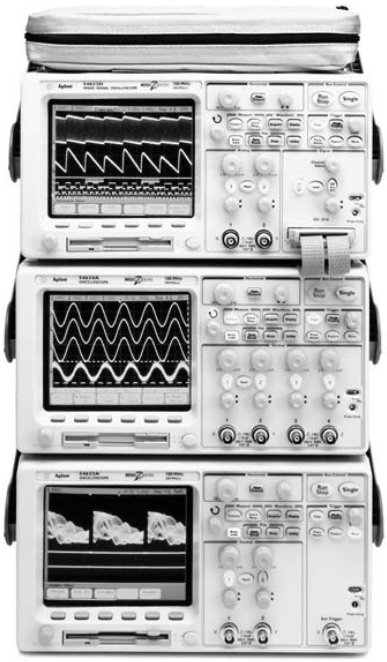
Agilent Technologies 54600-Series Oscilloscopes

Data Sheet

Easily see what's happening in your mixed analog and digital designs

- **60 to 500 MHz, up to 2 GSa/s**
- **Unique 2 + 16-channel MSO and 2- or 4-channel models**
- **4 MB to 8 MB MegaZoom deep memory standard**
- **Patented high-definition display system**
- **Flexible triggering including CAN, I²C, LIN, SPI, and USB**
- **Deep memory transfer over the interface bus**



Multiple configurations to meet your needs

If you work with both analog and digital components, Agilent Technologies 54600-Series oscilloscopes can help you easily see more of what's going on in your designs. The unique 2 + 16-channel mixed signal oscilloscope (MSO) models and the traditional 2- and 4-channel models are optimized with just the capabilities you need for verifying and debugging designs that include A/Ds, D/As, DSPs, and embedded 8- or 16-bit microcontrollers. These scopes give you the tools you need to solve your mixed analog and digital engineering challenges more easily.

Ideal for mixed analog and digital analysis

Ideal for analyzing designs with both analog and digital components, the 54600-Series scopes combine three critical features:

- Up to 8 MB of MegaZoom deep memory come standard so you can capture long, non-repeating signals, maintain high sample rate, and quickly zoom in on areas of interest
- A revolutionary ultra-responsive, high-definition display that lets you see more signal detail than ever before
- Flexible triggering that lets you easily isolate and analyze the complex signals and fault conditions common in mixed analog and digital designs. I²C, CAN, LIN, USB, and SPI triggering come standard. N2758A CAN trigger module option is also available.

This combination of capabilities is tailored to give you the measurement power you need to get your mixed analog and digital job done faster.

At Agilent Technologies, we focus on developing products that help you do your job better. That's why 54600-Series scopes are optimized for your needs. Choose the one that's right for your application and your budget.

Agilent Technologies

Selection Guide

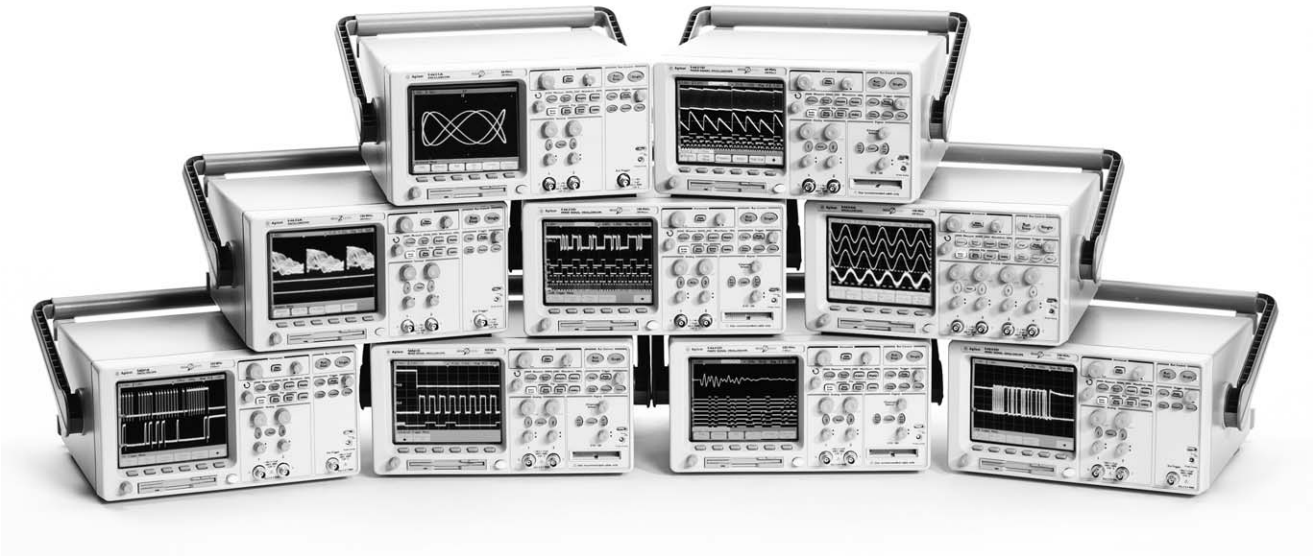


Figure 1. 2 + 16-channel mixed signal oscilloscope (MSO) family shown with 2- and 4-channel models.

Selection Guide

Model	Bandwidth	Maximum Sample Rate	Maximum Memory*	Channels
54621A	60 MHz	200 MSa/s	4 MB	2
54621D	60 MHz	200 MSa/s	4 MB	2+16
54622A	100 MHz	200 MSa/s	4 MB	2
54622D	100 MHz	200 MSa/s	4 MB	2+16
54624A	100 MHz	200 MSa/s	4 MB	4
54641A	350 MHz	2 GSa/s*	8 MB	2
54641D	350 MHz	2 GSa/s*	8 MB	2+16
54642A	500 MHz	2 GSa/s*	8 MB	2
54642D	500 MHz	2 GSa/s*	8 MB	2+16

* Maximum sample rate and memory are interleaved; deep memory is standard, no options needed.

Selection Guide (continued)

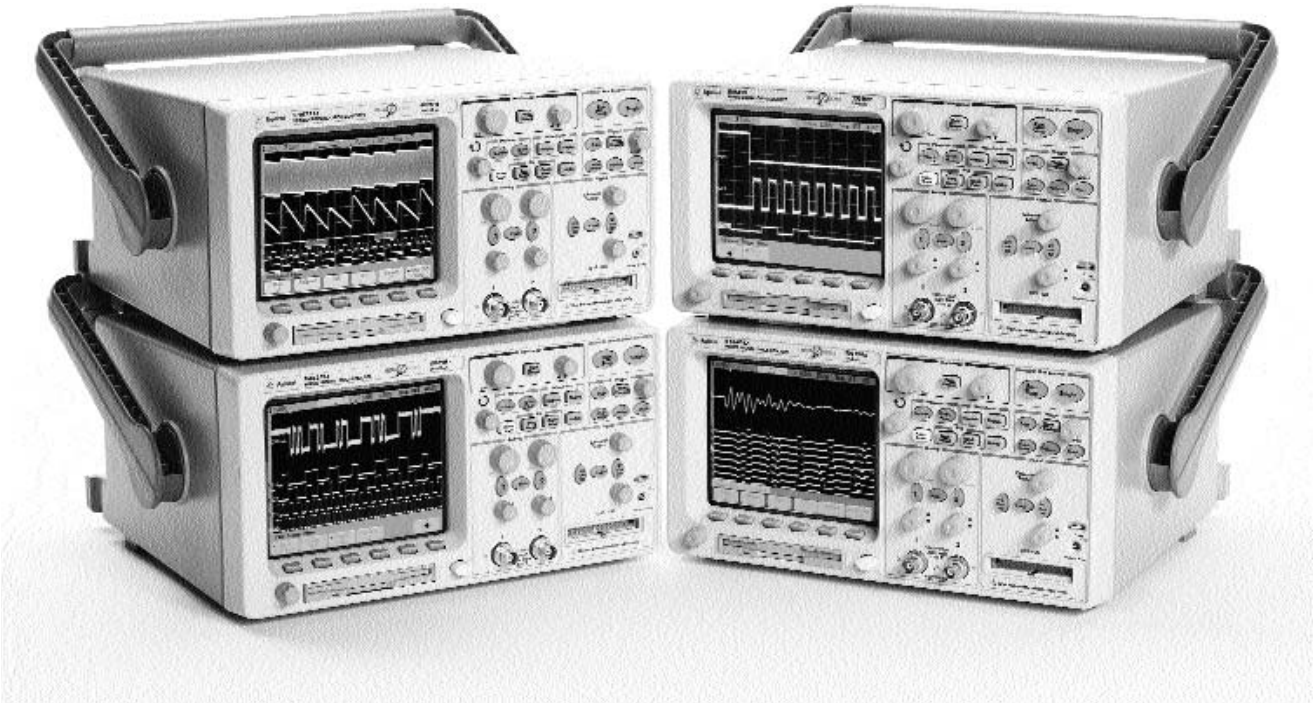


Figure 2. 2 + 16-channel mixed signal oscilloscope (MSO) allows you to view analog and digital content on one instrument.

Mixed-signal scopes (models 54621D, 54622D, 54641D, and 54642D)

The mixed-signal oscilloscopes (MSO), with 2 analog channels and 16 digital channels, uniquely combine the detailed signal analysis of a scope with the multi-channel timing measurements of a logic analyzer. They let you see the complex interactions among your signals on up to 18 channels at the same time. No more guesswork and no more poking around to see a few channels at a time. These scopes can easily conquer mixed analog and digital debugging problems that a traditional scope can't begin to address, because they let you simultaneously test and monitor the high-speed digital control signals and the slower analog signals in your design.

4-channel scope (model 54624A)

If your designs include heavy analog content, the 100-MHz 54624A will give you the channel count and measurement power you need, including MegaZoom deep memory, high-definition display, and flexible triggering. Whether you're testing designs with four inputs, such as anti-lock brakes, or monitoring multiple outputs of a power supply, the 4-channel model helps you get your debug and verification done with ease.

2-channel scopes (models 54621A, 54622A, 54641A, and 54642A)

The 2-channel models bring all the benefits of MegaZoom deep memory, high-definition display, and flexible triggering to those value-minded designers with lower channel requirements. They give you an affordable way to see long time periods while maintaining high sample rate so you can see details in your designs.

MegaZoom deep memory

With 4 MB to 8 MB of MegaZoom deep memory, 54600-Series scopes give you deep-memory capture without the sluggish response and complex operation you've had to tolerate with other deep-memory scopes. And unlike the alternatives, MegaZoom deep memory is not a special mode. That means it's always available to help you find details buried in complex signals, discover anomalies, correlate high-speed digital control signals with slower analog signals and capture infrequent events.

The dilemma of having to trigger twice to get a long time capture or to see detailed resolution is solved with MegaZoom deep memory as you can have both with a single measurement. Deep memory means that the sample rate stays high even when capturing long time periods.

The 54600-Series scopes are the only deep-memory scopes that respond instantly to your control inputs with a fast, responsive display. Compare them to other scopes in this price range – only the 54600-Series provides deep memory at an affordable price.

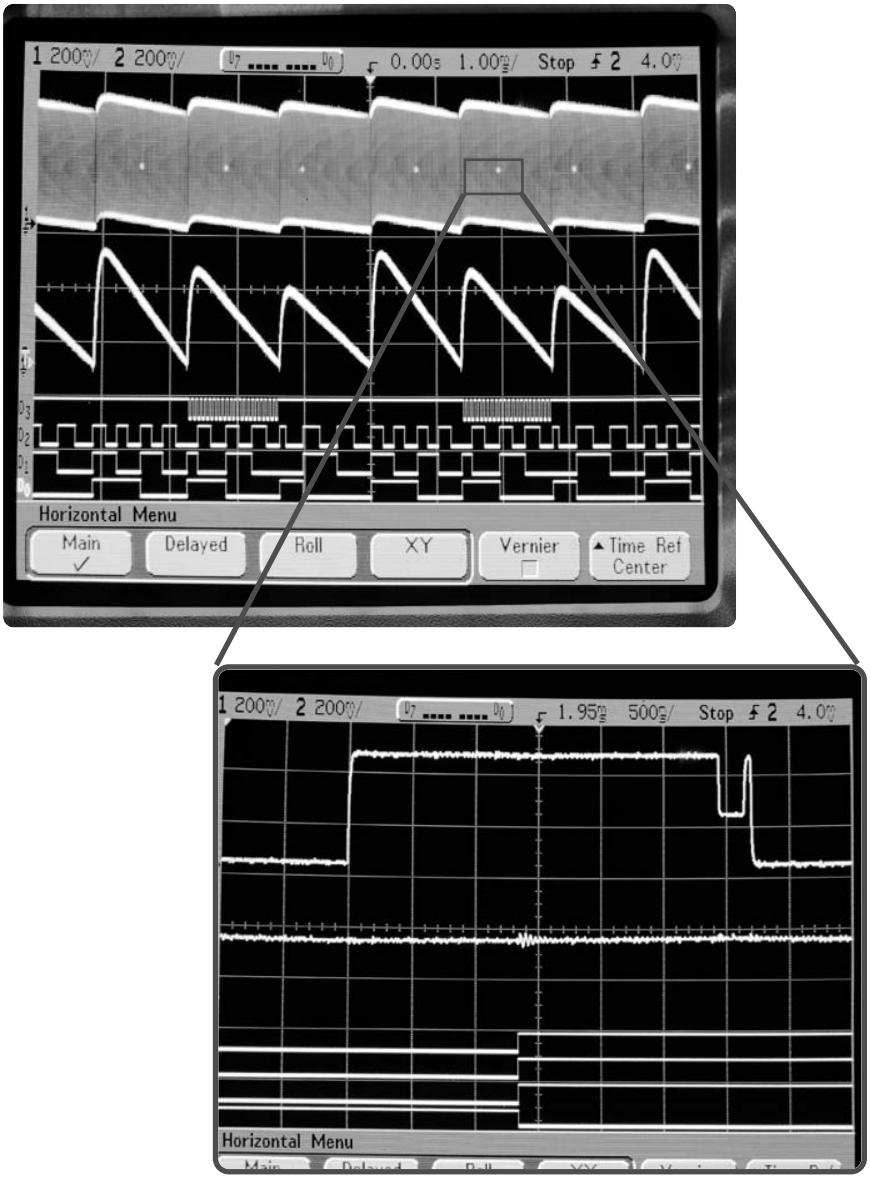


Figure 3. The bright dot on the high-definition display is a distortion in 1 of the 1,500 pulses captured in this single-shot measurement. Simply dial in for a closer look using MegaZoom pan and zoom, and you'll see the details that would have escaped other scopes, such as the distortion in this square wave. This deep memory and display system is not a special mode; it is available on every measurement pass at full speed.

Revolutionary high-definition display helps you see details

Combine MegaZoom deep memory with a patented high-definition display system, and you will see subtle details that most scopes won't show you. The MegaZoom deep memory is mapped into 32 levels of intensity on a display that has twice the horizontal resolution and update rates of up to 25 million vectors per second – so you see a more realistic representation of your signals.

There is less chance to miss a narrow occasional transient, less chance to miss a glitch or distorted edge that impacts circuit operation, and less chance to miss all those subtle details that can take weeks to find with a traditional digital scope.

Standard features

Agilent 54600-Series scopes include the standard features you need to get your job done easier and faster.

Connectivity made easier

- **Parallel and RS-232 interfaces** make connection to printers and PCs a snap. And the 54600-Series scopes come with standard parallel and RS-232 interfaces on the rear panel. For faster data transfers, an optional GPIB interface module is also available.

- **IntuiLink, a free software application, simplifies PC connectivity** when you need to transfer images and waveform data to your PC. IntuiLink lets you focus more time on design issues rather than on programming. With the click of a button on IntuiLink's toolbar, you can download data or insert a snapshot of an oscilloscope screen directly into your Microsoft® Excel spreadsheets or Word documents, or save the image as a bitmap file. Once the data is in an Excel spreadsheet, you can leverage Excel's extensive analysis functions to create custom graphs and views.

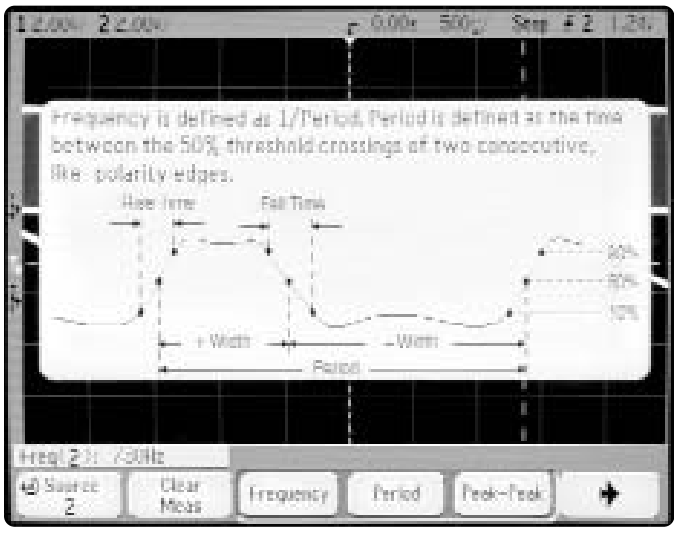


Figure 4. Press and hold any key for built-in Help, such as this description of the frequency measurement.

For more information on IntuiLink, please see the IntuiLink datasheet with Agilent publication number 5980-3115EUS or visit the URL **www.agilent.com/find/intuilink**

Built-in floppy drive

A built-in 1.44 MB floppy drive makes it easy for you to store waveform data, screen images, and scope setups. You can store your waveform images as TIF or BMP files and your waveform data as ASCII files for easy import into other PC applications. If you share your lab equipment with others, you can save your measurement setups and traces to diskette, making it simple to reproduce your every-day setups as well as your advanced configurations.

Built-in help at your fingertips

An innovative built-in help system in 11 different languages (English, French, German, Spanish, Italian, Japanese, Korean, Traditional Chinese, Simplified Chinese, Russian, and Portuguese) gives you quick access to the help you need. If you have a question about a particular feature, simply press and hold the corresponding front-panel key for a few seconds, and a help screen pops up to explain its function. You'll no longer have to look for the manual when you need assistance setting up scope functions or making complex measurements.

Affordable and Responsive (continued)

Deep memory transfer over the bus

Transfer all of your data over the bus, even when using deep memory. Typical transfer time is <70 seconds for 2 MB of data over GPIB.

The 54640-Series requires software revision 1.0 or later. The 54620-Series requires software revision 1.5 or later. The system software is stored in FLASH ROM that can be upgraded easily from a built-in floppy disk drive in the scope. Visit the 54620-Series customer web site at: **www.agilent.com/find/5462xsw** for a free copy of the system software and the IntuiLink Data Capture application to pull the data out of the scope to the PC.

Other standard features

- **Waveform math with FFTs:** Analysis functions include -, *, Integrate, and Differentiate, as well as Fast Fourier Transforms.
- **1-ns peak detect** on the 54640-Series and 5-ns peak detect on the 54620-Series means you won't have to worry about missing narrow glitches.
- **Autoscale** lets you quickly display any active signals, automatically setting the vertical, horizontal and trigger controls for the best display.
- **Printer connectivity** is easy for HP Deskjets, Laserjets, Epson, or integrated thermal printer option with the standard parallel port on the rear panel.
- **High resolution mode** offers up to 12 bits of resolution in real-time (single-shot) modes, reducing noise. This is accomplished by averaging sequential data points and mapping the average to the display when at slow sweep speeds.
- **1-year warranty:** All 54600-Series scopes include a full 1-year warranty with optional 3-year and 5-year warranty coverage.
- **Money-back guarantee:** Get a full refund if you're not satisfied with your purchase for any reason. See page 24 for more information.

N2758A CAN Trigger Module

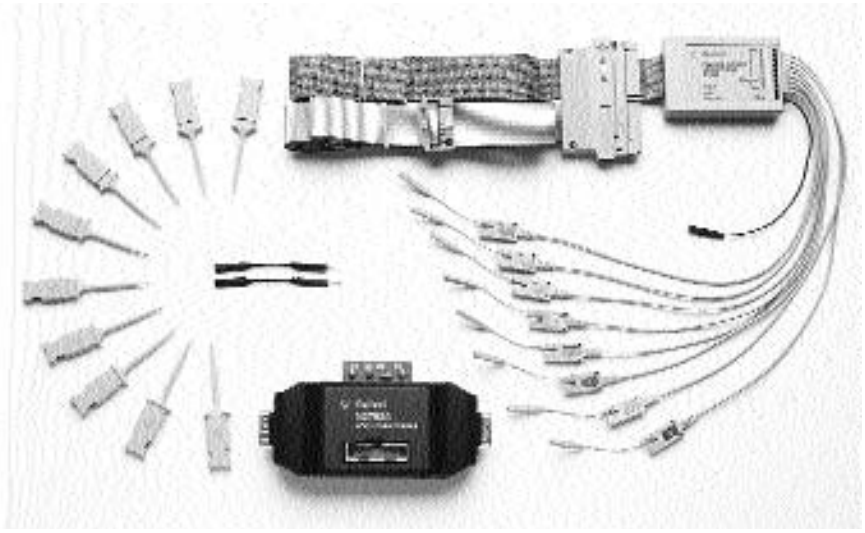
- **Trigger on CAN 2.0A/B message frames with user specified IDs and/or data**
- **Trigger on Error frames**
- **Differential CAN**
- **Acknowledge On/Off**
- **Built In QuickHelp**
- **Remote Control via GPIB/RS232**
- **Compatible with 54621D, 54622D, 54641D, 54642D**

The N2758A CAN trigger module extends your Mixed Signal Oscilloscope's (MSO) capabilities beyond the standard CAN SOF trigger. The module enables the MSO to isolate and trigger on a particular frame's content. This triggering allows you to:

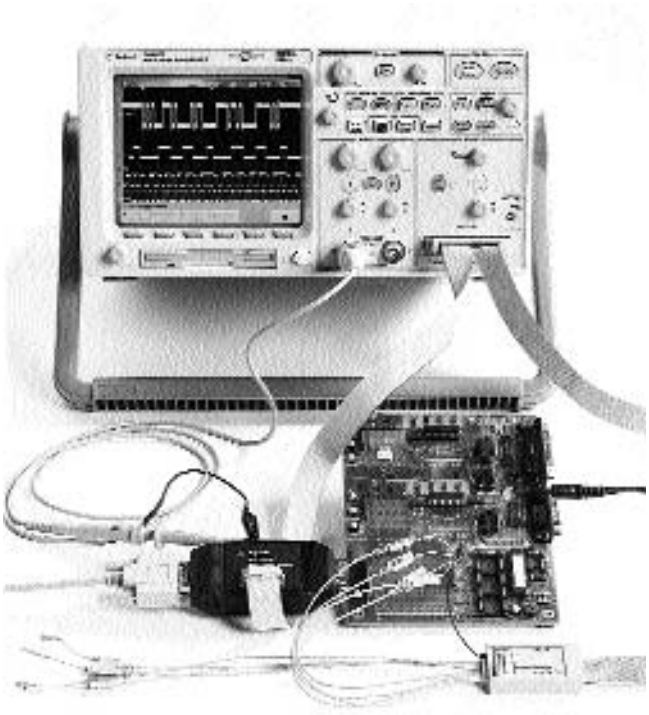
- sort through frame traffic on the bus
- isolate frames of interest
- specify particular frame characteristics
- trigger and measure latency between CAN frames meeting the user specification

The CAN trigger module is ideal for analyzing all traffic on the broadcast network. Quickly find frames that meet the specifications you select with an isolating capability similar to pattern triggering across multiple channels in the parallel domain. Synchronize to the particular frame then examine the system behavior of interest.

For more comprehensive information, please see the Agilent 54600-Series Oscilloscopes Probes and Accessories data sheet (Agilent publication number 5968-8153). You can get a copy by calling 1-800-452-4844 or by visiting our website at:
www.agilent.com/find/mso



The N2758A kit includes the CAN trigger module, digital cable, ten grabbers, and two probe ground leads.



The N2758A CAN trigger module reduces the time required to debug your mixed signal CAN based designs.

Triggering

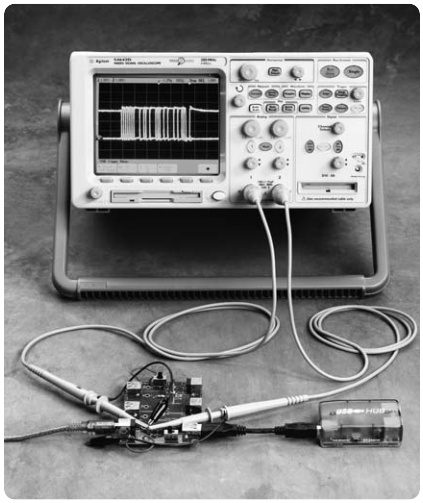


Figure 5. Easily synchronize to a USB packet.

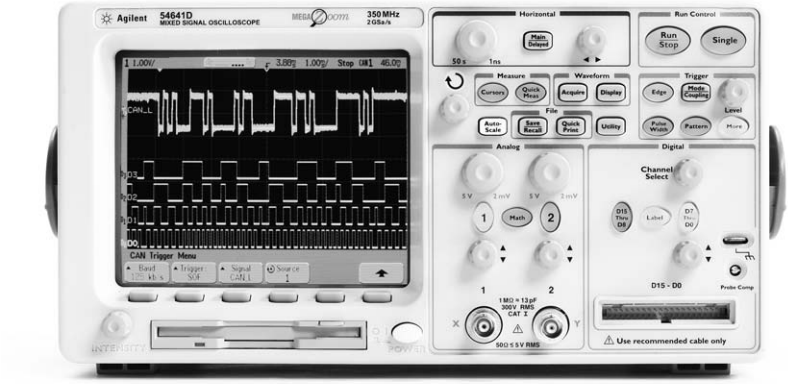


Figure 6. Make your automotive and industrial testing easier. CAN triggering synchronizes to the start of a CAN frame on any CAN high or CAN low signal.

Flexible Triggering

With mixed analog and digital designs, sometimes it is hard to trace an anomaly back to its root cause unless you can trigger on it and correlate it with another signal. With the 54600-Series scopes, triggering is no longer a hassle. They come with flexible triggering capabilities across all channels so you can easily isolate and analyze complex signals and interactions common in your mixed analog and digital designs.

CAN, LIN, and USB Triggering

Controller Area Network (CAN) and Universal Serial Bus (USB) triggering comes standard with the 54600-Series scopes. These triggering modes make it easy to synchronize CAN, LIN, and USB frames. Don't waste time finding the start of the complex frames – let Agilent do it for you.

CAN triggering synchronizes to the start of a CAN frame on any CAN high or CAN low signal.

Trigger on LIN (local interconnect network) sync break at the beginning of a message frame.

USB is quickly becoming the connection of choice for PC peripherals. Make your testing easy with Start of Packet (SOP), End of Packet (EOP), Reset Complete (RC), Enter Suspend, or Exit Suspend modes.

The N2758A CAN trigger module option enables the MSO to isolate and trigger on a particular frame's content. For more information , see page 7.

I²C and SPI Triggering

Don't spend your time sorting through communication frames to find the one of interest. Let Agilent set up an Inter-Integrated Circuit (I²C) or Serial Peripheral Interface (SPI) trigger to sift through the frames for you. And like the CAN, LIN, and USB triggers, I²C and SPI come standard with the 54600-Series scopes.

The full range of I²C triggering includes start or stop condition, missing acknowledge, restart, EEPROM data read, address and/or data frame, or 10-bit write. SPI triggering allows for trigger on user-definable framing and user-definable number of bits per frame, as well as data patterns.

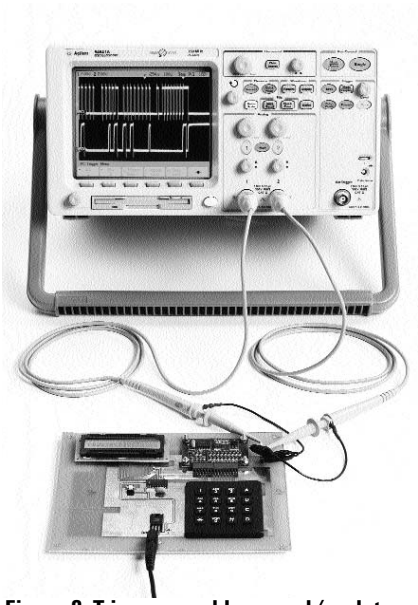


Figure 8. Trigger on address and/or data patterns within an I²C frame.

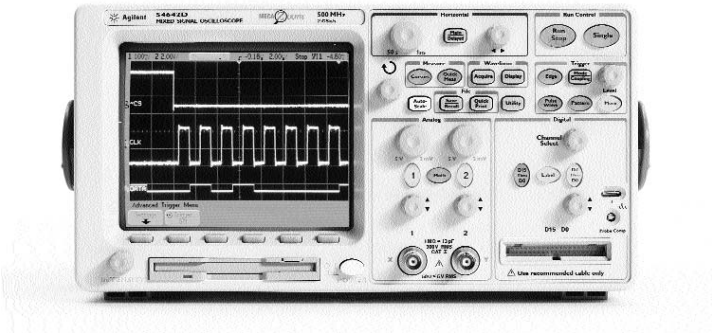


Figure 7. Trigger on data patterns within a SPI frame.

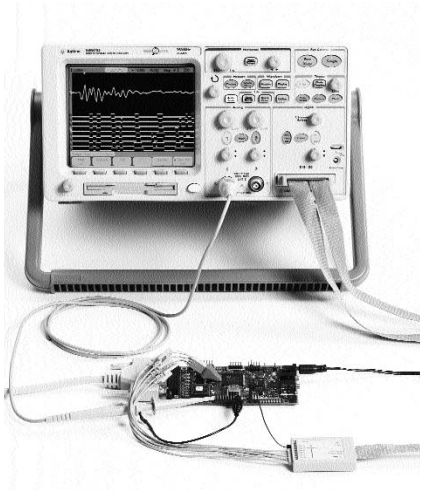


Figure 9. The 350 MHz and 500 MHz MSOs are a great fit for DSP applications.

Microcontroller and DSP Applications

Microcontrollers (MCUs) and Digital Signal Processors (DSPs) are here to stay, and are becoming more pervasive in industrial, communications, automobile, and consumer products. Design engineers must grapple with scopes that were not developed to tackle the mixed analog and digital signals found in MCU- and DSP-based designs. Many engineers, who rely primarily on typical 2-channel or 4-channel scopes in mixed analog and digital signal verification and debug, find these scopes to be inadequate when it comes to the channel count, memory depth, display and triggering. The interactions that occur in typical mixed analog and digital design – taking a real-world signal such as audio, video, temperature or pressure, performing some transformation on the signal, and finally returning that signal to the real world – require more viewing capability than current scopes can provide.

Agilent 54621D, 54622D, 54641D, and 54642D mixed-signal oscillscopes (MSOs) provide the channel count, memory depth, high-definition display, and triggering that MCU and DSP designs demand.

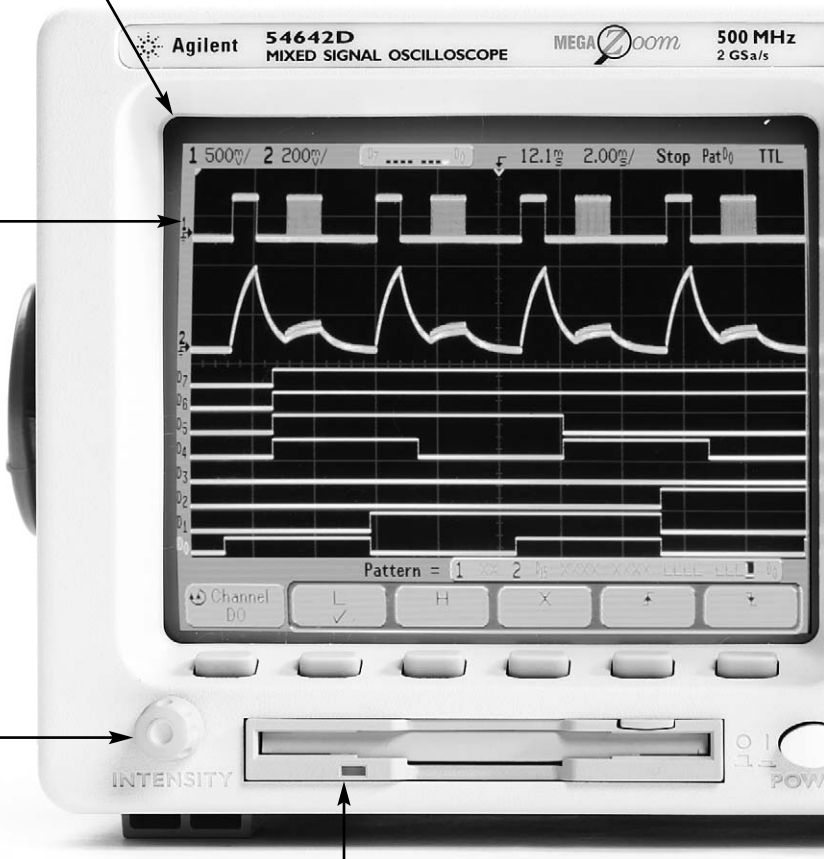
MegaZoom deep memory helps you determine how your signals are impacting each other. With shallow memory scopes, you have to choose whether you look at a slow analog signal or fast digital content. With up to 8 MB deep memory, you don't have to choose – capture all of your data at once.

Revolutionary high-definition display reveals subtle details that most scopes won't show you.

Standard RS-232 and parallel ports provide PC and printer connectivity.

Free IntuiLink PC software makes transfer of waveform data to PC fast and easy.

Intensity knob allows you to adjust the contrast on screen.

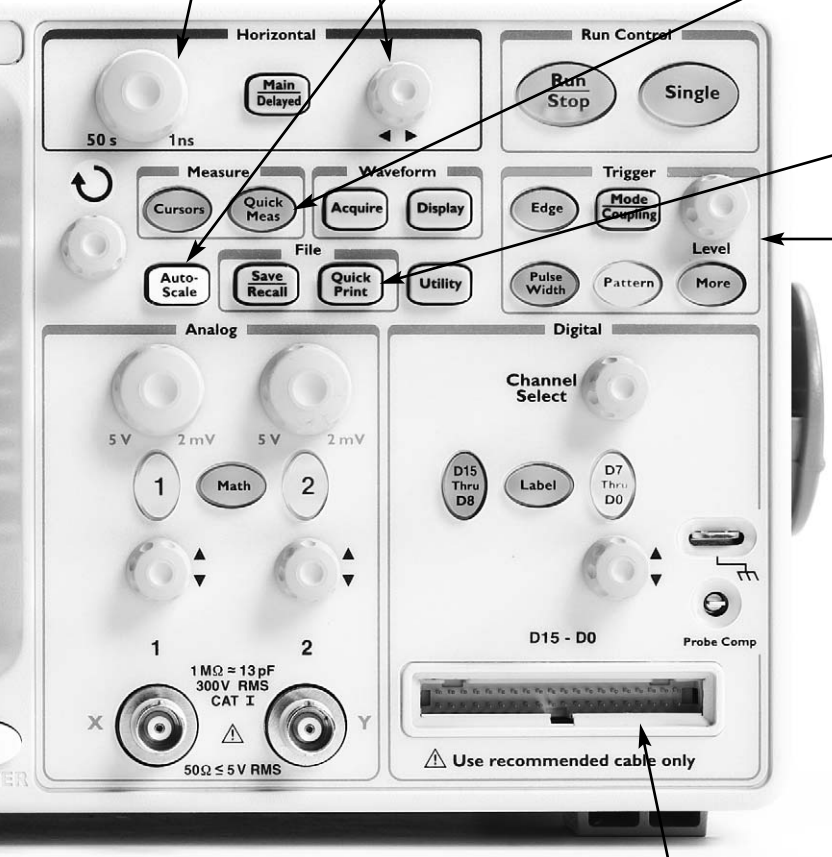


Built-in floppy drive makes it easy to save your work and update your system software.

Quickly pan and zoom for analysis with MegaZoom's instant response and optimum resolution.

Autoscale lets you quickly display any active signals, automatically setting the vertical, horizontal and trigger controls for the best display, while optimizing memory.

QuickMeas gives you any three automated measurements with the push of a button. **QuickPrint** automatically prints your screen or saves to disk with automated file names.



Standard Serial Triggering includes CAN, I^2C, LIN, SPI, and USB

Built-in help is available in 11 languages. Simply press and hold the front-panel key of interest for a few seconds, and a help screen pops up to explain its function.

Maximum sample rate and resolution on every measurement. The scope automatically adjusts memory depth as you use it, so you get maximum sample rate and resolution on every measurement. You don't even have to think about it.

2 analog and 16 digital channel MSOs allow you to see up to 18 time-aligned signals on your scope screen. Also available in 2- and 4-channel models.

Probes

To get the most out of your scope, you need the right probes and accessories for your particular application. That's why Agilent Technologies offers a complete family of innovative probes and 54600-Series scopes. For more comprehensive information, please see the Agilent 54600-Series Oscilloscopes Probes and Accessories data sheet (Agilent publication number 5968-8153). You can get a copy by calling 1-800-452-4844 or by visiting our website at: **www.agilent.com/find/mso**

Agilent Passive Probes Selection Guide

	10070C	**10073C** (shipped with 54640-Series)	**10074C** (shipped with 54620-Series)	**10076A** high-voltage probe	**N2771A** high-voltage probe
Probe Bandwidth	20 MHz	500 MHz	150 MHz	250 MHz	50 MHz
Probe Risetime (Calculated)	< 17.5 ns	< 700 ps	< 2.33 ns	< 1.4 ns	< 7 ns
Attenuation Ratio	1:1	10:1	10:1	100:1	1000:1
Input Resistance (when terminated into 1 MΩ)	1 MΩ	2.2 MΩ	10 MΩ	66.7 MΩ	100 MΩ
Input Capacitance	Approx. 70 pF	Approx. 12 pF	Approx. 15 pF	Approx. 3 pF	Approx. 1 pF
Maximum Input (dc + peak ac)	400 Vpk CAT I (mains isolated) 400 Vpk CAT II (post receptacle mains)	500 Vpk CAT I (mains isolated) 400 Vpk CAT II (post receptacle mains)	500 Vpk CAT I (mains isolated) 400 Vpk CAT II (post receptacle mains)	4000 Vpk	15 kV dc, 10 kVrms 30 kV dc + peak ac
Compensation Range	None	6 - 15 pF	9 - 17 pF	6 - 20 pF	7 - 25 pF
Probe Sense	No	Yes	Yes	Yes	No

Current Probes	**Description**
1146A	100 kHz current probe, ac/dc
N2774A	50 MHz current probe, ac/dc
N2775A	power supply for N2774A

Differential Probes	**Description**
N2772A	20 MHz differential probe
N2773A	Differential probe power supply

Performance Characteristics

Acquisition: Analog Channels

Max Sample Rate	54621A/D, 54622A/D, 54624A: 200 MSa/s 54641A/D, 54642A/D: 2 GSa/sec interleaved, 1 GSa/sec each channel
Max Memory Depth	54621A/D, 54622A/D, 54624A: 4 MB interleaved, 2 MB each channel 54641A/D, 54642A/D: 8 MB interleaved, 4 MB each channel
Vertical Resolution	8 bits
Peak Detection	54621A/D, 54622A/D, 54624A: 5 ns 54641A/D, 54642A/D: 1 ns @ max sample rate
Averaging	Selectable from 2, 4, 8, 16, 32, 64 ... to 16383
High Resolution Mode	54621A/D, 54622A/D, 54624A: 12 bits of resolution when ≥500 µs/div, (average mode with ave = 1) 54641A/D, 54642A/D: 12 bits of resolution when ≥100 µs/div, (average mode with ave = 1)
Filter	Sinx/x interpolation (single shot BW = sample rate/4 or bandwidth of scope, whichever is less) with vectors on.

Acquisition: Digital Channels (54621D, 54622D, 54641D, and 54642D only)

Max Sample Rate	54621D, 54622D: 400 MSa/s interleaved, 200 MSa/s each channel 54641D, 54642D: 1 GSa/s
Max Memory Depth	54621D, 54622D: 8 MB interleaved, 4 MB ea. channel 54641D, 54642D: 4 MB
Vertical Resolution	1 bit
Glitch Detection (min pulse width)	5 ns

Vertical System: Analog Channels

Analog Channels	54621A/D, 54622A/D, 54641A/D, 54642A/D: Ch 1 and 2 simultaneous acquisition 54624A: Ch 1, 2, 3 and 4 simultaneous acquisition
Bandwidth (-3dB)*	54621A/D: dc to 60 MHz 54622A/D, 54624A: dc to 100 MHz 54641A/D: dc to 350 MHz 54642A/D: dc to 500 MHz
ac Coupled	54621A/D: 3.5 Hz to 60 MHz 54622A/D: 54624A: 3.5 Hz to 100 MHz 54641A/D: 3.5 Hz to 350 MHz 54642A/D: 3.5 Hz to 500 MHz
Calculated Risetime (=0.35/bandwidth)	54621A/D: ~5.8 ns 54622A/D, 54624A: ~3.5 ns 54641A/D: ~1.0 ns 54642A/D: ~700 ps
Single Shot Bandwidth	54621A/D, 54622A/D, 54624A: 50 MHz 54641A/D: 350 MHz maximum 54642A/D: 500 MHz maximum

* Denotes Warranted Specifications, all others are typical. Specifications are valid after a 30-minute warm-up period and ±10 °C from firmware calibration temperature.

Performance Characteristics (continued)

Vertical System: Analog Channels (continued)

Range[1,2]	54621A/D, 54622A/D, 54624A: 1 mV/div to 5 V/div 54641A/D, 54642A/D: 2 mV/div to 5 V/div
Maximum Input	CAT I 300 Vrms, 400 Vpk, CAT II 100 Vrms, 400 Vpk With 10073C/10074C 10:1 probe: CAT I 500 Vpk, CAT II 400 Vpk 5 Vrms with 50 Ω input
Offset Range	54621A/D, 54622A/D, 54624A: ±5 V on ranges <10 mV/div; ±25 V on ranges 10 mV/div to 199 mV/div; ±100 V on ranges ≥200 mV/div 54641A/D, 54642A/D: ±5 V on ranges <10 mV/div; ±20 V on ranges 10 mV/div to 200 mV/div; ±75 V on ranges >200 mV/div
Dynamic Range	Lesser of ±8 div or ±32 V from center screen
Input Resistance	54621A/D, 54622A/D, 54624A: 1 MΩ ±1% 54641A/D, 54642A/D: 1 MΩ ±1%, 50 Ω selectable
Input Capacitance	54621A/D, 54622A/D, 54624A: ~ 14 pF 54641A/D, 54642A/D: ~ 13 pF
Coupling	54621A/D, 54622A/D, 54624A: ac, dc, ground 54641A/D, 54642A/D: ac, dc
BW Limit	54621A/D, 54622A/D, 54624A: ~ 20 MHz selectable 54641A/D, 54642A/D: ~ 25 MHz selectable
Channel-to-Channel Isolation (with channels at same V/div)	54621A/D, 54622A/D, 54624A: dc to 20 MHz > 40 dB; 20 MHz to max bandwidth > 30 dB 54641A/D, 54642A/D:DC to max bandwidth >40 dB
Probes	54621A/D, 54622A/D, 54624A: 10:1 10074C shipped standard for each analog channel 54641A/D, 54642A/D: 10:1 10073C shipped standard for each analog channel
Probe ID (Agilent/HP and Tek compatible)	Auto probe sense
ESD Tolerance	±2 kV
Noise Peak-to-Peak	54621A/D, 54622A/D, 54624A: 2% full scale or 1 mV, whichever is greater 54641A/D, 54642A/D: 3% full scale or 3 mV, whichever is greater
Common Mode Rejection Ratio	20 dB @ 50 MHz
DC Vertical Gain Accuracy*[1,2]	±2.0% full scale
DC Vertical Offset Accuracy	54621A/D, 54622A/D, 54624A: <200 mV/div: ±0.1 div ±1.0 mV ±0.5% offset value; ≥200 mV/div: ±0.1 div ±1.0 mV ±1.5% offset value 54641A/D, 54642A/D: ≤200 mV/div: ±0.1 div ±2.0 mV ±0.5% offset value; >200 mV/div: ±0.1 div ±2.0 mV ±1.5% offset value
Single Cursor Accuracy[1,2]	±{DC Vertical Gain Accuracy + DC Vertical Offset Accuracy + 0.2% full scale (~1/2 LSB) } 54621A/D, 54622A/D, 54624A example: for 50 mV signal, scope set to 10 mV/div (80 mV full scale), 5 mV offset, accuracy = ±{2.0%(80mV) + 0.1 (10 mV) + 1.0 mV + 0.5% (5 mV) + 0.2%(80 mV)} = ± 3.78 mV
Dual Cursor Accuracy*[1,2]	±{DC Vertical Gain Accuracy + 0.4% full scale (~1 LSB)} Example: for 50 mV signal, scope set to 10 mV/div (80 mV full scale), 5 mV offset, accuracy = ±{2.0%(80 mV) + 0.4%(80 mV)} = ±1.92 mV

* Denotes Warranted Specifications, all others are typical. Specifications are valid after a 30-minute warm-up period and ±10 °C from firmware calibration temperature.

1 For 54621A, 54621D, 54622A, 54622D, and 54624A, 1 mV/div is a magnification of 2 mV/div setting. For vertical accuracy calculations, use full scale of 16 mV for 1 mV/div sensitivity setting.

2 For 54641A, 54641D, 54642A, and 54642D, 2 mV/div is a magnification of 4 mV/div setting. For vertical accuracy calculations, use full scale of 32 mV for 2 mV/div sensitivity setting.

Performance Characteristics (continued)

Vertical System: Digital Channels (54621D, 54622D, 54641D, and 54642D only)

Number of Channels	16 Digital – labeled D15 - D0
Threshold Groupings	Pod 1: D7 - D0 Pod 2: D15 - D8
Threshold Selections	TTL, CMOS, ECL, user-definable (selectable by pod)
User-Defined Threshold Range	±8.0 V in 10 mV increments
Maximum Input Voltage	±40 V peak CAT I
Threshold Accuracy*	±(100 mV + 3% of threshold setting)
Input Dynamic Range	±10 V about threshold
Minimum Input Voltage Swing	500 mV peak-to-peak
Input Capacitance	~ 8 pF
Input Resistance	100 kΩ ±2% at probe tip
Channel-to-Channel Skew	2 ns typical, 3 ns maximum

Horizontal

Range	54621A/D, 54622A/D, 54624A: 5 ns/div to 50 s/div 54641A/D, 54642A/D: 1 ns/div to 50 s/div
Resolution	54621A/D, 54622A/D, 54624A: 25 ps 54641A/D, 54642A/D: 2.5 ps
Vernier	1-2-5 increments when off, ~25 minor increments between major settings when on
Reference Positions	Left, Center, Right
Delay Range	54621A/D, 54622A/D, 54624A: Pre-trigger (negative delay): Greater of 1 screen width or 10 ms Post-trigger (positive delay): 500 seconds 54641A/D, 54642A/D: Pre-trigger (negative delay): Greater of 1 screen width or 1 ms Post-trigger (positive delay): 500 seconds
Analog Delta-t Accuracy	54621A/D, 54622A/D, 54624A: Same Channel*: ±0.01% reading ±0.1% screen width ±40 ps Channel-to-Channel: ±0.01% reading ±0.1% screen width ±80 ps 54641A/D, 54642A/D: Same Channel*: ±0.005% reading ±0.1% screen width ±20 ps Channel-to-Channel: ±0.005% reading ±0.1% screen width ±40 ps *Same Channel Example (54641A/D, 54642A/D):* for signal with pulse width of 10 µs, scope set to 5 µs/div (50 µs screen width), delta-t accuracy = ±{.005%(10 µs) + 0.1%(50 µs) + 20 ps} = 50.52 ns

* Denotes Warranted Specifications, all others are typical. Specifications are valid after a 30-minute warm-up period and ±10 °C from firmware calibration temperature.

Performance Characteristics (continued)

Horizontal (continued)

Digital Delta-t Accuracy (non-Vernier settings)	54621A/D, 54622A/D, 54624A: Same Channel: ±0.01% reading ±0.1% screen width ±(1 digital sample period, 2.5 or 5 ns based on sample rate of 200/400 MSa/s) Channel-to-Channel: ±0.01% reading ±0.1% screen width ±(1 digital sample period, 2.5 or 5 ns) ±chan-to-chan skew (2 ns typical, 3 ns maximum) 54641A/D, 54642A/D: Same Channel: ±0.005% reading ±0.1% screen width ±(1 digital sample period, 1ns) Channel-to-Channel: ±0.005% reading ±0.1% screen width ±(1 digital sample period) ±chan-to-chan skew *Same Channel Example (54641A/D, 54642A/D):* for signal with pulse width of 10 µs, scope set to 5 µs/div (50 µs screen width), delta-t accuracy = ±{.005%(10 µs) + 0.1%(50 µs) + 1 ns} = 51.5 ns
Delay Jitter	<1 ppm
RMS Jitter	0.025% screen width + 30 ps
Modes	Main, Delayed, Roll, XY
XY	Bandwidth: Max bandwidth Phase error @ 1 MHz: 1.8 degrees Z Blanking: 1.4 V blanks trace (use external trigger) - 54621A/D, 54622A/D, 54624A only

Trigger System

Sources:	54621A/622A, 54641A/642A: Ch 1, 2, line, ext 54621D/622D, 54641D/642D: Ch 1, 2, line, ext, D15 - D0 54624A: Ch 1, 2, 3, 4, line, ext
Modes	Auto, Triggered (normal), SingleAuto level (54621A/D, 54622A/D, 54624A only)
Holdoff Time	~60 ns to 10 seconds
Selections	Edge, Pulse Width, Pattern, TV, Duration, Sequence, CAN, LIN, USB, I^2C, SPI
Edge	Trigger on a rising or falling edge of any source
Pattern	Trigger on a pattern of high, low, and don't care levels and/or a rising or falling edge established across any of the sources. The analog channel's high or low level is defined by that channel's trigger level.
Pulse Width	Trigger when a positive- or negative-going pulse is less than, greater than, or within a specified range on any of the source channels. Minimum pulse width setting: 5ns (2 ns on 54641A/D, 54642A/D analog channels) Maximum pulse width setting: 10 s
TV	Trigger on any analog channel for NTSC, PAL, PAL-M, or SECAM broadcast standards on either positive or negative composite video signals. Modes supported include Field 1, Field 2, or both, all lines, or any line within a field. Also supports triggering on non-interlaced fields. TV trigger sensitivity: 0.5 division of synch signal.
Sequence	Arm on event A, trigger on event B, with option to reset on event C or time delay.
CAN	Trigger on CAN (Controller Area Network) version 2.0A and 2.0B signals. It can trigger on the Start of Frame bit of a data frame, a remote transfer request frame, or an overload frame.
LIN	Trigger on LIN (Local Interconnect Networking) sync break at beginning of message frame.
USB	Trigger on USB (Universal Serial Bus) Start of Packet, End of Packet, Reset Complete, Enter Suspend, or Exit Suspend on the differential USB data lines. USB low speed and full speed are supported.

* Denotes Warranted Specifications, all others are typical. Specifications are valid after a 30-minute warm-up period and ±10 °C from firmware calibration temperature.

Performance Characteristics (continued)

Trigger System (continued)

I^2C	Trigger on I^2C (Inter-IC bus) serial protocol at a start/stop condition or user defined frame with address and/or data values. Also trigger on Missing Acknowledge, Restart, EEPROM read, and 10 bit write.
SPI	Trigger on SPI (Serial Protocol Interface) data pattern during a specific framing period. Support positive and negative Chip Select framing as well as clock Idle framing and user specified number of bits per frame.
Duration	Trigger on a multi-channel pattern whose time duration is less than a value, greater than a value, greater than a time value with a timeout value, or inside or outside of a set of time values. Minimum duration setting: 5 ns Maximum duration setting: 10 s
Autoscale	Finds and displays all active analog and digital (for 54621D/54622D/54641D/54642D) channels, sets edge trigger mode on highest numbered channel, sets vertical sensitivity on analog channels and thresholds on digital channels, time base to display ~1.8 periods. Requires minimum voltage >10 mVpp, 0.5% duty cycle and minimum frequency >50Hz.

Analog Channel Triggering

Range (internal)	±6 div from center screen
Sensitivity*	54621A/D, 54622A/D, 54624A: Greater of 0.35 div or 2.5 mV 54641A/D, 54642A/D:<10mV/div: greater of 1 div or 5mV; ≥10mV/div: 0.6 div
Coupling	AC (~3.5 Hz on 54621A/D, 54622A/D, 54624A. ~10 Hz on 54641A/D, 54642A/D), DC, noise reject, HF reject and LF reject (~ 50 kHz)

Digital (D15 - D0) Channel Triggering (54621D, 54622D, 54641D, and 54642D)

Threshold Range (used defined)	±8.0 V in 10 mV increments
Threshold Accuracy*	±(100 mV + 3% of threshold setting)
Predefined Thresholds	TTL = 1.4 V, CMOS = 2.5 V, ECL = -1.3 V

External (EXT) Triggering

Input Resistance	54621A/D, 54622A/D, 54624A: 1 MΩ, ±3% 54641A/D, 54642A/D: 1 MΩ ±3% or 50 Ω
Input Capacitance	54621A/D, 54622A/D, 54624A: ~ 14 pF 54641A/D, 54642A/D: ~13pF
Maximum Input	CAT I 300 Vrms, 400 Vpk, CAT II 100 Vrms, 400 Vpk With 10073C/10074C 10:1 probe: CAT I 500 Vpk, CAT II 400 Vpk 5 Vrms with 50-ohm input
Range	54621A/D, 54622A/D, 54624A: ±10 V 54641A/D, 54642A/D: DC coupling: trigger level ± 8V; AC coup./LFR: AC input minus trig level not to exceed ±8V
Sensitivity	54621A/D, 54622A/D, 54624A: dc to 25 MHz, < 75 mV; 25 MHz to max bandwidth, < 150 mV 54641A/D, 54642A/D: dc to 100 MHz, < 100 mV; 100 MHz to max bandwidth, < 200 mV
Coupling	AC (~ 3.5 Hz), DC, noise reject, HF reject and LF reject (~ 50 kHz)
Probe ID (Agilent/HP and Tek compatible)	Auto probe sense for 54621A/622A/641A/642A

* Denotes Warranted Specifications, all others are typical. Specifications are valid after a 30-minute warm-up period and ±10 °C from firmware calibration temperature.

Performance Characteristics (continued)

Display System

Display	7-inch raster monochrome CRT
Throughput of Analog Channels	25 million vectors/sec per channel with 32 levels of intensity
Resolution	255 vertical by 1000 horizontal points (waveform area) 32 levels of gray scale
Controls	Waveform intensity on front panel. Vectors on/off; infinite persistence on/off 8 x 10 grid with continuous intensity control
Built-in Help System	Key-specific help in 11 languages displayed by pressing and holding key or softkey of interest
Real Time Clock	Time and date (user setable)

Measurement Features

Automatic Measurements	Measurements are continuously updated. Cursors track current measurement
Voltage (analog channels only)	Peak-to-Peak, Maximum, Minimum, Average, Amplitude, Top, Base, Overshoot, Preshoot, RMS (DC)
Time	Frequency, Period, + Width, - Width and Duty Cycle on any channels Rise time, Fall time, X at Max (Time at max volts), X at Min (Time at min volts), Delay, and Phase on analog channels only.
Counter	Built-in 5 digit frequency counter on any channel. Counts up to 125 MHz
Threshold Definition	Variable by percent and absolute value; 10%, 50%, 90% default for time measurements
Cursors	Manually or automatically placed readout of Horizontal (X, ΔX, 1/ΔX) and Vertical (Y, ΔY) Additionally digital or analog channels can be displayed as binary or hex values
Waveform Math	One function of 1-2, 1*2, FFT, differentiate, integrate. Source of FFT, differentiate, integrate: analog channels 1 or 2 (or 3 or 4 for 54624A), 1-2, 1+2, 1*2

FFT

Points	Fixed at 2048 points
Source of FFT	Analog channels 1 or 2 (or 3 or 4 on 54624A only), 1+2, 1-2, 1*2
Window	Rectangular, Flattop, Hanning
Noise Floor	-70 to -100 dB depending on averaging
Amplitude Display	In dBV, dBm@50 Ω
Frequency Resolution	0.097656/(time per div.)
Maximum Frequency	102.4/(time per div.)

* Denotes Warranted Specifications, all others are typical. Specifications are valid after a 30-minute warm-up period and ±10 °C from firmware calibration temperature.

Performance Characteristics (continued)

Storage

Save/Recall (non-volatile)	54621A/D, 54622A/D, 54624A: 3 setups and traces can be saved and recalled internally 54641A/D, 54642A/D: 4 setups and traces can be saved and recalled internally
Floppy Disk	3.5" 1.44 MB double density Image formats : TIF, BMP Data formats: X and Y (time/voltage) values in CSV format Trace/setup formats: Recalled

I/O

RS-232 (Serial) Standard Port	1 port: XON or DTR; 8 data bits; 1 stop bit; parity = none; 9600, 19200, 38400, 57600 baud rates (use Agilent 34398A cable)
Parallel Standard Port	Printer support
Printer Compatibility	HP DeskJet, LaserJet with HP PCL 3 or greater compatibility: Black and white @150x150 dpi; Gray scale @ 600x600 dpi Epson: black and white @180x180 dpi Seiko thermal DPU-414: black and white
Optional GPIB Interface Module (N2757A)	Fully programmable with IEEE488.2 compliance Typical GPIB throughput of 20 measurements or twenty 2000-point records per second
Optional Printer Kit	The N2727A is a thermal printer kit, includingprinter power, parallel cable, power cable and paper

General Characteristics

Physical	Size: 32.26 cm wide x 17.27 cm high x 31.75 cm deep (without handle) Weight: 6.35 kgs (14 lbs) on 54621A/D, 54622A/D, 54624A; 6.82 kgs (15 lbs) on 54641A/D, 54642A/D
Probe Comp Output	54621A/D, 54642A/D, 54624A: Frequency ~1.2 kHz; Amplitude ~5 V 54641A/D, 54642A/D: Frequency ~2 kHz; Amplitude ~5 V
Trigger Out	54621A/D, 54622A/D, 54624A: 0 to 5 V with 50 Ω source impedance; delay ~ 55 ns 54641A/D, 54642A/D: 0 to 5 V with 50 Ω source impedance; delay ~ 22 ns
Printer Power	7.2 to 9.2 V, 1 A
Kensington lock	Connection on rear panel for security

* Denotes Warranted Specifications, all others are typical. Specifications are valid after a 30-minute warm-up period and ±10 °C from firmware calibration temperature.

Performance Characteristics (continued)

Power Requirements

Line Voltage Range	54621A/D, 54622A/D, 54624A: 100 - 240 VAC ±10%, CAT II, automatic selection 54641A/D, 54642A/D: 100-240 VAC, 50/60 Hz, CAT II, automatic selection; 100-132 VAC, 440 Hz, CAT II, automatic selection
Line Frequency	54621A/D, 54622A/D, 54624A: 47 to 440 Hz 54641A/D, 54642A/D: 50/60 Hz, 100-240 VAC; 440 Hz, 100-132 VAC
Power Usage	54621A/D, 54622A/D, 54624A: 100 W max 54641A/D, 54642A/D: 110 W max

Environmental Characteristics

Ambient Temperature	Operating -10 °C to +55 °C; Non-operating -51 °C to +71 °C
Humidity	Operating 95% RH at 40 °C for 24 hr; Non-operating 90% RH at 65 °C for 24 hr
Altitude	Operating to 4,570 m (15,000 ft); Non-operating to 15,244 m (50,000 ft)
Vibration	HP/Agilent class B1 and MIL-PRF-28800F; Class 3 random
Shock	HP/Agilent class B1 and MIL-PRF-28800F; (operating 30 g, $^1/_2$ sine, 11-ms duration, 3 shocks/axis along major axis. Total of 18 shocks)
Pollution Degree2	Normally only dry non-conductive pollution occurs. Occasionally a temporary conductivity caused by condensation must be expected.
Indoor Use Only	This instrument is rated for indoor use only

Other

Installation Categories	CAT I:Mains isolated CAT II:Line voltage in appliance and to wall outlet
Regulatory Information:	Safety IEC 61010-1:1990+A1:1992+A2:1995 / EN 61010-1:1994+A2:1995 UL 3111 CSA-C22.2 No. 1010.1:1992
Supplementary Information	The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC, and carries the CE-marking accordingly. The product was tested in a typical configuration with HP/Agilent test systems.

* Denotes Warranted Specifications, all others are typical. Specifications are valid after a 30-minute warm-up period and ±10 °C from firmware calibration temperature.

Ordering Information

	Description
54621A	2-channel 60 MHz Oscilloscope
54621D	2+16 channel 60 MHz Mixed Signal Oscilloscope
54622A	2-channel 100 MHz Oscilloscope
54622D	2+16 channel 100 MHz Mixed Signal Oscilloscope
54624A	4-channel 100 MHz Oscilloscope
54641A	2-channel 350 MHz Oscilloscope
54641D	2+16 channel 350 MHz Mixed Signal Oscilloscope
54642A	2-channel 500 MHz Oscilloscope
54642D	2+16 channel 500 MHz Mixed Signal Oscilloscope

Accessories Included:	**54621A**	**54621D**	**54622A**	**54622D**	**54624A**	**54641A**	**54641D**	**54642A**	**54642D**
User's Guide (localized), Service Manual, Programmer's Manual	√	√	√	√	√	√	√	√	√
Power cord	√	√	√	√	√	√	√	√	√
10073C 10:1 divider probes with readout	0	0	0	0	0	2	2	2	2
10074C 10:1 divider probes with readout	2	2	2	2	4	0	0	0	0
16:2 x 8 input logic input probe assembly		√		√			√		√
Accessories pouch and front panel cover			√	√	√	√	√	√	√
IntuiLink software RS-232 cable	**	**	√	√	√	√	√	√	√

** IntuiLink Software available free on web at www.agilent.com/find/intuilink

Manual Options (if no option is specified, English ABA will be shipped)

ABA	English
ABJ	Japanese
AB2	Simplified Chinese

Ordering Information (continued)

Available Options	Description
Option 003	Shielding Option for use in severe environments or with sensitive devices under test – shields both ways (in and out): RS-03 Magnetic interface shielding added to CRT, and RE-02 display shield added to CRT to reduce radiated interference
Option 1CM	Rackmount kit (same as 1186A) .

Warranty and Calibration Options:
All models include a standard 1-year warranty. Contact local sales office for prices of extended options:

A6J	ANSI/NSCL Z540 calibration with test data (replaces 1BP)
R-50C-011-3	3-years of return-to-Agilent inclusive calibration service
R-50C-013-3	3-years of return-to-Agilent inclusive plus calibration service
R-50C-011-5	5-years of return-to-Agilent inclusive calibration service
R-50C-013-5	5-years of return-to-Agilent inclusive plus calibration service
R-51B-001-3C	1-year return-to-Agilent warranty, extended to 3-years
R-51B-001-5C	1-year return-to-Agilent warranty, extended to 5-years

Accessories	Description
1183A	Testmobile scope cart
1185A	Carrying case
1186A	Rackmount kit (same as option 1CM)
N2726A	Accessory pouch & front panel cover (standard with 100-MHz models, optional with 60-MHz models)
N2727A	Seiko thermal printer and pouch, parallel cable, power cable, 2 rolls paper, front panel cover
N2728A	10 rolls of printer paper
N2757A	GPIB interface module for 54620-Series and 54640-Series scopes
N2758A	CAN trigger module

Passive Probes	Description
10070C	1:1 passive probe with ID
10073C	10:1 500 MHz passive probe with ID
10074C	10:1 150 MHz passive probe with ID

Ordering Information (continued)

Fine Pitch Probing	Description
10072A	Fine-pitch probe kit
10075A	0.5 mm, IC clip kit
E2613B	0.5mm, Wedge probe adapter, 3-signal, qty 2
E2614A	0.5 mm, Wedge probe adapter, 8-signal, qty 1
E2643A	0.5 mm, Wedge probe adapter 16-signal, qty 1
E2615B	0.65mm, Wedge probe adapter, 3-signal, qty 2
E2616A	0.65 mm, Wedge probe adapter, 8-signal, qty 1
E2644A	0.65 mm, Wedge probe adapter, 16-signal, qty 1

Current Probes	Description
1146A	100 kHz current probe, ac/dc
N2774A	50 MHz current probe, ac/dc
N2775A	Power supply for N2774A

High Voltage Probes	Description
10076A	100:1, 4 kV 250 MHz probe with ID
N2771A	1000:1, 15 kV, 50 MHz high voltage probe.

Logic Probes	Description
10085-68701	16:16 logic cable and terminator (for use with 54621D/622D/641D/642D)
54620-68701	16:2 x 8 logic input probe assembly (shipped standard with 54621D/622D/641D/642D)

Active probes	Description
1144A	800 MHz active probe
1145A	2-channel 750MHz active probe
1142A	power supply for 1144A and 1145A

Differential Probes	Description
N2772A	20 MHz differential probe
N2773A	Differential probe power supply

Cables	Description
10833A	GPIB cable, 1m long
34398A	RS-232 cable (standard with 100 MHz, 350 MHz, and 500 MHz scopes)

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