main Lobe Width (null–null) in ns} = \frac{kW}{\text{Frequency Sweep Range (GHz)}}$$

where kW is two times the number of window terms (for example, four for a two-term window)

Frequency with Time Gate: Data that has been converted to time domain and selected by the application of gating function may be converted back to the frequency domain. This allows the display of the frequency response of a single element contained in the device under test. Frequency response accuracy is a function of window and gate type, and gate width. For a full reflection, minimum gate and window accuracy is within 0.2 dB of the un-gated response over a 40 GHz range.

Flexible Test Set (Option 15)

This option provides direct access to all the non-ratioed channels, namely a1 (Ref. A), a2 (Ref. B), b1 (Test A), and b2 (Test B), from the front panel. This is useful for antenna measurements, frequency translated device measurements (mixers, multipliers) and external test set additions (such as for multiport applications).

This option also adds an auxiliary source loop on each port to allow the addition of external devices. Thus, an amplifier or attenuator can be added to either boost the available power from each port or to further extend the ALC range of the instrument.

Port	Maximum Signal into Port (dBm)
a1	27
a2	27
b1	20
b2	20
Src. 1	30
Src. 2	30

(see page 11 for block diagrams)

Corrected Specifications

System Dynamic Range is defined as the difference between the available power from Port 1 incident on Port 2 in a through line connection and the noise floor. $S_{11} = S_{22} = 0$, $S_{21} = 0$

VNA settings: 10 Hz I.F. Bandwidth, 101 pts, 12-term SOLT calibration, 512 averages

37x47E (40 MHz to 20 GHz)

Model	Frequency (GHz)	Port 1 Power, Typical		Noise Floor at Port 2 (dBm)[5]		System Dynamic Range	
			With Option 15		With Option 15		With Option 15
37347E	0.04	10	10	–82	–82	92	92
	2	11	11	–104	–104	115	115
	20	8	7	–100	–99	108	106
37247E	0.04	10	10	–82	–82	92	92
	2	11	11	–104	–104	115	115
	20	7	6	–101	–100	108	106

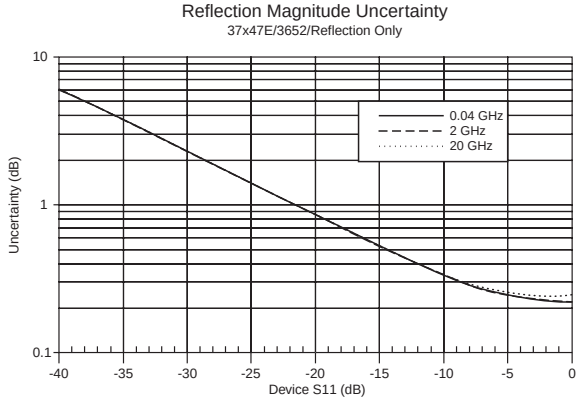
Test Port Characteristics[6]

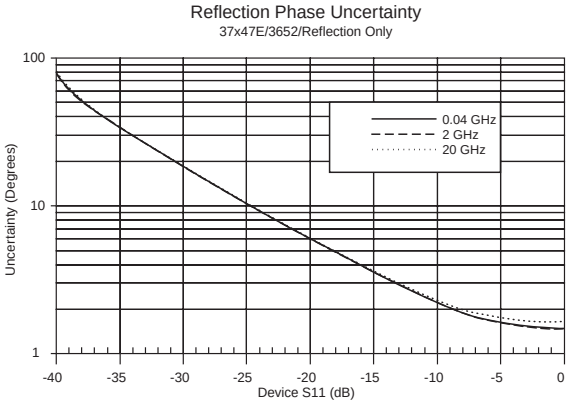
Connector	Frequency[4] (GHz)	Directivity (dB)	Source Match (dB)	Load Match (dB)	Reflection Tracking (dB)	Transmission Tracking (dB)	Isolation (dB)
K (2.92 mm)	0.04	> 42	> 40	> 42	± 0.005	± 0.030	> 105
	2	> 42	> 40	> 42	± 0.005	± 0.030	> 105
	20	> 42	> 38	> 42	± 0.006	± 0.070	> 110

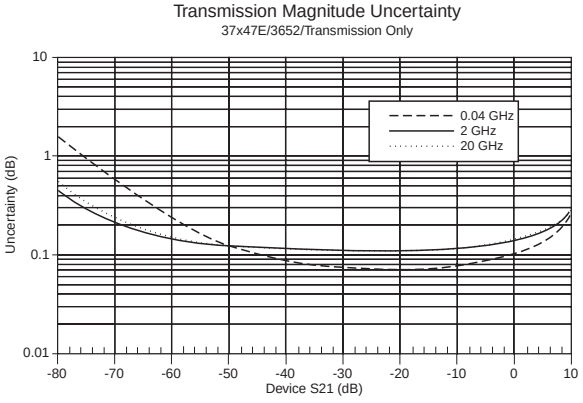
4: Specifications between the stated frequencies are to be linearly interpolated as typical values.
5: RMS Value, 32 readings, CW – compensated for loss in available source power from test port cable connected between Port 1 and Port 2.
6: The specifications for Test Port Characteristics apply when the VNA Universal Test Port Adapters are connected, with or without phase equal insertables, to the test set ports and calibrated with the appropriate calibration kit at 23 °C ± 3 °C using the SOLT calibration method with a sliding load to achieve 12-term error correction. (90 min. warm-up time is recommended.)

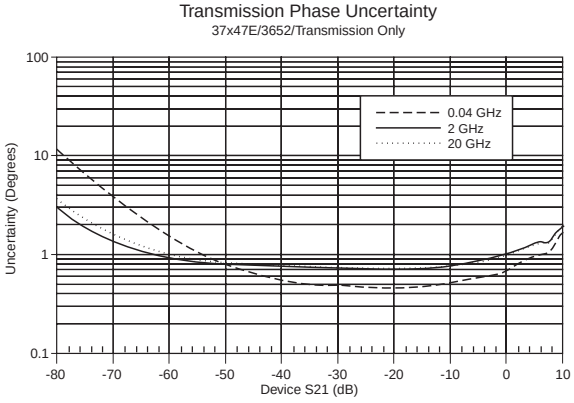
Measurement Uncertainty

The graphs give measurement uncertainty after 12-Term vector error correction. The errors are worst case contributions of residual directivity, load and source match, frequency response, isolation, network analyzer dynamic accuracy, and connector repeatability.









37x69E (40 MHz to 40 GHz)

Model	Frequency (GHz)	Port 1 Power, Typical		Noise Floor at Port 2 (dBm)[5]		System Dynamic Range	
			With Option 15		With Option 15		With Option 15
37369E	0.04	10	10	–85	–85	95	95
	2	8	8	–107	–107	115	115
	20	3	2	–103	–102	106	104
	40	2	1	–95	–94	97	95
37269E	0.04	10	10	–85	–85	95	95
	2	8	8	–107	–107	115	115
	20	2	1	–104	–103	106	104
	40	2	1	–97	–96	99	97

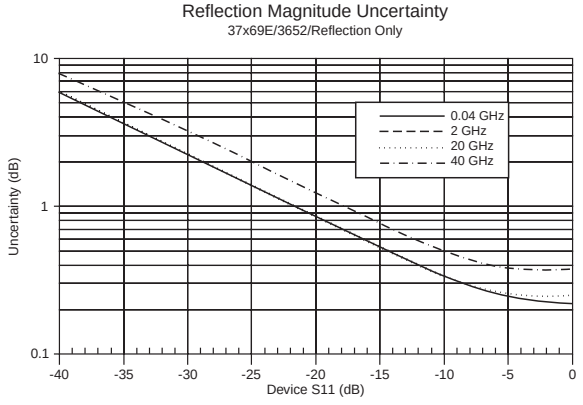
Test Port Characteristics[6]

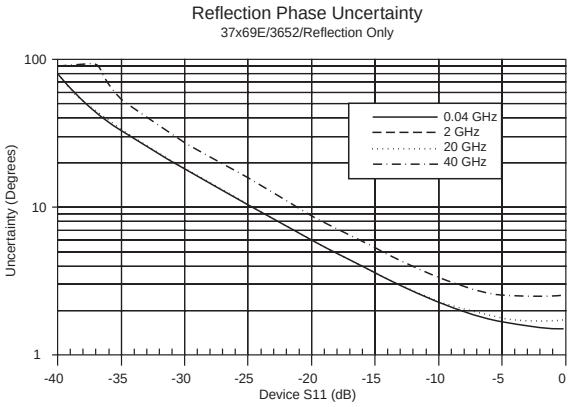
Connector	Frequency[4] (GHz)	Directivity (dB)	Source Match (dB)	Load Match (dB)	Reflection Tracking (dB)	Transmission Tracking (dB)	Isolation (dB)
K (2.92 mm)	0.04	> 42	> 40	> 42	± 0.005	± 0.030	> 105
	2	> 42	> 40	> 42	± 0.005	± 0.030	> 105
	20	> 42	> 38	> 42	± 0.006	± 0.070	> 110
	40	> 38	> 34	> 38	± 0.006	± 0.080	> 100

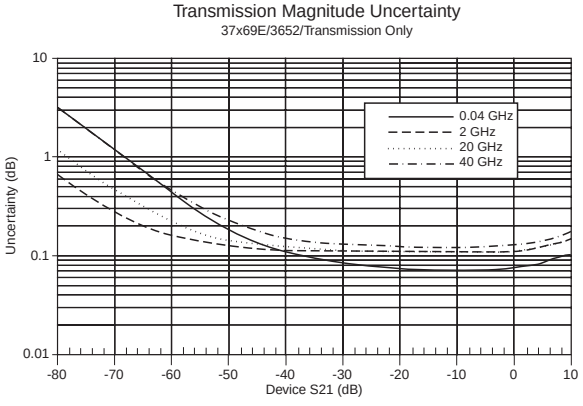
4: Specifications between the stated frequencies are to be linearly interpolated as typical values.
5: RMS Value, 32 readings, CW – compensated for loss in available source power from test port cable connected between Port 1 and Port 2.
6: The specifications for Test Port Characteristics apply when the VNA Universal Test Port Adapters are connected, with or without phase equal insertables, to the test set ports and calibrated with the appropriate calibration kit at 23 °C ± 3 °C using the SOLT calibration method with a sliding load to achieve 12-term error correction. (90 min. warm-up time is recommended.)

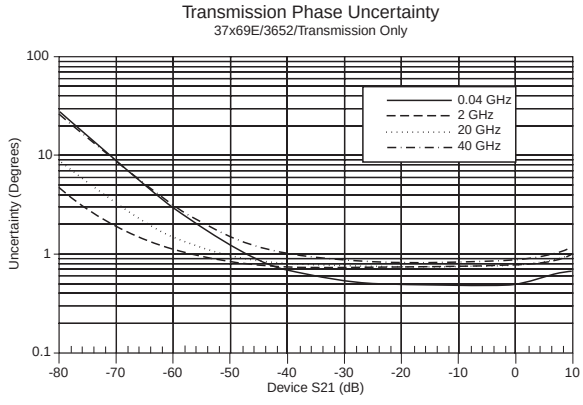
Measurement Uncertainty

The graphs give measurement uncertainty after 12-Term vector error correction. The errors are worst case contributions of residual directivity, load and source match, frequency response, isolation, network analyzer dynamic accuracy, and connector repeatability.









37x97E (40 MHz to 65 GHz)

Model	Frequency (GHz)	Port 1 Power, Typical		Noise Floor at Port 2 (dBm)[5]		System Dynamic Range	
			With Option 15		With Option 15		With Option 15
37397E	0.04	10	10	−88	−88	98	98
	2	5	5	−110	−110	115	115
	20	2	1	−106	−105	108	106
	40	1	0	−98	−97	99	97
	50	−1	−3	−94	−93	93	90
	65	−2	−4	−82	−80	80	76
37297E	0.04	10	10	−88	−88	98	98
	2	5	5	−110	−110	115	115
	20	1	0	−107	−106	108	106
	40	1	0	−100	−99	101	99
	50	−1	−3	−96	−95	95	92
	65	−1	−3	−84	−82	83	79

Test Port Characteristics[6]

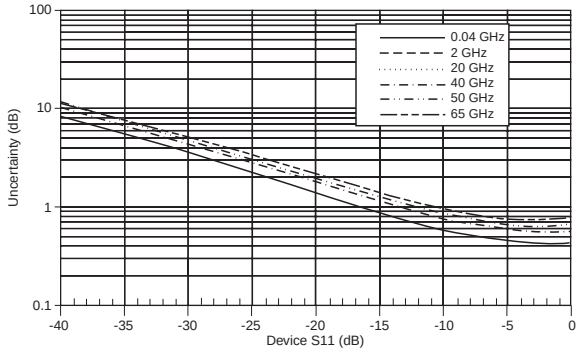
Connector	Frequency[4] (GHz)	Directivity (dB)	Source Match (dB)	Load Match (dB)	Reflection Tracking (dB)	Transmission Tracking (dB)	Isolation (dB)
V (1.85 mm)	0.04	> 40	> 36	> 40	± 0.050	± 0.050	> 115
	2	> 40	> 36	> 40	± 0.050	± 0.050	> 115
	20	> 40	> 36	> 40	± 0.060	± 0.070	> 110
	40	> 36	> 32	> 36	± 0.060	± 0.080	> 100
	50	> 34	> 30	> 34	± 0.080	± 0.100	> 90
	65	> 34	> 28	> 34	± 0.100	± 0.120	> 80

4: Specifications between the stated frequencies are to be linearly interpolated as typical values.
5: RMS Value, 32 readings, CW – compensated for loss in available source power from test port cable connected between Port 1 and Port 2.
6: The specifications for Test Port Characteristics apply when the VNA Universal Test Port Adapters are connected, with or without phase equal insertables, to the test set ports and calibrated with the appropriate calibration kit at 23 °C ± 3 °C using the SOLT calibration method with a sliding load to achieve 12-term error correction. (90 min. warm-up time is recommended.)

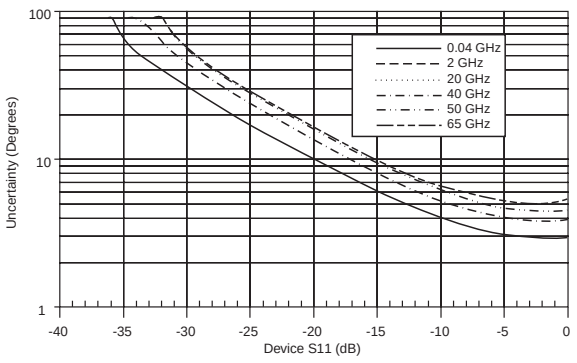
Measurement Uncertainty

The graphs give measurement uncertainty after 12-Term vector error correction. The errors are worst case contributions of residual directivity, load and source match, frequency response, isolation, network analyzer dynamic accuracy, and connector repeatability.

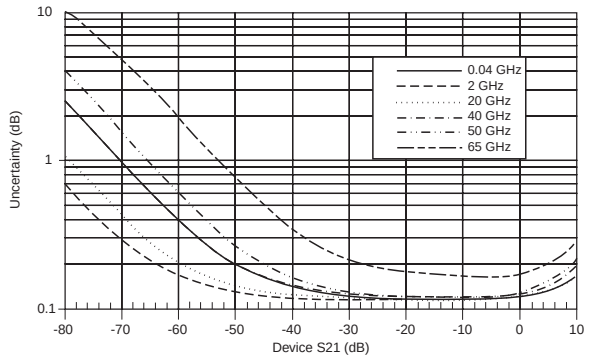
Reflection Magnitude Uncertainty
37x97E/3654B/Reflection Only



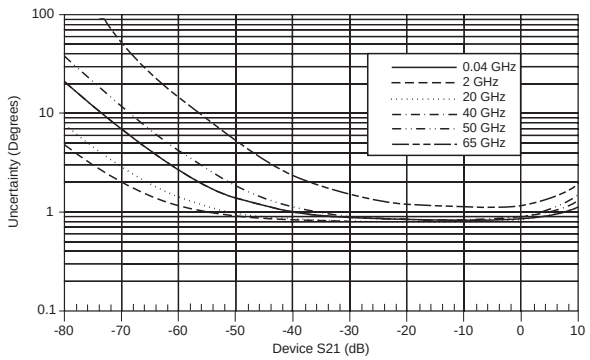
Reflection Phase Uncertainty
37x97E/3654B/Reflection Only



Transmission Magnitude Uncertainty
37x97E/3654B/Transmission Only



Transmission Phase Uncertainty
37x97E/3654B/Transmission Only



Signal Source Specifications

Resolution: 1 Hz

Frequency Stability:

Temperature: < $5x10^{-9}$ over 0 ºC to 55 ºC range
Aging: < 1 x 10^{-9}/day

Source Power Level: The source power (dBm) may be set from the front panel menu or via GPIB. In addition, on 37300E models, the port 1 power may be attenuated in 10 dB steps, using the internal 70 dB (60 dB for 37397E) step attenuator. Similarly, high input signals into port 2, not exceeding 1 watt, can be attenuated up to 40 dB, using the internal port 2 step attenuator.

Sweep Type: Linear, CW, Marker, or N-Discrete point sweep

Phase Noise: > 60 dBc/Hz at 10 kHz offset and 20 GHz center frequency

Spurious Response (Harmonics)

Frequency	Typical (at default power)
40 MHz to 20 GHz	< –40 dBc
20 GHz to 40 GHz	< –20 dBc
40 GHz to 65 GHz	< –20 dBc

Spurious Response (Non-harmonics): < –35 dBc at maximum rated power

High Level Noise (pk–pk typical at 1 kHz I.F. BW)

Frequency	Magnitude (dB)	Phase (degrees)
40 MHz to 20 GHz	< 0.04	< 0.5
20 GHz to 40 GHz	< 0.08	< 1.0
40 GHz to 65 GHz	< 0.25	< 2.5

Receiver Noise Floor and System Dynamic Range into Direct Access Ports (Option 15 only)

Model	Frequency (GHz)	Typical Noise Floor* (dBm)	Power into b1 or b2 Ports at 0.2 dB Compression (dBm)	Typical System Dynamic Range (dB)
372xxE	0.04	–130	–12	> 118
	2	–123	–10	> 113
	20	–121	–7	> 114
	40	–111	–8	> 103
	50	–102	–3	> 99
	65	–92	–3	> 89
373xxE	0.04	–130	–12	> 118
	2	–123	–9	> 114
	20	–120	–6	> 114
	40	–110	–6	> 104
	50	–100	0	> 100
	65	–90	0	> 90

*RMS value, 10 Hz IF BW, 512 avg, 32 readings, CW

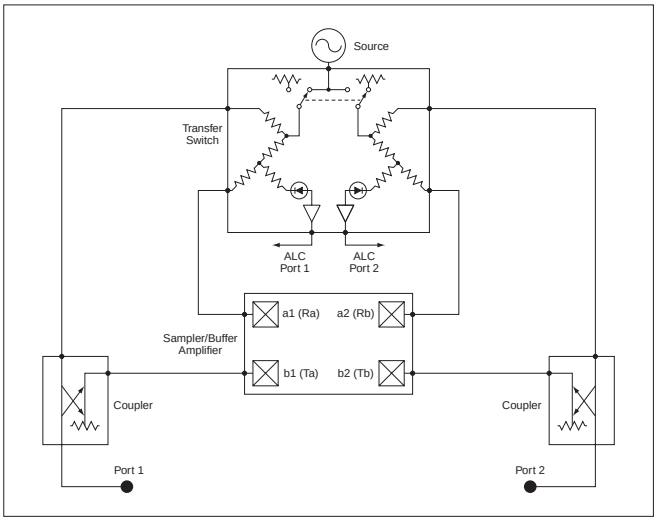
Power Flatness

Frequency	Flatness (dB)
40 MHz to 13.5 GHz	± 1.5
13.5 GHz to 20 GHz	± 2.0
20 GHz to 40 GHz	± 3.0
40 GHz to 65 GHz	± 5.0

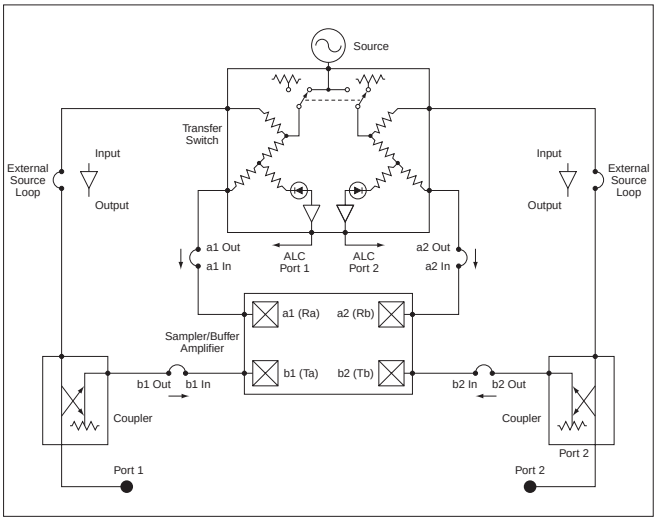
Power Range

Model	Rated Power (dBm)	Minimum Power (dBm)	Resolution (dB)
37247E	5	–20	0.05
37269E	–7	–27	0.05
37297E	–7	–19	0.05
37347E	5	–90	0.05
37369E	–7	–97	0.05
37397E	–7	–79	0.05

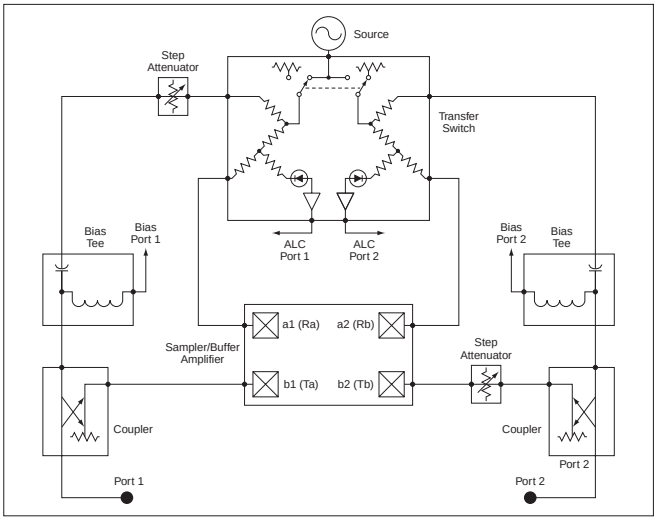
37x00E Block Diagrams



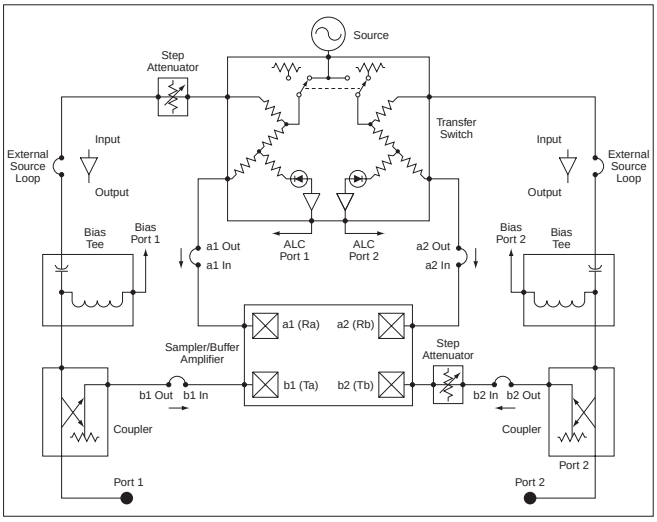
37200E Block Diagram



37200E Block Diagram with Option 015



37300E Block Diagram



37300E Block Diagram with Option 015

General

Power Requirements: 85 to 240 volts, 48 Hz to 63 Hz, 540 VA maximum

Dimensions: 267 mm H x 432 mm W x 585 D mm
(10.5 in H x 17in W x 23 D in.)

Weight: 27 kg (60 lb)-(2-man lift required)

Environmental: Conforms to MIL-PRF-28800F (Class 3)

Storage Temperature Range: –40 ºC to +75 ºC

Operating Temperature Range: 0 ºC to +50 ºC

Relative Humidity: 5% to 95% at +40 ºC

EMI: Meets the emissions and immunity requirements of EN55011/1991
Class A/CISPR-11 Class A
EN50082-1/1993
IEC 801-2/1984 (4 kV CD, 8 kV AD)
IEC 1000-4-3/1995 (3 V/m, 80-1000 MHz)
IEC 801-4/1988 (500V SL, 1000V PL)
IEC 1000-4-5/1995 (2 kV L-E, 1 kV L-L)

Ordering Information

Models

37200E Passive Device Vector Network Analyzers

(see page 11 for block diagram)

The 37200E series is a high performance VNA designed to measure S-parameters for mainly passive devices.

37247E	40 MHz to 20 GHz
37269E	40 MHz to 40 GHz
37297E	40 MHz to 65 GHz

37300E Active Device Vector Network Analyzers

(see page 11 for block diagram)

The 37300E series is a VNA optimized to measure S-parameters for both active and passive devices. It offers the full suite of Lightning features, including gain compression, power sweep capability, internal bias tees and step attenuators, which are not available on the 37200E models.

37347E	40 MHz to 20 GHz
37369E	40 MHz to 40 GHz
37397E	40 MHz to 65 GHz

System Options

Option 001A	Rack mount kit with handles only (no slides). Rack mount kit containing a set of mounting ears and hardware to permanently mount the instrument in a standard 19-inch equipment rack.
Option 002A	Time Domain (Distance) measurement capability analyze impedance discontinuities as a function of time or distance with Lightning's high speed time domain capability.
Option 004A	Extra 8 GB SD card used to store secure data and operating system.
Option 007A	Replaces K test port connectors with GPC-7 connectors
Option 007N	Replaces K test port connectors with N(m) connectors
Option 007NF	Replaces K test port connectors with N(f) connectors
Option 007S	Replaces K test port connectors with 3.5 mm-(m) connectors
Option 015	Flexible test set Provides direct access to all four reference and test channels and adds two auxiliary source loops for each port for connecting amplifiers etc.
Option 098	Z540/Guide 25 calibration
Option 099	Premium calibration

Calibration Kits

Using Anritsu's precision calibration kits ensures accurate operation of your 37000E series VNA. These kits include precision components required to perform full 12 term calibrations. The AutoCal® modules are automatic precision calibrators that provide fast, repeatable, and accurate coaxial calibrations up to 40 GHz. The AutoCal system includes the module, serial cable, power supply, power cord, software disk, and operation manual. The Mechanical Calibration Kit include Cal Coefficients on both a USB Memory Device and a Floppy Disk.

Coaxial Mechanical SOLT

3650A	SMA/3.5 mm calibration kit
3650A-1	SMA/3.5 mm calibration kit with sliding terminations
3651A	GPC-7 calibration kit
3651A-1	GPC-7 calibration kit with sliding terminations
3652A	K Connector calibration kit
3652A-1	K Connector calibration kit with sliding terminations
3653A	Type N calibration kit
3654D	V connector calibration kit with improved return loss terminations
3654D-1	V connector calibration kit with improved return loss terminations and sliding terminations
3656B	W1 Connector calibration/verification kit

Coaxial Mechanical LRL

3657	V connector multiple line calibration kit, includes six beadless lines
3657-1	V connector multiple line calibration kit, includes six beadless lines, 2 male shorts, 2 female shorts

AutoCal® (Automatic Calibration)

36581NNF	N(m) to N(f), 40 MHz to 18 GHz (without USB drive or floppy disk)
36581KKF	K(m) to K(f), 40 MHz to 20 GHz (without USB drive or floppy disk)
36582KKF	K(m) to K(f), 40 MHz to 40 GHz (without USB drive or floppy disk)
760-208	Transit Case for AutoCal

Waveguide

3655V	WR-15 Waveguide calibration kit
3655V-1	WR-15 Waveguide calibration kit with sliding terminations
3655E	WR-12 Waveguide calibration kit
3655E-1	WR-12 Waveguide calibration kit with sliding terminations
3655W	WR-10 Waveguide calibration kit
3655W-1	WR-10 Waveguide calibration kit with sliding terminations

Verification Kits

Anritsu offers a complete line of coaxial verification kits to confirm your system's performance. All verification kits contain precision components with characteristics traceable to the US National Institute of Standards and Technology (NIST).

3663	Type N verification kit
3666	SMA/3.5 mm verification kit
3667	GPC-7 verification kit
3668	K Connector verification kit
3669B	V Connector verification kit

Test Port Cable Converters

Test port cable converters are high precision, phase equal adapters, which can be used with K Connector AutoCal to adapt to either SMA or 3.5 mm connectors. Each set consists of four adapters, two of each sex that can be substituted for each other without affecting calibration accuracy.

36583S	Test Port Cable converter set, SMA type
36583L	Test Port Cable converter set, 3.5 mm type
36583K	Test Port Cable converter set, K type

Test Port Cables

Flexible, High Performance, Phase Stable

3671A50-1	K(f) to GPC-7 cables, 63.5 cm (25 in), one pair
3671S50-1	K(f) to 3.5 mm cables, 63.5 cm (25 in), one pair
3671K50-1	K(f) to K(m) cables, 63.5 cm (25 in), one pair
3671K50-2	K(f) to K(m) cable, 96.5 cm (38 in)
3671K50-3	K(f) to K(f) cable and K(f) to K(m) cable, 63.5 cm (25 in)
3671V50B-1	V(f) to V(m) cable, 63.5 cm (25 in), one pair
3671V50B-2	V(f) to V(m) cable, 96.5 cm (38 in)

Semi-Rigid, Economy

3670A50-2	GPC-7 cable, 61 cm (24 in)
3670N50-1	N(f) to N(m) cable, 30.5 cm (12 in)
3670N50-2	N(f) to N(m) cable, 61 cm (24 in)
3670NN50-1	N(m) to N(m) cable, 30.5 cm (12 in)
3670NN50-2	N(m) to N(m) cable, 61 cm (24 in)
3670K50-1	K(f) to K(m) cable, 30.5 cm (12 in)
3670K50-2	K(f) to K(m) cable, 61 cm (24 in)
3670V50-1	V(f) to V(m) cable, 30.5 cm (12 in)
3670V50-2	V(f) to V(m) cable, 61 cm (24 in)

Precision Adapters

Coaxial

K220B	Adapter, DC to 40 GHz, 50 Ω, K(m) to K(m)
K222B	Adapter, DC to 40 GHz, 50 Ω, K(f) to K(f)
K224B	Adapter, DC to 40 GHz, 50 Ω, K(m) to K(f)
34VK50	Adapter, DC to 46 GHz, 50 Ω, V(m) to K(m)
34VKF50	Adapter, DC to 46 GHz, 50 Ω, V(m) to K(f)
34VFK50	Adapter, DC to 46 GHz, 50 Ω, V(f) to K(m)
34VFKF50	Adapter, DC to 46 GHz, 50 Ω, V(f) to K(f)
34VV50	Adapter, DC to 65 GHz, 50 Ω, V(m) to V(m)
34VVF50	Adapter, DC to 65 GHz, 50 Ω, V(m) to V(f)
34VFVF50	Adapter, DC to 65 GHz, 50 Ω, V(f) to V(f)

Waveguide to Coax

35WR15V	Waveguide to Coax adapter, 50 GHz to 65 GHz (Usable to 67 GHz), WR15 to V(m)
35WR15VF	Waveguide to Coax adapter, 50 GHz to 65 GHz (Usable to 67 GHz), WR15 to V(f)
35WR19K,	Waveguide to Coax adapter, 40 GHz to 50 GHz (Usable to 54 GHz), WR19 to K(m)
35WR19KF	Waveguide to Coax adapter, 40 GHz to 50 GHz, (Usable to 54 GHz), WR19 to K(f)
35WR19V	Waveguide to Coax adapter, 40 GHz to 60 GHz, WR19 to V(m)
35WR19VF	Waveguide to Coax adapter, 40 GHz to 60 GHz, WR19 to V(f)
35WR22K	Waveguide to Coax adapter, 33 GHz to 50 GHz, WR22 to K(m)
35WR22KF	Waveguide to Coax adapter, 33 GHz to 50 GHz, WR22 to K(f)
35WR22V	Waveguide to Coax adapter, 33 GHz to 50 GHz, WR22 to V(m)
35WR22VF	Waveguide to Coax adapter, 33 GHz to 50 GHz, WR22 to V(f)
35WR28K	Waveguide to Coax adapter, 26.5 GHz to 40 GHz, WR28 to K(m)
35WR28KF	Waveguide to Coax adapter, 26.5 GHz to 40 GHz, WR28 to K(f)
35WR42K	Waveguide to Coax adapter, 18 to 26.5 GHz, WR42 to K(m)
35WR42KF	Waveguide to Coax adapter, 18 GHz to 26.5 GHz, WR42 to K(f)
35WRD180K	Waveguide to Coax adapter, 18 GHz to 40 GHz, WRD180 (Double Ridge Waveguide) to K(m)
35WRD180KF	Waveguide to Coax adapter, 18 GHz to 40 GHz, WRD180 (Double Ridge Waveguide) to K(f)

Measurement Accessories

MN4765A	O/E calibration module (40 MHz to 65 GHz) Unamplified photodiode module. Characterized to 65 GHz in both magnitude and phase using a NIST traceable standard. Used for electro-optical and opto-electrical measurements with the VNA.
ML2430A	Universal Power Meter combines thermal meter accuracy with diode meter speed. Used for flat test port power calibration.

GPIB Cables

2100-5	GPIB Cable, 0.5 m (1.6 ft)
2100-1	GPIB Cable, 1 m (3.3 ft)
2100-2	GPIB Cable, 2 m (6.6 ft)
2100-4	GPIB Cable, 4 m (13.2 ft)

Test Port Converters

Test port converters allow you to change the connector type on the VNA test ports.

20 and 40 GHz Test Sets

34UA50	Universal Test Port connector to GPC-7 converter
34UK50	Universal Test Port connector to K(m) converter
34UN50	Universal Test Port connector to N(m) converter
34UNF50	Universal Test Port connector to N(f) converter
34US50	Universal Test Port connector to 3.5 mm(m) converter

65 GHz Test Sets

34YA50	Universal Test Port connector to GPC-7 converter
34YK50B	Universal Test Port connector to K(m) converter
34YSS50	Universal Test Port connector to SMA(m) converter
34YV50B	Universal Test Port connector to V(m) converter

Universal Test Fixtures (UTF)

Anritsu's UTF accommodates measurements in microstrip and coplanar waveguide. An optional MMIC attachment and substrate launchers help you test integrated circuits.

3680-20	20 GHz Universal Test Fixture
3680K	40 GHz Universal Test Fixture
3680V	60 GHz Universal Test Fixture

UTF Accessories

36801K	40 GHz Right-Angle launcher
36801V	60 GHz Right-Angle launcher
36802	MMIC attachment
36803	Bias Probe
36805-10M	Four 10 mil substrate launchers for the 36802 MMIC attachment
36805-15M	Four 15 mil substrate launchers for the 36802 MMIC attachment
36805-25M	Four 25 mil substrate launchers for the 36802 MMIC attachment

UTF Calibration/Verification Kits

36804B-10M	10 mil Microstrip calibration/verification kit, DC to 60 GHz
36804B-15M	15 mil Microstrip calibration/verification kit, DC to 40 GHz
36804B-25M	25 mil Microstrip calibration/verification kit, DC to 20 GHz
36804B-25C	25 mil Coplanar Waveguide (CPW) Calibration/ Verification Kit (Includes CPW Jaws for UTF), DC to 20 GHz

Fixed Attenuators

Precision

41KB-3	Fixed Attenuator, 3 dB, DC to 26.5 GHz, 50 Ω, K(m) to K(f)
41KB-6	Fixed Attenuator, 6 dB, DC to 26.5 GHz, 50 Ω, K(m) to K(f)
41KB-10	Fixed Attenuator, 10 dB, DC to 26.5 GHz, 50 Ω, K(m) to K(f)
41KB-20	Fixed Attenuator, 20 dB, DC to 26.5 GHz, 50 Ω, K(m) to K(f)
41KC-3	Fixed Attenuator, 3 dB, DC to 40 GHz, 50 Ω, K(m) to K(f)
41KC-6	Fixed Attenuator, 6 dB, DC to 40 GHz, 50 Ω, K(m) to K(f)
41KC-10	Fixed Attenuator, 10 dB, DC to 40 GHz, 50 Ω, K(m) to K(f)
41KC-20	Fixed Attenuator, 20 dB, DC to 40 GHz, 50 Ω, K(m) to K(f)
41V-3	Fixed Attenuator, 3 dB, DC to 60 GHz, 50 Ω, V(m) to V(f)
41V-6	Fixed Attenuator, 6 dB, DC to 60 GHz, 50 Ω, V(m) to V(f)
41V-10	Fixed Attenuator, 10 dB, DC to 60 GHz, 50 Ω, V(m) to V(f)
41V-20	Fixed Attenuator, 20 dB, DC to 60 GHz, 50 Ω, V(m) to V(f)

Economy

43KB-3	Fixed Attenuator, 3 dB, DC to 26.5 GHz, 50 Ω, K(m) to K(f)
43KB-6	Fixed Attenuator, 6 dB, DC to 26.5 GHz, 50 Ω, K(m) to K(f)
43KB-10	Fixed Attenuator, 10 dB, DC to 26.5 GHz, 50 Ω, K(m) to K(f)
43KB-20	Fixed attenuator, 20 dB, DC to 26.5 GHz, 50 Ω, K(m) to K(f)
43KC-3	Fixed attenuator, 3 dB, DC to 40 GHz, 50 Ω, K(m) to K(f)
43KC-6	Fixed attenuator, 6 dB, DC to 40 GHz, 50 Ω, K(m) to K(f)
43KC-10	Fixed attenuator, 10 dB, DC to 40 GHz, 50 Ω, K(m) to K(f)
43KC-20	Fixed attenuator, 20 dB, DC to 40 GHz, 50 Ω, K(m) to K(f)

Other Accessories and Tools

760-231	Lightning transit case
01-201	5/16” torque wrench, 8 ft-lbs, for SMA, 3.5 mm, and K connectors
01-202	Universal Test Port connector wrench
01-204	Anritsu stainless steel connector wrench

Extended Service Options

On-Site Support Plans

Option ES311	3 Year On-Site Repair
Option ES314	3 Year On-Site Standard Verification
Option ES318	3 Year On-Site Premium Verification

Return-to-Service Center Support Plans

Option ES312	3 Year Return-to-Service Center standard calibration
Option ES315	3 Year Return-to-Service Center premium calibration
Option ES510	5 Year Return-to-Service Center repair only
Option ES512	5 Year Return-to-Service center standard calibration
Option ES515	5 Year Return-to-Service Center premium calibration
Option ES513	5 Year Return-to-Service Center repair plus standard calibration
Option ES516	5 Year Return-to-Service Center repair plus premium calibration

Upgrade Options

37200E to a higher frequency 37200E

37200D to an equivalent 37200E

37300E to a higher frequency 37300E

37300D to an equivalent 37300E

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11410-00573, Rev. A Printed in United States 2010-06

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