

TEK HANDSHAKE™

VOL 14 NO 4, WINTER 1989/90

YOUR VISIBLE EDGE IN MEASUREMENTS

HIGH-SPEED COMMUNICATIONS SIGNAL ANALYSIS

FEATURED INSIDE:

- CSA 803
- 1230DSM/30DSM
- 2467BHD



Tektronix®
COMMITTED TO EXCELLENCE

One of the newest and most exciting developments in the growing test and measurement segment of the electronics industry is the VXIbus — a concept that holds promise for many advancements in test equipment modularity and flexibility. The VXIbus is unique in that it was designed from “the ground up” to meet the needs of the test and measurement industry. Before the first VXIbus product became available, a specification was defined by a consortium made up of test equipment manufacturers. The resulting VXIbus specification defines a standard which guarantees interchangeability and interconnectability between test equipment from various manufacturers.



As part of our commitment to the test and measurement needs of our customers, Tektronix took an active part in the VXIbus Consortium. Then, after the VXIbus specification was complete, we began to introduce VXIbus-based test instruments to complement our existing product line.

Recently, we took another step to enhance that commitment. Tektronix has acquired Colorado Data Systems, a co-founder of the VXIbus Consortium, and is now offering the full line of CDS VXI-bus and card modular products in addition to the existing Tektronix VXIbus products. This greatly expands the VXIbus products available from Tektronix/CDS to meet your measurement needs and holds the promise for even more to come. The New Product Update in this issue of **HANDSHAKE** describes a few of those products. Watch future issues of **HANDSHAKE** for information on new VXIbus products as well as tips and techniques on designing your new test system based upon the available VXIbus products.

We've made a commitment to test and measurement and we intend to live up to it. **Tektronix — Your Visible Edge in Measurements!**

Richard I. Knight
Vice President, Test and Measurement Group
Tektronix, Inc.



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A look inside

This issue of **HANDSHAKE** provides a brief look into the telecommunications world. We'll look at some of the test instruments and applications used to test today's networks and signals. The cover story, **CSA 803 — signal analyzer with a communications focus** describes how this newest member of the Tektronix 11000 Family, the CSA 803 Communications Signal Analyzer, is designed to specifically address the needs of the telecommunications market. In a sidebar to this article, you'll also see how Tektronix is **Meeting your telecommunications test needs** through a full line of telecommunications test products from different Tek divisions.

The applications article, **Automating optical component evaluation**, describes the P6703 Optical-to-Electrical Converter and the Template/Waveform Processing Program used with a 11400-Series Digitizing Oscilloscope to provide a complete solution for automated testing of optical signals to either industry-standard or custom-designed measurement templates.

New products featured in this issue include the 1230DSM/30DSM Digitizing Scope Modules which put a digitizing scope in your logic analyzer. Beyond the obvious advantage of combining multiple test functions into a single, compact instrument, these new scope-on-a-card modules allow some unique test features through cross triggering and combined scope and logic analyzer display modes.

Also new is the 2467BHD HDTV Scope which is designed to test any of the three most popular HDTV systems currently proposed. This scope combines advanced TV triggering capability with the ability to view even the fastest pulses on the high-writing rate micro-channel plate CRT.

Again in this issue, we take a look at the Analytek Series 2000 Digitizer. The article **Analytek Series 2000 Systems... high performance in small packages** looks at some typical measurement challenges and how they were solved with the Analytek Series 2000 modular system.

In addition to all of the above, the **New Product Update** describes 16 new products, four new accessories, and three new support software packages that help provide *Your Visible Edge* in measurements.



A. Dale Aufrecht
HANDSHAKE Editor

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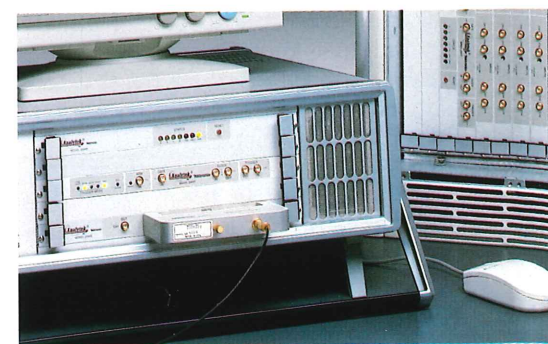
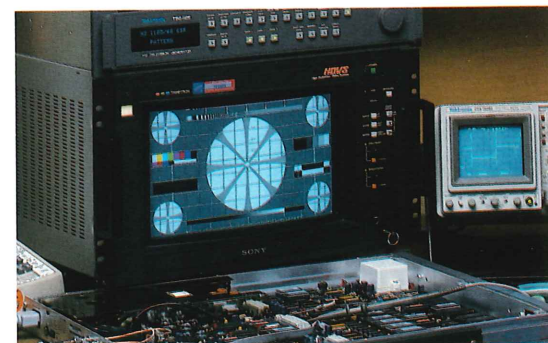
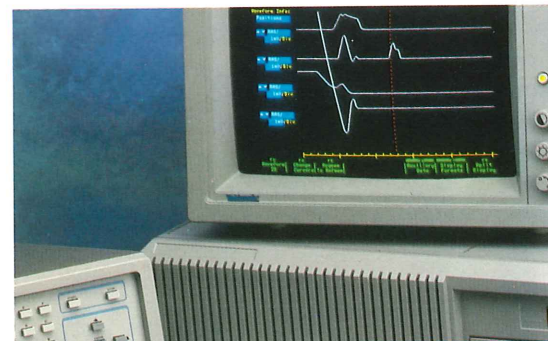
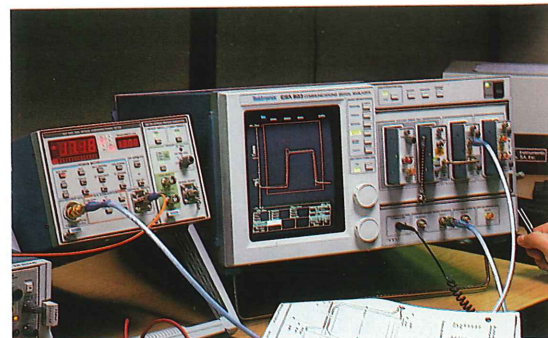
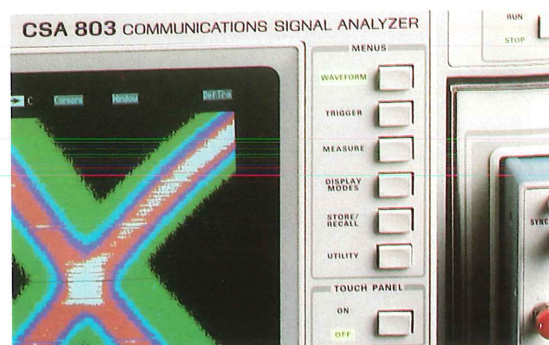
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Testing FDDI transmitters using the mask testing capability of the CSA 803.

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CSA 803 — signal analyzer with a communications focus

Communications — a growing industry

The rapid growth of the high-speed digital communications market can be attributed to a number of factors. Advances in fiber optics, VLSI, and GaAs technologies, for example, are helping to drive the conversion of communications systems from analog to digital technologies.

In addition, deregulation of the telephone industry in the United States, the restructuring of AT&T, and the subsequent heated competition between the major competitors has made possible the rapid confluence of telecommunications with computer technology.

Several manufacturers of products for fiber-distributed data interface (FDDI) local-area networks have formed a working group to speed the evolution and acceptance of the new FDDI standard. FDDI networks can transmit data 10 times faster than conventional LAN transmission rates. The new SONET (Synchronous Optical NETwork) standard will expand these concepts for worldwide communications.

Unique test and measurement requirements

Paralleling this growth in the communications field has been a growing need

for specialized test and measurement instrumentation. Researchers, designers, troubleshooters, and manufacturers of high-data-rate digital communications equipment need instruments that can perform timing measurements at very high bandwidths. High-speed data streams must be monitored for noise, jitter, and bit error rates (BER) — tasks most effectively accomplished with eye or constellation diagram analysis and BER testing. Propagation delays and characteristic impedance of components, strip lines, and cables are most effectively measured by using TDR (time domain reflectometry) or differential TDR methods. Mask testing capabilities are needed for pass/fail and tolerance testing. Characterization of opto-electronic devices is becoming more important as applications expand for fiber optics in telecommunications and data communications.

General-purpose digital oscilloscopes do not offer the "complete" test and measurement capabilities this market requires. Most are bandwidth limited by their front-end amplifiers and attenuators. And their measurement sets are, by intention, so broad that they don't adequately meet the specific needs of the communications field.

Sampling oscilloscopes, which don't attenuate or amplify signals before sam-

pling, offer the bandwidths needed. However, until now, they haven't fully addressed the specific measurement needs of the communications industry.

A Tektronix solution

The 11800 Series Digital Sampling Oscilloscopes are Tek's original, ultra-high bandwidth instruments (see **Introducing the 11800 family of digital sampling oscilloscopes** in the Winter 1988/89 **HANDSHAKE**). The 11800 Series offers features that meet many communications industry needs: High bandwidth — up to 40 GHz (depending upon sampling head); low noise characteristics; the only high-bandwidth instrument with continuously updated on-board waveform measurements and on-board measurement statistics; the only sampling oscilloscope with windowing capability for up to 1 picosecond/division time resolution; and the first true differential TDR measurement capability.

While many communications engineers like these features, the 11800 Series isn't focused directly at the rapidly growing, high-data-rate communications field. Customers dealing with gigabit-per-second data rates need higher trigger bandwidths. Variable persistence is important for viewing eye diagrams. The measurement set needs to be expanded to include "communications fo-

cused" measurements. On-board histograms are needed to provide accurate noise and jitter measurements without having to download data to a host computer. And mask-testing capabilities should be included to allow users to perform pass/fail and tolerance tests at the touch of a button.

The "communications focused" CSA 803 Communications Signal Analyzer

The new Tektronix CSA 803 Communications Signal Analyzer is tailor-made for test and measurement of communications components, modules, and links (fiber optic cables with repeaters, etc.) operating at high data rates. By combining high-performance signal acquisition capabilities, tailored test and measurement functions, plus an innovative use of color, the CSA 803 bundles new and much-needed analysis functions directly focused on the specialized needs of the high-speed digital communications industry.

The CSA 803 builds upon and extends the functionality of the 11800 Series Digital Sampling Oscilloscopes. Signals up to 40 GHz (depending upon sampling head selected) can be displayed. Trigger bandwidth has been improved to achieve 2.5 GHz full-function, variable threshold pulse triggering with

an on-board 10 GHz prescaler.

A color display allows viewing of up to eight waveforms in different colors. A new "display modes" function displays waveforms in one of four persistence modes: Normal, variable, infinite, and color-graded.

An extensive on-board measurement system provides 20 continuously updated measurements. Also included is a continuously updated on-board statistical database with the capability of displaying both time and voltage histograms.

Mask testing capability has been added to accommodate manufacturing pass/fail and tolerance testing on all waveforms including eye and constellation diagrams. Template/mask testing capabilities are provided for the emerging SONET, FDDI, and B-IDSN communications standards.

Like other members of the Tektronix 11000-Series family, the CSA 803 incorporates the modular design concept — it operates with a combination of four SD-Series sampling, TDR, or optical-to-electrical converter heads. This flexibility allows you to adapt your measurement capability to both today's and tomorrow's needs without the threat of technical obsolescence.

The two plug-in slots on the right are "acquisition-capable" and can acquire

and display up to four channels of information (with dual-channel sampling heads). The two slots on the left are "power only", accommodating plug-ins such as the SD-42 and SD-46 Optical-to-Electrical Converter Heads for optical signal acquisition or the SD-51 Trigger Countdown Head to extend trigger bandwidths to 20 GHz.

Benefits of a communications focus

The designed-in communications focus of the CSA 803 brings many benefits to communications measurements. We've chosen only a few for elaboration here; many more are available.

On-board statistics. If one feature truly sets the CSA 803 apart from all other instruments, it's the continuously updated, on-board statistical database. This database allows the user to accumulate data and perform sophisticated analyses — such as jitter, noise, etc. — on the data without reacquisition.

The CSA 803 accumulates its database by counting the number of times each pixel is turned on in a three-dimensional display array ($x = 512$ bits, $y = 256$ bits, $z = 16$ bits). It acquires up to 16 bits (65,535 samples) of data for each pixel. This information is then displayed in a color-graded format (see Figure 1). The color-graded display gives

Meeting your telecommunications test needs

Tektronix offers a full line of test instruments to help with your telecommunication tests and measurements — in design, manufacturing, or in the field. Here's a summary of these products. Contact your local Tektronix Field Office or sales representative for further information.

The 2410 Digital Interface Test System tests "telecom" signals at the digital signal cross-connect to ANSI and CCITT standards. The 2410 performs pulse shape, pulse symmetry, and pulse spectral power tests. The system also allows multi-test looping, user-defined template generation, and can operate at the monitor jack on live traffic. For more information on the 2410, see **Automating digital interface testing for telecommunications** in the Spring 1989 **HANDSHAKE**.


The TC 1000 Single-Function and TC 2000 Multi-Function Test Sets are designed specifically for high-performance testing of analog and digital communications networks. Both instruments are based upon IBM PC architecture to provide a versatile and easy-to-use test instrument which can easily be adapted to your specific test needs.

To help find and solve problems with communications protocols and interfaces, Tektronix offers the 830 Series Programmable Communications Analyzers. These lightweight, rugged, portable diagnostic tools plug into serial data communication ports or cables to monitor data. In addition, they can produce simulated data to test performance of the network or other network devices.

The 1502C and 1503C Metallic TDR Cable Testers are portable, rugged main-

tenance tools to test and troubleshoot metallic cable installations. These units are ideal for detecting a wide range of faults including opens, shorts, crimps, taps, water, and more.

For testing optical cable installations, Tektronix offers the OF150 and OF235 Optical TDR Testers. With these OTDRs, you can easily check for splice loss, breaks, and end-to-end loss. The OF192 Bandwidth Test Set measures bandwidth and loss of optical systems.

The TFS2020 FiberScout™ provides the ultimate in optical cable testing. This handheld optical fault finder is designed to locate faults or catastrophic events in optical cable systems. Its small size and light weight make the FiberScout an ideal addition to your cable restoration toolbox. 

the user a third dimension — an overall qualitative view of the acquired waveform. Data distribution in eye or constellation diagrams can be seen at a glance.

Horizontal or vertical histograms, as well as key measurements from those histograms, can be generated from the database for any portion of the acquired waveform; the display is periodically updated along with the database. Horizontal histograms can be used to make accurate jitter measurements. Vertical histograms give the user precise noise measurements. Key measurements — such as mean, standard deviation, peak-to-peak, and the number of samples within the user-defined area of the histogram — are displayed at the bottom of the screen.

Of major importance is the fact that the database, and all measurements derived from it, are periodically updated. There's no need to stop the acquisition and reacquire the data in order to make a new measurement. Several measurements can be made consecutively from the same database.

Mask testing. Mask generation and testing abilities assist the manufacturer in pass/fail and tolerance testing, and correlations with bit error rates. The CSA 803 lets the user define up to 10 on-screen polygons, with up to 50 ver-

tices each, that constitute the masks or "areas of unacceptability" (see Figure 2). Masks, including industry-standard masks, are easily defined through the instrument's touch-screen interface, or via the GPIB or RS-232C interface.

The CSA 803 provides a dynamic readout of the number of acquisitions that fall within a mask. These masks can be calibrated, giving the user a qualitative correlation with the bit error rate. When performing mask testing, signal acquisition can be stopped after acquiring "n" waveforms which is useful in ATE applications where each part must be tested for compliance against a specified number of acquisitions.

With the Store/Recall function, up to 10 different mask sets and/or screen setups can be stored. The CSA can then be programmed to sequence through the masks. This feature can greatly improve productivity in ATE applications where multiple tests must be performed on each component.

The CSA 803's mask testing capabilities have other applications beyond the telecommunications. Some examples include metastability testing and TDR testing using impedance masks.

Constellation diagrams. The constellation diagram display feature of the CSA 803 is designed for RF and micro-

wave communications applications. The X-Y display provides information about phase relationships for QAM (quadrature amplitude modulation) signals and signal quality. Histograms and mask testing can be performed on the constellation diagram to quantify measurements.

Automatic measurements. A total of 20 on-board, continuously updated measurements are provided, including four "communications focused" measurements — duty cycle, phase, undershoot, and overshoot. The results of up to six measurements can be selected for display on-screen through the touch-screen measurement menu. All measurement results are accessible via the GPIB or RS-232C interfaces.

Only a piece of the picture ...

In the limited space available here, we could only give you a small piece of the total performance picture for the CSA 803. If you would like to know more about Tek's new communication signal analyzer or for a hands-on demonstration on your signals, call your local Tektronix Field Office or sales representative. For immediate information or prices, U.S. customers can call the Tektronix National Marketing Center toll free — (800) 426-2200. And tell them you read about the CSA 803 in **HANDSHAKE!**

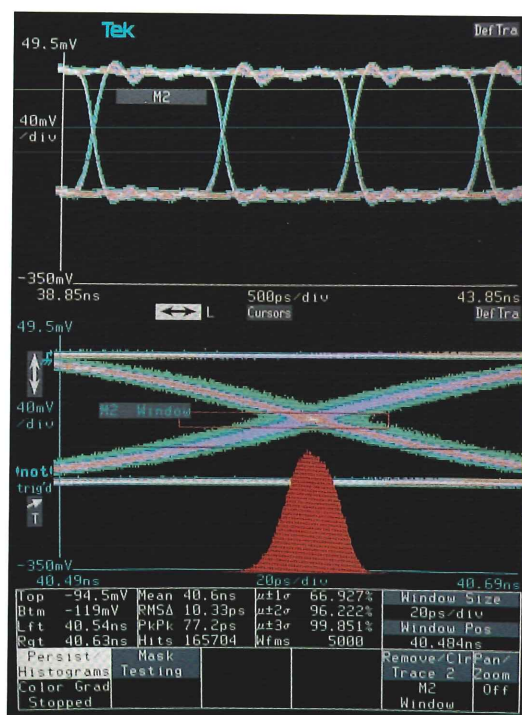
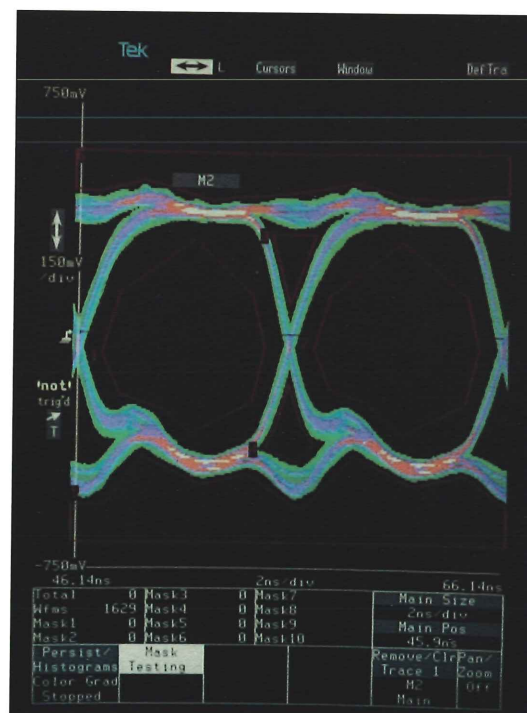


Figure 1. Color-graded display adds a third dimension — sample density — to the displayed waveform. This display shows jitter measurements made on a high-resolution eye crossing displayed as a full eye diagram (upper window) with a close-up view in the bottom window. Note the histogram at the base of the display.

Figure 2. The user can define up to 10 polygons for mask testing. Masks can be stored in non-volatile memory for later recall.





Add the 1230DSM or 30DSM module to your Tektronix logic analyzer to make high-quality scope measurements from a single setup. Waveforms are captured with high-speed sampling and 8-bit digitizing for precision viewing and measurement.

Putting a digitizing scope in your logic analyzer

When you're characterizing logic waveforms, you no longer have to hook up a separate scope in order to get the complete story. Now you can see and measure the analog aspects of logic pulses right from your logic analyzer. Not only does this provide a higher level of convenience in logic system design and debug, but it also provides a quicker, more powerful means of tracing logic faults related to waveform integrity.

Such scope-in-a-logic-analyzer capability is not entirely new. However, it has never before been accomplished with the degree and level of capability provided by the new 1230DSM and 30DSM Digitizing Scope Modules (DSMs) from Tektronix. Both DSMs provide dual-channel waveform capture with the benefits of 8-bit digitizing, cross triggering with the logic analyzer functions, combined logic analyzer and scope displays, and a wide range of waveform analysis capabilities.

Essentially, each DSM module is a complete digitizing scope compressed onto a card that can be installed in a matter of minutes. The 1230DSM card can be installed in any Tektronix 1230 Series logic analyzer. This integrates general-purpose 100 megasamples/second digitizing scope capabilities into a portable logic analyzer that can be battery powered (1230B). The 30DSM card can be installed in any of the Prism 3002 logic

analysis platforms and integrates high-performance, 400 megasamples/second waveform capture with any of the Prism 3000 Series application modules. (For further information on the Prism 3000 Series, see **Breaking logic analysis barriers** in the Fall 1989 **HANDSHAKE**.)

The power of combined displays

With a 1230DSM or 30DSM card installed, your logic analyzer is transformed into an advanced, more powerful logic analysis and debug tool. You can trigger the DSM on any state or timing condition detected by the logic analyzer and see a mixed scope/logic analyzer display such as shown in Figure 1. This allows you to quickly check logic waveforms for noise, jitter, or other aberrations that might be causing logic timing problems. With the built-in processing features, you can also quickly measure waveform parameters and check margins.

With the 1230DSM, up to two waveforms can be viewed at once. Or the logic analyzer screen can be split to display a DSM waveform in one half and a timing diagram in the other half.

Even more display flexibility and power are available from the 30DSM. Up to four waveforms can be displayed on the Prism 3002 screen. Or the screen can be split to show four waveforms in one half and either a timing diagram or state diagram in the other half.

Additionally, the 30DSM and Prism 3002 provide automatic time stamping and correlation of all acquired logic and waveform data. This automatic time correlation allows the measurement cursors to be linked across logic and waveform displays, allowing simultaneous and correlated display scrolling through the entire acquisition memory.

High-resolution digitizing

The resolution provided by 8-bit digitizing is vital for precise, accurate timing measurements. For example, a waveform's 10-90% amplitude points must be precisely established before rise time can be accurately measured; the same is true for pulse width and delay measurements. The 8-bit digitizers in both DSMs provide a 400% improvement in digitizing resolution over 6-bit digitizers.

At the same time, it's important that the samples are closely spaced for adequate timing resolution. This is determined by the sampling rate, which is the number of samples taken per second on the waveform.

High effective sampling rates can be achieved by equivalent-time methods, where closely spaced samples are built up over several triggered acquisitions of a repetitive waveform. However, the true test of state-of-the-art waveform digitizing is the real-time sampling rate. This real-time rate is the fastest sam-

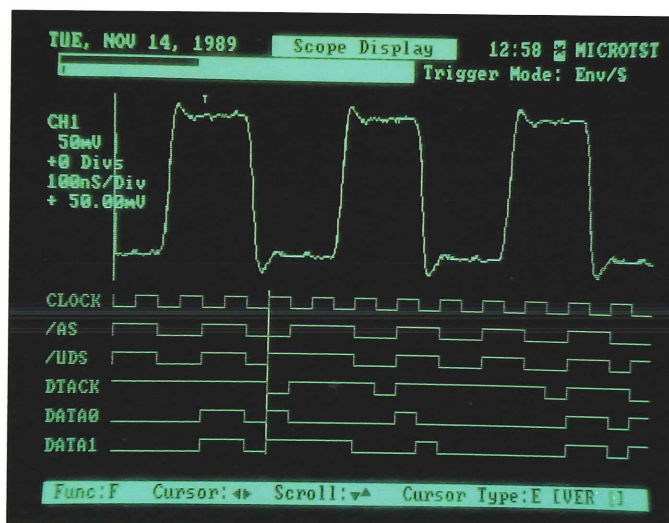


Figure 1. *The 1230DSM/30DSM Digitizing Scope Modules provide Your Visible Edge in logic analysis—the ability to view timing diagrams and associated waveforms simultaneously.*


oping. Signal averaging provides noise reduction on repetitive waveforms and allows greater accuracy in critical amplitude and timing measurements.

The enveloping mode allows repetitive waveforms to be examined over time for abnormal excursions. This is particularly useful for checking noise and timing margins. The 1230DSM can also be left unattended in continuous enveloping, essentially a “babysitting” mode, to capture unexpected or infrequent events such as noise spikes, drop outs, or timing slips. If a fleeting spike or aberration occurs, enveloping catches it and holds it for later analysis.

Fully integrated waveform and logic analysis

With the 1230DSM card installed, the 1230/1230B Logic Analyzer takes on a whole new range of capabilities. The logic analyzer functions remain completely intact and can be used in the same manner as before. At the same time, there's a complete digitizing scope available for independent use in dual-channel waveform observation and analysis.

In the same manner, the 30DSM can be quickly installed in a Prism 3002 platform and can be operated as an independent digitizing scope or in conjunction with any of the Prism 3002 triggering and analysis features. This includes operation and cross triggering with state and timing analysis, high-speed timing analysis to 2 GHz, and prototype debug tools that include microprocessor control and real-time performance analysis. Additionally, because of the Prism 3002 Series time stamping, waveform displays are automatically time correlated with logic analysis displays.

This ability for high-resolution capture, viewing, and analysis of logic waveforms in conjunction with other logic analyzer functions gives today's digital designers and system integrators a clear visible edge in digital design, debug, and verification. To learn more about how this can be your visible edge too, contact your local Tektronix Field Office or sales representative. And tell them **HANDSHAKE** sent you. 

pling available for single-shot waveform capture. It determines the single-shot bandwidth of the digitizer and the resolution available for capturing non-repetitive logic signals such as keyboard interrupts and transient events such as noise glitches.

For high-performance needs, the 30DSM provides an exceptional 400 megasamples/second real-time sampling rate in single channel operation (200 megasamples/second dual channel). This provides resolution to 2.5 nanoseconds for non-repetitive waveform capture. Additionally, high resolution can be maintained for long durations of capture due to the 32K record length of the 30DSM (16K dual channel). Analog bandwidth for the 30DSM is 300 MHz.

For less-demanding, general-purpose applications, the 1230DSM turns in a still admirable performance with its 100 megasamples/second real-time sample rate for both single- and dual-channel operation. An equivalent-time sampling mode is also provided for repetitive waveform capture up to 100 MHz bandwidths with time resolutions to 100 picoseconds.

Flexible cross-triggering

Both the 1230DSM and 30DSM offer a full range of independently selectable digitizing scope triggering features. But their most important feature is the ability to operate in conjunction with the logic analyzer triggering functions. This is implemented with logic analyzer/DSM cross triggering.

Cross triggering allows the DSM to take advantage of the full and complete set of logic analyzer trigger functions. Any suspect condition seen on the logic analyzer can immediately be captured with the DSM for waveform observation and analysis. There's no need to set up separate word recognizer probes as with standalone scopes. This, alone, offers tremendous convenience and time savings.

As an example of cross-triggering power, data bus errors from waveform reflections or improperly slewed signals can be easily viewed by triggering the DSM from the logic analyzer. Such errors would be extremely difficult to capture with a standalone scope, because standalone scopes typically don't have the capacity to trigger on a complex event or a series of logic events. But since complex triggering requirements are common fare for logic analyzers, they also become common fare for a DSM that's tightly integrated with logic analyzer triggering and display capabilities.

Built-in waveform analysis

With the desired waveforms captured and displayed on the logic analyzer, it's quite likely that some waveform parameters will need to be checked. Both the 1230DSM and 30DSM have measurement cursors that can be used to determine amplitude and time differences anywhere on any waveform.

The 1230DSM also provides built-in signal averaging and waveform envel-

TEK NEW PRODUCT UPDATE

TEST AND MEASUREMENT PRODUCTS FROM TEKTRONIX

SCD1000/SCD5000 Transient Digitizer



Price — SCD1000 \$29,900 (U.S.)
SCD5000 \$46,900 (U.S.)

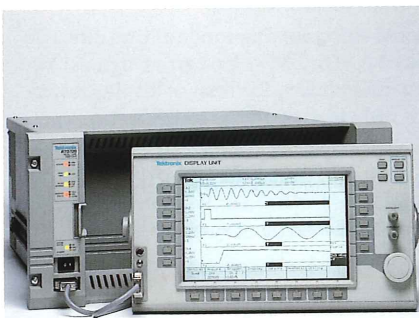
- 200 Gigasamples/second maximum sample rate
- Up to 5 picosecond time resolution
- High analog bandwidth
 - 4.5 GHz with SCD5000
 - 1 GHz with SCD1000
- High vertical resolution
 - 11 bits with SCD1000
 - 9 bits with SCD5000
- 256, 512, or 1024 point record lengths
- Internal calibration for high accuracy
- Detachable touch-screen with cursor measurements
- Fully programmable via GPIB

The Tektronix SCD1000/SCD5000 Transient Digitizers are fast sample rate, high-bandwidth digitizers, ideally suited for capturing very fast single-shot events. Whether its EMP simulation, laser research, telecommunications, electrostatic discharge (ESD) and electromagnetic compatibility (EMC), or other high-speed transient applications, the SCD Series has the performance to accurately capture the signal of interest.

These digitizers share a common architecture and are similar in all aspects except bandwidth, vertical resolution, and input sensitivity. The SCD1000 has two 1 GHz amplifiers with invert and add, 11-bit vertical resolution, and an input sensitivity of 100 millivolts to 10 volts full scale. The SCD5000 has 4.5 GHz bandwidth with 9-bits vertical resolution and direct-access input at ± 2.5 volts.

The SCD1000 and SCD5000 come standard with a detachable display unit, Type N connectors, and rack slides. The detachable display unit allows direct operator control, waveform display with cursor measurements, and instrument status.

RTD 720 Real Time Digitizer



Price — Starting at \$23,200 (U.S.)

- 2 Gigasamples/second single channel mode
- 1 Gigasample/second simultaneous dual channel operation
- 500 Megasamples/second simultaneous four channel operation
- 500 Megahertz analog bandwidth
- 8 bit vertical resolution
- Acquisition record length to over 1,000,000 waveform points
- Auto-advance operation with up to 1024 records per channel
- Fast rearm time of less than 5 microseconds between events
- Time stamping of each record
- Fully programmable over GPIB — data out via GPIB or parallel port

The Tektronix RTD 720 Real Time Digitizer is a high bandwidth, high sample rate, long record length digitizer designed to accurately capture fast transient events.

The RTD 720 provides the basic acquisition performance needed to assure the capture of fast transient events over long time windows. Special attention has been given to the analog signal path in order to maintain high signal fidelity to the analog-to-digital converters over a wide signal range. The high-performance analog-to-digital converters have 8 bits of vertical resolution for 256 discrete levels (vs only 64 levels with 6 bit resolution).

The RTD 720 has memory capabilities to over 1,000,000 waveform data points which can be assigned to a single channel or shared equally among the active channels. Optional battery back-up is available.

The RTD 720 is designed with system use in mind — from the high data throughput and auto-advance capability for rapid data capture to the relatively small rack height of only 8.75 inches.

For additional information on products and services listed in this edition of the New Product Update, call your local Tektronix field office or sales representative. Tektronix has field offices or sales representatives located in major cities around the world. For the location of the nearest Tektronix sales office, check your local phone book or call (503) 627-7111.

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Tektronix
COMMITTED TO EXCELLENCE

2467BHD HDTV Scope



Price — \$14,950 (U.S.)

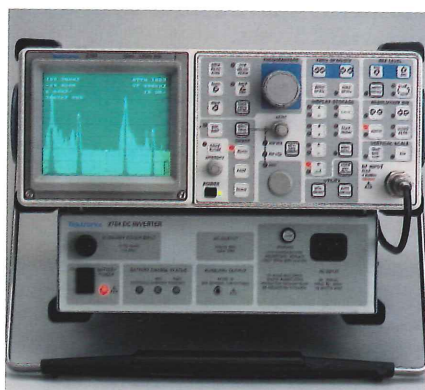
To order, or for information, call 1-800-426-2200

- Bright display of intermittent events using micro-channel plate technology
- 4 centimeters/nanosecond visible writing speed
- 400 MHz bandwidth
- Selectable 50 MHz bandwidth limit
- $\pm 1\%$ frequency response flatness to 30 MHz
- Triggering on 1050/60, 1125/60, and 1250/50 line/field rates
- Automatic sensing of HDTV standard
- Recognizes and separates trilevel synchronizing pulses without external triggers
- Line counts up to 1280 lines/frame
- Automatic push-button setup and measurement

The Tektronix 2467BHD Scope combines the ability to trigger on any of the three proposed HDTV standards (1050/60, 1125/60, and 1250/60) with the proven advantages of Tektronix micro-channel plate (MCP) display technology. The trigger circuits can recognize and separate trilevel synchronizing pulses on any of the standards with line counts up to 1280 lines/frame.

The MCP display allows viewing of intermittent or frame-rate events under normal lighting conditions — even at the very high sweep speeds required to evaluate single-pixel signal details. The MCP display and the 400 MHz bandwidth make the 2467BHD ideal both for viewing the video signal and analyzing the high-speed digital circuitry commonly used in HDTV systems. For example, the 2467BHD can easily locate a fault that causes an individual pixel in a frame of about two million pixels to intermittently twinkle — equivalent to locating a 14-nanosecond pulse that occurs 50 or 60 times/second.

2710 Spectrum Analyzer



(shown with optional 2704 Inverter)

Price — \$8,250 (U.S.)

To order, or for information, call 1-800-426-2200

- 10 KHz to 1800 MHz frequency range
- $1 \times 10^{-5} \pm 5$ KHz frequency accuracy ($5 \times 10^{-7} \pm 700$ Hz with Option 01)
- 1 Hz frequency counter readout resolution (with Option 02)
- -117 dBm (-70 dBmV) resolution bandwidth at 3 KHz
- Built-in signal counter (with Option 02)
- Built-in tracking generator (with Option 04)
- Video monitor mode (with Option 10)
- Non-volatile storage for up to 18 displays and 9 front-panel setups
- Full programmability via GPIB (with Option 03)
- 21 pound (9.5 kg) portable package

The 2710 Spectrum Analyzer provides a low-cost alternative for spectrum analysis. The basic 2710 configuration is ideal for checking broadcast transmitter performance, CATV headend operation, looking for unwanted RF emissions, and more. If your measurement demands more performance, the 2710 has a full range of options available to add performance only where you need it.

The optional signal counter allows accurate frequency identification to within 0.5 PPM with readout resolution to the nearest Hertz. The optional tracking generator provides a compact, integrated package for swept frequency measurements.

The optional video monitor mode allows direct demodulation of AM or FM video carrier signals. You can analyze individual video lines or display rasterized AM or FM video on the 2710 CRT.

With the optional GPIB interface, the 2710 can be used along with available software and an IBM PC™ (or compatible) controller to provide a complete, low-cost, automatic measurement system.

2721/2722 CATV Non-Interfering System Sweep



Price — 2721 \$6,900 (U.S.)
2722 \$7,900 (U.S.)

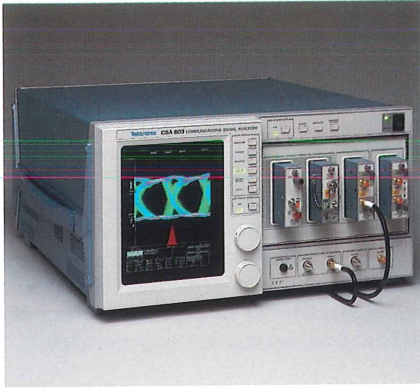
- Completely non-interfering system sweep
- Fully frequency-agile telemetry carrier
- True portability
- On-board digital storage of up to 50 waveforms
- On-board storage of up to 8 normalization references
- Optional on-board hardcopy capability
- Download waveforms to external RS-232C printer

The Tektronix 2721/2722 Non-Interfering System Sweep allows an operating CATV or LAN system to be sweep tested (frequency vs amplitude) during normal operation, without interfering with the normal program material.

The 2721 Sweep Transmitter is normally rack-mounted at the system headend or antenna site. It is programmed to inject sweep pulses across any selected portion of the 5 to 600 MHz range of the system. By sampling the timing of each video channel at the headend, the actual injected sweep pulses are carefully timed to be injected only during the vertical blanking period, completely eliminating sweep interference to the picture content.

The 2722 Receiver is a 17 pound, fully portable unit, with built-in battery power, LCD screen, and full alphanumeric keypad for data entry and storage. The optional YT-1 Chart Recorder can provide hardcopy printouts at any field location. The 2722 also allows the monitoring of carrier levels with the use of a "Signal Level Meter" mode for accurate display of carrier spectrum.

CSA 803 Communications Signal Analyzer



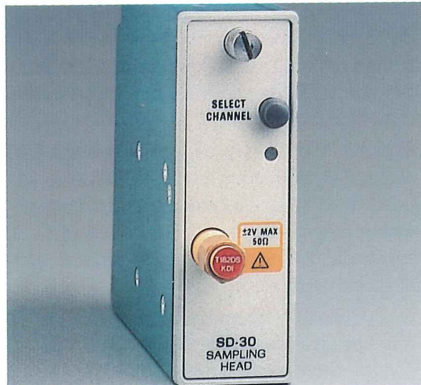
Price — \$23,950 (U.S.)

- Up to 40 GHz bandwidth (sampling head dependent)
- Up to 10 GHz trigger bandwidth
- On-board statistical database
- Built-in mask testing
- Automated measurement capability with 20 built-in measurements
- Optical-to-electrical capability (with SD-42 or SD-46 O-E head)
- 200 KHz sample rate
- On-board waveform processing
- Constellation diagram capability
- Color display
- Touch-screen human interface
- Hardcopy capability
- Fully programmable via GPIB and RS-232-C

The Tektronix CSA 803 Communications Signal Analyzer is tailor-made for the high-speed digital communications industry. The CSA 803 features bandwidths up to 40 GHz (depending upon sampling head), a continuously updated on-board statistical database, up to 10 GHz trigger bandwidth, eye-diagram and histogram analysis capabilities, template/mask testing capabilities, and 20 on-board measurements.

Either optical or electrical tests can be made with the selection of the appropriate sampling head. Template/mask tests can be made using a built-in template/mask generator to emerging communications standards such as SONET, FDDI, and B-ISDN. TDR measurements can be easily made, and the CSA 803 offers the unique measurement capability of differential TDR. The on-board statistical database records statistical information about waveform behavior over time in a 3-dimensional array which is continuously updated. A color-graded display gives the user an overall qualitative view of the waveform.

SD-30 High-Bandwidth Sampling Head



Price — \$9,000 (U.S.)

- 40 GHz bandwidth
- Calculated risetime of less than 8.8 picoseconds
- Typical noise floor of 2 millivolts RMS (700 microvolts with smoothing)
- 50-ohm input impedance
- One volt peak-to-peak dynamic range
- Compatible with CSA 800 and 11800 Series

The Tektronix SD-30 High Bandwidth Sampling Head is the ideal tool for very high-speed telecommunications R&D as well as RF applications. The SD-30 is compatible with the Tektronix CSA 803 Communications Signal Analyzer and 11800-Series Digital Sampling Oscilloscopes.

The SD-30 provides the bandwidth needed for applications such as characterizing high-speed digital data, measurements in RF and microwave circuits, measuring distortion in high-frequency amplifiers, performing broadband phase analysis, and sampling the output from high-speed optical-to-electrical converter circuits. It will find ready application in the development of high-speed technologies such as fiber optics, VLSI, GaAs, RF and microwave components, as well as in their subsequent implementation in digital communication networks.

SD-46 Optical to Electrical Converter



Price — \$8,500 (U.S.)

- DC to 20 GHz bandwidth (~3 dB optical)
- 35 microwatts/millivolt conversion gain
- 18 picoseconds optical pulse response (FWHM)
- Up to 25 milliwatt peak or 5 milliwatt average optical power input
- 1200 to 1650 nanometers spectral response
- Calibrated at 1300 nanometers
- Optical power meter for average power monitoring
- Compatible with Tektronix CSA 800 and 11800 Series

The Tektronix SD-46 Optical to Electrical Converter is designed for use with the Tektronix CSA 800 Communications Signal Analyzer and 11800-Series Digital Sampling Oscilloscopes. It enables timing analysis and characterization of lightwave modulation in optical fiber-based equipment and communications systems. Easy and accurate broad-bandwidth measurements can be made of risetimes, aberrations, optical power vs drive current and voltage, modulation bandwidth, and sensitivity.

The SD-46 can also be used in the manufacturing environment for process control, quality control, calibration, and troubleshooting of electro-optic components and systems.

The SD-46 is equipped with an optical power meter for average power monitoring via front-panel voltage outputs. A selector button switches the sensitivity to one of two ranges at microwatt or milliwatt levels, allowing measurements of power from 5 microwatts to 5 milliwatts. Overload warning lights prevent signal degradation due to unintentional overloading.

1230DSM/30DSM Digitizing Scope Module



Price — 1230DSM \$2,995 (U.S.)
30DSM \$6,000 (U.S.)

- 8-bit digitizing
- Real-time sample rates to 400 megasamples/second (30DSM) or 100 megasamples/second (1230DSM)
- Single-shot bandwidth to 100 MHz (30DSM) and 10 MHz (1230DSM)
- Record length of 32K samples (30DSM) or 2048 samples (1230DSM)
- Signal averaging
- Dual-channel mode (at reduced performance)
- Cross triggering with associated logic analyzer functions for time-correlated displays

To order, or for information, call 1-800-426-2200

The Tektronix 1230DSM and 30DSM Digitizing Scope Modules integrate high-performance scope measurements with the superior logic analysis capabilities of the Tektronix 1230 or Prism 3002 Series Logic Analyzers.

Combining the functions of a logic analyzer and a digitizing oscilloscope in a single instrument provides many unique advantages. The digitizing scope function can be used to examine any suspect state or timing condition without the need of additional equipment. The full and complete set of logic analyzer trigger functions can be used to develop a trigger for the digitizing scope without need for additional external logic probes. And there's also the convenience of having both functions together in a single, compact instrument.

The 30DSM can be installed in any of the Prism 3002 Series platforms for a total of up to 10 DSM or other card modules to create a flexible system. The 1230DSM can be installed in any 1230 or 1230B Logic Analyzer to form a general-purpose, portable system.

CG 5010/CG 5011 Programmable Calibration Generator



Price — CG 5010 \$14,495 (U.S.)
CG 5011 \$15,995 (U.S.)

- Timebase waveform calibration from 5 seconds to 0.5 nanoseconds
- Pulse risetime up to 200 picoseconds
- Positive and negative DC capability
- 0.5% long-term flatness accuracy
- 0.25% standard amplitude accuracy
- Slewed-edge waveforms (CG 5010) or extended time marks (CG 5011)
- Next-cal-date feature
- Learn mode feature
- Fully programmable from front-panel and GPIB
- Supported by TekTMS and TEK EZ Test program generators
- Follows Tek Standard Codes and Formats

The Tektronix CG 5010 and CG 5011 Programmable Calibration Generators can be used for calibration and verification of all major oscilloscope parameters. A "learn" mode allows any manually set function or range to be acquired by a controller. Subsequent use of the resulting program requires a minimum of operator skill or interaction.

The CG 5010 and CG 5011 are identical except for the timing method employed. The CG 5010 uses Tek-patented slewed-edge waveforms for calibrating the fastest analog scope time bases. The CG 5011 uses extended time marks which are suitable for either analog or digital scope calibration.

The CG 5010/CG 5011 are compatible with Tektronix TM 5000 programmable modular test instruments and occupy three slots in any TM 5000 Mainframe. They can be combined with over 50 TM 5000/TM 5000 modular test instruments to form a complete stimulus and measurement system.

To order, or for information, call 1-800-426-2200

3001HSM/30HSM Hardware Analysis Logic Analyzer



Price — 3001HSM \$11,000 (U.S.)
30HSM \$6,500 (U.S.)

- 400 MHz, 20 channels
- 2 GHz, 4 channels
- Dual threshold at 200 MHz, 20 channels
- 300 MHz synchronous, 18 channels
- 12K deep memory
- Transitionally stored data
- Direct fault triggering with configurable limits or 15 preconfigured measurement tests
- Easily reconfigurable by changing software, probes, and/or lead sets
- Standalone (3001HSM) or system (30HSM) configuration
- Compatible with Prism 3000 Series via TekLink bus

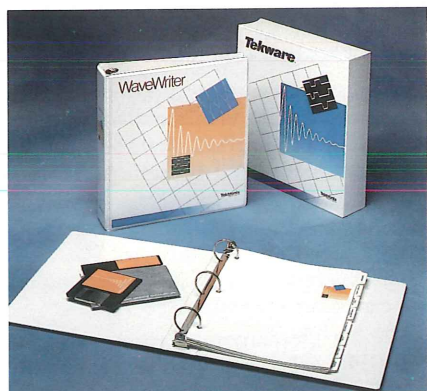
The Tektronix 3001HSM Hardware Analysis Logic Analyzer and the 30HSM Hardware Analysis Module provide a complete tool for digital hardware analysis. The 3001HSM and 30HSM are powerful, flexible tools that can identify and debug state, timing, and analog problems. Software and leadset changes provide a total of five acquisition modes for troubleshooting digital hardware problems.

Fifteen preset trigger measurements allow the designer to test directly for timing faults. The tests directly measure setup times, hold times, pulse durations, period durations, delay between pulses or words, accumulate the time a word is present, count the occurrences of a word, test for the occurrence of a word, and more. Each test can trigger greater than, equal to, or less than a specified time using the integrated 2.5 nanosecond resolution counters and timers.

The 12K of transitionally stored data offers the most efficient storage method, especially when the data consists of high-speed bursts separated by long durations of no activity.

To order, or for information, call 1-800-426-2200

WaveWriter™ Waveform Creation and Editing Software



Price — \$1,695 (U.S.)

To order, or for information, call 1-800-426-2200

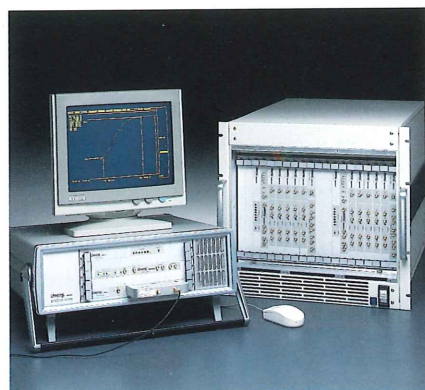
- Create and modify waveforms for arbitrary waveform generators and digital oscilloscopes
- Waveform entry via:
 - Equations (polynomial equation entry)
 - Freehand drawing (with mouse)
 - Point-to-point drawing
- Edit waveforms by cut and paste
- Invert, flip, add, subtract, multiply, or divide whole or partial waveforms
- Standard functions available — sine, square, pulse, triangle
- Use stand-alone or with TekTMS software
- Conforms to ADIF file format
- Microsoft™ Windows-based user interface

The Tektronix WaveWriter™ software simplifies the creation and editing of waveforms for arbitrary waveform generators and templates for digital oscilloscopes. WaveWriter represents a major step forward in allowing easy creation of the real-world signals which are increasingly being used to test circuit tolerances, drive vibration/shake tables, and simulate non-ideal or corrupted signals. It offers an easy-to-use alternative to general-purpose programming languages or tedious instrument front-panel entry for waveform definitions.

User interface is based upon Microsoft™ Windows with pull-down menus and mouse-selected icons. A command-driven interface is also provided. WaveWriter automatically configures the generated waveform to the target test instrument based on the instrument's vertical and horizontal resolution, etc.

WaveWriter can be used on its own, or it can be used as an integral part of Tektronix Test Management System (TekTMS) software. WaveWriter is compatible with any 80286- or 80386-based computer which can run Microsoft Windows.

Analytek Series 2000 Waveform Capture System



Price — 2000PR1 \$22,500 (U.S.)
(4 channels at 500 megasamples/second)

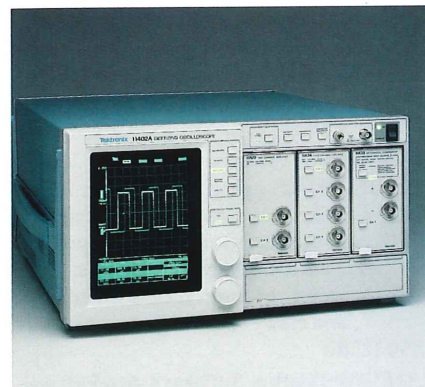
To order, or for information, call 1-800-366-5060

- Sampling speed up to 2 gigasamples/second
- 12-bit resolution
- High-density packaging
 - 12 (96) channels at 2 (0.250) gigasamples/second
- 300 MHz analog bandwidth
- Modular VME-based design
- Low per channel cost
- Menu-driven operator interface
- Low power consumption
- Fast throughput — greater than 1000 waveforms/second
- Fast signal averaging — greater than 1000 waveforms/second
- PC-based data acquisition software over GPIB

The Analytek Series 2000 System acquires multi-channel waveforms at rates up to 2 gigasamples/second. Offered in VME modular benchtop or rack-mount configurations, the Series 2000 subsystem consists of a 2000P processing board, a 2000T timing module, and up to six 2004S, 2008S, or four 2004HS sampling modules. The advanced design of the Series 2000 System is based upon patented VLSI circuitry.

The 2004S Sampling Module provides four channels which can capture high-speed events up to 500 megasamples/second with a total record length of 8K words/board. External signal adapters allow the user to operate the system in two-channel mode at 1 gigasample/second, or one-channel mode at 2 gigasamples/second. The 2008S provides eight channels at 250 megasamples/second. The 2004HS provides high throughput for high rep rate acquisition. The 2000T Timing Module generates the clock signals which synchronize the sampling modules. The 2000P Processor module handles user interface via menu-driven displays. A GPIB port allows remote system operation.

11201A and 11402A Digitizing Oscilloscopes



Price — 11201A, \$11,900 (U.S.)
11402A, \$14,950 (U.S.)

- Extensive waveform measurement system
- Waveform measurement statistics
- Fully programmable over GPIB and RS-232C
- Full hardcopy support
- 11402A features:
 - 1 GHz bandwidth
 - 10-bit vertical resolution
 - 1 GHz trigger bandwidth
 - 8 channels of acquisition and display
- 11201A features:
 - 400 MHz bandwidth
 - 9-bit vertical resolution
 - 4 channels of acquisition, up to 8 channels of display

The Tektronix 11201A and 11402A Digitizing Oscilloscopes add new capabilities to the 11000-series family. These instruments are based upon the previous 11201 and 11402 Digitizing Oscilloscopes.

Instrument operation is simple and easy using a touch-screen interface. This eliminates the confusing assortment of knobs and buttons found on many signal acquisition instruments and keeps the operator's attention focused on the screen where it belongs.

A comprehensive set of 24 continuously-updated measurements allows you to make "live" measurements from displayed signals. This includes standard pulse parameters plus gain, phase, undershoot, overshoot, skew, and duty cycle. In addition, waveform statistics (min, max, mean, and standard deviation) can be automatically calculated and displayed.

Both GPIB and RS-232C interfaces are provided for easy integration into measurement systems. Extensive software support is available from Tektronix to make system building easy.

New VXIbus Products



Price — VX1505 — \$6,800 (U.S.)
 VX4242 — \$4,300 (U.S.)
 VX4426 — \$4,200 (U.S.)
 VX4427 — \$1,200 (U.S.)
 VX4520 — \$3,250 (U.S.)
 Option 03 — \$1,200 (U.S.)
 Option 04 — \$1,400 (U.S.)

Seven new VXIbus products:

- VX1505 6-slot D-size mainframe
- VX4242 data acquisition system
- VX4426 16-channel multiplexer
- VX4427 32-channel multiplexer
- VX4520 slot 0/resource manager
- Ethernet™/DECnet® link (Option 03 for VX5530/VX5535 System Controllers)
- Token Ring link (Option 04 for VX5530/VX5535 System Controllers)

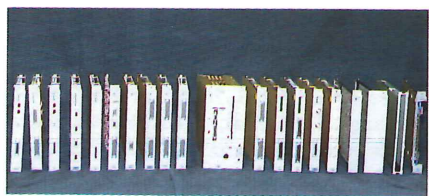
Tektronix now offers three VXI mainframes — 13-slot and 6-slot D-size and 5-slot C-size. The mainframes support VXIbus Rev 1.3 specifications and have a number of mounting options.

The VX4242 data acquisition system is a 200 kilosample/second, true 16-bit multichannel A/D converter on a single-slot C-size card. Eight shielded differential inputs are multiplexed through a programmable gain amplifier with four software-selectable gains, into a 200 kilosamples/second, high resolution, sampling analog-to-digital converter. The VX4426 16-channel and VX4427 32-channel multiplexer cards can be used to expand the VX4242.

The VX4520 slot 0/resource manager provides VXIbus 1.3, GPIB 488.2, and VXEbus support. It features word-serial communication and performs startup initialization and configuration functions and can configure non-VXI devices.

The Option 03 Ethernet™/DECnet® link and Option 04 Token Ring links provide links between the VXIbus and industry standard local area networks.

Colorado Data Systems VXIbus Products Available from Tektronix



- VXIbus Products
 - Mainframes
 - Controllers
 - Prototyping
 - Instrumentation
- CDSbus Card Modular Instrumentation
 - Switching and scanning
 - Digital stimulus and measurement
 - Analog stimulus and measurement
 - General testing
 - RF/Microwave instrumentation
 - Aerospace testing
 - Special instrumentation functions

Tektronix has acquired Colorado Data Systems (CDS) and is now offering the full line of CDS VXIbus and card modular products in addition to the existing Tektronix VXIbus products. Both Tektronix and Colorado Data Systems were founding members of the VXIbus Consortium which defined the original specifications for the VXIbus.

This greatly expands the VXIbus products available from Tektronix/CDS. The combined VXIbus offering comprises a complete instrumentation solution to meet your testing needs. All Tektronix/CDS VXIbus instruments fully implement the VXIbus standard and can be used with any compatible system. In addition, all instruments are compatible with TekTMS software.

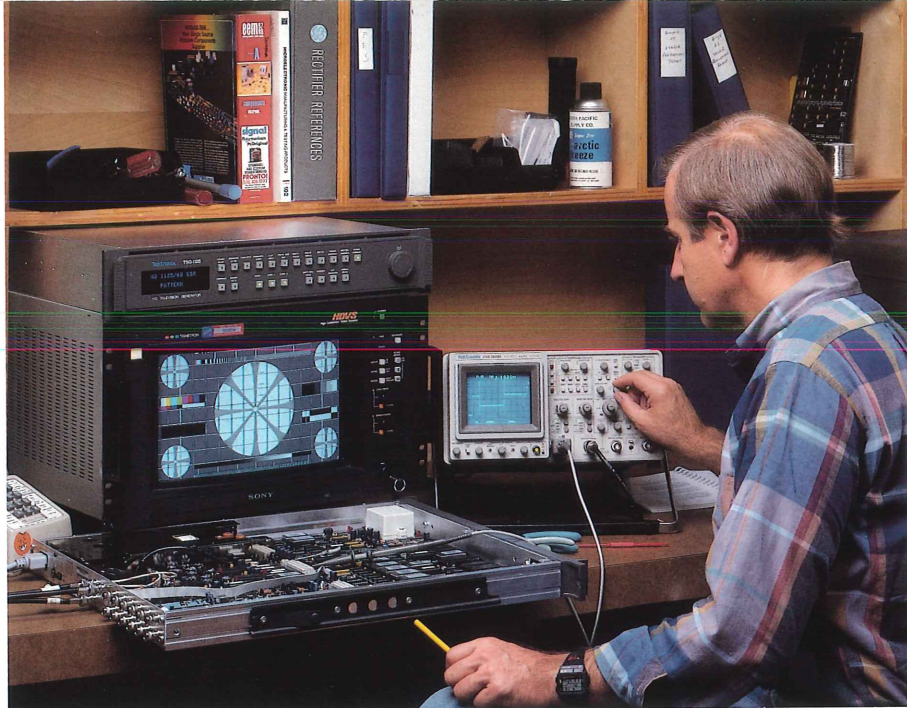
NEW ACCESSORIES

- The 2704 Inverter and 2705 Battery Pack can provide a minimum of 1 hour continuous operation for the 2710 Portable Spectrum Analyzer in locations where AC power is not available. Multiple 2705 Battery Packs can be used sequentially for uninterrupted operation or the 2704 Inverter can be operated from an external 12 volt DC source. Price — 2704 \$995 (U.S.), 2705 \$295 (U.S.)
- A6501 Buffer Amplifier is a high performance, 10X, DC-to-1 GHz FET input buffer amplifier designed for placement onto a circuit board or probe card test fixture. The A6501 is ideal for high-frequency probing in a fixtured environment (i.e., bed-of-nails, probe cards). Price — \$399 (U.S.)
- The K636 Rackmount Mobile Workstation provides an attractive, sturdy, and versatile platform for rackmount as well as desktop instrument mounting applications. Rackmount section is 26 3/8 inches high, 24 1/2 inches deep, and 17 3/4 inches wide. A 16 x 22 3/4 inch shelf on top of unit slides out for easy access to instruments. Price — \$975 (U.S.)
- The SA-42 Optical Converter is a battery-powered, stand-alone optical-to-electrical converter for general purpose, high frequency use with Tektronix spectrum analyzers and oscilloscopes. Spectral response is 1000 to 1700 nanometers with an optical pulse response equal to 50 picoseconds (Full Width Half Maximum). Electrical bandwidth is 7 GHz (−3 dB). The SA-42 can accept optical inputs

up to 25 milliwatts peak and 5 milliwatts average optical power. Price — \$3,250 (U.S.)

NEW SUPPORT SOFTWARE

- CAT200™ Software for the Tektronix 222 Digital Handheld Oscilloscope provides an easy-to-use interface for local measurements (via RS-232C) or remote measurements (via modem). The instrument is setup and controlled using a virtual front panel on the associated computer display. CAT200 can be used with IBM PC® or PS/2® (or compatible) controllers. Price — \$350 (U.S.)
- TekDB/Ada Source Level Debugger Software is a source level debugger developed specifically for debugging Ada software in embedded systems. TekDB/Ada supports Ada compilers available from Alslys, Telesoft, SD-SCICON, and others. It incorporates emulator features to provide extensive analysis and control of the target hardware environment and runs on a variety of host systems including VAX™/VMS™, VAX/Ultrix™, and Sun™ Series 3. Price — Starting at \$3,850 (U.S.)
- S43R101 1230/PC RS-232C Application Software provides routines to establish RS-232C communication between a personal computer and a Tektronix 1230/1230B Logic Analyzer equipped with an RS-232C interface. This software allows storage and retrieval of analyzer setups and data. It can also be used to create automated tests. Price — \$95 (U.S.)



The 2467BHD HDTV scope provides a broad range of measurements suitable for all aspects of research and development in high-definition TV as well as equipment and system testing.

A scope for HDTV applications

High-definition television (HDTV) is generating a lot of interest in the television industry. But making this promise of a new level of viewing excellence a reality requires more than just establishing a new standard and designing a new consumer TV product. It also requires revamping all the products essential to this industry. This includes not only the studio equipment such as cameras, switchers, character generators, special effects devices, etc., but the measurement equipment required for design, test, and service as well.

The Tektronix 2467BHD HDTV Scope is a unique product designed specifically for this emerging industry. It combines the ability to trigger on any of the three major proposed HDTV standards with the proven advantages of the Tektronix proprietary MCP (micro-channel plate) display technology.

A versatile trigger for HDTV

The three most popular HDTV systems that have been proposed double the number of scan lines used in present TV systems — for example, from 625 to 1250 lines/frame. This significantly increases the amount of information carried by the signal and creates tighter timing requirements that cannot be handled with conventional sync techniques. To meet these more stringent requirements, a "trilevel" sync has been developed (see Figure 1). Oscilloscopes with conventional TV triggering cannot es-

tablish a proper trigger on this new sync pulse without complex external triggering arrangements. The 2467BHD HDTV Scope can trigger on the trilevel sync used in any of the major proposed HDTV standards as well as the bilevel syncs used in current TV systems.

This trilevel sync trigger makes it possible to take full advantage of the 2467HB's autoset function on any HDTV signal. Just "auto set" the HDTV scope and you can automatically display an accurate, properly triggered signal from any of the HDTV standards as well as all current broadcast standards such as PAL, NTSC, and Secam.

Raising the bandwidth limit

In both HDTV and conventional TV, the trend is toward the use of component rather than composite signals in the studio and post-production environ-

ment. One component color set in HDTV [G-B-R] comprises three equal-bandwidth 30 MHz signals. The color difference set [VpBpR] comprises a 30 MHz luminance signal and color difference signals [EPB, EPR] with a bandwidth of 30 MHz for analog originating equipment and 15 MHz for digital. Composite signal bandwidth is only 5-6 MHz.

To make precise measurements on these higher frequency components, engineers need an oscilloscope with a selectable bandwidth limit above 30 MHz rather than the common 20 MHz limit. A 20 MHz bandwidth limit removes a significant percentage of the signal along with the unwanted noise. However, much of the unwanted noise on an HDTV signal comes from a 70-80 MHz clock. This means that an HDTV scope must have a selectable bandwidth limit

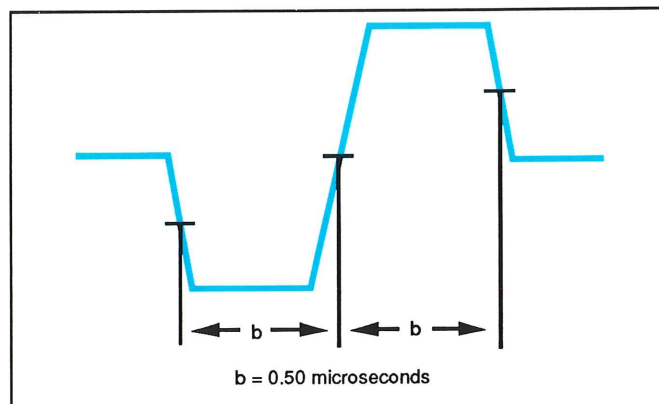


Figure 1. Trilevel Sync for SMPTE 1125/60 HDTV.

below 70-80 MHz but above 30 MHz. The 2467BHD Scope is designed with a selectable bandwidth limit of 50 MHz to achieve optimum roll-off performance.

A new standard in amplifier flatness and accuracy

Verifying and maintaining the technical characteristics of an HDTV signal is critical because small signal distortions in any part of the system can cause noticeable loss in final picture quality. A scope amplifier that does not have sufficient quality can add its own distortions, making accurate evaluation difficult or impossible. The HDTV scope has a bandwidth flatness of ± 2 percent over the first 30 MHz and a square wave flatness of ± 1 percent at line and field rates. This virtually eliminates distortions from the scope, allowing measurements to the more precise HDTV standards.

This vertical accuracy is matched by a high degree of timing accuracy. To make vital timing measurements as accurately as possible, the HDTV scope enables channel-to-channel timing corrections of any two channels to 50 picoseconds. This allows the user to remove all timing errors from the scope before making critical timing measurements across the three channels of an HDTV system, thus guaranteeing the accurate measurements necessary for high picture quality. A maximum sweep rate of 500 picoseconds/division helps ensure the accuracy of timing measurements as required by HDTV standards.

Viewing a pixel-width pulse

A typical problem when viewing TV waveforms is trace brightness. The usual procedure is to dim room lighting and increase the screen intensity while avoiding trace blooming. This helps, but trying to display fast transients as short as 14 nanoseconds at the low 50-60 Hz repetition rate of TV signals is virtually impossible with a conventional oscilloscope.

The 2467BHD HDTV Scope uses a micro-channel plate (MCP) CRT which selectively enhances trace brightness on fast or infrequent pulses while limiting the intensity of high repetition rate signals. By enhancing infrequent signals by three or four orders of magnitude, the MCP CRT makes it possible to clearly see a 1-in-10,000 amplitude ab-

erration or a time shift in the field and frame signals (50Hz or 60Hz). In effect, the MCP CRT makes it possible to view a single pixel within an entire field. And these enhanced transients can be seen instantly with the unaided eye under normal room lighting conditions. Such events would be invisible on any other instrument, either analog or digital.


One development group that defined the shape of the high-definition sync pulses used a prototype of the 2467BHD Scope to study pulse jitter on the order of less than a nanosecond. This would not have been possible with a conventional oscilloscope.

Unmatched versatility and integration for HDTV

The HDTV scope is well suited to troubleshooting and calibrating the equipment used with any of the three major HDTV standards. In addition, the 2467BHD has the versatility and quality that make it ideal for a wide range of precise measurement tasks in the television environment. For example, you can selectively trigger on line or field signals, display a selected range of lines for an uncluttered display (active video), and have the scope automatically count lines up to 1280. Line number and field selected are displayed on the CRT.

The new HDTV Scope complements the Tektronix TSG-1000 Family of Television Generators. The scope and generators together provide a new level of instrument integration over a broad range of capabilities suitable for all aspects of high-definition research and development, as well as equipment and system testing.

For more information

We've only touched on the highlights of the 2467BHD HDTV Scope and some of its uses in the high-definition TV environment. The HDTV scope also has the full set of measurement features required for general-purpose applications. If you would like more information on the 2467BHD or a demonstration of its capabilities, contact your local Tektronix Field Office or sales representative. U.S. customers can call the Tektronix National Marketing Center toll free to place an order or for more information — (800) 426-2200. Tell them you read about it in **HANDSHAKE**. 

Analytek Series 2000 Systems... high performance in small packages

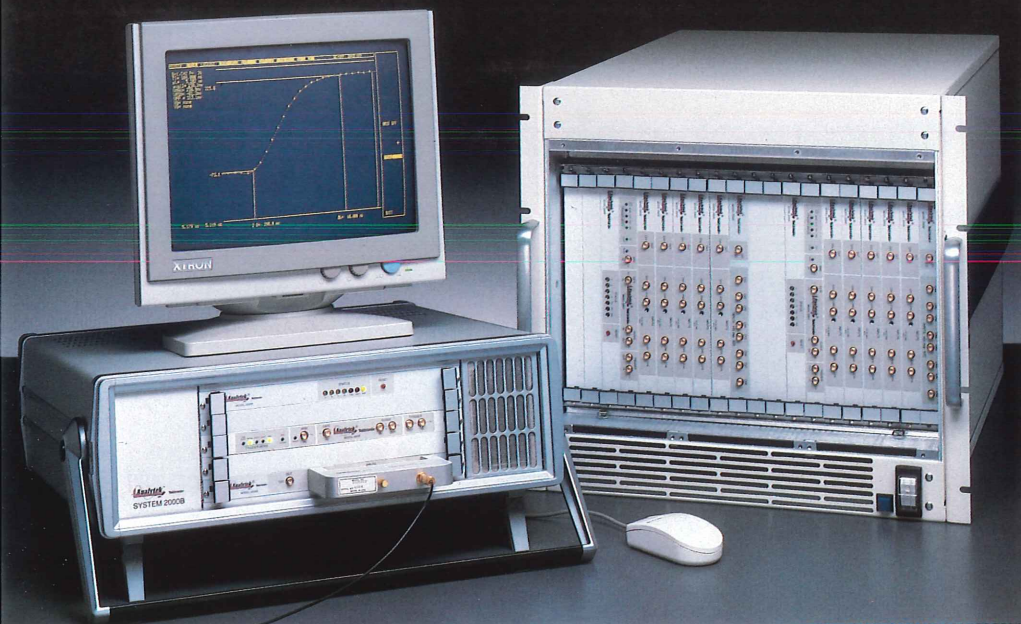
The Analytek Series 2000 VME card-modular components provide some of the highest performance levels of conventional semiconductor-based waveform measurement instruments. While sampling at 2 gigasamples/second with high resolution (12 bits), the low noise of the proprietary Analytek technology leads to a dynamic range of more than 1000:1. This performance is achieved through Analytek's patented analog sampling array, which enables higher density, lower power consumption, and lower cost-per-channel than competitive flash ADC or CCD products.

However impressive the performance may be, the real power in the Analytek approach lies in its adaptability to high performance systems. In contrast with conventional semi-autonomous instruments such as DSOs or rack-and-stack DVMs, RF generators, function generators, etc., the Series 2000 modules communicate over a much faster channel — the VME bus (see sidebar, **The VME data bus**).

The Analytek instruments were introduced in the article, **The Analytek Series 2000 Waveform Sampler** in the Fall 1989 **HANDSHAKE**. In this issue, we'd like to describe some typical Analytek Series 2000 applications and show why the modularity provided by the VME bus make it the best choice for these applications.

Monitoring radar detectors

A system is required to monitor a 15 x 15 radar detector matrix. The measurement system must meet a number of considerations: It must have good time resolution in each of the 225 channels; it must take up a minimum of space; and it must have a low-cost-per-channel. In addition, the system requires an excellent signal-to-noise ratio, 4 nanosecond sampling capability, and a moderate record length.



The Analytek 2000B and 2000RV2 provide solutions spanning needs from 4 to 96 channels and 1 megasample/second to 2 gigasamples/second.

The Analytek 2008S 8-Channel Sampler can provide up to 96 channels in a 19-inch rack width, so the full 225-channel system can fit into a 6-foot instrument rack. The 2008S meets the performance requirements of the system and the resulting system meets the cost-per-channel requirements.

Mapping water depth

Another system is used to map the depth of water in a lake by bouncing laser light off the lake bottom from an airplane in flight. To get good spatial resolution, the laser needs to be fired at a high repetition rate. Good dynamic range is important because the reflected light intensity decreases with the square of the distance.

For this application, the 2004HS High Throughput Module provides the best solution. The maximum throughput rate of 8000 waveforms/second with 256-point resolution and the high sensitivity meet the measurement requirements. In addition, the small system size resulting from the VME architecture is a favorite in many avionics applications.

Adjusting laser alignment

The accelerator for a free-electron laser under development must be pointed with extreme accuracy in order to "lase" properly. To do this, the beam position is measured with a quadrant detector at many points along the accelerator.

The high-bandwidth signal output from the quadrant detector is measured with the 2004S 4-Channel Sampling Module. The small size and low cost-

per-channel allow an optimal number of beam position monitors to be instrumented. Extra channels can be added quickly and easily when needed.


Monitoring large number of channels

A high-energy physics lab needs to monitor a 200-channel test system using phototube detectors. These phototubes produce narrow nanosecond risetime pulses.

The 4-channel 500 megasamples/second 2004S or the 8-channel 250 megasamples/second 2008S are good choices for this application. The wide range of sampling speeds, coupled with the high channel density, offer an economic, easily reconfigurable laboratory development tool.

What's your application?

Even the most complicated systems can be configured using Analytek Series 2000 modules. With the VME format, you can also draw upon many available modules to fill out the system for a complete, real time, high-performance solution. As measurement needs change, you can enhance or expand your system by adding the appropriate modules.


Analytek offers both systems expertise and special software support to solve the most challenging scientific measurement problems. Contact your local Tektronix Field Office or sales representative for information. U.S. customers can call (800) 366-5060 for information. And tell them you read about Analytek in **HANDSHAKE**. 

Analytek is a Cupertino, CA company with experience in card modular instrumentation. Tektronix is marketing the Analytek Series 2000 as a complement to their existing line of Tek digitizers.

The VME data bus

VME is a computer-oriented data bus operating at speeds of up to 40 Mbytes/second. VME is now a mature technology with thousands of individual modules supported by many companies. VME modules are computer oriented, and traditionally are centered around the Motorola 68000-series microprocessors. The VME bus is one of the most popular system buses in use today, second only to the PC Bus, which is used mainly for lower-level functions.

The unique advantage of the VME system lies in the degree of modularization of the components, and a strong industrial base of very high-performance processor and support functions. The level of modularization is just below the "instrument on a card" approach of VXI. The basic VME approach is to provide a high-level function, such as a digitizer, on a single card with supporting functions, such as the time base, provided as a separate module. Similarly, signal conditioning functions would be provided separately in a programmable amplifier.

For the system builder, this finer partitioning gives much more flexibility. The functionality is high enough to generate high board densities and cost efficiencies, while allowing an optimal custom fit to most applications. 

Automating optical component evaluation

As optical fiber system standards such as FDDI (Fiber Distributed Data Interface) and SONET (Synchronous Optical Network) evolve, test parameters for component and system evaluation are becoming better defined. In particular, optical data signal shapes are being specified with strict envelopes of parameter limits. The intent is to insure compatibility between various optical components and networks.

Beyond controlling system performance, detailed signal limit specifications also offer some distinct advantages for automated evaluation of optical components and systems. Waveform templates of upper and lower signal limits can be created and used in automated test systems for quick, accurate, and detailed assessment of optical component performance.

The test methods and equipment discussed here are generally applicable to a wide range of signal types in both optical and electrical applications. Component manufacturers, system designers, and incoming inspection departments will find these methods advantageous for both simplifying and accelerating the test and evaluation process.

The template testing technique

Any waveform that has specified upper and lower bounds is a good candidate for template testing. One example is the FDDI Active Input/Output Interface signal specification shown in Figure 1. Numerous other examples exist where signals — either electrical or optical — must fit within a certain specification envelope. For example, T1 carrier signals are similarly specified by the telephone industry. Thus, template techniques can also be used for Channel Service Unit testing and evaluation of other T1 system components. (See **Automating digital interface testing for telecommunications** in the Spring 1989 **HANDSHAKE**.)

While many signals may have rigorously specified parameters and upper and lower waveshape bounds, the methods of testing are less rigorously specified, if at all. In practice, measurements

are often made by looking at the waveform on an oscilloscope screen and visually comparing it to a specification sheet. In some instances, critical limits may be marked on the scope screen with a grease pencil. Or, when envelope checks must be done frequently, a clear plastic template overlay may be fitted to the scope screen in an attempt to simplify the process.

However, for detailed waveshape specifications such as shown in Figure 1, relying on visual interpretation is both inaccurate and time consuming. A more reliable and more cost-effective approach is to automate the process with digital waveform processing techniques.

The essential elements for automating template testing are:

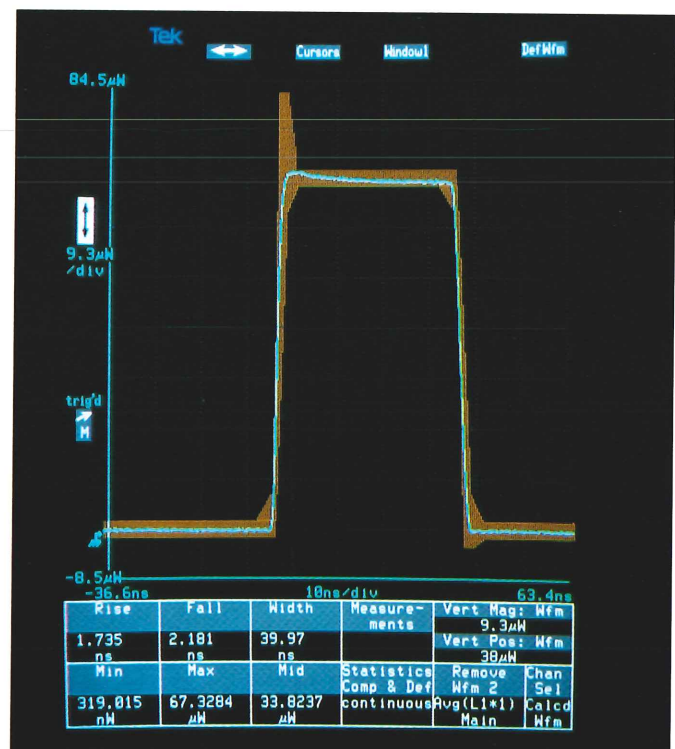
- Some means of digitizing the signal to be tested — a digitizing oscilloscope for example.
- Some method of generating the specification template and making a comparison with the captured signal. (Some digitizing oscilloscopes have built-in waveform envelope features

that can be used for template testing. However, an external computer or controller usually provides more precise template generation and control as well as providing disk storage and extended signal processing capabilities.)

Generating a template for on-screen testing is a matter of creating upper- and lower-bound template waveforms. Then, the captured signal is point-by-point compared to this template — this can be done with a software routine that looks for any signal point that is outside the template (greater than the upper bound or less than the lower bound). If you want to measure specified signal parameters (rise and fall times, width, etc.), additional software routines or signal processing facilities are required.

The process is relatively straightforward and offers tremendous advantages in both testing speed and reliability. However, by now, you are probably beginning to consider the substantial programming investment necessary to create a template testing package. Fortunately, Tektronix has a solution.

Figure 1. Typical template test results showing an FDDI specification template overlaid on the test waveform. Automatically measured waveform parameters are shown at bottom of display.



TWPP — the Tektronix template solution

The Tektronix Template/Waveform Processing Program (TWPP) provides two primary functions — waveform template editing and act-on-delta processing. In combination with a Tektronix PEP 300-Series controller and a Tektronix 11400-Series Digitizing Oscilloscope, it offers a complete solution for automated template testing of any rigorously specified waveform — optical or electrical.

Using the TWPP template editor, an entire template can be created by entering X-Y coordinates (time and amplitude values) for each key breakpoint. The editor then automatically fills in points to “straight-line” connect the entered points. Alternatively, the “create template” function can create a template from any acquired waveform. Additionally, the template editor allows complete editing of any template. Points can be added, deleted, or moved up, down, left, or right. Templates can also be stored on disk or sent to an oscilloscope for display or further processing.

Once a template is created, the TWPP act-on-delta function can be used for automatic signal-to-template comparisons. The act-on-delta function is a three-step process that repeats continuously until stopped manually or by pre-set TWPP conditions:

1. TWPP acquires a waveform from the digitizing oscilloscope.
2. The waveform is automatically compared to the template.
3. One or more actions are taken, depending upon conditions that you've set and whether the waveform passes or fails the template comparison.

For example, TWPP can be told to save each failed waveform to a disk file along with a time-date stamp, to beep on failure, to stop after a certain number of failures, or to pause on failure.

An FDDI media signal interface example

The best way to understand TWPP and its use is through an actual example. In this case, a signal is tested to the FDDI template requirements as shown in Figure 1. In addition, various specified waveform parameters are measured by the system. The result is complete

FDDI optical interface test results on a single display (or hardcopy).

The test system for automating FDDI testing is shown in Figure 2. A Tektronix P6703 Optical-to-Electrical Converter is used for calibrated sensing and conversion of the optical signal to an electrical signal. An important advantage of the P6703, other than its optical response and bandwidth characteristics, is its ability to provide signals calibrated in microwatts/division. These actual units of measurement are maintained with the signal throughout capture by the 11403 Digitizing Oscilloscope and TWPP template comparison. This allows final results to be displayed directly on screen with correct scaling and units.

Setting up the test involves first creating a template with TWPP through simple menu selections and entering X-Y (time-amplitude) coordinates for the template breakpoints. After a template is entered, it can be quickly modified or adjusted using the various TWPP editing features. Other features allow transfer of captured signals to the controller's screen for template fitting and observation or for application of the 11403's signal analysis features. Several automatically measured parameters are shown in the measurement table at the bottom of Figure 1. These measured parameters can be used to calculate waveform-derived characteristics, such as extinction ratio, etc.

A system for SONET applications


For higher bandwidth applications such as testing to SONET requirements,

a similar test system can be assembled based on the Tektronix 11800-Series Digital Sampling Oscilloscope combined with a Tektronix SD-42 Optical-to-Electrical Converter and SD-22 Sampling Head. This combination provides 1000 to 1700 nanometer coverage with DC to 6.4-GHz bandwidth, allowing coverage of SONET requirements up to OC-48 (2.4 gigabits).

Other template testing possibilities

As the above examples indicate, template testing techniques can be used to automate and simplify evaluation of various optical signal interfaces. Remember, however, that the template technique is widely applicable to a variety of signal evaluation problems.

Keep in mind that template testing need not be confined to industry specified waveforms. This technique can be used as a general tool for testing any waveform to any set of limit specifications that you choose to define. This makes the process generally useful in a wide variety of research, engineering evaluation, quality control, and incoming inspection applications. Just acquire the waveform and apply your template for quick, accurate, and automatic determination of pass/fail conditions and characteristics.

For a demonstration of equipment described here or for assistance with any of your testing needs, contact your local Tektronix Field Office or sales representative. 

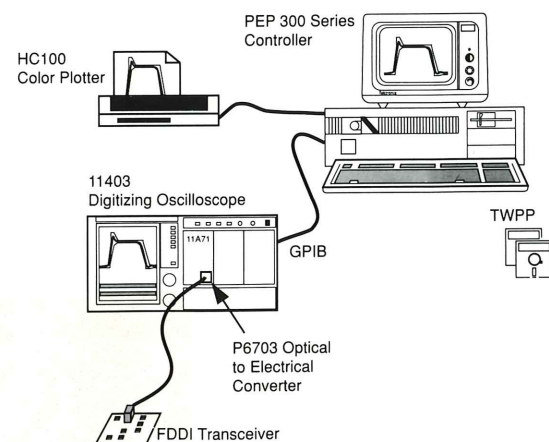


Figure 2. A test system for automating evaluation of FDDI interface signals or any other signal with similar rigorous shape specifications.

Classes and seminars

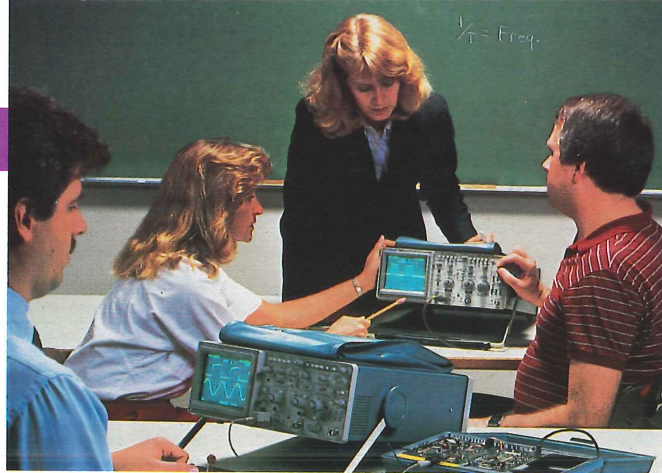
Tektronix offers classes and seminars for the convenience of customers with application, operational, or service training needs. Workshop and class sizes are limited. We recommend that you enroll early. Other classes are planned beyond this schedule. We retain the option to cancel or reschedule classes, seminars, or workshops.

Product service training classes

Tektronix Service Training provides new technicians the skills and techniques required for effective maintenance of Tektronix products. In addition, it brings experienced technicians up-to-date on maintenance of new products. A comprehensive product service class schedule, with class descriptions and prices, is available from the T&M Training Registrar. Call Tektronix Service Training, 1-800-835-9433, Ext. WR1407 to register for the following classes or additional information.

CG 5001 Prog. Calibration Generator	Beaverton, OR	Mar 19-23
FG 5010 Function Generator	Beaverton, OR	Mar 12-16
GURU II/GPIB Data Communications	Irvine, CA	Feb 19-23
	Beaverton, OR	Mar 26-30
	Chicago, IL	Apr 30-May 4
Personal Computer (PC) User/DOS Familiarization	Irvine, CA	Feb 14-16
	Chicago, IL	Apr 26-27
PRISM 3000 Logic Analyzer	Beaverton, OR	Apr 2-13
SG 5010 Signal Generator/AA 5001 Distortion Analyzer	Beaverton, OR	Mar 5-9
Time Domain Reflectometer (TDR) User	Beaverton, OR	Feb 15-16
TM 500 Calibration Package	Irvine, CA	Apr 30-May 4
465B/475A Portable Oscilloscopes	Atlanta, GA	Apr 30-May 4
2465/2467 Microprocessor Based Scope	Dallas, TX	Feb 19-Mar 2
7904/7633 Lab Storage Oscilloscopes	Wash. D.C.	Mar 26-Apr 6


In addition to classroom instruction, Tektronix Service Training has a variety of training packages and video tapes available for self-study. Classes are also available for maintenance of other Tektronix products. Call for further information.



New self-study training packages

These new courses offer both front-panel exercises as well as application measurements. The courses all include a signal source board.

Operating the 2245A	068-0325-04
Operating the 2246A	068-0326-04
Operating the 2247A	068-0327-04

Order self-study training packages through your local Tektronix field office or the Tektronix National Marketing Center — 1-800-426-2200. Other self-study training packages are available. For a complete listing, check the **HANDSHAKE** Reply Card. 

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