

# Keysight Basic Instruments

May-July 2017



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Keysight Authorized Distributors



See how educators can now measure frequency response without a network analyzer.



Agilent's Electronic Measurement Group has become **Keysight Technologies**.

## SPOTLIGHT

# Perform automatic frequency response analysis (Bode gain and phase plots) with your oscilloscope

Years ago, engineering students created Bode plots by hand for everything from finding theoretical poles and zeros to drawing the plot. In the Electrical Engineering (EE) lab, students didn't have analyzers to automatically perform tasks like verifying the frequency response of a passive or active filter.

The solution was to take multiple  $V_{IN}$ ,  $V_{OUT}$ , and  $\Delta t$  measurements on an oscilloscope while changing the input sine wave frequency on a function generator. After making 15 or 20 measurements, students would have enough measured data points to convert to gain ( $20\text{Log}V_{OUT}/V_{IN}$ ) and phase shift ( $\Delta t/T \times 360$ ). Students could then plot the results alongside the theoretical graph for comparison.

That tedious process must have changed by now, right? Yes and no. Most engineering students today – and those who have moved on to amplifier design and digital control – use MATLAB to plot theoretical results. And the test industry offers a broad range of frequency response analyzers (FRA) and vector network analyzers (VNA) that create gain and phase plots automatically.

But FRAs and VNAs are specialized instruments that are not often seen in universities, mostly due to their cost. Schools will usually purchase a typical student bench consisting of an entry-level two-channel oscilloscope, function generator, digital voltmeter, and power supply for under \$2K, keeping in line with their limited lab budgets.

## Save money with oscilloscopes that combine multiple instruments into one

Keysight's new **InfiniiVision 1000 X-Series** family of low-cost oscilloscopes addresses educator's needs and budget constraints by giving them multiple instruments in one oscilloscope, including a digital voltmeter, frequency response analyzer (select models) and WaveGen function generator (select models). The baseline model is \$449 (USD),

but for about \$200 more, you can get a model with a built-in WaveGen function generator and frequency response analysis.

To use the 1000 X-Series to make measurements on a passive bandpass filter (Figure 1), you connect the generator output to  $V_{IN}$  and also probe  $V_{IN}$  and  $V_{OUT}$  with channel 1 and channel 2 of the oscilloscope, respectively.

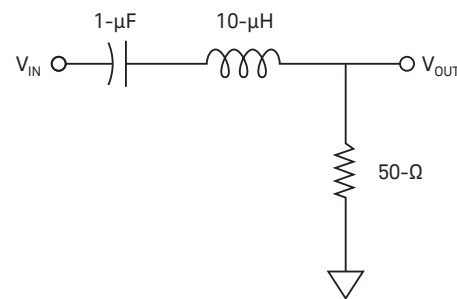


Figure 1. In a passive RLC bandpass filter, the 1- $\mu\text{F}$  capacitor and 10- $\mu\text{H}$  inductor dominate and block most of  $V_{IN}$  from getting to  $V_{OUT}$  at lower and higher frequencies, respectively. In mid-band frequencies, the 50- $\Omega$  load resistor dominates such that most of  $V_{IN}$  reaches  $V_{OUT}$  (~0 dB).

To help you make the proper connections, the FRA setup menu displays a block diagram (Figure 2). You can also define which of the oscilloscope's input channels is probing  $V_{IN}$ , which channel is probing  $V_{OUT}$ , the minimum and maximum test frequency, and test amplitude. The oscilloscope executes a one-time test, sometimes called a "sweep."



Figure 2. The FRA setup menu includes a block diagram to help you make the proper connections.

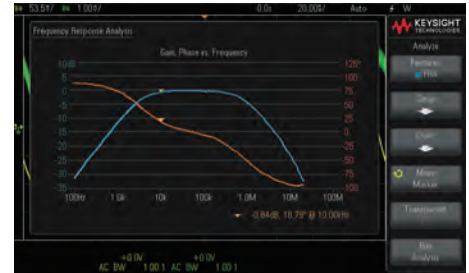


Figure 3. FRA option automatically creates Bode plots of test results.

Figure 3 shows the test results. The blue trace represents gain (in dB) with scale factors shown on the left. The orange trace represents phase (in degrees) with scale factors shown on the right. You can use markers to measure gain and phase at any frequency. The oscilloscope even optimizes magnitude and phase scaling factors automatically. But you can also establish your own scale factors manually after the test is completed.

Not only is this one of the most easy-to-use FRAs on the market, but it is also one of the least expensive. Frequency response analysis comes standard on 1000 X-Series oscilloscope models with the built-in function generator. And performance is not sacrificed either; Using a proprietary measurement algorithm, the 1000 X-Series can achieve up to 80 dB of dynamic range based on a 0 dBm (224 mVrms) input.

The FRA option is also available on Keysight's higher performance 3000T X-, 4000 X-, and 6000 X-Series oscilloscopes with additional advanced features, including test amplitude profiling, single frequency test mode, and tabular results view.

Learn more about the InfiniiVision 1000 X-Series and its industry-unique Bode plot capability by checking out the [data sheet](#) or [web page](#).

► [Learn more about the 1000 X-Series](#)

## Keysight & Our Distributor Network

RIGHT Instrument. RIGHT Expertise. Delivered RIGHT Now.

Keysight and our network of Keysight Authorized Distributors have teamed up to provide fast, easy access to the world's largest selection of off-the-shelf T&M instruments. It's the best of both worlds: Keysight's measurement expertise and product breadth combined with speed, convenience and same-day shipping from our distribution partners. It's never been easier to get the right instrument in the right hands, right away.



## InfiniiVision oscilloscopes










▶ Learn more about InfiniiVision oscilloscopes



- Up to 1,000,000 waveforms/sec update rate
- MegaZoom IV responsive, uncompromised smart memory
- Multiple instrument functionality
- Upgradable: bandwidth, MSO, serial analysis, built-in WaveGen function generator, or digital voltmeter and counter

 BenchVue software enabled

▶ Oscilloscope how-to video series. The basics for beginners and some helpful tips for more advanced users.

Model	Description	Bandwidth	Channels	Sample rate	Memory depth	Standard warranty	Calibration period	Special triggers	Built-in instruments	Price from (USD)
<b>NEW</b> 1000 X-Series  1000X Data Sheet 	Basic R&D bench - 50,000 wfms/s update rate - 7-inch display - Serial bus options	50 MHz to 100 MHz	2	Up to 2 GSa/s	Up to 1 Mpts	3 years	5 years	Serial protocol	Frequency response analyzer, protocol analyzer, 20 MHz FG, 5-digit counter, 3-digit DVM	<b>EDU:</b> \$448 <b>DSO:</b> \$647
2000 X-Series  2000X Data Sheet 	Basic R&D bench - 50,000 wfms/s update rate - 8.5-inch display - Serial bus options	70 MHz to 200 MHz	2, 2+8, 4, 4+8	Up to 2 GSa/s	Up to 1 Mpts	5 years	2 years	Serial protocol	Protocol analyzer, 20 MHz FG, 5-digit counter, 3-digit DVM	<b>DSO:</b> \$1,307 <b>MSO:</b> \$2,053
3000T X-Series  3000TX Data Sheet 	Everything the 2000X has plus - 1,000,000 wfms/s update rate - Advanced math and power analysis - Capacitive touch screen	100 MHz to 1 GHz	2, 2+16, 4, 4+16	Up to 5 GSa/s	4 Mpts and segmented memory standard	3 years	3 years	Near Field Communication (NFC) Trigger, Serial protocol, Zone touch	Protocol analyzer, 20 MHz AWG, 8-digit counter and totalizer, 3-digit DVM	<b>DSO:</b> \$3,341 <b>MSO:</b> \$4,986
4000 X-Series  4000X Data Sheet 	Everything the 3000T has plus - 12.1-inch capacitive touch screen - FFT, USB 2.0 pre-compliance and FPGA applications - Up to four active probes	200 MHz to 1.5 GHz							Protocol analyzer, dual 20 MHz AWG, 5-digit counter, 3-digit DVM	<b>DSO:</b> \$5,045 <b>MSO:</b> \$7,841
6000 X-Series  6000X Data Sheet	Everything the 4000X has plus - 450,000 wfms/s update rate - Multi-touch display - Voice control - Jitter and real-time eye diagram analysis	1 GHz to 6 GHz		Up to 20 GSa/s			2 years	Serial protocol Zone touch	Protocol analyzer, dual 20 MHz AWG, 10-digit counter and totalizer, 3-digit DVM	<b>DSO:</b> \$14,886 <b>MSO:</b> \$18,382

### InfiniiVision Software Applications



#### Serial protocols and triggering

I<sup>2</sup>C, SPI, RS232, UART, USB 2.0, CAN, CXPI, LIN, FlexRay, Audio, MIL-STD 1553, ARINC 429, and more

#### Features

Dual-channel WaveGen, jitter, real-time eye diagram, integrated voltmeter, 10-digit counter, mask limits, USB signal quality, video/TV, FPGA dynamic probe, power analysis, frequency response analysis via Bode plot, near field communication testing, and more.


▶ Learn more about oscilloscope software applications

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Keysight software is downloadable expertise. [www.keysight.com/find/software](http://www.keysight.com/find/software)

### 34970A / 34972A data acquisition switch units



- Low-cost, 3-slot unit with 6½ digit DMM and built-in signal conditioning
- Choose from 8 plug-in modules, up to 120 1-wire (60 2-wire) channels or 96 cross points
- 34972A has built-in Web interface
-  BenchVue software enabled

 [34970A/34972A Data Sheet](#)

**Price from (USD) \$1,778 and \$2,013**

### 34970A/72A modules

Model	Key specifications
34901A/02A/08A multiplexers	Up to 300 V, 16, 20, or 40 channels
34903A general-purpose switch	300 V, 20 actuator channels
34904A matrix	4x8 matrix
34905A/06A RF switches	2 GHz dual, 50 and 75 Ω
34907A multi-function	DIO, DAC, totalizer

## Digital Multimeters | [www.keysight.com/find/dmm](http://www.keysight.com/find/dmm)

### Truevolt digital multimeters (DMMs)

 BenchVue software enabled

 [34460A, 34461A, 34465A, 34470A Data Sheet](#)

 [Learn more about Truevolt](#)

- 6½ digit 7½ digit performance
- Graphical capabilities such as trend and histogram charts
- Measure very low current, 1 µA range with pA resolution, allowing measurements on very low power devices.
- Auto calibration to compensate for temperature drift
- Basic measurements: DCV, ACV, DCI, ACI, 2- and 4-wire resistance, frequency, period, continuity, diode, temperature, capacitance



Model	Description	Digits of resolution	Max reading rate at 4½ digits (rdgs/s)	Built-in PC interfaces	Price from (USD)
34460A	New industry standard. Display DMM results in ways you never have before and measure with unquestioned Truevolt confidence.	6½	300	USB; optional GPIB, LAN	<b>\$942</b>
34461A			1,000	USB, LAN; optional GPIB	<b>\$1,094</b>
34465A	More measurements, higher speed, better accuracy, and more memory than the 34461A.	6½	5,000;	USB, LAN; optional GPIB	<b>\$1,391</b>
34470A			optional 50,000		

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 [Data Sheet](#)

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Look for this icon throughout this flyer to identify BenchVue enabled instruments (470+ Keysight instruments, and counting).

BenchVue software for the PC makes it simple to connect, record and achieve results across multiple instruments with no programming.

- Configure the most commonly used controls and measurements from instruments
- Visualize multiple measurements simultaneously
- Easily log and export data and screen images in just a few clicks for faster analysis
- Create automated test sequences fast with minimal instrument knowledges

[BenchVue Software Data Sheet](#)

[Play BenchVue examples and learn how to increase your productivity and make the most of your bench](#)

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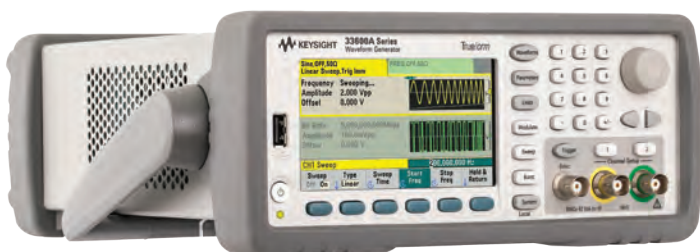
## Benchtop Waveform Generators | www.keysight.com/find/functiongenerators

### 33500B and 33600A Series Waveform Generators

- Generate Trueform arbitrary waveforms with less jitter, more fidelity and greater resolution
- Modulation: AM/FM, FSK, PWM

BenchVue software enabled

[Learn more about benchtop waveform generators](#)



Model	Description	Channels	Frequency range	Pulse	Arbitrary waveforms				Price from (USD)				
					Std/Opt arb	# bits	Sample rate	Memory/Channel					
33509B 33510B	Exclusive Trueform waveform technology with <40 ps jitter and <0.04% THD.	1 2	20 MHz	20 MHz	Opt	16	160 MSa/s	1 M Standard, 16 M Optional	\$1,739 / \$2,657				
33511B 33512B		1 2			Std				\$2,056 / \$3,110				
33519B 35520B		1 2	30 MHz	30 MHz	Opt				250 MSa/s	\$1,950 / \$2,978			
33521B 33522B		1 2			Std				\$2,266 / \$3,426				
<a href="#">33500 Series Data Sheet</a> <a href="#">33500 Series Videos</a>													
33611A 33612A		Exclusive Trueform waveform technology at higher frequency ranges with <1 ps jitter <0.03% THD.	1 2	80 MHz	80 MHz	Std	14	660 MSa/s	4 M Standard, 64 M Optional	\$3,991 \$5,689			
33621A 33622A			1 2	120 MHz	100 MHz			1 GSa/s		\$4,690 \$6,689			
<a href="#">33600 Series Data Sheet</a> <a href="#">33600 Series Videos</a>													

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**N6700 modular power system family**



**N6700:** Ideal DC power supply solution for automated test systems

- Small 1U mainframe (400, 600, 1200 W); up to four modules per mainframe
- More than 30 programmable DC power modules: basic, high performance, precision and SMU; available in 20 to 500 W

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[N6700 Series Data Sheet](#)

**Price from (USD) \$2,731**

**N6705C:** Deep insight into DUT power consumption—without assembling a complex test system

- Integrated benchtop unit holds up to four N6700 Series modules (600 W total)
- DMM, scope, arb, and data logger features
- Source/measure units and application-specific modules

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[N6705C Data Sheet](#)

**Price from (USD) \$7,765**

**FieldFox Handheld Analyzers** | [www.keysight.com/find/fieldfox](http://www.keysight.com/find/fieldfox)



- Maximum frequency from 4 to 50 GHz across family of 22 models
- Measurement results agree with those obtained with benchtop analyzers
- Compact form factor measures 29 x 19 x 7 cm (11.5 x 7.4 x 2.8 in)
- Light weight (3.2 kg /7.1 lbs), dust-free, and weather-resistant
- MIL-PRF-28800F Class 2 compliant
- MIL-STD-810G, Method 511.5 Procedure I requirements for operation in explosive environments (type tested)

BenchVue software enabled

[Learn more about FieldFox](#)

	Combination analyzers			Vector network analyzers		Spectrum analyzers	
Model number	N9912A	N9913/4/5/6/7/8A	N9950/1/2A	N9923A	N9925/6/7/8A	N9935/6/7/8A	N9960/1/2A
Maximum frequency range	4, 6 GHz	4, 6.5, 9, 14, 18, 26.5 GHz	32, 44, 50 GHz	4, 6 GHz	9, 14, 18, 26.5 GHz	9, 14, 18, 26.5 GHz	32, 44, 50 GHz
Cable and antenna analyzer	Standard			Optional		Optional (VSWR & RL)	
Vector network analyzer	Optional (1 port)	Optional		Standard		—	
QuickCal	Optional		—	Optional		—	
Full 2-port S-parameters	—	Optional		Optional		—	
VNA time domain	Optional			Optional		—	
Spectrum analyzer	Optional			—		Standard	
Real-time spectrum analyzer	—	Optional		—		Optional	
Interference analyzer	Optional			—		Optional	
Tracking generator	Optional			—		Optional	
Vector voltmeter	Optional			Optional		—	
Built-in power meter	Optional			—	Optional	Optional	
USB power sensor support	Optional			Optional		Optional	
DC voltage source	—	Optional		—	Optional	Optional	
iOS device remote control	Optional			Optional		Optional	
<b>Price from (USD)</b>	<b>\$8,309</b>	<b>\$10,892</b>	<b>\$28,198</b>	<b>\$11,009</b>	<b>\$16,915</b>	<b>\$15,824</b>	<b>\$32,226</b>

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Data Sheet Brochure Learn More YouTube Video

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## Products

### Scrap the Toys, Treat Yourself to a Real Oscilloscope!

Keysight's InfiniiVision 1000 X-Series oscilloscopes are engineered to give you quality, industry-proven technology at unbelievably low prices.

▶ [Learn more about the 1000 X-Series](#)

### Control. Automate. Simplify.



Keysight Technologies' BenchVue 2017 software for the PC reinvents your bench testing by making it simple to connect, control and build automated tests with your Keysight instruments. With no need to program and an intuitive interface, this expandable software platform will streamline data capturing, measurement analysis and your overall workflow. BenchVue software connects to over 470 Keysight instruments and counting.

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### IoT Systems Design Applied Courseware

A ready-to-teach package that focuses on the Internet of Things and introduces IoT system design techniques. Comes with teaching slides and a training kit for a full semester of teaching. Integrates hands-on, industry-relevant experiences and real-world applications in IoT design and testing.

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### Keysight Technologies' New Look Builds on Tradition of Unsurpassed Quality, Craftsmanship

Keysight products will be transitioning to a new look in 2017 incorporating leading-edge materials, a modern vision and environmental stewardship.

▶ [Learn more about Keysight's New Look](#)



## Promotions

### Score 2 Scopes for the Price of 1

Receive a complimentary InfiniiVision DSOX1102G 100 MHz oscilloscope when you buy a 3000T X-, 4000 X-, or 6000 X-Series. Valid: March 1, 2017 to September 30, 2017. Promotion code: 6.012.

To claim your complimentary scope, visit: [www.keysight.com/find/score2scopes](http://www.keysight.com/find/score2scopes)



### Get More Productive with Keysight's BenchVue 2017 Software

For a limited time save 35% on BenchVue's most popular apps. Let BenchVue software easily Control, Automate and Simplify your workflow today. Valid: April 1, 2017 to September 30, 2017. Promotion code: 6.013.

For more information: [www.keysight.com/find/BVpromo](http://www.keysight.com/find/BVpromo)

### Buy Any Keysight Big5 Bench Instrument and Get a Complimentary Handheld

With select Keysight bench instrument purchases, receive a complimentary U1242C handheld digital multimeter.

Valid: April 1, 2017 to September 30, 2017. Promotion code: 6.015. For more information: [www.keysight.com/find/BIG5Bench](http://www.keysight.com/find/BIG5Bench)



## Hints

How does your digital multimeter measure RMS; Thermal AC-to-DC, Peak and averaging AC-to-DC or, Analog AC-to-DC converters, or Digital sampling? Each have their limitations.

▶ [Learn more about Keysight digital multimeters](#)

## Catalogs

### RF and microwave test accessories catalog

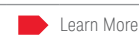
📄 [RF and Microwave Test Accessories Catalog](#)

### Keysight offers more than 300 power products to meet your specific needs.

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## Get Greater Reliability – Standard



You've come to expect the highest quality from Keysight. We stand behind our products with a three-year warranty that's standard on all instruments, worldwide.

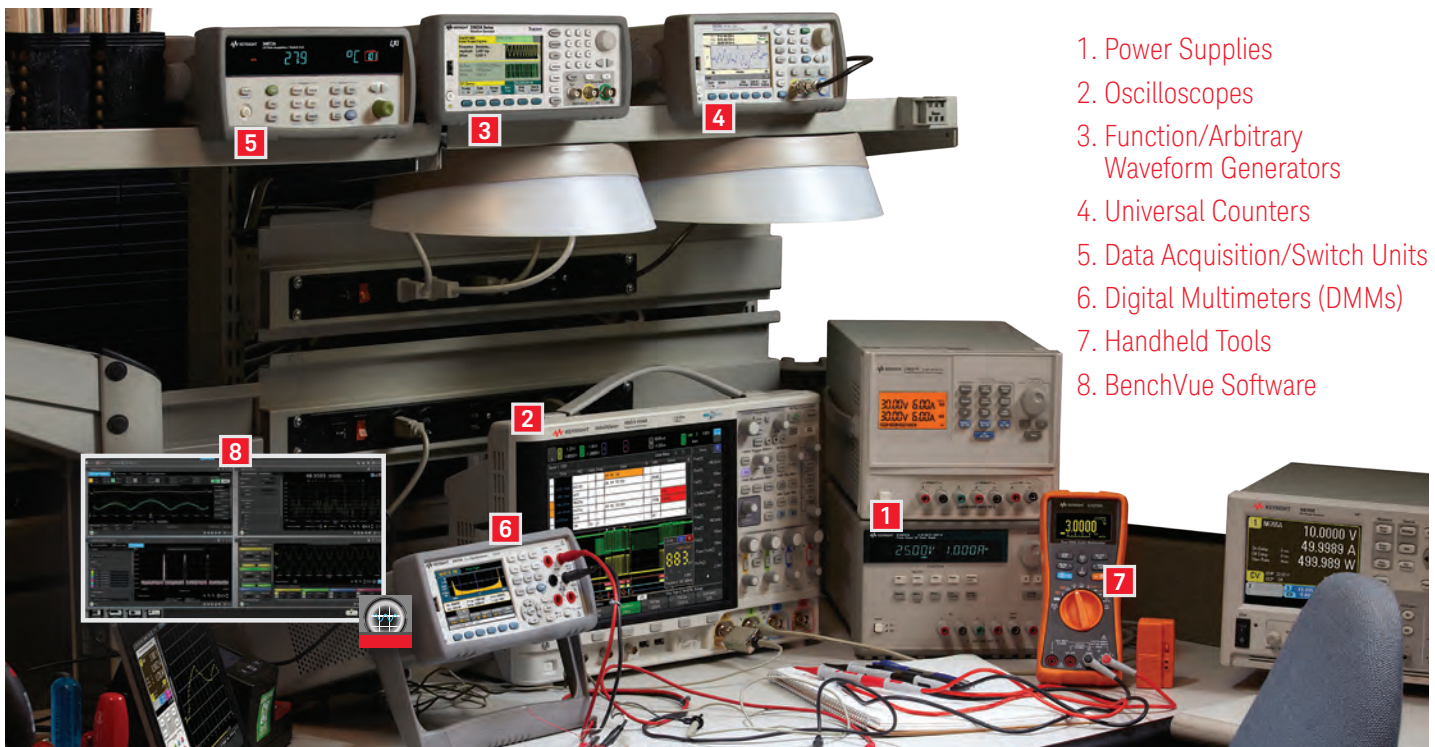
[www.keysight.com/find/ThreeYearWarranty](http://www.keysight.com/find/ThreeYearWarranty)

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## The Keysight Bench

Only Keysight delivers the industry's largest selection of bench instruments and groundbreaking BenchVue software – the zero-programming way to view, capture, and export the data you collect from your bench.



1. Power Supplies
2. Oscilloscopes
3. Function/Arbitrary Waveform Generators
4. Universal Counters
5. Data Acquisition/Switch Units
6. Digital Multimeters (DMMs)
7. Handheld Tools
8. BenchVue Software