11300-Series extends the usefulness of analog scopes

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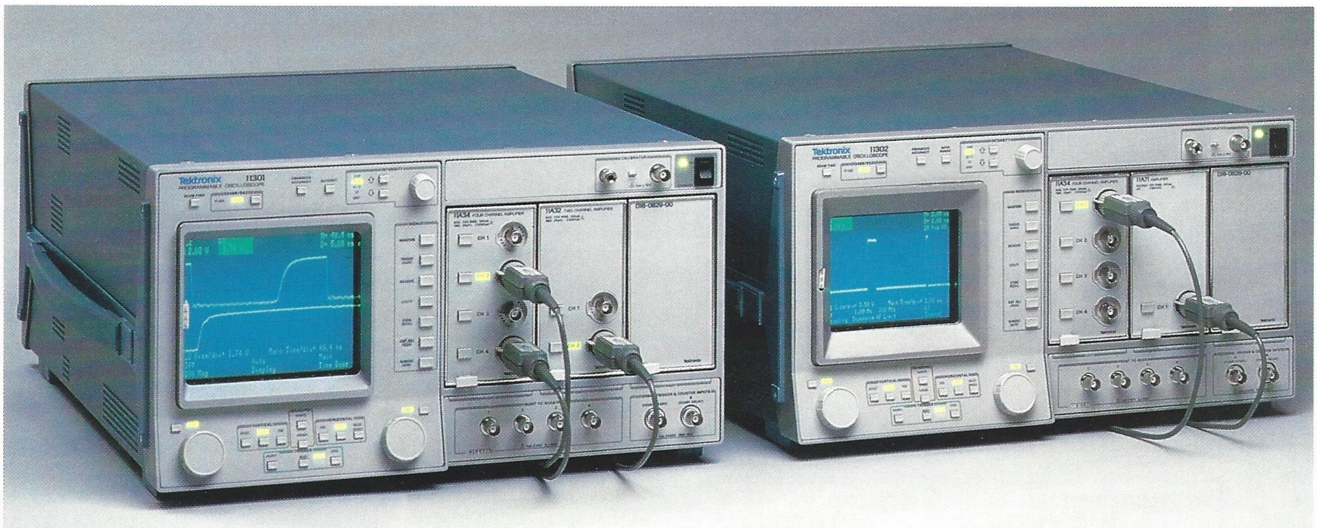

The new 11300-Series analog oscilloscopes from Tektronix. 400 MHz 11301 Oscilloscope on left, 500 MHz 11302 Oscilloscope with microchannel-plate CRT on right

Analog scopes have provided the foundation for precision measurements for the past four decades. But recent advances in digital measurement techniques have eroded this base. In fact, some manufacturers of digitizing oscilloscopes would like you to believe that analog scopes have outlived their usefulness (see sidebar **Analog scopes are alive and well**).

In designing a new family of oscilloscopes, Tektronix engineers had to rethink the position of the analog scope in the measurement world. The result was a new commitment to the analog oscilloscope because it provides measurement capability unattainable by any other means. As a result, Tektronix is proud to introduce the latest in a long history of precision analog oscilloscopes — the 400 MHz 11301 Oscilloscope and the 500 MHz 11302 Oscilloscope.

New from the outside

The 11300-Series analog oscilloscopes have a whole new look from the outside, a look which they share with the 11400-Series digitizing oscilloscopes — all part of the new 11000-Family from Tektronix (see preceding 11000-Family overview article **Tektronix redefines the oscilloscope**). The first thing you notice is an all new size and shape — low on the bench and built for rackmounting. Then you notice the simple, uncluttered front panel made possible by the touch-screen interface (see **Touch screen provides front-panel simplicity** in 11000-Family overview).

New from the inside

There's more to the 11300-Series Oscilloscopes than meets the eye. Inside are many of the familiar circuit modules you would expect to find in any analog oscilloscope (see Figure 1). But these familiar circuits are augmented by some circuitry you wouldn't expect to find in an analog scope — such as a microprocessor-based Main Processor system and a built-in 500-MHz universal counter-timer.

Briefly, the 11300-Series circuits operate as follows: Signals for vertical deflection are applied to the Left and Center Plug-Ins. Trigger signals for both the Main and Delayed Trigger can be selected from these plug-ins as well as the Right Plug-In. Signals from the Center Plug-In can also provide horizontal deflection for X-Y displays. The Main and Delayed Sweeps operate in a conventional manner except that they are an integral part of the mainframe circuitry rather than being in plug-ins as with previous Tektronix plug-in oscilloscopes.

Selected signals from the plug-ins are displayed on the CRT. The 11302 uses a microchannel-plate CRT to provide a bright display of low-repetition rate or single-shot transient signals up to the 500 MHz bandwidth even in normal room light (see sidebar **Microchannel-plate CRT and Digital Camera System capture fast signals** for more detail).

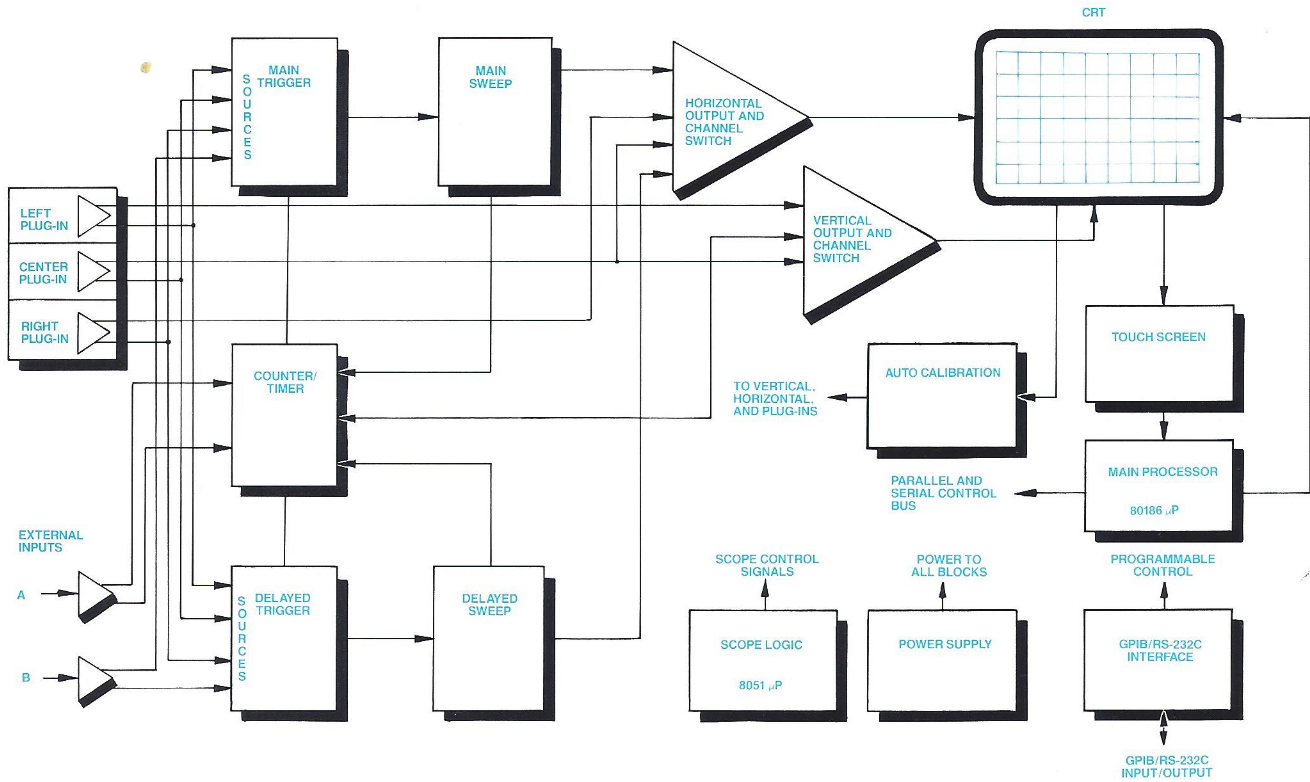

Figure 1. *Simplified 11300-Series block diagram*

Virtually all operation of the 11300-Series, including the plug-ins, is controlled through the Touch Screen. This circuitry senses a touch on the CRT screen which is interpreted and acted upon by the Main Processor. The pushbuttons adjacent to the CRT call up the various menus for the touch screen. The two large control knobs below the CRT perform various functions as assigned by the pushbuttons or the menu selections. Characters and graphics for menu selection, operator prompts, status information, measurement results, and cursors are produced by the Main Processor.

The Scope Logic stage generates signals to control the analog circuits (e.g., switching logic, signal selection, sweep control, etc.). Programmable control for all functions of the oscilloscope is provided via both IEEE-488 (GPIB) and RS-232C by the GPIB/RS-232C Interface.

The Enhanced Accuracy mode provides automatic self-calibration of the gain and timing of the vertical and horizontal systems including all installed plug-ins. The Auto Calibration circuit provides accurate voltage and timing references. Optical sensors on the CRT bezel sense when the beam crosses the graticule lines to factor this information into the auto cal control signals. As a result, accuracy of the 11300-Series is controlled from the plug-in input connector to the CRT graticule without operator intervention. Provision is also made for calibration to the probe tip when an 11000-Series probe is used.

At the heart of these unique analog oscilloscopes is the 500-MHz universal counter-timer. This counter-timer provides measurement of frequency, period, width, ratio, totalize, and time A→B. Measurements can be made on any of 12 different plug-in input channels and/or from the external A and B inputs. A counter-view function allows display of signals from within the counter to show exactly what is being counted. This is especially useful on gated measurements or in measurements on complex signals where positioning of a gate or triggering level can easily produce a false reading with a conventional counter.

Power for all circuits in the 11300-Series mainframes, associated plug-ins, and active probes is provided by the Power Supply.

Is it a scope with a built-in counter-timer or a counter-timer with a built-in scope?

It's hard to tell whether the 11300-Series should be described as a precision oscilloscope with a built-in counter-timer or an extremely versatile counter-timer with a built-in scope. Either way, it adds up to precise measurement capability unequaled in any other single package. By combining a high-performance universal counter-timer with a high-performance oscilloscope, Tektronix simplifies the most difficult counter-timer measurements while adding capabilities never previously possible with a counter-timer alone. And all this combined measurement power is available for the price you would pay for either a precision oscilloscope or a high-performance counter-timer alone.

Combining an oscilloscope and a counter-timer provides other benefits besides lower equipment cost. For one, you only need to allot space on your bench for one instrument rather than two. And then, both functions are always available and can be accessed with a single connection to the circuit-under-test. By taking advantage of oscilloscope resources — such as delayed sweeps, multiple trigger inputs, high-sensitivity inputs, interchangeable plug-ins for signal conditioning to match signal demands, and a CRT display of what you're counting — counter measurements are moved to new dimensions.

See what you're counting with counter view

Measuring pulses without the new counter-view feature which is standard on the Tektronix 11300-Series is like counting paper currency in the dark — you know how many bills you have but you aren't sure what your fortune is worth.

A unique feature on the 11300-Series is a Counter View mode — essentially what the counter is actually "seeing" and how it is being interpreted. This counter-view signal can be compared with the analog oscilloscope signal to show exactly what is being counted. Now you can adjust and control counter measurements with greater precision and complete confidence.

Several signals are available for counter-view display. In all cases, the counter-view display is shown as a binary signal (only two levels) representing the triggering points.

- **Count In** displays the actual counted events as detected by the counter-timer.
- **Gate** shows the gating signal that is used to exclude or mask unwanted portions of the signal from the measurement.
- **Sync Gate** displays the actual interval during which the counter performs the measurement.
- **A Ext and B Ext** shows the detected signal present at the A External or B External inputs.

The Counter View feature is helpful when making any type of counter measurements, but it becomes almost indispensable for making accurate measurements on complex waveforms. For example, trying to measure the frequency of only the signal burst on the waveform shown in Figure 2 with a conventional counter often results in too low a reading because the counter averages the pulses over a fixed time interval (see waveform and frequency results on left).

However, you can easily get the correct frequency reading by confining the measurement to only the burst signal. This is easy to set up with the 11300-Series counter-view feature using the delayed sweep to provide a gating signal. Then while observing the time relationship between the signal and the counter view gate, you can adjust the duration and position of the gate so only the burst signal of interest is counted (see waveform and frequency results on right). Since the measurement interval has been confined to the burst signal you want to measure, the frequency measurement is now correct.

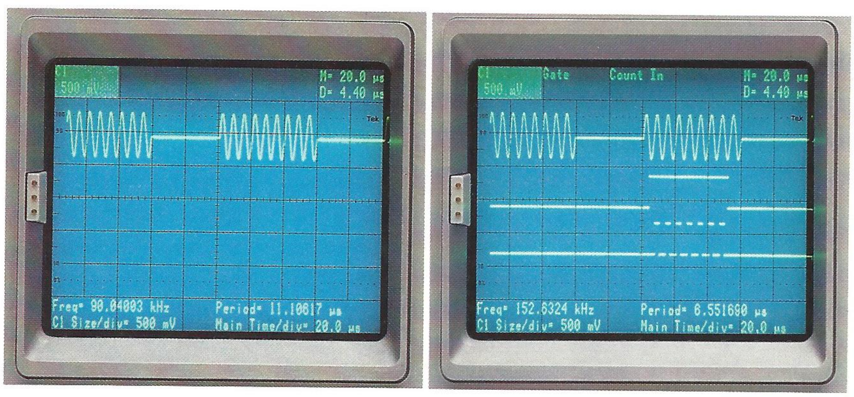

Figure 2. *Typical counter produces the incorrect frequency (90.04003 KHz) reading shown on the left. With Counter View as shown on the right, you can get the correct reading (152.6324 KHz) by positioning the gating signal so only the burst signal of interest is counted*

Accurate one-touch measurements

With the 11300-Series, complex measurements are reduced to a simple touch. Pressing the AUTOSET button on the front panel (or a button on the probe tip) captures and displays an automatically scaled, correctly triggered signal.

Press the MEASURE button and then select up to eight common waveform parameters from the menu for automatic measurement on the selected waveform. Results are displayed on the screen or made available over the GPIB or RS-232C bus.

Delayed sweep measurements, counter-timer measurements, cursor measurements — these are just some of the measurements that can be made easily from the touch screen. To end confusion over which knob to turn or which button to press when making a measurement, the touch-screen interface narrows your choice of functions to those menu items appropriate to the task.

You can even select enhanced-accuracy measurements with a single touch. Pressing the ENHANCED ACCURACY button after the instrument has reached a stable operating temperature (20 minutes after power turned on) invokes an auto cal routine to provide the most accurate measurements you can make with any analog oscilloscope. Special probe calibration functions are also provided for compensation and deskewing (matching time delay through the probes and associated channels). And to ensure that you're always making measurements to the expected accuracy, a warning message tells you when enhanced accuracy no longer applies — instrument has been turned off, plug-ins have been changed, or the temperature changed ±5 degrees C.

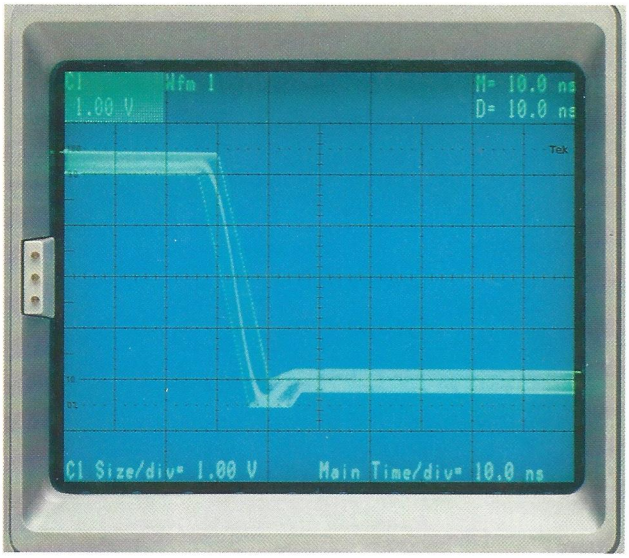

Figure 3. *Displayed waveforms can be compared to stored reference waveforms for quicker visual go/no-go comparisons. In this case, the "live" waveform is compared to a stored "tolerance band."*

Easier measurements with cursors

Vertical or horizontal cursors can be displayed to aid in making amplitude and timing measurements. When using cursors, signal variations can be measured in percent, dB, or degrees without the need for additional calculation. The numeric result of cursor measurements is always displayed on the screen along with the appropriate units of measure.

Reference waveforms for comparison

Although these analog scopes cannot digitize and store input waveforms, a special memory allows two reference waveforms to be stored and displayed for comparison purposes. These reference waveforms can serve as templates for quick visual go/no-go comparison (see Figure 3). The reference waveforms can be downloaded to the template memory over the GPIB or RS-232C bus.

For more information

There just isn't enough room in this article to tell everything about the new 11300-Series analog oscilloscopes. If you would like to know more about what the 11300-Series can do for your measurements, contact your local Tektronix Sales Engineer or representative for a videotape preview or a hands-on demonstration. For a brochure, check the appropriate box on the **HANDSHAKE** reply card.

With appreciation to Paul Thompson, Tektronix Laboratory Instruments Division Marketing, for technical assistance in preparing this article.

Analog scopes are alive and well

Mark Twain is reported to have cabled the Associated Press from London in 1897 with the message "The reports of my death are greatly exaggerated." This same message could be applied to analog scopes today as many are saying they're dead and gone — some companies have even decided to get out of the analog scope business.

But Tektronix is committed to the analog scope — not out of tradition but because there are certain measurements that can only be made using analog techniques. Digitizing techniques have just not advanced to the point where digitizing oscilloscopes can take over all oscilloscope applications.

As long as a signal is repetitive and always behaves as expected, a digitizing oscilloscope will generally perform as well or better than a comparable analog oscilloscope. And besides, they give you some added benefits like digital storage, almost unlimited waveform manipulation capability, save on delta, hardcopy output, comparison with a reference, digitized waveform output for computer analysis, etc., etc.

That's all well and good as long as the signal is fairly stable. However, if the signal is constantly varying, the display from a digitizing oscilloscope can be almost incomprehensible. In some digitizing oscilloscopes, this is offset by using a point-accumulate mode which shows the outer limits of the signal variations. But it still doesn't show you what the individual variations were within these limits. In order to see and measure these variations, you need a fast, bright analog oscilloscope such as the 11301 or the 11302.

Another limitation of digitizing oscilloscopes is that the signal must be repetitive. From both a practical and economical standpoint, digitizing scopes cannot capture single-shot signals with frequency components in excess of a few megahertz. Some specialty digitizers can perform up into the gigahertz range, but their price eliminates them from consideration in all but the most important and demanding applications.

For the foreseeable future, there will remain a need for real-time analog oscilloscopes. At the same time, there are applications where a digitizing oscilloscope may provide the best answer. That's why Tektronix doesn't lock you in to either analog-only or digital-only measurements but gives you a choice — the 11300-Series analog oscilloscopes and the 11400-Series digitizing oscilloscopes. And they're both part of the new 11000-Family from Tektronix, sharing common architecture, operating features, and plug-ins.

Microchannel-plate CRT and Digital Camera System

What is a microchannel plate?

Microchannel-plate technology provides one of the major technological breakthroughs in the effort to increase CRT writing rate for the display of single-shot phenomena. A microchannel-plate CRT is quite similar to a conventional CRT. The major difference is the microchannel plate (MCP) located just behind the CRT phosphor screen. Figure A shows the details of an MCP CRT.

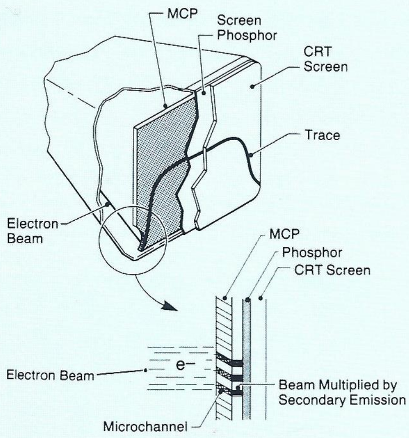

Figure A. *Detail of microchannel-plate CRT showing how an electron beam is amplified*

The MCP is a 0.050-inch thick glass plate with millions of tiny (approximately 25 micron), closely spaced holes (microchannels). These holes are offset angularly from the beam axis by about 15 degrees and are internally treated to promote the generation of secondary-emission electrons.

When the electron beam scans across the MCP, electrons enter the holes and strike the treated sides. This causes secondary emission within the channel which is amplified by further secondary emission as it moves down the channel. The amplified electron beam exits the channel and travels the short distance to produce a trace on the phosphor screen.

Because of the channel multiplication of beam electrons, trace brightness is increased, even for extremely fast traces that would otherwise not be visible on the CRT. Individual channels of the MCP saturate in regions of high trace intensity while maintaining full gain for less intense portions. This feature called "adaptive intensity" tends to normalize overall trace intensity between high and low repetition rate signals. Bright traces are limited to a safe viewing level while the intensity of dim traces is increased for good visibility.

Digitizing Camera System makes 11302 a 500 MHz, 100 gigasample/second transient digitizer

The Tektronix Digitizing Camera System can turn the 11302 Oscilloscope into a 500 MHz transient digitizing oscilloscope with an effective single-shot digitizing rate in excess of 100 gigasamples per second. The Digitizing Camera System consists of the C1001 Video Camera which mounts on the CRT bezel, a Frame Store Board which mounts in an IBM PC or compatible, and DCS01 Software for waveform processing. An optional video copier provides high-resolution black and white prints of waveforms at low cost.

Used with the 11301 Oscilloscope, the Digitizing Camera System can acquire repetitive events at full bandwidth and transient events to the limits determined by the photographic writing rate of the CRT. On both the 11301 and 11302, the Digitizing Camera System allows waveforms to be digitized, stored, and displayed. Routines in DCS01 Software can perform many waveform processing operations on the acquired waveforms.

To find out more about the Digitizing Camera System, contact your local Tektronix Field Office or sales representative. For a brochure, check the appropriate box on the **HANDSHAKE** reply card in this issue.

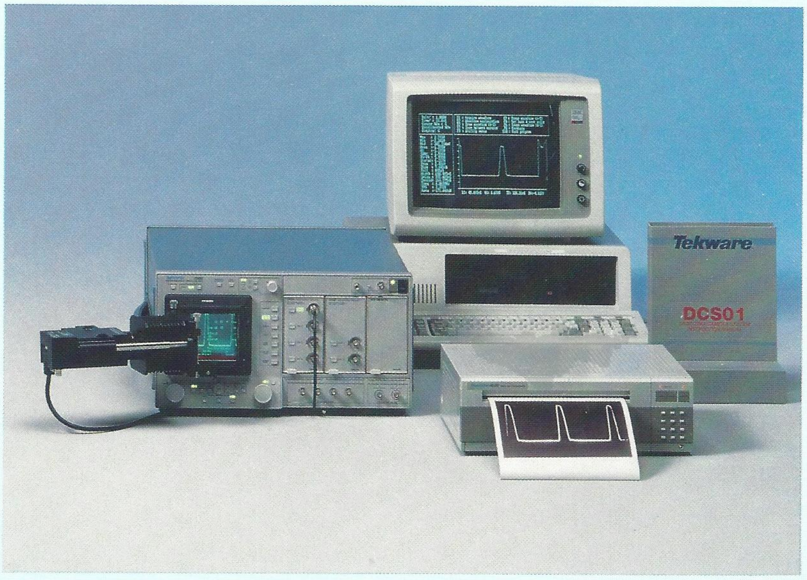

Figure B. *Digitizing Camera System turns the 11302 Oscilloscope into a 500 MHz transient digitizer*