HAMEG Instruments

Professional Article

Analog, digital or rather both?

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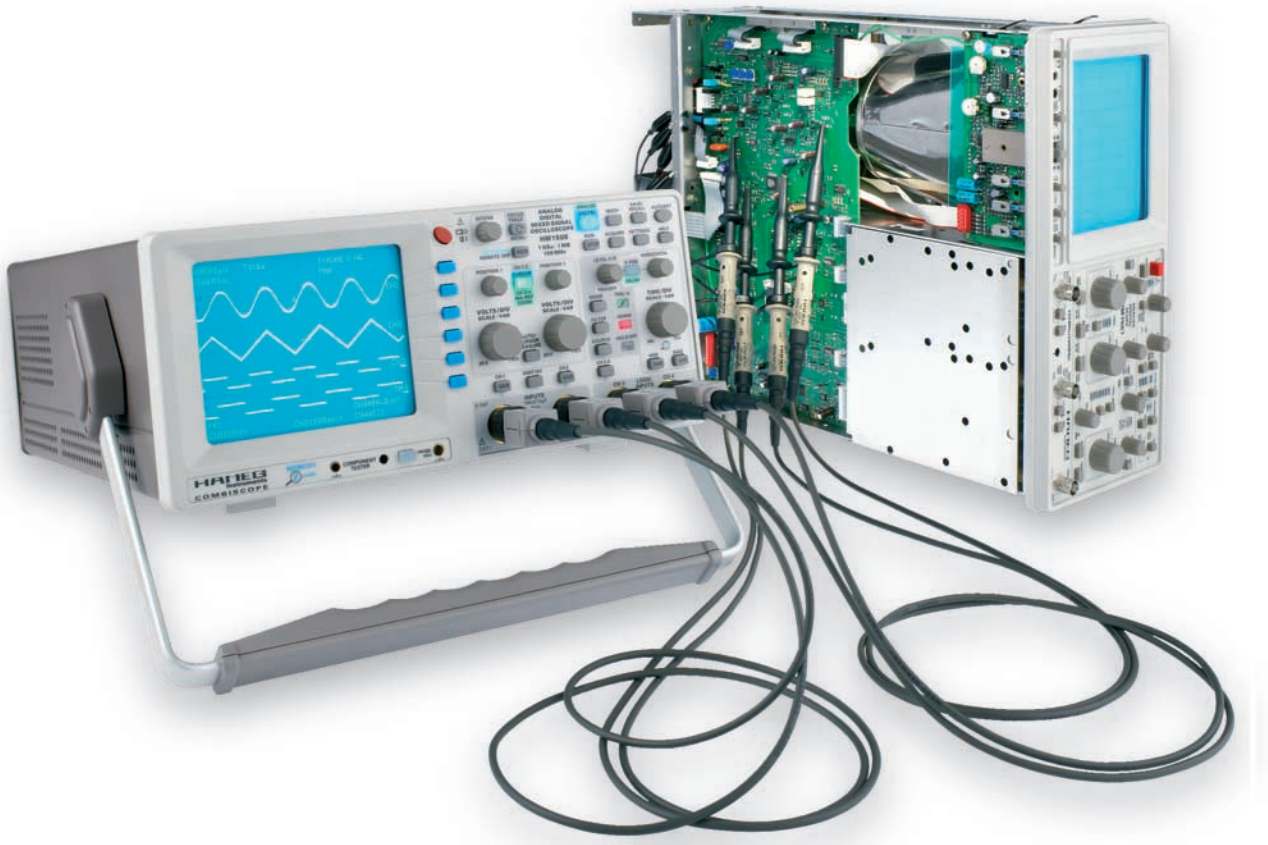
Analog scopes are obsolete, they are succeeded by digital storage scopes, this message has become a standard, proven by statistics, however, it should be taken with caution as these statistics include socalled Combiscopes under the heading DSOs. A Combiscope is a combination analog – digital scope. There are sound reasons to rely on a Combiscope due to some serious shortcomings of DSOs.



Traditionally, apart from research and development departments, also universities, schools and training centers buy scopes. These customers expect quality, easy handling and especially reliable measuring results. This is why renowned companies offer analog and Analog/Digital scopes (Combiscopes).

Analog and digital

For elementary physical reasons analog scopes feature an unexcelled quality of signal representation and the highest capture rate. DSOs do not show the signal but only a more or less accurate reconstruction of the signal after sampling, analog to digital conversion and further treatment of the stored information. The 8 bit a/d converters used mostly can only differentiate between 256 amplitude levels. The effective sampling rate of a DSO is not constant but depends on the time base setting used, any DSO must decrease its maximum sampling rate with decreasing sweep speed. GS/s may thus be reduced to KS/s without that the user becomes aware of this and its consequences. A correct signal reconstruction is only possible if the sampling rate is at least twice the highest signal frequency component. Strictly speaking a DSO should include a lowpass the cut-off frequency of which must be automatically decreased in line with the decrease of the sampling rate. This is obviously impracticable. Or the user must tailor the frequency content of his signal according to the effective sampling rate which is equally impractical. Hence aliasing with signal distortions and artifacts will result any time the effective sampling rate is too low. In such cases also the numerical measurements presented by a DSO may be wrong by orders of magnitude. There is only one remedy: a deep memory which is costly. A manufacturer which provides e.g. 1 MPts of memory can use the maximum sampling rate down to a sweep speed of 100 µs/cm. If a DSO sports only 10 KPts the sampling rate will be reduced from 1 GS/s to 10 MS/s at 100 us/cm.

In contrast to this analog scopes show the signal itself and their bandwidth is independent of the time base speed. An analog scope can not distort the signal nor generate artifacts. If signals are very fast in the vicinity of the scope's rise time the corners will be rounded.

Analog Scopes + Digital Scopes = CombiScopes

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150 MHz Analog/Digital Mixed Signal

CombiScope HM1508

- **Combined analog and digital storage oscilloscope**
- **1 GS/s Real time and 10 GS/s random sampling**
- **Memory zoom technology up to 40,000 : 1**
- **2 channels + 2 logic channels 150 MHz**
- **1 MPts memory depth per channel Slope, video, logic trigger modes**
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- **11 cursor measurement functions**
- **8 auto measurement functions**
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- **5 mathematics memories**
- **Interfaces:**
  RS-232(standard),
  RS-232+USB,
  IEEE-488, Ethernet (optional)
- **High resolution crt with 2,000 x 1,000 points**
- **Simple, intuitive operation, multilingual messages**
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2 channel Analog/Digital
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CombiScopes

DSOs hence can only replace analog scopes in certain applications. They do have advantages, e.g. documentation is easy as the signal is available already in digital format. This also easies any further mathematical treatment. DSOs excel if the signal's repetition frequency is low or for capturing single events. An analog scope would also present the signal on the screen, but it would remain invisible to the eye.

Combiscopes combine the best of both worlds as pressing a button is all that is required to switch from one to the other. In case of doubt about the correct representation in DSO mode a quick look at the signal in analog mode will answer the question. The Combiscope is thus the best buy for any scope application.

Analog and digital operation are not in competition, rather they complement each other, both with specific features. The HAMEG scopes were designed for cost-sensitive applications such as schools, production, research and development labs. Although parameters important today like analog operation, sampling rate, memory depth, logic channels were optimized cost and price remained in focus. In spite of their high performance the instruments are easy to operate, much like a classical analog scope. Fast reactions to operator commands are by no means a matter of course, especially when deep memories are provided. A RISC 32 bit processor with a 166 MHz clock and a 32 bit RISC vector graphics engine support graphics and alphanumeric displays without disturbances in analog mode. A special operating system was developed to ensure fast reaction and compact code. The interface module is a plug-in type.

Sampling rate, memory, memory zoom

Sampling rate an memory determine the time interval which still can be measured with the highest sampling rate. At a sweep rate fo 100 µs/cm a time interval of 1 ms can be sampled at 1 GS/s. This is equal to 100,000 samples per divison(cm) which are all used to generate a signal display. The display is thus an overview of the whole memory contents. In order to gain access to signal details the memory zoom function is used. Signals containing frequencies up to the bandwidth limit may be studied. Aliases are not to be expected as they are only possible for frequencies › 500 MHz, far beyond the bandwidth of 150 MHz. The table below compares the performance of DSOs with different memory depths. Assuming scopes with 1 GS/s maximum sampling rate and a time interval of 1 ms the one with a 10 KPts. memory will have to decrease its sampling rate to 10 MS/s, the one with only 2 KPts. even to 2 MS/s. Consequently, aliases and false measurements are preprogrammed as the frequencies where aliases will appear are far below the scope's bandwidth.

Summary

A decision between analog scope and DSO is not required if one chooses a Combiscope. Both are united within a single instrument. Depending on the specific measuring task one or the other will be used.

Analog mode is the only one which can never produce false measurements and it also features the highest signal quality. Thus only this mode guarantees of correct results. The capture rate may be up to 1 million per second. The DSO part of the combiscope is best of its class with 1 GS/s and 1 MPts. memory.

Oscilloscope Memory depth	Time interval	Resulting sampling rate	Aliases beginning from	Max. sampling rate available down to a sweep rate of
1 MPts	1 ms	1 GSa/s	500 MHz	100 µs/cm
10 kPts	1 ms	10 MSa/s	5 MHz	1 µs/cm
2 kPts	1 ms	2 MSa/s	1 MHz	200 ns/cm