

Pocket-Friendly Oscilloscopes Under ₹ 50,000



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Do you feel your old oscilloscope has served you long enough; is it bulky, cumbersome and feature-starved? Or, are you planning to buy an entry-level, digital oscilloscope for your basic test and measurement (T&M) needs but cannot figure out which one to buy? Look no further. In this article, we attempt to help you find the best oscilloscope for your application from a wide range available in the market.

Being a widely-used T&M instrument, an oscilloscope is a useful tool for any engineer, maker or hacker. It comes in a variety of form factors.

There are hardly any exciting develop-

ments or introductions transpiring in the entry-level, benchtop oscilloscope segment. However, there are many interesting universal serial bus (USB), do-it-yourself (DIY) and pocket-sized oscilloscopes that have been released in the last couple of years. From benchtop to portable and miniature ones, let us take a look at the wide variety of digital oscilloscopes available out there, which are also pocket-friendly.

Benchtop scopes are reliable, provide solid performance

Many companies today are offering benchtop oscilloscopes targeted at engineers, hobbyists, do-it-yourselfers (DIYers) and

Some pocket-friendly oscilloscopes currently available in the market

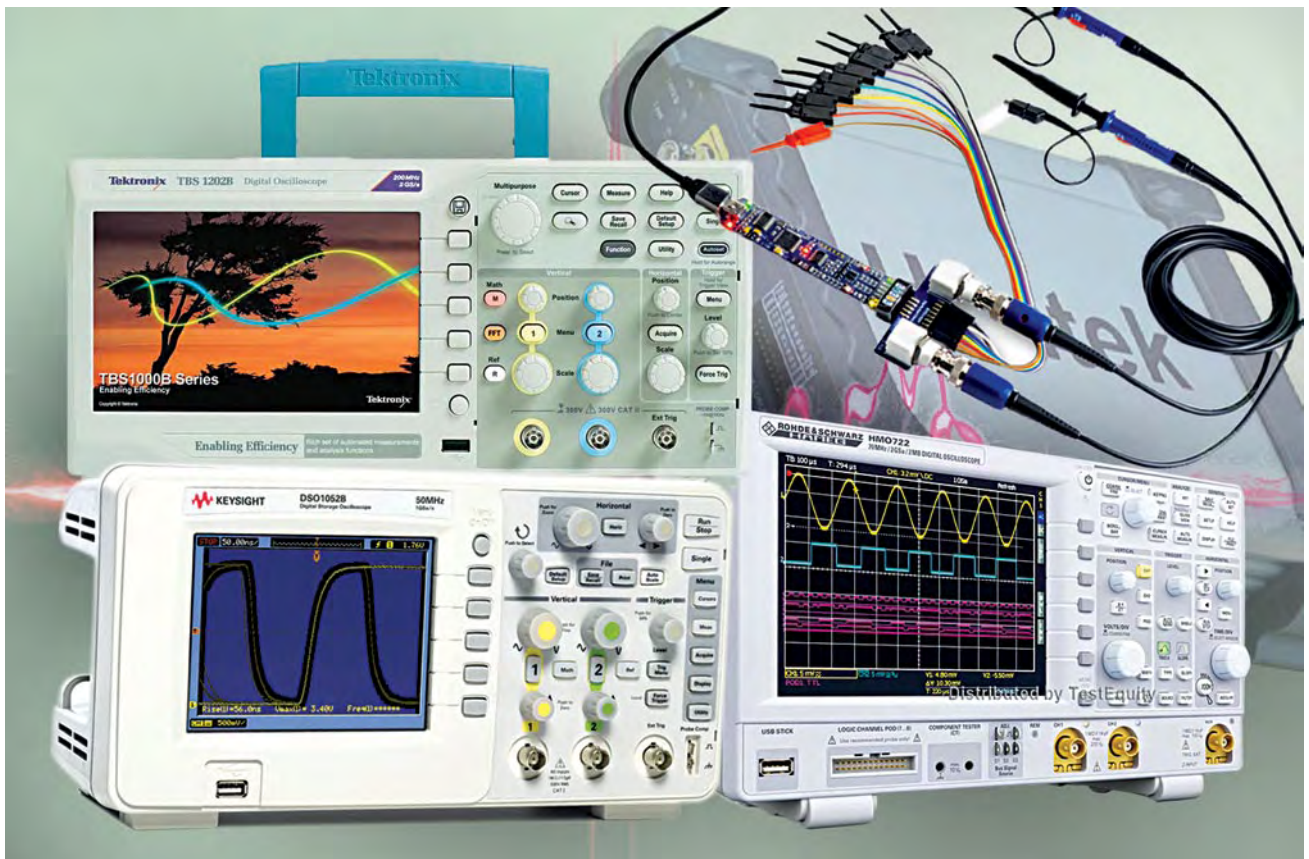


TABLE I
Some Benchtop Oscilloscopes

Brand	Product	Channels	Bandwidth	Sampling rate	Memory depth	Display#	Warranty	Other notable features	Price
Rigol	DS1102E/ DS1052E	Two analogue	50MHz/ 100MHz	1GSa/s	1Mpts	14.5cm (5.7-inch) TFT	Three years	<ul style="list-style-type: none"> Vertical sensitivity ranges between 2mV/div and 10V/div Standard interfaces such as USB host and device, RS232, P/F out 	₹ 21,080**/ ₹ 25,564**
Tektronix	TBS1052B	Two analogue	50MHz	1GSa/s	2.5kpts	17.8cm (7-inch) TFT	Five years	<ul style="list-style-type: none"> 34 automated measurements Dual-window FFT Automated, extended data-logging feature Auto-set and signal auto-ranging Small footprint and lightweight Only 124.5mm (4.9-inch) deep and 2kg 	₹ 32,801*
Keysight	DSO1052B	Two	50MHz	Up to 1GSa/s	Up to 16kpts	14.5cm (5.7-inch) LCD	Three years	<ul style="list-style-type: none"> 23 automatic measurements Waveform math including FFT Free education student lab guides and professor slide sets Sequential acquisition of up to 1000 trigger events, go/no-go mask testing and selectable digital filters 	₹ 34,696*
Tektronix	TBS1052 B-EDU	Two analogue	50MHz	1GSa/s	2.5kpts	17.8cm (7-inch) TFT	Five years	<ul style="list-style-type: none"> Same as TBS1052B but comes with integrated courseware feature, which gives the ability to create lab descriptions and instructions and then upload the material directly onto a TBS1000B-EDU oscilloscope 	₹ 37,911*
Tektronix	TBS1022	Two analogue	25MHz	500MSa/s	2.5kpts	14.5cm (5.7-inch) TFT	Five years	<ul style="list-style-type: none"> 16 automated measurements Automated, extended data-logging feature Auto-set and signal auto-ranging Small footprint and lightweight Only 124.5mm (4.9-inch) deep and 2kg 	₹ 39,555*
Rohde & Schwarz	HMO722/ HMO724	Two/four analogue	70MHz	Up to 2GSa/s	2Mpts	16.5cm (6.5-inch) TFT	Three years	<ul style="list-style-type: none"> Mixed-signal oscilloscope with eight logic channels Component tester, 6-digit counter, auto-measurement six parameters (maximum) Trigger modes: Slope, video, pulsewidth, logic, delayed and event 	N/A
Scientechnologies	Scientechnologies 401	One	50MHz	500MSa/s	32kpts	17.8cm (7-inch) TFT	One year	<ul style="list-style-type: none"> Real-time sampling rate 500MSa/s, equivalent sampling rate 50GSa/s Unique digital filter function and waveform recorder function 32 parameters auto-measure function 	N/A
Scientechnologies	Scientechnologies 402	One	70MHz	1GSa/s	2Mpts	17.8cm (7-inch) TFT	One year	<ul style="list-style-type: none"> With a higher bandwidth, memory depth and sampling rate, other notable features are same as above 	N/A

*Price listed as on e-commerce websites like element14.com and others

Colour displays

** Price converted from US\$ to ₹ (1 US\$ = ₹ 64). Landing price may vary slightly when bought from Indian distributors

design houses, providing affordable performance on a tight budget. Although, these limit mobility and consume considerable amount of bench space, most oscilloscopes available under this category come with reliable features required for basic T&M needs such as USB connectivity for easily connecting to a laptop or per-

sonal computer and data storage purposes, signal auto ranging, numerous automated measurements, automated data logging, frequency counter, auto set with selective bandwidth models like 25MHz, 40MHz, 50MHz, 60MHz, 70MHz, 100MHz, 150MHz and 200MHz.

Considering a price point of

₹ 50,000 and below, majority of the general-purpose digital scopes offer bandwidths up to 70MHz with dual analogue channels. The sample rate for such oscilloscopes is usually between 1GSa/s and 2GSa/s. Higher bandwidth and four analogue channels for educational and industrial purposes exceed the ₹ 50,000 mark.



An oscilloscope is an indispensable tool for any engineer who is working on design, test or even repair of any electronics equipment. It helps to visualise the functioning of an electronics circuit and can act as an engineer's eye to the electronics world. Therefore it is important to carefully choose the right oscilloscope, which would be required to capture the signal of interest” — Akash Srivastava, application engineer, Keysight Technologies India Pvt Ltd



Apart from technical features, a unique aspect that some oscilloscope makers are incorporating is assistance for students and professors. For instance, Keysight Technologies' DSO1000A/B series provides training tools such as education student lab guides and tutorials, and professor slide sets of oscilloscope fundamentals.






Tektronix's TBS1000B-EDU series come with an integrated courseware

TABLE II
Some USB/PC Based Oscilloscopes

Company	Product	Channels	Bandwidth	Sampling rate	Display memory depth	Price
Bitscope	Bitscope Micro (oscilloscope + logic analyser)	Two analogue, six digital	20MHz	40MSa/S	—	₹ 11,641*
Pico Technology	PICOSCOPE 2204A-D2	Two analogue	10MHz	100MSa/S	8kpts	₹ 15,312*
Pico Technology	PICOSCOPE 2205A-D2	Two analogue	25MHz	200MSa/S	16kpts	₹ 19,502*
Hantek	DSO3064	Four analogue	60MHz	200MSa/S	10kpts-16Mpts	₹ 27,490*
Tenma	72-10155	Two analogue	40MHz	100MSa/S	64kpts	₹ 29,936*
MEILHAUS	DS1M12	Two analogue	250kHz	20MSa/S	32kpts	₹ 39,933*

*Price listed as on e-commerce websites like element14.com and company websites

TABLE III
Interesting Miniature, Pocket-Size Oscilloscopes

	Oscium's iMSO-204 and iMSO-204L (lightning-compatible) are mixed-signal oscilloscopes designed specifically for the iPhone, iPad and iPod. Highlights: Two analogue + four digital channels, sample rate: 50MSa/S, bandwidth: 5MHz, 200ns/div-10s/div Price: US\$ 399.97
	Gobotronics' Xminilab Portable is a small mixed-signal oscilloscope with an arbitrary waveform generator and protocol sniffer. Highlights: Two analogue inputs, maximum sampling rate: 2MSa/S, analogue bandwidth: 200kHz, resolution: 8-bits, input impedance: 1MΩ 15pF, buffer size per channel: 256, input voltage range: -14V to +20V Price: US\$ 118
	LabNation's SmartScope is a 100MSa/s open source oscilloscope for iPad, Android and PC. A must-have for every Arduino and Raspberry Pi developer. Highlights: 2x100MSa/s 45MHz oscilloscope, 50MSa/s arbitrary waveform generator digital-logic analyser at 100MSa/s, digital waveform generator at 100MSa/s, 200 waveforms/second data updates Price: US\$ 229
	Gobotronics' oscilloscope watch Highlights: Two analogue inputs, maximum sampling rate: 4MSa/s, analogue bandwidth: 200kHz, resolution: 8-bits Price: US\$ 150
	RedPitaya Highlights: DIY oscilloscope with dual channels with a sampling rate of 125MSa/s, spectrum analyser with 50MHz, 14-bit arbitrary waveform generator, frequency response analyser with 60MHz bandwidth and a 2x2 MIMO PID programmable controller Price: ₹ 46,750

*Price listed as on e-commerce websites like element14.com and company websites

feature, which gives educators the power to share courseware materials between professors from the same institute or anywhere around the world. Professors can create lab descriptions and instructions, which can be made available on the oscilloscope.

These oscilloscopes are best-suited for research and development (R&D) applications, engineering measurements at educational institutions, and standard manufacturing and testing.

USB based and DIY oscilloscopes could be the right choice

Some industry experts are of the opinion that USB scopes have not yet reached the level of desktop models, but these are getting better with technological advancements in terms of measurement and reliability.

USB based scopes provide two important value additions to engineers—flexibility of converting a PC into a T&M platform and portability. In this era of the IoT, these scopes have a slightly greater edge over desktop versions. In fact, there are some interesting miniature devices that convert your laptops, tablets and mobile phones into a waveform analysing device at an affordable price. And, some of these are DIY type and open source, too.

Of course, not all USB scopes are as accurate as traditional oscilloscopes. For critical applications, USB devices would probably not be the right choice, but these are perfectly suited for educational institutions as well as hobbyists and engineers working on small- and mid-level applications on a tight budget.

With even major T&M companies (that are known for impeccable desktop oscilloscopes) continuing to add support to their range of USB oscilloscopes and introduce newer versions, it would not be wrong to predict that USB oscilloscopes in the future could completely replace desktop oscilloscopes in the basic

General Selection Criteria

Following specifications/features of an oscilloscope should be part of the selection criteria:

Bandwidth. Choose your bandwidth based on the edge speed (rise-time) of your signal. If you are unsure of your edge speed, you can use three times the clock rate for analogue signals or five times the clock rate for digital signals.

Application. Choose an oscilloscope according to the application like performing signal-integrity measurements or capturing intermittent signals.

Sample rate. For a Gaussian front-end, use four times the bandwidth. For a maximally flat (or brick wall) front-end, use 2.5 times the bandwidth.

Memory depth. Acquisition memory is the place where digitised samples are stored. Deeper memory allows you to keep your sample rate higher at slower time base settings, which allows you to maintain the full bandwidth longer. It is also useful when analysing waveforms particularly in single-shot mode. Look for a digital oscilloscope that remains responsive, even when deep memory is used.

Waveform update rate. When digital oscilloscopes are processing data, these cannot capture and display signals. Processing time is known as dead time. The shorter the dead time, the more likely you are to find infrequent events. In order to capture an infrequent signal, check if the digital oscilloscope slows down when you use features like digital channels, serial decode or more than the default memory. For debugging and troubleshooting, the higher the update rate, the better the oscilloscope.

Number of channels. The oscilloscope generally has an option to choose between two or four analogue channels and, additionally, have digital channels.

Probes. The oscilloscope probe is an integral part of the measurement system. These are classified as passive and active probes. Select an oscilloscope that provides connectivity to passive as well as active probes.

—Akash Srivastava, application engineer, Keysight Technologies India Pvt Ltd



For general-purpose measurement, prices of oscilloscopes vary from ₹ 12,000 to over ₹ 150,000. Therefore buyers need to be clear on their requirements for use, budget and expected lifetime of its use, while not forgetting the warranty that comes with it” — Abhishek Rao, technical marketing manager, element14 India



oscilloscopes segment for general-purpose usage, provided these are reliable and sturdy like traditional box-type instruments in their measurements and analysis. You can take a look at some of the interesting devices in this arena listed in Tables II and III.

Choose wisely

Between benchtop, USB and DIY, it could be a daunting task to choose the right oscilloscope for your needs. We have featured some of the hundreds of varying models with widely differing costs and specifications. It is important to invest some time considering the use case and application

area of your potential oscilloscope. It would be wise to follow the try-before-you-buy policy, read reviews and ask the T&M vendor to provide a demonstration.

Warranty is also an important factor to pay heed to. Tektronix provides a five-year warranty on their benchtop scopes, whereas other reputed companies such as Rigol, Keysight and Rohde & Schwarz offer three-year warranty on their range of desktop scopes. USB and DIY scopes typically come with a one-year warranty. Features such as bandwidth, sampling rate and memory depth are not upgradable in most of the oscilloscopes in the market. ●