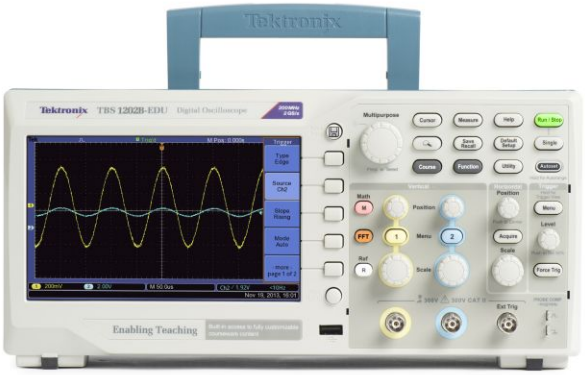
Digital Storage Oscilloscope

TBS1000B-EDU Series Datasheet



The TBS1000B-EDU Digital Storage Oscilloscope Series is designed specifically to meet the needs of today's schools and universities. It's the first oscilloscope to use an innovative new Courseware system that enables educators to seamlessly integrate teaching materials onto TBS1000-EDU oscilloscopes. The Courseware information is presented directly on the oscilloscope display and can be used to provide; step by step instructions, background theory, hints and tips or an efficient way for students to document their lab work. The instrument includes a 7-inch WVGA TFT color display, up to 2 GS/s sampling rate, bandwidths from 50 MHz to 200 MHz, dual channel frequency counters and a 5 year standard warranty, just a few of the features that make the TBS1000B-EDU the industry's best-value entry level oscilloscope for educational activities.

Key performance specifications

- 200MHz, 150 MHz, 100 MHz, 70 MHz and 50 MHz bandwidth models
- 2-channel models
- Up to 2 GS/s sample rate on all channels
- 2.5k point record length on all channels
- Advanced triggers including pulse and line-selectable video triggers

Key features

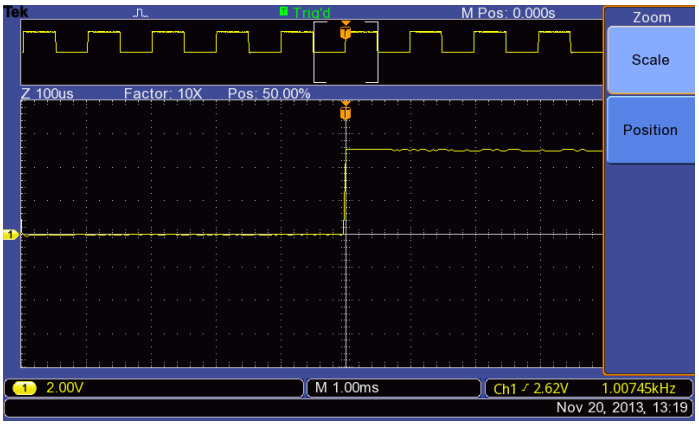
- 7 inch WVGA (800X480) Active TFT Color Display
- 34 automated measurements
- Dual window FFT, simultaneously monitors both the time and frequency domains
- Integrated Courseware feature
- Dual channel frequency counter
- Zoom Function
- Autoset and signal auto-ranging
- New affordable 50 MHz TPP0051 passive probes
- Multiple-language user interface
- Small footprint and lightweight - Only 4.9 in. (124 mm) deep and 4.4 lb. (2 kg)

Connectivity

- USB 2.0 host port on the front panel for quick and easy data storage
- USB 2.0 device port on rear panel for easy connection to a PC

Seeing signal details

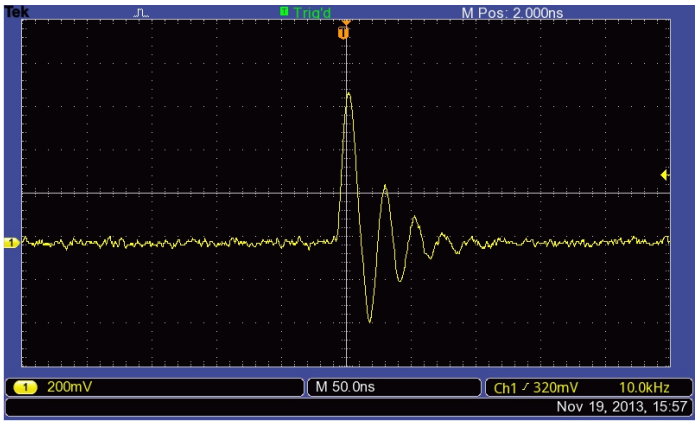
To properly analyze signals you need to make sure that you can see them in enough detail. The TBS1000B-EDU comes standard with a 7-inch high resolution TFT display for a clear view of all of your signals and critical on screen information. The instrument is further enhanced by a user interface inspired by the award winning Tektronix MSO/DPO series of instruments. The interface is easy to use, provides quick access to all of the oscilloscope functions and includes a high resolution "Pan & Zoom" feature enabling you to see even more signal details of up to 10 times normal resolution.



The zoom function shows details in an event of up to 10X the normal view.

Digital precision for accurate measurements

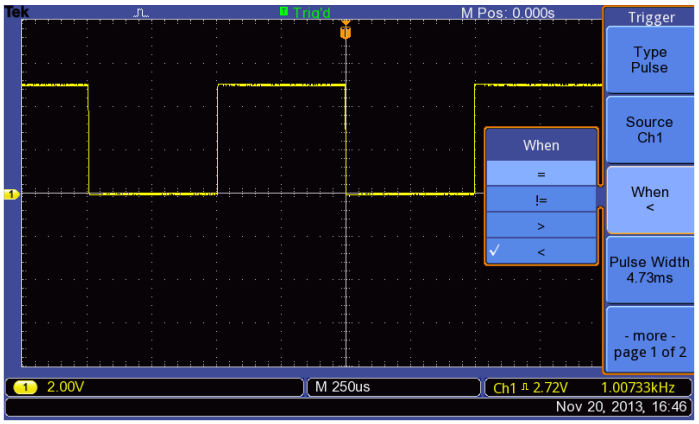
With up to 200 MHz bandwidth, 2 GS/s maximum sample rate and 3% vertical measurement accuracy the TBS1000B-EDU allows you to see all of your signals details. With the Tektronix proprietary sampling technology there are no compromises, you will get the stated real-time sampling rate on all channels, all the time with at least 10X oversampling. The sampling performance is not reduced when changing horizontal settings or when using multiple channels, enabling you to see the true characteristics of your signals.



See all the details other oscilloscopes might miss with Tektronix proprietary digital real-time sampling.

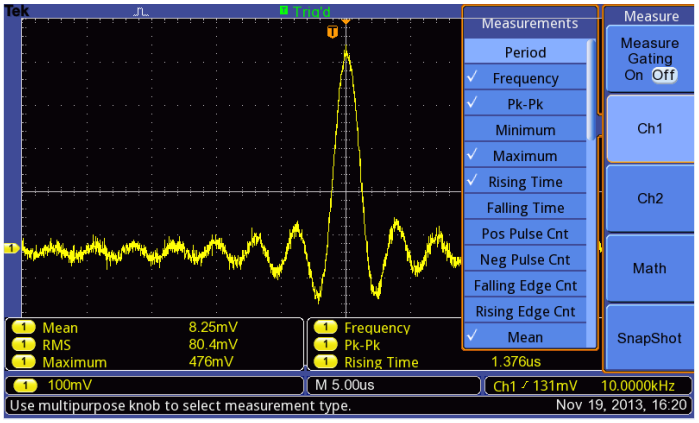
Critical tools for troubleshooting your device

The TBS1000B-EDU oscilloscope enables students to learn about the advanced triggers used to debug today's complex circuitry. Standard rising or falling edge, pulse width and video trigger set-ups will allow students to quickly isolate signals of interest and investigate alternative triggering options using the flexible trigger set-up menus.



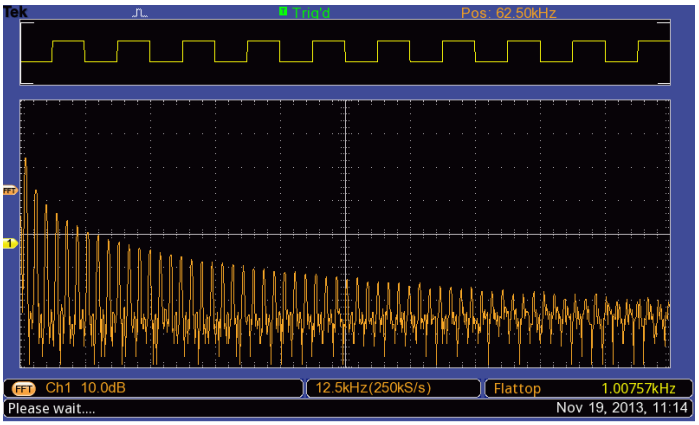
The pulse trigger function can easily capture critical events.

Once signals are captured, the TBS1000B-EDU offers advanced math and measurement capabilities making it easy to evaluate signal quality . Users can quickly add, subtract and multiply waveforms or use any one of 34 automated measurements to quickly and reliably calculate important signal characteristics such as frequency, rise time or overshoot.



Quickly analyze signals with the standard 34 automated measurements.

For advanced frequency analysis, a dedicated front panel button provides quick access to the FFT function that can show both frequency and time domain waveforms simultaneously, providing the student with a convenient way to understand the relationship between their signals and the FFT results.



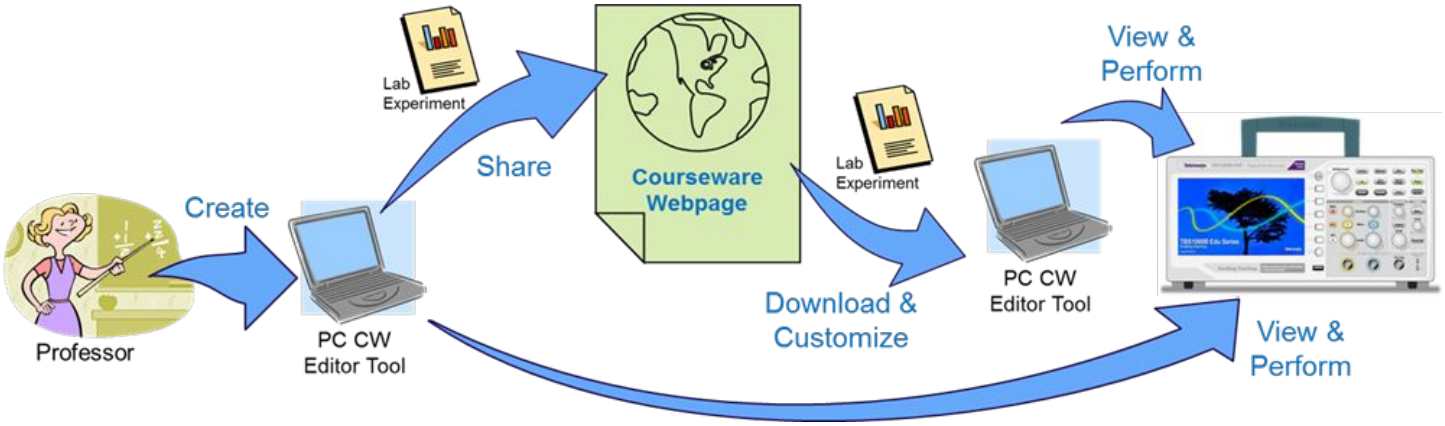
Quickly perform an FFT with a dedicated front panel button.

To further enhance the teaching process, the oscilloscopes "Autoset" function can be disabled. For those beginning labs where it is important for a student to learn the basic operation of the oscilloscope, disabling Autoset will help them apply their knowledge of an oscilloscope's operation instead of taking shortcuts with the Autoset button. This feature is password controlled so Autoset can be disabled or enabled by accessing the Autoset screen in the Utility menu.

The "Autoset" function can be disabled or enabled by entering a password in the Utility menu.

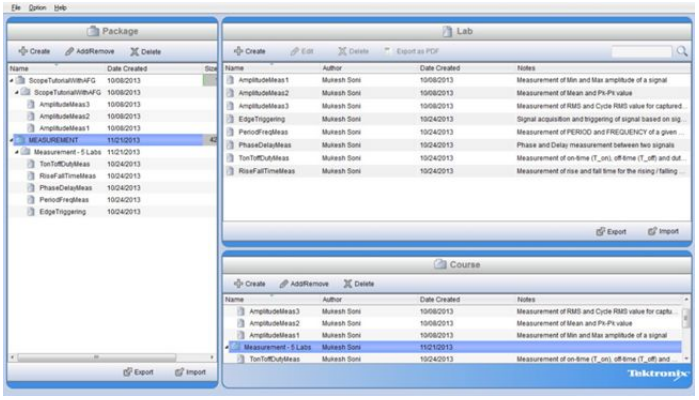
The TBS1000B-EDU also comes with built-in dual channel frequency counters. Independent control of each counter's trigger level provides an easy way to monitor two different signal frequencies simultaneously.

Dual channel - 6 digit frequency counters come standard with all TBS1000B-EDU models.



Courseware feature

The innovative Courseware feature sets up an education ecosystem by combining powerful PC Course Editor software with the TBS1000B-EDU instruments and a Courseware landing page. The new feature gives educators the ability to create lab descriptions and instructions and then upload the material directly onto a TBS1000-EDU oscilloscope. Existing labs can be modified with content that directly supports recent lectures or explores new ideas discovered in class discussions. Students can perform their lab work directly on the oscilloscope and record their progress in a report file consisting of oscilloscope screen captures. Courseware materials can easily be shared between different labs, professors at the same institution or even between educators from around the world. The Tektronix Courseware Web Page is set up to make it easy for educators to share their own course material or get inspired by reviewing new and interesting ideas from their peers.



The Courseware PC interface uses Labs to build courses. The courses are then used to build packages which are uploaded to the oscilloscope.

PC Course Editor software

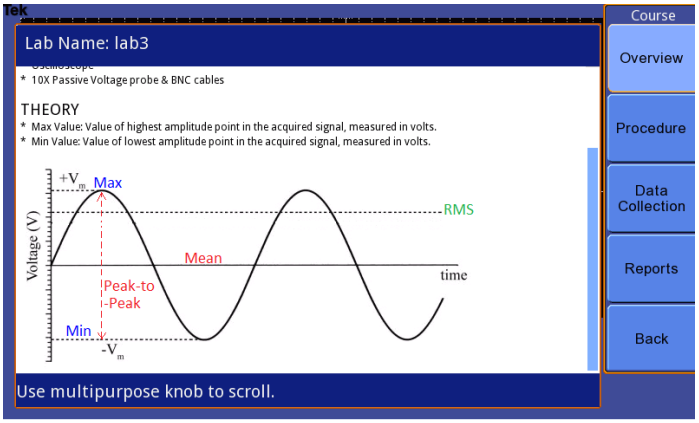
It all starts with the PC Courseware editor tool. This Windows based application provides the framework in which the courseware is developed. With simple Windows tools instructors can create new labs or edit existing labs using text, images, formulas or tables. A profile signature can also be created that identifies the professor, class or school.

The basic building block of the Courseware content is the Lab section. An overview, equipment set-ups, theory discussions and step by step instructions can all be included in this section. When the labs are completed a course can be created. In general, a course is made up of several labs with related topics, for example a basic digital course may consist of lab topics that include; "Basic Boolean Logic", "Simple AND & OR Gates", "Clocks", "Metastable Devices", "Memory Devices", etc. Individual Labs can be shared among multiple courses enabling professors to cater course material to a specific audience. Once all of the courses are defined a package/workspace file is created which contains all of the courses with their related labs and enables the content to be uploaded onto a TBS1000-EDU oscilloscope.

To accommodate regional differences the Courseware PC software and the help wizard support is available in 11 different languages.

The oscilloscope courseware features

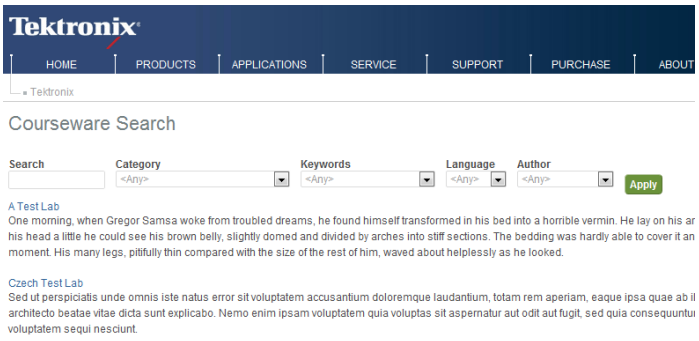
When the workspace file is loaded onto an instrument, students can easily access the content by using the dedicated "Course" button located on the front panel. Using the oscilloscopes soft keys and the multipurpose knob, students can access up to 8 courses which can have up to 30 labs each. To accommodate situations where and instrument is used for several classes, up to 100 MB of course material can be stored on the oscilloscope. Once a lab is chosen, the student is able to review the overview section, perform the lab using the step-by-step procedure, collect data, check & save the data results and generate reports that show the waveforms created for each step in the procedure. And all of this work can be done directly on the oscilloscope.



The Courseware menus accessed by the oscilloscope soft keys provide easy access to all of the Courseware features.

Tektronix Courseware landing page

To help educators find new and interesting ideas for creating content for their labs Tektronix has created a Courseware Web page. At this site, users can download and customize relevant course material or upload material to share their own labs with peers. The site also contains a comprehensive search engine that allows visitors to search for labs by key word, author, category, topic and/or language. Although registration for the site is required, once registered, users are able to download or upload material and they will also be able to comment on material that they've used.



A powerful search engine makes is easy to find material of interest.

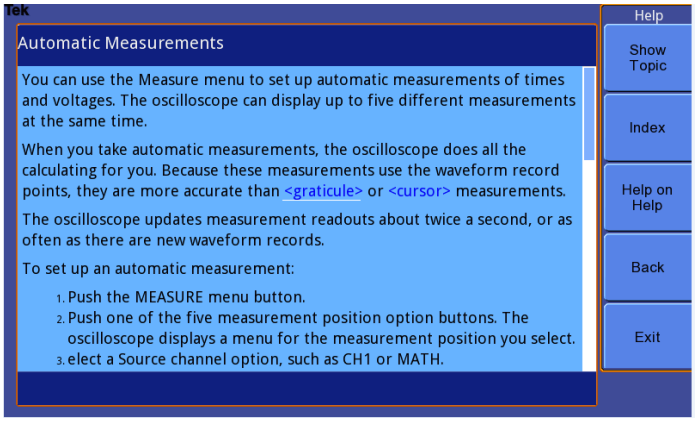
Designed to make your work easy

The TBS1000B-EDU series oscilloscopes are designed with the ease of use and familiar operation you have come to expect from Tektronix.

Intuitive operation

The intuitive user interface with dedicated per-channel vertical controls, zoom/magnifier button and convenient access to functions using the oscilloscope's soft keys and multi-purpose knob make these instruments easy to use, reducing learning time and increasing efficiency.

Help when you need it where you need it



The context-sensitive help system provides important information specific to the task you are working on.

The built-in Help menu provides you with important information about your oscilloscope's features and functions. Help is provided in the same languages as the user interface.

Performance you can count on

In addition to industry-leading service and support, every TBS1000B-EDU series oscilloscope comes backed with a standard 5-year warranty.

Specifications

All specifications apply to all models unless noted otherwise.

Model overview

	TBS1052B-EDU	TBS1072B-EDU	TBS1102B-EDU	TBS1152B-EDU	TBS1202B-EDU
Bandwidth	50 MHz	70 MHz	100 MHz	150 MHz	200 MHz
Channels	2	2	2	2	2
Sample rate on each channel	1.0 GS/s	1.0 GS/s	2.0 GS/s	2.0 GS/s	2.0 GS/s
Record length	2.5k points at all-time bases				

Vertical system – Analog channels

Vertical resolution	8 bits
Input sensitivity range	2 mV to 5 V/div on all models with calibrated fine adjustment
DC gain accuracy	±3%, from 10 mV/div to 5 V/div
Maximum input voltage	300 V_{RMS} CAT II; derated at 20 dB/decade above 100 kHz to 13 V_{p-p} AC at 3 MHz and above
Offset range	2 mV to 200 mV/div: ±1.8 V >200 mV to 5 V/div: ±45 V
Bandwidth limit	20 MHz
Input coupling	AC, DC, GND
Input impedance	1 MΩ in parallel with 20 pF
Vertical zoom	Vertically expand or compress a live or stopped waveform

Horizontal system — Analog channels

Time base range	2.5 ns to 50 s/div
Time base accuracy	50 ppm
Horizontal zoom	Horizontally expand or compress a live or stopped waveform

Input/Output ports

USB interface	USB host port on front panel supports USB flash drives
	USB device port on back of instrument supports connection to PC
GPIB interface	Optional

Data storage

Nonvolatile storage

Reference waveform display	2.5K point reference waveforms
Waveform storage without USB flash drive	2.5K point
Maximum USB flash drive size	64 GB
Waveform storage with USB flash drive	96 or more reference waveforms per 8 MB
Setups without USB flash drive	10 front-panel setups
Setups with USB flash drive	4000 or more front-panel setups per 8 MB
Screen images with USB flash drive	128 or more screen images per 8 MB (the number of images depends on file format selected)
Save All with USB flash drive	12 or more Save All operations per 8 MB
	A single Save All operation creates 3 to 9 files (setup, image, plus one file for each displayed waveform)
Course content	100 MB

Acquisition system

Acquisition modes

Peak Detect	High-frequency and random glitch capture. Captures glitches as narrow as 12 ns (typical) at all time base settings from 5 µs/div to 50 s/div
Sample	Sample data only
Average	Waveform averaged, selectable: 4, 16, 64, 128
Single Sequence	Use the Single Sequence button to capture a single triggered acquisition sequence
Roll	At acquisition time base settings of >100 ms/div

Trigger system

External trigger input	Included on all models
Trigger modes	Auto, Normal, Single Sequence

Trigger types

Edge (Rising/Falling)	Conventional level-driven trigger. Positive or negative slope on any channel. Coupling selections: AC, DC, Noise Reject, HF Reject, LF Reject
Video	Trigger on all lines or individual lines, odd/even or all fields from composite video, or broadcast standards (NTSC, PAL, SECAM)
Pulse Width (or Glitch)	Trigger on a pulse width less than, greater than, equal to, or not equal to, a selectable time limit ranging from 33 ns to 10 s

Trigger source	Two channel models: CH1, CH2, Ext, Ext/5, AC Line
Trigger view	Displays trigger signal while Trigger View button is depressed.
Trigger signal frequency readout	Provides a frequency readout of the trigger source.

Waveform measurements

Cursors

Types	Amplitude, Time
Measurements	ΔT, 1/ΔT, ΔV

Automatic measurements	Period, Frequency, Pos Width, Neg Width, Rise Time, Fall Time, Maximum , Minimum , Peak-Peak, Mean, RMS, Cycle RMS, Cursor RMS, Phase, Pos Pulse Cnt, Neg Pulse Cnt, Rise Edge Cn, Fall Edge Cn, Pos Duty, Neg Duty, Amplitude, Cycle Mean, Cursor Mean, Burst Width, Pos Overshoot, Neg Overshoot, Area, Cycle Area, High, Low, Delay RR, Delay RF, Delay FR, Delay FF

Waveform math

Arithmetic	Add, Subtract, Multiply
Math functions	FFT
FFT	Windows: Hanning, Flat Top, Rectangular 2048 sample points
Sources	Two channel models: CH1 - CH2, CH2 - CH1, CH1 + CH2, CH1 × CH2

Autoset menu

Single-button, automatic setup of all channels for vertical, horizontal, and trigger systems, with undo autoset.

Square wave	Single cycle, multicycle, rising or falling edge
Sine wave	Single cycle, multicycle, FFT spectrum
Video (NTSC, PAL, SECAM)	Field: All, Odd, or Even Line: All or Selectable Line Number

Autorange

Automatically adjust vertical and/or horizontal oscilloscope settings when probe is moved from point to point, or when the signal exhibits large changes.

Frequency counter

Resolution	6 digits
Accuracy (typical)	+ 51 parts per million including all frequency reference errors and +1 count errors
Frequency range	AC coupled, 10 Hz minimum to rated bandwidth
Frequency counter signal source	Pulse width or edge selected trigger source Frequency counter measures selected trigger source at all times in pulse width and edge mode, including when the oscilloscope acquisition is halted due to changes in run status, or acquisition of a single shot event has completed. The frequency counter does not measure pulses that do not qualify as legitimate trigger events. Pulse Width mode: Counts pulses of enough magnitude inside the 250 ms measurement window that qualify as triggerable events (e.g. all narrow pulses in a PWM pulse train if set to "<" mode and the limit is set to a relatively small number). Edge Trigger mode: Counts all pulses of enough magnitude.
Channels	2 channel

Display system

Interpolation	Sin (x)/x
Waveform styles	Dots, vectors
Persistence	Off, 1 s, 2 s, 5 s, infinite
Format	YT and XY

Courseware software

System requirements

The following PC configuration represents the minimum requirements needed to install the Courseware software.

Operating System	Windows XP, Windows 7, Windows 8, Linux (ubuntu 12.04, 12.10, 13.04 or fedora 18, 19)
RAM	512 Megabytes (MB)
Disk space	1 Gigabyte of available hard disk space
Display	XVGA 1024×768 with 120 dpi font size recommended
Removable media	CD-ROM or DVD drive
Peripherals	Keyboard and Microsoft mouse or other compatible pointing device

Physical characteristics

Dimensions

	mm	in.
Height	158.0	6.22
Width	326.3	12.85
Depth	124.2	4.89

Shipping dimensions

	mm	in.
Height	266.7	10.5
Width	476.2	18.75
Depth	228.6	9.0

Weight

	kg	lb.
Instrument only	2.0	4.3
...with accessories	2.2	4.9

RM2000B rackmount

	mm	in
Width	482.6	19.0
Height	177.8	7.0
Depth	108.0	4.25

Environmental

Temperature	
Operating	0 to +50 ºC
Nonoperating	–40 to +71 ºC
Humidity	
Operating and nonoperating	Up to 85% RH at or below +40 ºC Up to 45% RH up to +50 ºC
Altitude	
Operating and nonoperating	Up to 3,000 m (9,843 ft.)
Regulatory	
Electromagnetic compatibility	Meets Directive 2004/108/EC, EN 61326-2-1 Class A; Australian EMC Framework
Safety	UL61010-1:2004, CSA22.2 No. 61010-1:2004, EN61010-1:2001, IEC61010-1:2001

Ordering information

Models

TBS1052B-EDU	50 MHz, 2 Ch, 1 GS/s, TFT DSO
TBS1072B-EDU	70 MHz, 2 Ch, 1 GS/s, TFT DSO
TBS1102B-EDU	100 MHz, 2 Ch, 2 GS/s, TFT DSO
TBS1152B-EDU	150 MHz, 2 ch, 2 GS/s, TFT DSO
TBS1202B-EDU	200 MHz, 2 ch, 2 GS/s, TFT DSO

Instrument options

Language options

Opt. L1	French overlay
Opt. L2	Italian overlay
Opt. L3	German overlay
Opt. L4	Spanish overlay
Opt. L5	Japanese overlay
Opt. L6	Portuguese overlay
Opt. L7	Simplified Chinese overlay
Opt. L8	Traditional Chinese overlay
Opt. L9	Korean overlay
Opt. L10	Russian overlay

Power plug options

Opt. A0	North America power plug (115 V, 60 Hz)
Opt. A1	Universal Euro power plug (220 V, 50 Hz)
Opt. A2	United Kingdom power plug (240 V, 50 Hz)
Opt. A3	Australia power plug (240 V, 50 Hz)
Opt. A4	North America power plug (240 V, 50 Hz)
Opt. A5	Switzerland power plug (220 V, 50 Hz)
Opt. A6	Japan power plug (100 V, 110/120 V, 60 Hz)
Opt. A10	China power plug (50 Hz)
Opt. A11	India power plug (50 Hz)
Opt. A12	Brazil power plug (60 Hz)
Opt. A99	No power cord

Service options

Opt. D1	Calibration Data Report

Probes and accessories are not covered by the oscilloscope warranty and Service Offerings. Refer to the datasheet of each probe and accessory model for its unique warranty and calibration terms.

Probe option

TBS1XX2B-EDU P2220	Replaces standard probes with P2220 probes (200 MHz passive voltage probes with 1x/ 10x attenuation)

Accessories

Standard accessories

Accessory	Description
Passive probes, one per channel	TPP0051: 50MHz passive probe for: TBS1052B-EDU
	TPP0101: 100 MHz passive probe for: TBS1072B-EDU, TBS1102B-EDU
	TPP0201: 200 MHz passive probe for: TBS1152B-EDU, TBS1202B-EDU
Power cord	(Please specify plug option)
NIM/NIST	Traceable certificate of calibration
Printed documentation	Installation and safety manual
	(English, Japanese, and Simplified Chinese)
CD with customer documentation	Customer documentation including detailed user manuals (English, French, German, Italian, Japanese, Korean, Portuguese, Russian, Simplified Chinese, Spanish, Traditional Chinese)
Education CD	Courseware PC Software, example Courseware labs, ABC's of Probes application note, XYZ's of Oscilloscopes application note, Courseware PC Software download link, www.tek.com Education landing page
5-year warranty	Covers labor and parts for defects in materials and workmanship for 5 years, excluding probes and accessories (probes and accessories are not covered by the oscilloscope warranty and service offerings. refer to the data sheet of each probe and accessory model for its unique warranty and calibration terms)

Recommended accessories

Accessory	Description
TEK-USB-488	GPIB-to-USB converter
AC2100	Soft carrying case for instrument
HCTEK4321	Hard plastic carrying case for instrument (requires AC2100)
RM2000B	Rackmount kit
077-0444-xx	Programmer manual – English only
077-0897-xx	Service manual – English only
174-4401-xx	USB host to device cable, 3 ft. long

Recommended probes

Probe	Description
TPP0051	10X passive probe, 50 MHz bandwidth
TPP0101	10X passive probe, 100 MHz bandwidth
TPP0201	10X passive probe, 200 MHz bandwidth
P2220	1X/10X passive probe, 200 MHz bandwidth
P6101B	1X passive probe (15 MHz, 300 V RMS CAT II rating)
P6015A	1000X high-voltage passive probe (75 MHz)
P5100A	100X high-voltage passive probe (500 MHz)
P5200A	50 MHz, 50X/500X high-voltage differential probe
P6021A	15 A, 60 MHz AC current probe
P6022	6 A, 120 MHz AC current probe
A621	2000 A, 5 to 50 kHz AC current probe
A622	100 A, 100 kHz AC/DC current probe/BNC
TCP303/TCPA300	150 A, 15 MHz AC/DC current probe/amplifier
TCP305A/TCPA300	50 A, 50 MHz AC/DC current probe/amplifier
TCP312A/TCPA300	30 A, 100 MHz AC/DC current probe/amplifier
TCP404XL/TCPA400	500 A, 2 MHz AC/DC current probe/amplifier

CE

Tektronix is registered to ISO 9001 and ISO 14001 by SRI Quality System Registrar.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

ASEAN / Australasia (65) 6356 3900
Belgium 00800 2255 4835*
Central East Europe and the Baltics +41 52 675 3777
Finland +41 52 675 3777
Hong Kong 400 820 5835
Japan 81 (3) 6714 3010
Middle East, Asia, and North Africa +41 52 675 3777
People's Republic of China 400 820 5835
Republic of Korea 001 800 8255 2835
Spain 00800 2255 4835*
Taiwan 886 (2) 2722 9622

Austria 00800 2255 4835*
Brazil +55 (11) 3759 7627
Central Europe & Greece +41 52 675 3777
France 00800 2255 4835*
India 000 800 650 1835
Luxembourg +41 52 675 3777
The Netherlands 00800 2255 4835*
Poland +41 52 675 3777
Russia & CIS +7 (495) 6647564
Sweden 00800 2255 4835*
United Kingdom & Ireland 00800 2255 4835*

Balkans, Israel, South Africa and other ISE Countries +41 52 675 3777
Canada 1 800 833 9200
Denmark +45 80 88 1401
Germany 00800 2255 4835*
Italy 00800 2255 4835*
Mexico, Central/South America & Caribbean 52 (55) 56 04 50 90
Norway 800 16098
Portugal 80 08 12370
South Africa +41 52 675 3777
Switzerland 00800 2255 4835*
USA 1 800 833 9200

* European toll-free number. If not accessible, call: +41 52 675 3777

Updated 10 April 2013

For Further Information. Tektronix maintains a comprehensive, constantly expanding collection of application notes, technical briefs and other resources to help engineers working on the cutting edge of technology. Please visit www.tektronix.com.

22 Jan 2014

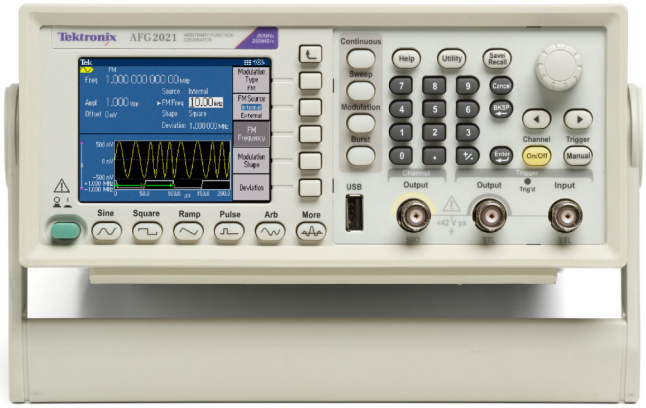
3GW-30001-0

www.tektronix.com

Tektronix®

Arbitrary/Function Generator

AFG2021 Data Sheet



Features & Benefits

- 20 MHz sine wave, 10 MHz square and pulse wave provides a cost-effective solution for most applications
- 250 MS/s sampling rate and 14-bit vertical resolution provide best-in-class signal fidelity
- The intuitive and AFG3000-like UI shorten the learning curve and customers' time to market
- 4 × 128 kS built-in and USB memory expansion for user-defined arbitrary waveforms
- Standard USB host/device, optional GPIB and LAN interfaces keep the best balance between cost and versatility
- Multiple run modes and modulation modes cover most customer requirements to finish the job
- Menu and online help are in 8 languages
- 2U height and half-rack width fit both benchtop and rack-mounted applications
- Free ArbExpress makes user-defined waveform editing and downloading extremely easy
- Free SignalExpress combines Tektronix bench instruments into a low-cost solution for automatic testing

Applications

- Electronic test and design
- Sensor simulation
- Education and training
- Functional test
- System integration

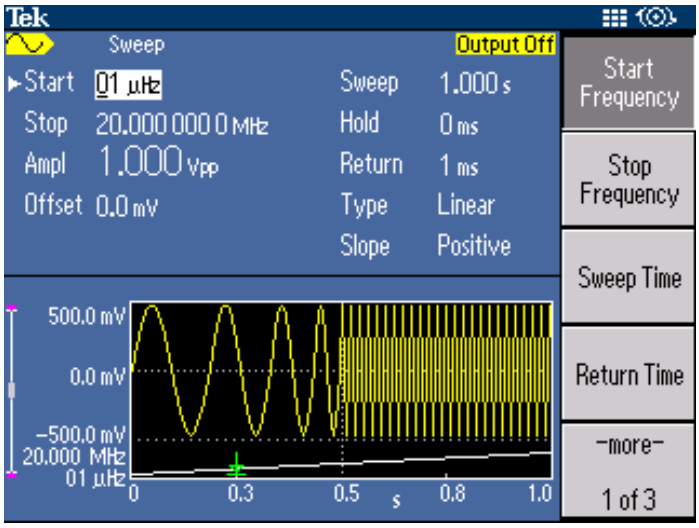
Tektronix®

Superior Performance at an Affordable Price

Nearly all consumer products today have circuits or devices that require the input of specific electronic signals in order for the product to perform correctly. These signals can be as simple as an audio frequency or clock signal or more complex such as a serial data stream or signal from an airbag sensor during a crash. With 20 MHz bandwidth, 14-bit resolution, and 250 MS/s sample rate, the AFG2021 Arbitrary Function Generator can create both simple and complex signals at an entry-level price. With 12 standard waveforms, modulation capability, and a built-in noise generator you can quickly create the signal you need to thoroughly exercise your designs.

Intuitive User Interface Inherited from the AFG3000

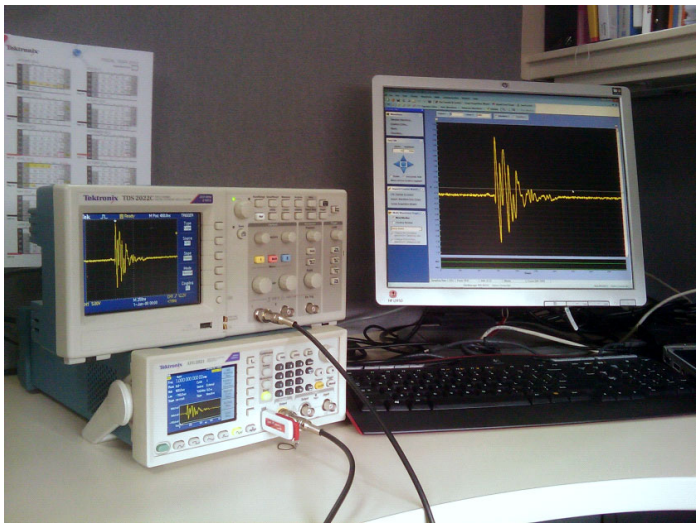
The innovative ease-of-use features first seen on the AFG3000 Series arbitrary/function generators are the building blocks for the AF2021, providing quick access to setup and operational features. Additionally, AFG3000 customers can easily migrate to the new AFG2021 without having to learn a new UI. To easily see waveform information, a 3.5 in. color TFT screen shows relevant parameters in both graphic and text formats, which gives users full confidence in their settings, and lets them focus on the task at hand. The front-panel shortcut buttons and rotary knob allow access to the most frequently used functions and settings with minimum effort and time.



Frequency range from 1 µHz to 20 MHz, fits for most amplifier and filter testing cases.

Efficient Shortcuts to High Frequency

Traditional function generators created their output signals using analog oscillators and signal conditioning. The Tektronix AFG2021 relies on Direct Digital Synthesis (DDS) techniques to determine the rate at which samples are clocked out of their memory. DDS technology synthesizes waveforms by using a single clock frequency to spawn any frequency within the instrument's range. DDS architecture provides exceptional frequency agility, making it easy to program both frequency and phase changes on the fly, which is useful to test any type of frequency-related DUT – radio and satellite system components, amplifiers, or filters for example.



ArbExpress makes real-world signal replication almost with no effort.

ArbExpress® Makes Real-world Waveform Replication with Minimum Efforts

With the ArbExpress software, you can quickly create waveforms that can be transferred to the AFG2021 to meet custom stimulus requirements. ArbExpress supports direct connection to Tektronix oscilloscopes and AFGs through USB, GPIB, or LAN. With the software, users can import real-world signals captured with an oscilloscope onto a PC, then edit and download them onto an AFG to replicate the captured waveform. This is extremely useful for automotive, medical, and industrial applications where recreating sensor data is critical to analyzing the integrity of the design.

Increase Productivity with SignalExpress

Every AFG2021 ships with a free copy of the Limited Tektronix Edition of National Instrument's LabVIEW SignalExpress for basic instrument control, data logging, and analysis. SignalExpress supports the range of Tektronix bench instruments enabling you to connect your entire test bench. You can then access the feature-rich tools packed into each instrument from one intuitive software interface. This allows you to automate complex measurements requiring multiple instruments, log data for an extended period of time, time-correlate data from multiple instruments, and easily capture and analyze your results, all from your PC. Only Tektronix offers a connected test bench of intelligent instruments to simplify and speed debug of your complex design.

Connectivity

Using the USB host socket, users can save their customized waveforms or instrument settings onto a USB memory stick. Reloading the data is easily done by plugging the device back into the USB host socket. The USB connector and optional GPIB/LAN functionality offers a way for users to connect the instrument to a PC for waveform download and remote control.

Compact Form Factor

The 2U height and half-rack width form factor enables the AFG2021 to be stacked on other bench instruments, such as digital multimeters, power supplies, and frequency counters, saving valuable bench space. Together with the standard RMU2U rackmount kit, GPIB interface, and full SCPI support the AFG2021 is also a perfect option for rackmount applications, such as ATE configuration in manufacturing environments.

Characteristics

General

Characteristic	Description
Channels	1
Waveforms	Sine, Square, Pulse, Ramp, Noise, DC, Sin(x)/x, Gaussian, Lorentz, Exponential Rise, Exponential Decay, and Haversine
Sine Wave	1 µHz to 20 MHz
Sine Wave in Burst Mode	1 µHz to 10 MHz
Effective Maximum Frequency Out	20 MHz
Amplitude Flatness (1 V_{p-p})	
<5 MHz	±0.15 dB
5 MHz to 20 MHz	±0.3 dB
Harmonic Distortion (1 V_{p-p})	
10 Hz to 20 kHz	<–70 dBc
20 kHz to 1 MHz	<–60 dBc
1 MHz to 10 MHz	<–50 dBc
10 MHz to 20 MHz	<–40 dBc
THD	<0.2% (10 Hz to 20 kHz, 1 V_{p-p})
Spurious (1 V_{p-p})	
10 Hz to 1 MHz	<–60 dBc
1 MHz to 20 MHz	<–50 dBc
Phase Noise, Typical	20 MHz: <–110 dBc/Hz at 10 kHz offset, 1 V_{p-p}
Residual Clock Noise	–63 dBm
Square Wave	1 µHz to 10 MHz
Rise/Fall Time	≤18 ns
Jitter (RMS), Typical	<500 ps
Ramp Wave	1 µHz to 200 kHz
Linearity	≤0.1% of peak output at 10% to 90% of amplitude range
Symmetry	0.0% to 100.0%
Pulse Wave	1 mHz to 10 MHz
Pulse Width	30.00 ns to 999.99 s
Resolution	10 ps or 5 digits
Pulse Duty	0.001% to 99.999% (Limitations of pulse duty width apply)
Edge Transition Time	18 ns to 0.625 × Pulse Period
Resolution	10 ps or 4 digits
Lead Delay	
Range	Continuous Mode: 0 ps to Period Trigger/Gate Burst Mode: 0 ps to Period – [Pulse Width + 0.8 × (Leading Edge Time + Trailing Edge Time)]
Resolution	10 ps or 8 digits
Overshoot, Typical	<5%
Jitter (RMS), Typical	<500 ps

Characteristic	Description
Other Waveforms	1 µHz to 200 kHz
Noise Bandwidth (–3 dB)	20 MHz
Noise Type	White Gaussian
DC (into 50 Ω)	–5 V to +5 V
Arbitrary Waveforms	1 mHz to 10 MHz
Arbitrary Waveforms in Burst Mode	1 mHz to 5 MHz
Effective Analog Bandwidth (–3 dB)	34 MHz
Nonvolatile Memory	4 waveforms
Memory: Sample Rate	2 to 128k: 250 MS/s
Vertical Resolution	14 bits
Rise/Fall Time	≤20 ns
Jitter (RMS)	4 ns
Amplitude, 50 Ω Load	10 mV_{p-p} to 10 V_{p-p}
Amplitude, Open Circuit	20 mV_{p-p} to 20 V_{p-p}
Accuracy	±(1% of setting + 1 mV), (1 kHz sine waveform, 0 V offset, >10 mV_{p-p} amplitude)
Resolution	0.1 mV_{p-p}, 0.1 mV_{RMS}, 1 mV, 0.1 dBm, or 4 digits
Units	V_{p-p}, V_{RMS}, dBm (sine wave only)
Output Impedance	50 Ω
Load Impedance Setting	Selectable: 50 Ω, 1 Ω to 10.0 kΩ, High Z (adjusts displayed amplitude according to selected load impedance)
Isolation	<42 V_{Peak} maximum to earth
Short-circuit Protection	Signal outputs are robust against permanent shorts against floating ground
External Voltage Protection	To protect signal outputs against external voltages use fuse adapter 013-0345-00
DC Offset Range, 50 Ω Load	±(5 V_{Peak} – amplitude V_{p-p}/2)
DC Offset Range, Open Circuit	±(10 V_{Peak} – amplitude V_{p-p}/2)
Accuracy	±(1% of |setting| + 5 mV + 0.5% of amplitude (V_{p-p}))
Resolution	1 mV

Modulation

AM, FM, PM

Characteristic	Description
Carrier Waveforms	All, including ARB, except Pulse, Noise, and DC
Source	Internal/External
Internal Modulating Waveform	Sine, Square, Ramp, Noise, ARB (AM: Maximum waveform length 4,096; FM/PM: Maximum waveform length 2,048)
Internal Modulating Frequency	2 mHz to 50.00 kHz
AM Modulation Depth	0.0% to +120.0%
Min FM Peak Deviation	DC
Max FM Peak Deviation	10 MHz

Frequency Shift Keying

Characteristic	Description
Carrier Waveforms	All, including ARB, except Pulse, Noise, and DC
Source	Internal/External
Internal Modulating Frequency	2 mHz to 1.000 MHz
Number of Keys	2

Pulse Width Modulation

Characteristic	Description
Carrier Waveform	Pulse
Source	Internal/External
Internal Modulating Waveform	Sine, Square, Ramp, Noise, ARB (Maximum waveform length 2,048)
Internal Modulating Frequency	2 mHz to 50.00 kHz
Deviation	0% to 50.0% of pulse period

Sweep

Characteristic	Description
Waveforms	All, including ARB, except Pulse, Noise, and DC
Type	Linear, Logarithmic
Sweep Time	1 ms to 300 s
Hold/Return Time	0 ms to 300 s
Max Total Sweep Time (Sweep + Hold + Return)	300 s
Resolution	1 ms or 4 digits
Total Sweep Time Accuracy, Typical	0.4%
Min Start/Stop Frequency	All except ARB: 1 µHz ARB: 1 mHz
Max Start/Stop Frequency	Sine: 20 MHz Square: 10 MHz ARB: 10 MHz Others: 200 kHz

Burst

Characteristic	Description
Waveforms	All, including ARB, except Noise and DC
Type	Triggered, Gated (1 to 1,000,000 cycles or Infinite)
Internal Trigger Rate	1 µs to 500.0 s
Gate and Trigger Sources	Internal, External, Manual Trigger, and Remote Interface

Auxiliary Input

Modulation Input

Characteristic	Description
Input Range	All except FSK: ±1 V full scale FSK: 3.3 V logic level
Impedance	10 kΩ
Frequency Range	DC to 25 kHz (122 kS/s sample rate)

External Triggered/Gated Burst Input

Characteristic	Description
Level	TTL compatible
Pulse Width	100 ns minimum
Slope	Positive/Negative selectable
Trigger Delay	0.0 ns to 85.000 s
Resolution	100 ps or 5 digits
Jitter (RMS), Typical	Burst: <500 ps (Trigger input to signal output)

10 MHz Reference Input

Characteristic	Description
Impedance	1 kΩ, AC coupled
Required Input Voltage Swing	100 mV_{p-p} to 5 V_{p-p}
Lock Range	10 MHz ±35 kHz

Auxiliary Output

Trigger Output

Characteristic	Description
Level	Positive TTL level pulse into 1 kΩ
Impedance	50 Ω
Jitter (RMS), Typical	500 ps
Max Frequency	4.9 MHz (4.9 MHz to 20 MHz: A fraction of the frequency is output)

Common Characteristics

Remote Programming (GPIB, LAN 10BASE-T/100BASE-TX, USB 1.1, compatible with SCPI-1999.0 and IEEE 488-2 standards)

Characteristic	USB	LAN*1	GPIB*1
Function Change	95 ms	103 ms	84 ms
Frequency Change	2 ms	19 ms	2 ms
Amplitude Change	60 ms	67 ms	52 ms
Select User ARB	88 ms	120 ms	100 ms
Data Download Time for 4k Point ARB Waveform Data (8 KB), Typical	20 ms	84 ms	42 ms

*1 GPIB and LAN interfaces are only available on the instrument with Option GL.

General

Characteristic	Description
Frequency Setting Resolution	1 µHz or 12 digits
Phase (except DC, Noise, Pulse)	
Range	–360° to +360°
Resolution	Sine: 0.01° Other Waveforms: 0.1°
Internal Noise Add	When activated, output signal amplitude is reduced to 50%
Level	0.0% to 50% of amplitude (V_{p-p}) setting
Resolution	1%
Main Output	50 Ω
Effective Frequency Switching Speed	2 ms through remote control
Internal Frequency Reference	
Stability	All except ARB: ±1 ppm, 0 °C to 50 °C ARB: ±1 ppm, ±1 µHz, 0 °C to 50 °C
Aging	±1 ppm per year
Power Source	100 V to 240 V, 50 Hz to 60 Hz or 115 V, 400 Hz
Power Consumption	60 W
Warm-up Time, Typical	20 minutes
Power On Self Diagnostics, Typical	<10 s
Acoustic Noise, Typical	<50 dBA
Display	3.5 in. Color TFT LCD
User Interface and Help Language	English, French, German, Japanese, Korean, Simplified and Traditional Chinese, Russian (User selectable)

Physical Characteristics

Benchtop Configuration

Dimension	mm	in.
Height	104.2	4.10
Weight	241.8	9.52
Depth	419.1	16.50
Weight	**kg**	**lb.**
Net	2.87	6.3
Shipping	4.72	10.4

Environmental and Safety Characteristics

Characteristic	Description
Temperature	
Operating	0 °C to +50 °C
Nonoperating	–30 °C to +70 °C
Humidity	
Operating	≤80%, +0 °C to +40 °C, noncondensing ≤60%, +40 °C to +50 °C, noncondensing
Nonoperating	5% to 90%, <+40 °C, noncondensing 5% to 80%, ≥+40 °C to ≤+60 °C, noncondensing 5% to 40%, >+60 °C to ≤+70 °C, noncondensing
Altitude	
Operating	Up to 3,000 m (9,842 ft.)
Nonoperating	Up to 12,000 m (39,370 ft.)
EMC Compliance	EU Council Directive 2004/108/EC
Safety	UL61010-1; 2004 CAN/CSA C22.2 No. 61010-1; 2004 EN61010-1; 2001 IEC61010-1; 2001

Ordering Information

AFG2021

Arbitrary/Function Generator.
Includes: User Manual, Power Cord, USB Cable, CD-ROM with Programmer Manual, Service Manual, Labview and IVI Drivers, CD-ROM with ArbExpress® Software, NIST-traceable Calibration Certificate.

Please specify power cord and local language for user manual when ordering.

Configuration Options

Option	Description
Opt. GL	GPIB and LAN interfaces

Language Options

Option	Description
Opt. L0	English manual
Opt. L1	French manual
Opt. L2	Italian manual
Opt. L3	German manual
Opt. L4	Spanish manual
Opt. L5	Japanese manual
Opt. L6	Portuguese manual
Opt. L7	Simplified Chinese manual
Opt. L8	Traditional Chinese manual
Opt. L9	Korean manual
Opt. L10	Russian manual
Opt. L99	No manual

Power Plug Options

Option	Description
Opt. A0	North America power
Opt. A1	Universal Euro power
Opt. A2	United Kingdom power
Opt. A3	Australia power
Opt. A5	Switzerland power
Opt. A6	Japan power
Opt. A10	China power
Opt. A11	India power
Opt. A12	Brazil power
Opt. A99	No power cord or AC adapter

Service Options

Option	Description
Opt. C3	Calibration Service 3 Years
Opt. C5	Calibration Service 5 Years
Opt. D1	Calibration Data Report
Opt. D3	Calibration Data Report 3 Years (with Opt. C3)
Opt. D5	Calibration Data Report 5 Years (with Opt. C5)
Opt. R5	Repair Service 5 Years
Opt. R5DW	Repair Service Coverage 5 Years (starts at time of customer instrument purchase)

Recommended Accessories

Accessory	Description
RMU2U	Rackmount kit
013-0345-00	Fuse adapter, BNC-P to BNC-R
159-0454-00	Fuse set, 3 pcs, 0.125 A
012-0482-00	BNC cable shielded, 3 ft.
012-1256-00	BNC cable shielded, 9 ft.
012-0991-00	GPIB cable, double shielded
011-0049-02	50 Ω BNC terminator

Warranty

Three-year warranty on parts and labor.

Contact Tektronix:

ASEAN / Australasia (65) 6356 3900

Austria 00800 2255 4835*

Balkans, Israel, South Africa and other ISE Countries +41 52 675 3777

Belgium 00800 2255 4835*

Brazil +55 (11) 3759 7627

Canada 1 800 833 9200

Central East Europe and the Baltics +41 52 675 3777

Central Europe & Greece +41 52 675 3777

Denmark +45 80 88 1401

Finland +41 52 675 3777

France 00800 2255 4835*

Germany 00800 2255 4835*

Hong Kong 400 820 5835

India 000 800 650 1835

Italy 00800 2255 4835*

Japan 81 (3) 6714 3010

Luxembourg +41 52 675 3777

Mexico, Central/South America & Caribbean 52 (55) 56 04 50 90

Middle East, Asia, and North Africa +41 52 675 3777

The Netherlands 00800 2255 4835*

Norway 800 16098

People's Republic of China 400 820 5835

Poland +41 52 675 3777

Portugal 80 08 12370

Republic of Korea 001 800 8255 2835

Russia & CIS +7 (495) 7484900

South Africa +41 52 675 3777

Spain 00800 2255 4835*

Sweden 00800 2255 4835*

Switzerland 00800 2255 4835*

Taiwan 886 (2) 2722 9622

United Kingdom & Ireland 00800 2255 4835*

USA 1 800 833 9200

* European toll-free number. If not accessible, call: +41 52 675 3777

Updated 10 February 2011

For Further Information. Tektronix maintains a comprehensive, constantly expanding collection of application notes, technical briefs and other resources to help engineers working on the cutting edge of technology. Please visit **www.tektronix.com**

31 May 2012 75W-28089-0

Low-cost 5½-digit DMM for system, bench, or portable applications

DIGITAL MULTIMETERS & SYSTEMS

2110

5½-Digit Dual-Display Digital Multimeter

- **High accuracy, high speed for general purpose measurements**
- **15 measurement functions, including capacitance and thermocouple measurements**
- **Dual-line display allows concurrent measurements**
- **TMC-compliant USB 2.0 interface for use with SCPI test commands**
- **GPIB option for use in system applications**
- **Includes PC software utilities for graphing and data sharing in both Microsoft® Word and Excel**
- **Rugged construction for durability in bench/portable applications**
- **Includes all accessories, such as start-up software, USB cable, power cable, and safety test leads**
- **CE compliant and c UL us listed**

APPLICATIONS

Built for Production Testing

The Model 2110 Digital Multimeter is ideal for applications in manual, semi-automatic, and automatic testing of low-cost electronic devices, circuits, modules, electrical components, and semiconductor components. Key features include:

- **Speed: up to 50,000 readings per second**
- **Control: GPIB (optional) and USB interfaces, accepting SCPI (IEEE-488.2) commands**
- **External BNC trigger lines**
- **NIST traceability (with included calibration certificate)**

Built for General Purpose Uses

The Model 2110 Digital Multimeter is also ideal for bench uses such as research, development, service, calibration, and teaching. Bench-oriented features include:

- **Accuracy: 0.012% basic DCV accuracy**
- **Easy-to-operate panel**
- **Easy waveform plotting and data collection with KI-Tool and KI-Link**
- **Store up to 2000 readings**

The Model 2110 5½-Digit Dual-Display Digital Multimeter combines a compelling price with a comprehensive set of capabilities, superior measurement accuracy, and high speed for a broad range of applications. It features 15 measurement functions and 7 math functions and has dual-line display capability, which allows it to display two different measurements concurrently. The Model 2110 is an unbeatable value for production, R&D, and test engineers, scientists, and students making a wide variety of measurements in portable, bench, and system applications.

High Accuracy, Abundant Capabilities, Low Cost

The Model 2110 provides precision and a rich set of capabilities at a value price. It has 0.012% one-year basic DC voltage accuracy and 0.020% one-year basic resistance accuracy up to the 100kΩ range.

The Model 2110 provides a wide number of measurement ranges and functions:

- DC voltage: 0.1V, 1V, 10V, 100V, and 1000V
- AC voltage: 0.1V, 1V, 10V, 100V, and 750V
- DC current: 10mA, 100mA, 1A, 3A, and 10A
- AC current: 1A, 3A, and 10A
- Two- and four-wire resistance: 100Ω, 1kΩ, 10kΩ, 100kΩ, 1MΩ, 10MΩ, and 100MΩ
- Frequency: From 10Hz to 300kHz
- Capacitance measurement: 1nF, 10nF, 100nF, 1μF, 10μF, 100μF
- Thermocouple measurement: J-, R-, S-, T-, E-, N-, B-, C-, and K-type thermocouples
- Temperature (RTD and NTC Thermistor) measurements
- Diode measurement
- Continuity test
- Programmable A-D converter and filter settings for signal to noise optimization. Additionally, seven mathematical operations can be performed on measurement readings: percentage, average, min/max, NULL, limits, mX+b, dB, and dBm testing.

Speed

At 5½ digits, the Model 2110 delivers up to 200 readings/s via the USB remote interface. At the fast 4½-digit setting, it reads up to 50,000 readings/s and up to 30,000 readings/s into the buffer, making it ideal for production and monitoring applications in which speed is critical.

2110

5½-Digit Dual-Display Digital Multimeter

Ordering Information

2110-100: 5½-digit USB Digital Multimeter (100V)

2110-120: 5½-digit USB Digital Multimeter (120V)

2110-220: 5½-digit USB Digital Multimeter (220V)

2110-240: 5½-digit USB Digital Multimeter (240V)

2110-100-GPIB: 5½-digit USB and GPIB Digital Multimeter (100V)

2110-120-GPIB: 5½-digit USB and GPIB Digital Multimeter (120V)

2110-220-GPIB: 5½-digit USB and GPIB Digital Multimeter (220V)

2110-240-GPIB: 5½-digit USB and GPIB Digital Multimeter (240V)

Accessories Supplied

Reference Manual on CD, Specifications, LabVIEW® Driver, Keithley I/O Layer, USB Cable, Power Cable, Safety Test Leads, KI-Tool, and KI-Link Add-in (both Microsoft Word and Excel versions), Calibration Certificate

All accessories, such as start-up software, USB cable, power cable, and safety test leads, are included with the Model 2110.

Simplicity

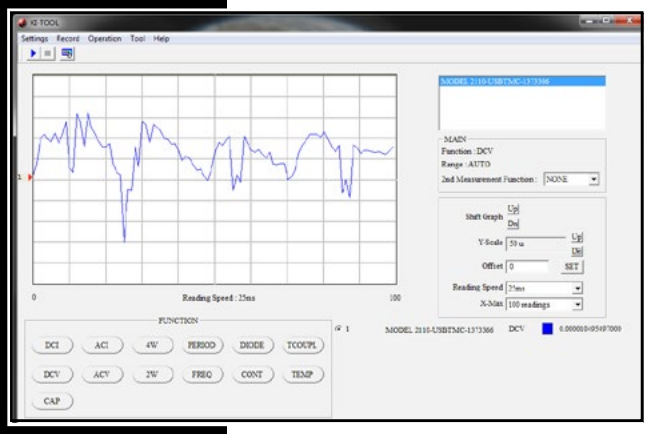
The Model 2110 is operational and intuitive to use right out of the box. The functions on the front panel are user friendly and easy to read. Its KI-Tool and KI-Link software allow users to quickly control the instrument over GPIB (if equipped) or USB, record measurements, and display time-series plots of the data. Its LabView® and IVI drivers give more-advanced customers even more control over the instrument. Both the TMC-compliant USB remote interface and the GPIB interface allow easy re-use of existing SCPI programs.

Startup Software, PC Utilities Included

The KI-Tool application provides charting and graphing capabilities without programming to simplify setup, checkout, and basic measurement applications requiring graphical data representation. Scale, offset, and level can be adjusted to fine-tune images for visual evaluation of signal and noise elements over time. It also includes tabular data and SCPI command prompt windows for maximum flexibility. Data sets can also be saved to disk files.

The Microsoft Excel Add-In utility is also included and provides quick data import into a standard Microsoft Excel spreadsheet, including selectable graphing, instrument settings, and number of data points collected. Data can then be analyzed through standard or optional Microsoft Excel functions, including graphical, statistical, and trend charting. A version supporting Microsoft Word is also included for direct data import into reports.

LabView, IVI-C, and IVI-COM drivers are also supplied to allow for increased flexibility in integrating the Model 2110 into new and existing systems and test routines.



KI-Tool simplifies basic measurement applications through every setup and graphical data representation.

Low-cost 5½-digit DMM for system, bench, or portable applications

DIGITAL MULTIMETERS & SYSTEMS

2110 5½-Digit Dual-Display Digital Multimeter

Specifications

DC CHARACTERISTICS

DC VOLTAGE

Range	Resolution	Input Resistance	Accuracy[1] ±(% of reading + % of range) 1 Year, 23° ±5°C	Temperature Coefficient 0°–18°C & 28°–40°C
100.000 mV	1 µV		0.012 + 0.004	0.001 + 0.0005
1.00000 V	10 µV		0.012 + 0.001	0.0009 + 0.0005
10.0000 V	0.1 mV	10 MΩ	0.012 + 0.002	0.0012 + 0.0005
100.000 V	1 mV		0.012 + 0.002	0.0012 + 0.0005
1000.00 V	10 mV		0.02 + 0.003	0.002 + 0.0015

DCI (DC CURRENT)

Range	Resolution	Shunt Resistance	Accuracy[1] ±(% of reading + % of range) 1 Year, 23° ±5°C	Temperature Coefficient 0°–18°C & 28°–40°C
10.0000 mA	0.1 µA	5.1 Ω	0.05 + 0.020	0.005 + 0.002
100.000 mA	1 µA	5.1 Ω	0.05 + 0.010	0.005 + 0.001
1.00000 A	10 µA	0.1 Ω	0.150 + 0.020	0.008 + 0.001
3.0000 A	100 µA	0.1 Ω	0.200 + 0.030	0.008 + 0.001
10.0000 A	100 µA	5 mΩ	0.250 + 0.050	0.008 + 0.001

RESISTANCE[2]

Range	Resolution	Test Current	Accuracy[1] ±(% of reading + % of range) 1 Year, 23° ±5°C	Temperature Coefficient 0°–18°C & 28°–40°C
100.000 Ω	1 mΩ	1 mA	0.020 + 0.020	0.003 + 0.0005
1.00000 kΩ	10 mΩ	1 mA	0.020 + 0.003	0.003 + 0.0005
10.0000 kΩ	100 mΩ	100 µA	0.020 + 0.002	0.003 + 0.0005
100.000 kΩ	1 Ω	10 µA	0.020 + 0.002	0.003 + 0.0005
1.00000 MΩ	10 Ω	1 µA	0.030 + 0.004	0.005 + 0.0005
10.0000 MΩ	100 Ω	0.1 µA	0.200 + 0.004	0.05 + 0.0005
100.000 MΩ	1 kΩ	0.1 µA	2.000 + 0.005	0.5 + 0.0005

DIODE TEST

Range	Resolution	Test Current	Accuracy[1] ±(% of reading + % of range) 1 Year, 23° ±5°C	Temperature Coefficient 0°–18°C & 28°–40°C
1.0000V	10 µV	1 mA	0.020 + 0.030	0.002 + 0.0005

CONTINUITY

Range	Resolution	Test Current	Accuracy[1] ±(% of reading + % of range) 1 Year, 23° ±5°C	Temperature Coefficient 0°–18°C & 28°–40°C
1000Ω	10 mΩ	1 mA	0.020 + 0.020	0.002 + 0.0005

1. Specifications valid after two hour warm-up.
   a. ADC set for continuous trigger operation.
   b. Input bias current <30pA at 25°C.
   c. Measurement rate set to 10 PLC.
2. Specifications for 4W ohms mode. For 2W ohms, use zero null or subtract lead resistance from displayed reading.
   a. Maximum lead resistance 10% of range per lead for 100Ω and 1kΩ ranges; add 1kΩ per lead for all other ranges.

MEASUREMENT NOISE REJECTION DC (60Hz/50Hz) at 5.5 DIGITS

CMRR: 120dB for 1kΩ unbalance in LO lead.

NMRR: 60dB for line frequency ±0.1%.

TEMPERATURE (THERMOCOUPLE) CHARACTERISTICS

Thermocouple Type	Range	Accuracy[1] ±°C 1 Year, exclusive of lead accuracy
B	600 to 1800°C	1.5
C	0 to 2300°C	1.5
E	–250 to 1000°C	1.5
J	–200 to 1200°C	1.0
K	–200 to 1350°C	1.0
N	–200 to 1300°C	1.0
R	0 to 1750°C	1.5
S	0 to 1750°C	1.5
T	–250 to 400°C	1.5

1. Specifications valid after two hour warm-up;
   a. ADC set for continuous trigger operation.

RTD and NTC Thermistor Measurements: Accuracy ±0.8°C, 1 year, exclusive of lead accuracy. PT100, D100, F100, PT385, PT3916, SPRTD (R-Zero, A4, B4, Ax, Bx, Cx, and Dx), NTCT (A, B, and C), and user-definable RTD.

CAPACITANCE CHARACTERISTICS

Range	Test Current	Accuracy[1] ±(% of reading + % of range) 1 Year, 23° ±5°C
1.000 nF	10 µA	2.0 + 0.80
10.00 nF	10 µA	1.0 + 0.50
100.0 nF	100 µA	1.0 + 0.50
1.000 µF	100 µA	1.0 + 0.50
10.00 µF	100 µA	1.0 + 0.50
100.0 µF	1 mA	1.0 + 0.50

1. Specifications valid after two hour warm-up.
   a. ADC set for continuous trigger operation.
   b. Null enabled.

ACCESSORIES AVAILABLE

4299-3	Single Rack Mount Kit
4299-4	Dual Rack Mount Kit
4299-7	Fixed Rack Mount Kit
5805	Kelvin Probes, 0.9m (3ft)
5805-12	Kelvin Probes, 3.6m (12ft)
5808	Low Cost, Single Pin, Kelvin Probes
5809	Low Cost, Kelvin Clip Lead Set
6517-TP	Thermocouple Bead Probe (K-Type)
7007-1	Shielded GPIB Cable, 1m (3.3 ft)
7007-2	Shielded GPIB Cable, 2m (6.6 ft)
8605	High Performance Modular Test Leads
8606	High Performance Modular Probe Kit
8680	RTD Probe Adapter
8681	Low Cost RTD

SERVICES AVAILABLE

2110-3Y-EW	1 Year Factory Warranty extended to 3 years from date of shipment
2110-5Y-EW	1 Year Factory Warranty extended to 5 years from date of shipment
C/2110-3Y-DATA	3 (Z-540-1 compliant) calibrations within 3 years of purchase for Model 2110
C/2110-5Y-DATA	5 (Z-540-1 compliant) calibrations within 5 years of purchase for Model 2110
C/2110-3Y-ISO	3 (ISO-17025 accredited) calibrations within 3 years of purchase for Model 2110
C/2110-5Y-ISO	5 (ISO-17025 accredited) calibrations within 5 years of purchase for Model 2110

2110 5½-Digit Dual-Display Digital Multimeter

AC CHARACTERISTICS

FREQUENCY AND PERIOD

Range	Frequency (Hz)	Accuracy[1] ±(% of reading + % of range) 1 Year, 23° ±5°C	Temperature Coefficient 0°–18°C & 28°–40°C
100.000 mV to	10–40	0.03	0.002
750.000 V[2]	40–300k	0.02	0.002

ACV (AC TRMS VOLTAGE)

Range	Resolution	Frequency	Accuracy[1] ±(% of reading + % of range) 1 Year, 23° ±5°C	Temperature Coefficient 0°–18°C & 28°–40°C
100.000 mV to 750.000 V[2]	1 μV to 10 mV	10 Hz–20 kHz	0.12 + 0.05	0.01 + 0.01
		20 kHz–50 kHz	0.25 + 0.05	0.02 + 0.02
		50 kHz–100 kHz	0.65 + 0.08	0.04 + 0.02
		100 kHz–300 kHz	5.00 + 0.50	0.2 + 0.02

ACI (AC TRMS CURRENT)

Range	Resolution	Frequency	Accuracy[1] ±(% of reading + % of range) 1 Year, 23° ±5°C	Temperature Coefficient 0°–18°C & 28°–40°C
1.0000 A to	10 μA to	10 Hz–900 Hz	0.30 + 0.06	0.02 + 0.01
3.00000 A	100 μA	900 Hz–5 kHz	1.50 + 0.15	0.02 + 0.01
10.0000 A	100 μA	10 Hz–900 Hz	0.50 + 0.12	0.02 + 0.01
		900 Hz–5 kHz	2.50 + 0.20	0.02 + 0.01

1. Specifications valid after two hour warm-up.
   a. Slow AC filter (3Hz bandwidth).
   b. Pure sine wave input greater than 5% of range.
2. 750VAC range is limited to 100kHz.

GENERAL

Input bias current: <30pA at 25°C.
Input protection: 1000V all ranges (2W input).
AC CMRR: 70dB (for 1kΩ unbalance LO lead).
Power Supply: 100V/120V/220V/240V.
Power Line Frequency: 50/60Hz auto detected.
Power Consumption: 25VA max.
Digital I/O interface: USB-compatible Type B connection, GPIB (option).
Environment: For indoor use only.
Operating Temperature: 0° to 40°C.
Operating Humidity: Maximum relative humidity 80% for temperature up to 31°C.
Storage Temperature: –40° to 70°C.
Operating Altitude Up to 2000 m above sea level.
Bench Dimensions (with handles and bumpers): 107 mm high × 252.8 mm wide × 305 mm deep (3.49 in. × 9.95 in. × 12.00 in.).
Weight: 2.23 kg (4.92 lbs.).
Safety: Conforms to European Union Low Voltage Directive, EN61010-1. Measurement Cat 1 1000V and CAT II 600V.
EMC: Conforms to European Union Directive 89/336/EEC, EN61326-1.
Warranty: One year.

Model 2110 rear panel.

DIGITAL MULTIMETERS & SYSTEMS

2220
2230

Multi-Channel Programmable DC Power Supplies

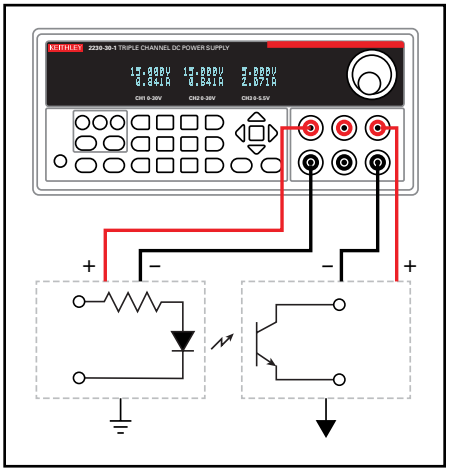
- **Dual and triple output models with two 30V/1.5A (45W) channels and a 6V/5A (30W) channel on the triple output supply**
- **All channels are independently controlled and have isolated outputs for maximum flexibility**
- **All channels have remote sensing to ensure that programmed voltage is accurately applied to the load**
- **Two 30V channels can be combined either in series to double output voltage or in parallel to double output current**
- **0.03% basic voltage output accuracy and 0.1% current accuracy ensure quality test data**
- **Low noise, linear regulation with <3mVpp ripple and noise**
- **Voltage and current outputs for all channels are displayed simultaneously for easy observation of each output state**
- **Keypad entry allows fast, precise entry of output values**
- **Standard USB interface for automated testing**

The Models 2220 and 2230 Multi-Channel Programmable DC Power Supplies combine two and three channels of output power to cost-effectively characterize and test a wide range of devices, circuit boards, modules, and products that require more than one power source. The Model 2220-30-1 supply provides two channels, with each channel capable of outputting up to 30V and up to 1.5A. The Model 2230-30-1 includes two 30V/1.5A channels and adds a 6V channel with up to 5A output for powering digital circuits. The Models 2220 and 2230 Multi-Channel Power Supplies offer an excellent combination of performance, versatility, and ease of use to maximize the information from characterization or test as quickly and as easily as possible. They perform as effectively in automated test systems as they do in manual instrument configurations.

Independent and Isolated Outputs

Since each channel in the Models 2220 and 2230 Multi-Channel Power Supplies is completely independent and isolated from each other, these power supplies can be used to provide power to two circuits that are optically isolated or transformer-isolated from each other and have different reference points. Their isolated channels eliminate the need for a second power supply to power one of the isolated circuits.

Additionally, each channel can be independently controlled, so channels can be individually turned on and turned off at any time. Thus, these power supplies can be used to power up a circuit with multiple voltage levels (such as a digital circuit) that must be turned on in a specified time sequence. Furthermore, the timer capability allows you to set up unattended tests that turn off the channels after a programmed time interval to protect a device-under-test (DUT) from potential damage due to the continuous application of power beyond a recommended time interval. Both isolated and independent channels provide excellent versatility and flexibility to address a wide range of test applications.



Power two isolated circuits with isolated output channels.

Accurate Power Delivery to the Load

With basic voltage setting accuracy and voltage readback accuracy of 0.03% for each channel, the exact voltage programmed for any channel is applied at the output terminals. Plus, the rear panel connections for each channel include remote sense terminals that compensate for voltage drops in the power supply leads. This helps to ensure that the correct voltage is delivered accurately to the load terminals of the DUT. Many other multi-channel power supplies do not provide remote sensing, which reduces overall system accuracy.

2220
2230

Multi-Channel Programmable DC Power Supplies

3-Year Warranty

Multi-channel programmable DC power supplies

DC POWER SUPPLIES

Ordering Information

2220-30-1
Programmable Dual Channel DC Power Supply

2220J-30-1
Programmable Dual Channel DC Power Supply for Japan

2230-30-1
Programmable Triple Channel DC Power Supply

2230J-30-1
Programmable Triple Channel DC Power Supply for Japan

Accessories Supplied

CS-1655-15 Rear Panel Mating Connector for Models 2220 and 2230 Multi-Channel Power Supplies

Documentation and Driver CD

ACCESSORIES AVAILABLE

CS-1655-15	Rear Panel Mating Connector for Series 2200 Power Supplies
4299-7	Fixed Rack Mount Kit

SERVICES AVAILABLE

2220-30-1-EW	1 additional year of factory warranty
C/2220-30-1-3Y-STD	3 calibrations within 3 years of purchase
C/2220-30-1-3Y-DATA	3 (ANSI-Z540-1 compliant) calibrations within 3 years of purchase
C/2220-30-1-5Y-STD	5 calibrations within 5 years of purchase
C/2220-30-1-5Y-DATA	5 (ANSI-Z540-1 compliant) calibrations within 5 years of purchase
2230-30-1-EW	1 additional year of factory warranty
C/2230-30-1-3Y-STD	3 calibrations within 3 years of purchase
C/2230-30-1-3Y-DATA	3 (ANSI-Z540-1 compliant) calibrations within 3 years of purchase
C/2230-30-1-5Y-STD	5 calibrations within 5 years of purchase
C/2230-30-1-5Y-DATA	5 (ANSI-Z540-1 compliant) calibrations within 5 years of purchase

Note: For Japan versions, include a "J" in the model number (example: 2230J-30-1-EW)

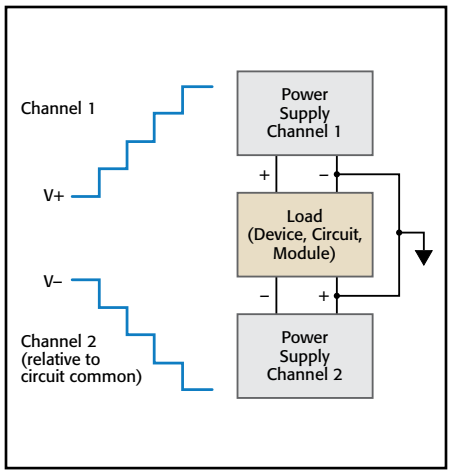
Great accuracy is not limited to voltage; the basic current setting and readback accuracy is 0.1%, providing high quality load current measurements. Also, with less than 3mV p-p noise, the power applied to the DUT's load terminals is both accurate and of high quality.

Excellent accuracy, remote sensing, and a wide power output range make the Series 2200 Multi-Channel Power Supplies essential test instruments both on the bench and in test systems. Their ability to generate a wide range of output power and measure a wide range of load currents is supported with:

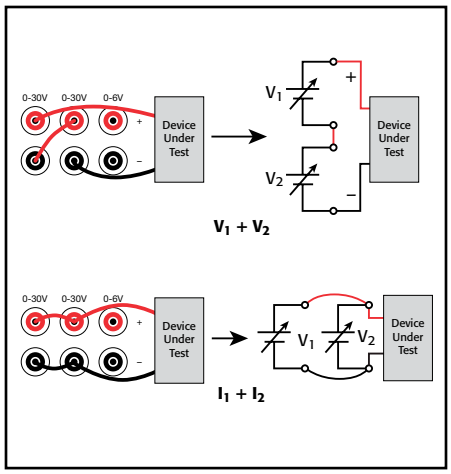
- Maximum output power of 45W on the 30V channels
- Maximum output power of 30W on the 6V channel
- Voltage setting and reading resolution of 1mV
- Current setting and reading resolution of 1mA

Configure the Channels to Double Output Voltage or Current or Create Bipolar Power Supplies

The two 30V channels can be combined if more than 30V or more than 1.5A is required. The two 30V outputs can be wired in series to enable an output of 60V with a maximum current output of 1.5A or can be wired in parallel to get up to 3A at 30V. In series or parallel configurations, the power supplies offer special display modes that indicate the actual voltage and current for the combined pair. It's also easy to wire the outputs to make a ±30V bipolar supply, and to maintain a user-defined ratio between the two outputs when using Tracking mode. These modes of operation extend the performance of the power supplies, while the display shows the actual outputs in these special modes to avoid any confusion or incorrect interpretation of the displayed data.



Use the two 30V channels to test a bipolar integrated circuit or a bipolar module over its specified voltage operating range.



Combine two channels in series to output up to 60V or combine two channels in parallel to output up to 3A. The Model 2220/2230 display will show the combined value.

Convenience Features Help Get Results More Quickly

The Models 2220 and 2230 Multi-Channel Power Supplies offer a number of features that return results quickly and easily:

- A rotary knob, with user-selectable step size, makes it easy to check circuit response to changing voltage or current. Alternatively, a direct-entry numeric keypad can be used to simplify setting precise voltage and current values.
- Each channel has its own readout on the display. The voltage and current being delivered to each channel are visible at a glance. A bright vacuum fluorescent display provides excellent readability

2220
2230

Multi-Channel Programmable DC Power Supplies

at a distance, at an angle, or under dim lighting conditions.

- To save time when repeating tests, instrument settings can be saved in one of 30 internal memory locations by simply pressing the Save button. To recall that setting, just push the Recall button, and choose the desired setup.

Protection for Your Device-Under-Test

The Models 2220 and 2230 Multi-Channel Power Supplies include maximum voltage settings that prevent voltage from being accidentally adjusted above user-specified limits. Independent outputs allow a different limit to be specified for each output channel. With the numeric keypad, a current limit can be quickly and precisely specified before a test is started. In addition, a user-definable password allows the front panel to be locked to prevent unwanted adjustment during critical tests.

Easy Test Automation

Each of these power supplies includes a USB TMC-compliant device port, enabling PC control from a user-preferred programming environment. For basic instrument control, data logging, and analysis, the Models 2220 and 2230 Multi-Channel Power Supplies can be controlled by Tektronix Edition LabVIEW SignalExpress™ from National Instruments. SignalExpress supports a wide range of Tektronix bench instruments* and can be used to automate the entire test bench or test system. The features in each instrument are accessible from one intuitive software interface that can automate complex measurements that require multiple instruments and easily capture and analyze results—all from the user's PC.

*For a complete listing of Tektronix instruments supported by Tektronix LabVIEW Signal Express, visit www.tektronix.com/signalexpress.

APPLICATIONS

Series 2200 Multi-Channel Power Supplies typical applications include:

- **Circuit design**
- **Electrial engineering student labs**
- **Materials research**
- **Automated test**

Specifications

	2230-30-1, 2230J-30-1			2220-30-1, 2230J-30-1	
DC OUTPUT RATING					
Voltage	0 to 30 V	0 to 30 V	0 to 6 V	0 to 30 V	0 to 30 V
Current	0 to 1.5 A	0 to 1.5 A	0 to 5 A	0 to 1.5 A	0 to 1.5 A
MAXIMUM POWER		120 W			90 W
LOAD REGULATION					
Voltage	< 0.01% + 3 mV	< 0.01% + 3 mV	< 0.01% + 3 mV	< 0.01% + 3 mV	< 0.01% + 3 mV
Current	< 0.01% + 3 mA	< 0.01% + 3 mA	< 0.01% + 3 mA	< 0.01% + 3 mA	< 0.01% + 3 mA
LINE REGULATION					
Voltage	< 0.01% + 3 mV	< 0.01% + 3 mV	< 0.01% + 3 mV	< 0.01% + 3 mV	< 0.01% + 3 mV
Current	< 0.1% + 3 mA	< 0.1% + 3 mA	< 0.1% + 3 mA	< 0.1% + 3 mA	< 0.1% + 3 mA
RIPPLE AND NOISE					
Voltage (7MHz)	< 1 mV rms < 3 mV p-p	< 1 mV rms < 3 mV p-p	< 1 mV rms < 3 mV p-p	< 1 mV rms < 3 mV p-p	< 1 mV rms < 3 mV p-p
Current (20MHz)	< 5 mA rms	< 5 mA rms	< 6 mA rms	< 5 mA rms	< 5 mA rms
SETTING RESOLUTION					
Voltage	1 mV	1 mV	1 mV	1 mV	1 mV
Current	1 mA	1 mA	1 mA	1 mA	1 mA
SETTING ACCURACY					
Voltage	± 0.03% + 10 mV	± 0.03% + 10 mV	± 0.03% + 10 mV	± 0.03% + 10 mV	± 0.03% + 10 mV
Current	± 0.1% + 5 mA	± 0.1% + 5 mA	± 0.1% + 5 mA	± 0.1% + 5 mA	± 0.1% + 5 mA
METER RESOLUTION					
Voltage	1 mV	1 mV	1 mV	1 mV	1 mV
Current	1 mA	1 mA	1 mA	1 mA	1 mA
METER ACCURACY					
Voltage	± 0.03% + 10 mV	± 0.03% + 10 mV	± 0.03% + 10 mV	± 0.03% + 10 mV	± 0.03% + 10 mV
Current	± 0.1% + 5 mA	± 0.1% + 5 mA	± 0.1% + 5 mA	± 0.1% + 5 mA	± 0.1% + 5 mA

ISOLATION VOLTAGE, OUTPUT TO CHASSIS: Any output can be floated up to 240V (DC + peak AC with AC limited to a maximum of 3Vpk-pk and a maximum frequency of 60Hz) relative to earth ground terminal.

ISOLATION VOLTAGE, OUTPUT TO OUTPUT: Any output can be floated up to 240V (DC + peak AC with AC limited to a maximum of 3Vpk-pk and a maximum frequency of 60Hz) relative to any other output terminal.

VOLTAGE TRANSIENT RESPONSE SETTLING TIME, LOAD CHANGE (typical): <150ms to within 75mV following a change from 0.1A to 1A.

VOLTAGE TRANSIENT RESPONSE SETTLING TIME, SETTING CHANGE, RISING (typical): <150ms to within 75mV following a change from 1V to 11V into a 10Ω resistor (Ch. 1, 2); from 0.4V to 4V into a 4Ω resistor (ch. 3.)

VOLTAGE TRANSIENT RESPONSE SETTLING TIME, SETTING CHANGE, FALLING (typical): <150ms to within 75mV following a change from 11V to 1V into a 10Ω resistor (Ch. 1, 2); from 0.4V to 4V into a 4Ω resistor (ch. 3.)

DISPLAY: Vacuum fluorescent display.

MEMORY: 30 setup memories.

TRACKING AND COMBINATION MODES:

Tracking Mode: Maintains the ratio on the two 30V output channels that is present when the control is activated.

Combination V1+V2 Series Mode: Deliver up to 60 V when CH1 and CH2 are wired in series. Meter reads back combined voltage.

Combination I1+12 Parallel Mode: Deliver up to 3 A when CH1 and CH2 are wired in parallel. Meter reads back combined current.

REAR PANEL CONNECTIONS: USB Device Port, Type B connector, USBTMC compatible.

POWER SOURCE

110VAC SETTING: Standard Versions: 99 to 121V rms. Japan (J) Versions: 90 to 110V rms.

220VAC SETTING: Standard Versions: 198 to 242V rms. Japan (J) Versions: 180 to 220V rms.

FREQUENCY: 47Hz to 63Hz.

POWER CONSUMPTION: Standard Versions: 450VA. Japan (J) Versions: 450VA.

PHYSICAL CHARACTERISTICS

PROTECTIVE BOOTS AND HANDLE INSTALLED:

Height: 105.3mm (4.15 in.)
Width: 241.8mm (9.52 in.)
Depth: 384.0mm (15.12 in.)

PROTECTIVE BOOTS AND HANDLE REMOVED:

Height: 90.7mm (3.57 in.)
Width: 217.2mm (8.55 in.)
Depth: 361.6mm (14.24 in.)

NET WEIGHT:

2220-30-1: 8.2 kg (18 lb.)
2230-30-1: 8.5 kg (19 lb.)

SHIPPING WEIGHT:

2220-30-1: 11 kg (24 lb.)
2230-30-1: 11 kg (24 lb.)

2220
2230

Multi-Channel Programmable DC Power Supplies

ENVIRONMENTAL AND SAFETY

Temperature: **Operating:** 0° to +40°C.
Storage: –20° to +70°C.

Relative Humidity (non-condensing):

Operating: 5% to 95% relative humidity at up to +40°C

Storage: 5% to 95% relative humidity at up to +40°C. 5% to 60% RH above +40°C up to +70°C, non condensing.

Altitude:

Operating: Up to 2000m.

Storage: Up to 4000m.

Safety:

European Union: Complies with European Union EMC Directive.

USA: Nationally recognized testing laboratory listing UL61010-1-2004.

Canada: CAN/CSA C22.2 No. 61010-1 2004.

ELECTROMAGNETIC COMPATIBILITY

European Union: Complies with European Union Low Voltage Directive.

Australia: EMC Framework, demonstrated per Emission Standard AS/NZS 2064 (Industrial, Scientific, and Medical Equipment).

Model 2220-30-1 rear panel.

Model 2230-30-1 rear panel.

Models 2220 and 2230 specifications

DC POWER SUPPLIES