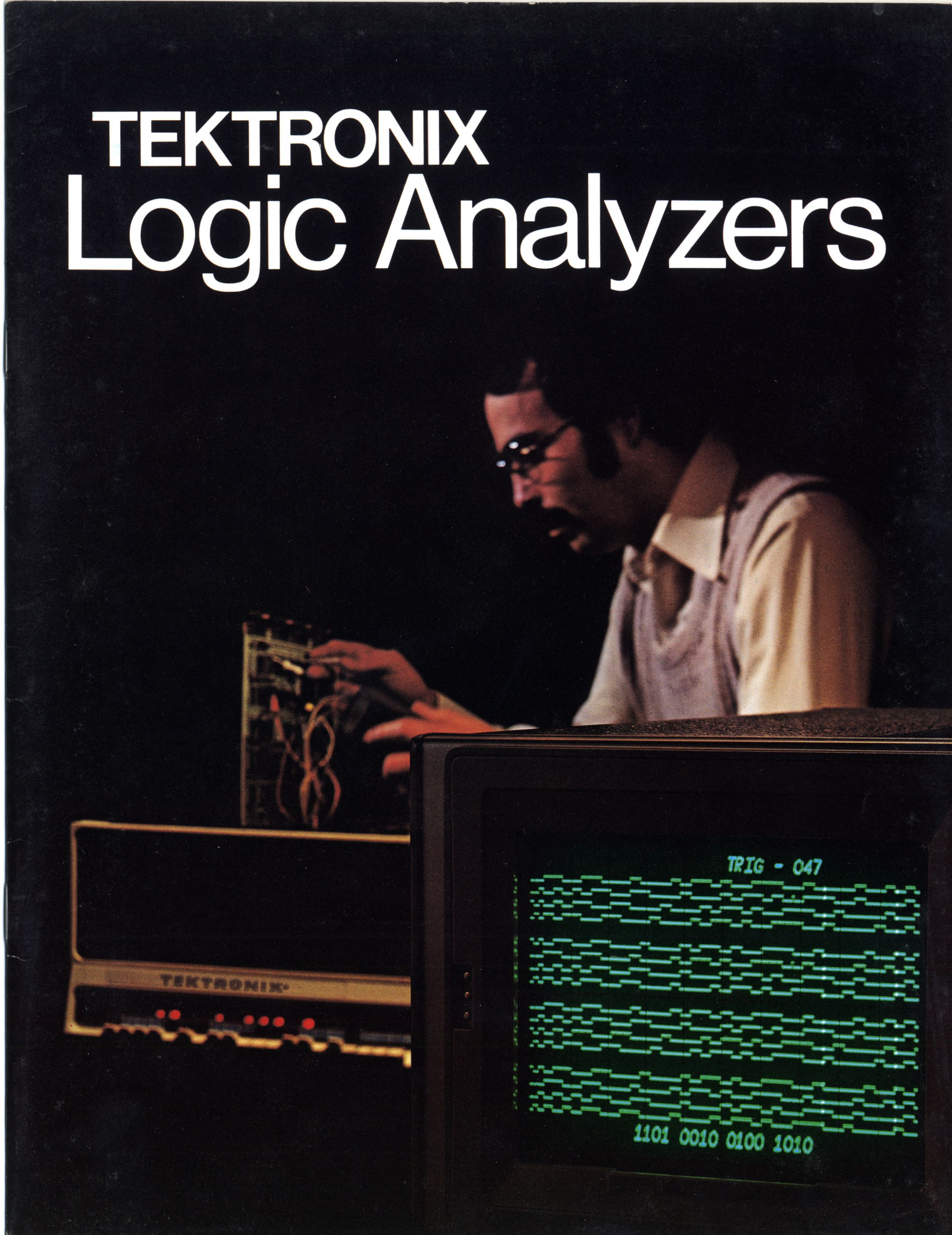
TEKTRONIX
Logic Analyzers



TEKTRONIX LOGIC ANALYZERS for the digital domain

- **16-Channel Operation**
- **15-ns Asynchronous Timing Resolution**
- **4k Memory to Store Pretrigger Data**
- **16-Channel Word Recognition**
- **High Z Probes**
- **Formattable: 16 channels x 256 bits at 20 MHz**
  8 channels x 512 bits at 50 MHz
  4 channels x 1024 bits at 100 MHz asynchronous; 50 MHz synchronous

Tektronix introduces two new high performance logic analyzers for your work in the digital domain. The 7D01, which includes its own word recognizer, is a new plug-in for the 7000-Series Laboratory Oscilloscope family. The portable LA 501W Logic Analysis Package, made up of the LA 501 Logic Analyzer and its new companion, the WR 501 Word Recognizer, belongs to the modular TM 500 Series and works with almost any oscilloscope or X-Y monitor.

Those logic analyzers help you perform detailed logic analysis by displaying data in a form convenient for both logic state and logic timing analyses. Both are high-performance instruments that offer you a choice of configurations to meet your requirements: the 7D01 for bench and lab environments, the LA 501W for portable applications as well. And both offer other ease-of-operation features.

In a 4-compartment 7000-Series Mainframe, the 7D01 may be configured with other plug-ins to operate simultaneously as both a logic analyzer and an oscilloscope. With this additional capability, you can locate the logic fault in your circuit from the logic analyzer display. Then you can trigger the oscilloscope on the fault and obtain a display of the analog signal simultaneously on the crt screen.

The LA 501W logic analysis package (which includes the new stand-alone WR 501 Word Recognizer) may be set to trigger on acquired data. Or, with the optional P6450 passive probe, you can use the LA 501W to acquire data separately—to trigger on one set of lines and store on another set.

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A New Instrument Concept for the Digital Domain.

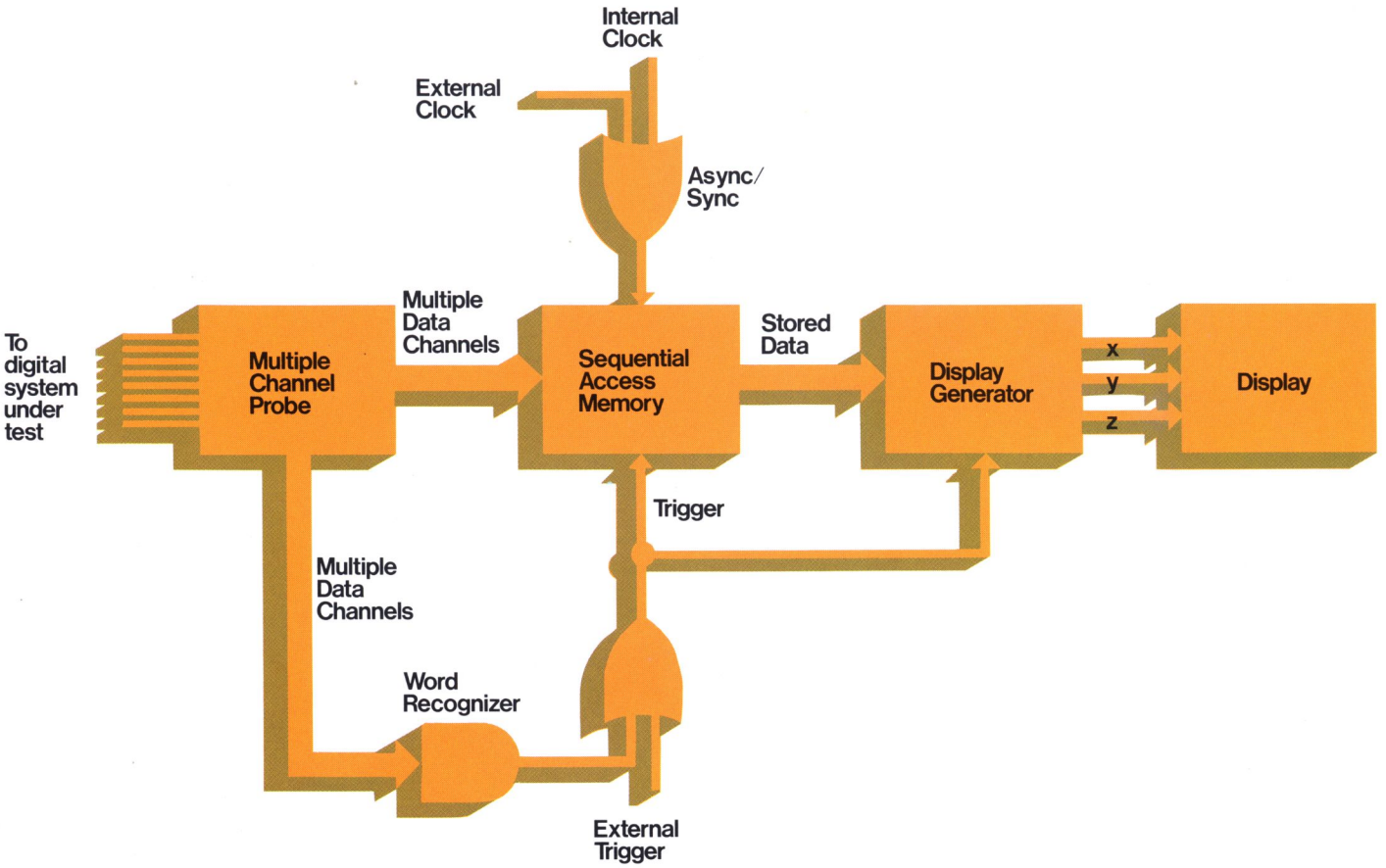
The logic analyzer is a relatively new instrument concept for the digital domain—and it's become an essential one for logic design and trouble-shooting. With today's logic circuitry, you want your logic analyzer to acquire a number of channels simultaneously, to sample data synchronously or asynchronously, to store data in memory, to trigger on a selected word, and to display data that occurs before a fault condition.

These basic capabilities define the logic analyzer. Let's take a look at each one in turn.

Acquiring a number of channels simultaneously. With some oscilloscopes you can view up to four channels at a time (sometimes 8), but that's often not enough for many complex digital problems. With a logic analyzer you can acquire many more. The data is accepted via probes (which must be designed so they don't overload the circuit under test), stored in a memory with enough capacity for multiple channels of data, and displayed on a crt screen as a logic state or logic timing display.

TEKTRONIX Logic Analyzers can acquire 4, 8, or 16 channels simultaneously, via two active multichannel probes. The probes feature a high input impedance—1 MΩ paralleled by 5 pF—so you won't load down your circuit.

Each instrument has a 4096-bit memory that allows you to store large blocks of data in a single shot. The memory is *formattable*: that is, you can store 1024 memory bits with 4 channels, 512 bits with 8 channels, 256 bits with 16 channels. A long, formattable memory like this is a particularly important capability for logic analysis because you deal with so much information in a digital system. Instead of having to look at data, say, 10 or 20 bits at a time (as you might with an oscilloscope), you can capture as many as 1024 bits per channel simultaneously in the 4-channel mode.



Triggering on a selected word. An oscilloscope can trigger on a selected pulse, or "condition," but it can only show you what happens after the fault. We've just seen that the logic analyzer can display pretrigger data—the events leading up to a fault. This important logic analyzer capability allows you to analyze pre-fault logic conditions.

The word recognizer is often the most versatile source of triggering. Any desired parallel word (up to 16 bits) can be selected with front-panel switches for Hi, Lo, or X (don't care) conditions on each channel. The word recognizer will then trigger the logic analyzer whenever an incoming parallel word matches the one selected.

Provision is also made for triggering on channel 0 of the input data or on an external signal such as an error flag, sector pulse, enable signal, or any other unique single-channel event.

Suppose you set the logic analyzer's word recognizer to "recognize" and trigger on a specific word pattern. Then, with the logic analyzer in the pretrigger mode, you get a display of about 90% of the pretrigger data and 10% of the post-trigger data. With TEKTRONIX Logic Analyzers, you can also get a 50%/50% center-trigger display or a 10%/90% post-trigger display.

Displaying data. A logic analyzer doesn't really analyze data. In one way, it's just like an oscilloscope: the user still needs to interpret the display. TEKTRONIX Logic Analyzers offer some convenient, and some unique, display capabilities.

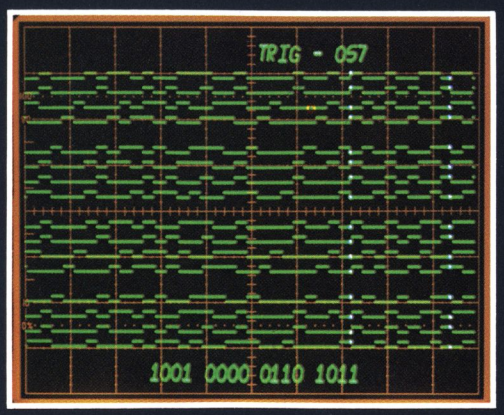
The LA 501W features timing tick marks that enable you to pinpoint data bits of interest and read them easily from the display. It also features a CHANNEL/POSITION control that allows you to move any channel adjacent to any other for easy timing comparisons.

Data is displayed as a timing diagram, and both instruments feature visual reference aids that make the displays easy to read. With the 7D01, for example, you get crt readout of the data word you select with the cursor. This gives you both timing information and state information in the same display. A trigger marker indicates the trigger point and tells you how much pretrigger data you're viewing (10%, 50%, or 90%).

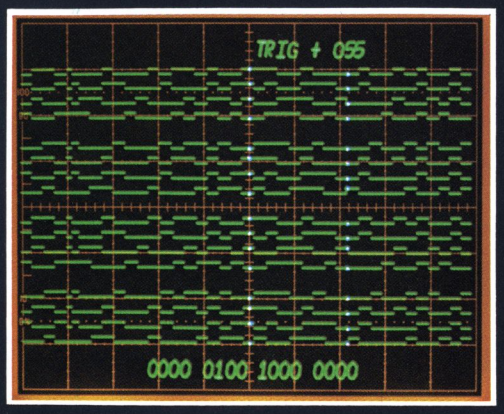
Sampling data synchronously or asynchronously. When you check your software, you need to be able to sample the program flow of clocked systems *synchronously*. In other words, you synchronize the logic analyzer with the system clock when you're only interested in the data that is valid at qualified clock transitions, not in the changes in between.

When you're analyzing logic timing in your hardware system, it's best to sample data *asynchronously*. The logic analyzer is clocked internally (asynchronous to the system under test). In this way you determine clock frequencies and make timing comparisons. Asynchronously clocked testing requires that data be sampled frequently —the shorter the time between samples, the better the timing resolution.

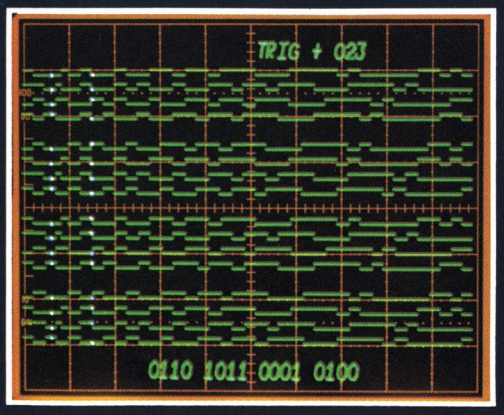
Not all logic analyzers can sample synchronously and asynchronously. Both the 7D01 and the LA501W can. In the synchronous mode, data is displayed—in timing-diagram format—as highs and lows. The fastest synchronous sampling speed is 50 MHz. In the asynchronous mode, data is sampled at speeds of up to 100 MHz, which gives you a timing resolution to 15 ns.



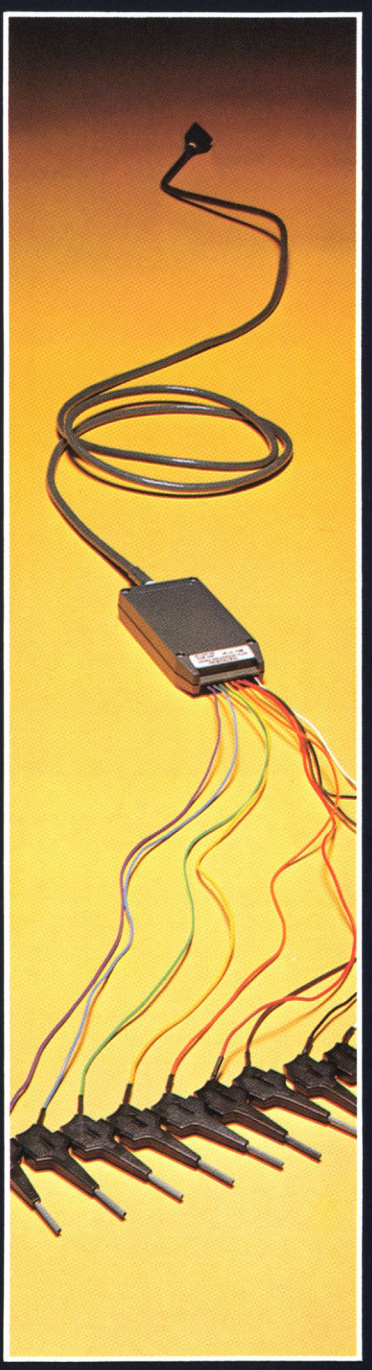
Pre-trigger



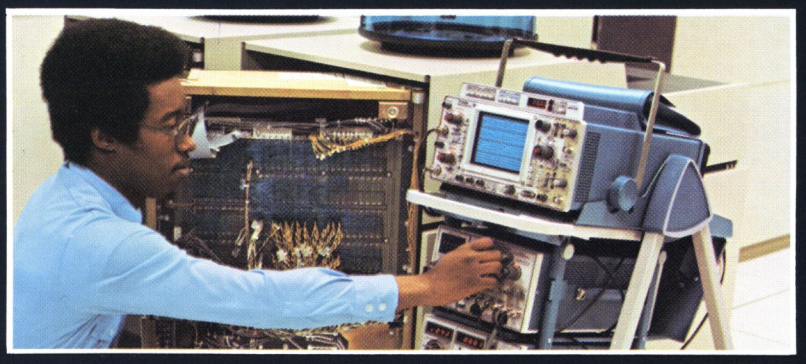
Center-trigger



Post-trigger



The new P6451 high Z probes minimize circuit loading.



Storing data in memory. Some oscilloscopes use storage crts to store data; the logic analyzer uses memory. As we've already seen, data enters from every channel simultaneously. Each bit is stored successively, with each clock pulse, in a particular memory location.

At the next clock pulse, the first bit is entered in the next location and a new bit takes its place. Data continues to be entered until the memory contents are "frozen" by the trigger. The data frozen in memory represents *events that happened before the trigger* as well as events that happened after.

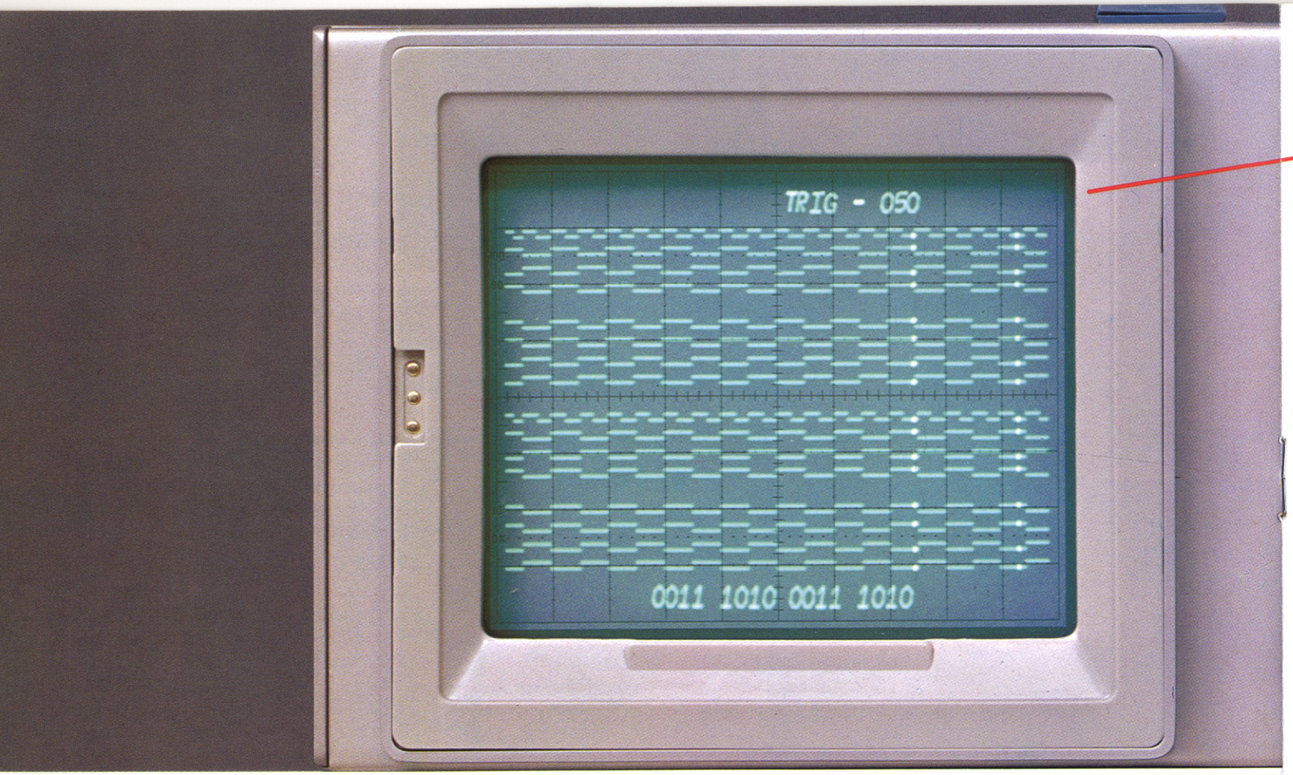
The 7D01 features a trigger marker and a cursor, two bright (or intensified) spots on each channel displayed. The trigger marker indicates whether the logic analyzer is operating in the pre, center, or post trigger mode. The cursor serves as a vertical reference point on every channel. When the cursor is positioned on a clock signal of interest, the binary word at that point is read out across the bottom of the display. This allows you to obtain state information and to make timing comparisons easily. Crt readout also gives you (at the top of the display) the time interval between the trigger marker and the cursor.

Just as the oscilloscope is an indispensable tool for analog measurements, the logic analyzer is indispensable in the digital domain.

A thorough analysis of digital circuitry often requires both capabilities. The logic analyzer monitors the data lines and recognizes a fault, and the oscilloscope triggers on the fault and displays it for detailed electrical analysis.

Besides that, the logic analyzer "borrows" the oscilloscope crt for its display. Some logic analyzers (the 7D01 in a 4-compartment 7000-Series mainframe, for example) make it possible for you to view both kinds of information simultaneously in the same crt display.

In fact, it could be said that the logic analyzer and the oscilloscope work hand in hand. Each kind of instrument allows you to see into its own specialized domain; together they allow you to gather a full range of analog and digital data. And from Tektronix you get both: logic analyzers and oscilloscopes that are literally made for each other.



Turn any 7000-Series oscilloscope into a logic analyzer with the 7D01

The 7D01 Logic Analyzer is a dual-wide plug-in for 7000-Series Laboratory Oscilloscopes. It features formattable 16-channel data acquisition, 4096-bit memory capacity, 16-channel word recognition, asynchronous or synchronous operation, a trigger marker and cursor plus crt readout of data, and active multichannel probes with low circuit loading.

When operated in a 4-compartment mainframe, it becomes an extra-powerful logic analysis tool. Since you have room for vertical-amplifier and time-base plug-ins, you get logic analyzer capabilities and standard oscilloscope functions in one package. You use the 7D01 to locate a problem in the digital domain, then zero in on the fault by using the 7D01's word recognizer to trigger the scope. Now you can display digital and analog information on the same crt.

Word Recognizer. The built-in word recognizer samples the qualifier and 16 display inputs from the active probes and an additional EXTERNAL qualifier. The two qualifiers allow you to trigger on words up to 18 channels wide. An asynchronous filter rejects false triggers from glitches or data skew.

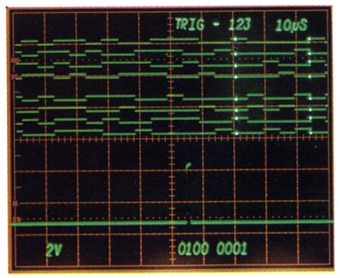
In addition to triggering the logic analyzer on a recognized word or pattern, the word recognizer has several specialized uses. In the synchronous mode, for example, you can test your microprocessor loop by inputting from the qualifier alone and setting all other channels to X (don't care). The word recognizer triggers on the signal you select without even sampling the other channels. You view an isolated window, not the whole stream of data.

Display Characteristics. The trigger marker indicates whether the logic analyzer is operating in the pre, center, or post trigger mode.

The cursor, which activates crt readout, allows you to display timing and state information simultaneously. When you position the cursor to a given timing-diagram word, that word is read out in 1s and 0s across the bottom of the display. When you move the cursor to another stored word, the binary word at that point is read out. And since you can step the cursor through the display word by word, timing comparisons are faster, easier, and less subject to error than visual estimates.

X10 horizontal and X5 vertical magnifiers and position controls allow you to expand any portion of the display for detailed analysis.

Digital Delay. With the new 7D10 or 7D11 digital delay-by-events units, it's possible to delay the logic analyzer by 1 to 10^7 events (such as clock pulses) or words. (The 7D11 will also delay by time.) These plug-ins feature maximum event frequency $\geq$ 50 MHz, delayed trigger and delay interval outputs, and 7½ digit readout. They allow you to process large blocks of data efficiently. In the 16-channel mode, for example, the 7D10 can be used to position the 256-bit window virtually anywhere along a data stream.



Simultaneous logic analyzer capabilities and standard oscilloscope functions (available with 4-compartment mainframes).

Display Size. *5-in. 7704A crt is shown actual size. A 6½-in. crt is available in the 7603 mainframe.*

Crt readout enables you to obtain binary as well as timing information from the display.

Formattable Memory.
16 channels x 256 bits at 20 MHz*
8 channels x 512 bits at 50 MHz*
4 channels x 1024 bits at 100 MHz*
asynchronously; 50 MHz synchronous sampling.

**(2, 4, or 8 bits are blanked during sweep retrace.)*

Cursor. *For easy visual interpretation and timing comparisons. Converts selected word from timing to binary format.*

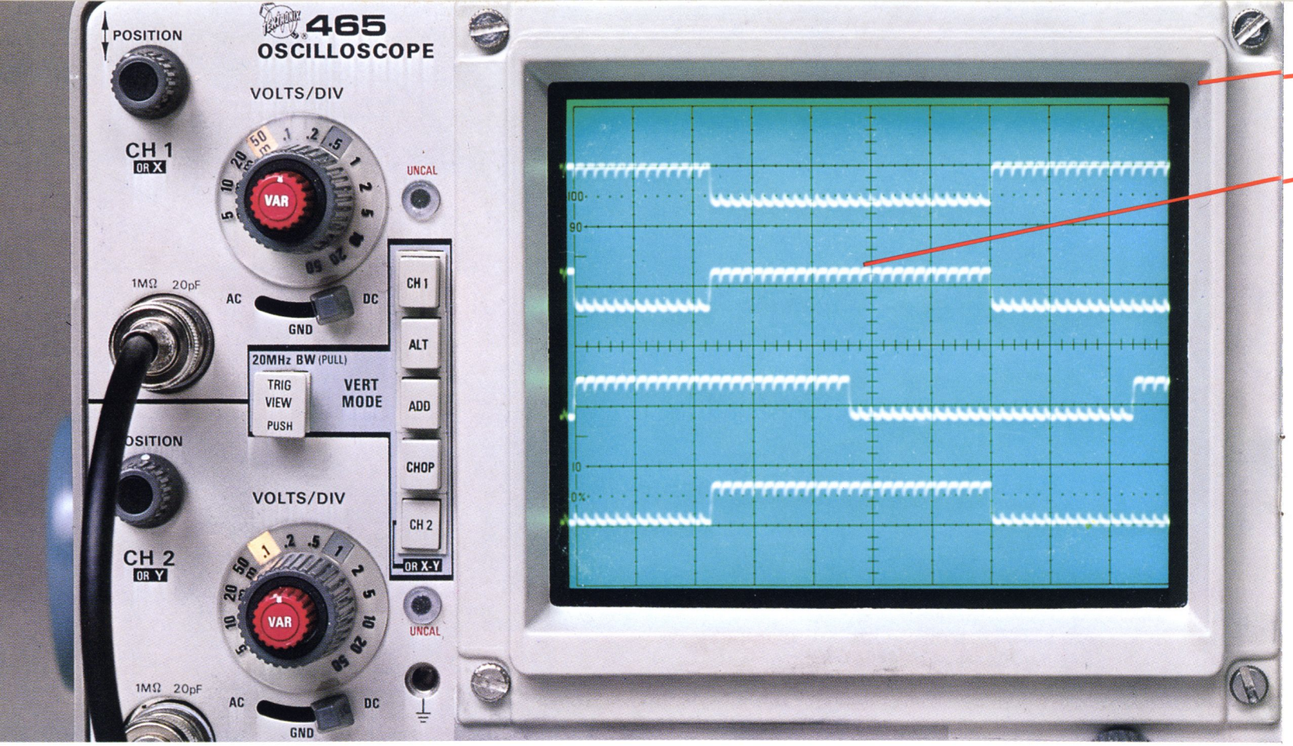
Pre-trigger. *For viewing faults before the trigger. Also offers center-trigger and post-trigger modes.*

Asynchronous/Synchronous Operation. *Asynchronous sample intervals from 5 ms to 10 ns. In synchronous mode (with SAMPLE INTERVAL control set to EXT), the 7D01 is clocked by the system under test.*

16-Channel Word Recognition. *The qualifiers provide 18-bit parallel pattern recognition.*

Active Probes. *Two active multichannel probes with high input impedance (1MΩ paralleled by 5 pF) feature low circuit loading. They acquire up to 16 channels of data plus qualifiers.*

7DO1 shown actual size.



Display. *Shown on 465 portable oscilloscope.*

Biphase Timing Tick Marks. *Also indicate whether an inactive line is high or low and facilitate easy timing comparisons.*

WR 501 EXT. TRIG OUT. *Trigger for oscilloscope or separate logic analyzer.*

16-Channel Word Recognition. *Event digital delay to 99,999; delay by words or clock pulses.*

Active Probes. *Feature independent probe thresholds—TTL, ECL, and Variable (± 10 V); compatible with virtually all logic families. Also feature high input impedance (1 MΩ paralleled by 5 pF), low circuit loading. They acquire up to 16 channels of data plus qualifier and clock.*

Formattable Memory
16 channels x 256 bits at 20 MHz*
8 channels x 512 bits at 50 MHz*
4 channels x 1024 bits at 100 MHz*
asynchronously; 50 MHz synchronous sampling.

**(2, 4, or 8 bits are blanked during sweep retrace.)*

Pretrigger. *For viewing faults before the trigger. Also offers center-trigger and post-trigger modes.*

Channel Position Control. *Enables you to position any channel next to any other for channel-to-channel comparisons.*

Turn any oscilloscope into a logic analyzer with the LA 501W

This logic analysis package, made up of the LA 501 and its new companion WR 501 Word Recognizer, operates in any TM 500 Mainframe. The 16 channels of acquired data are displayed on any oscilloscope or X-Y monitor. The LA 501W features formattable memory, 16-channel word recognition, independently variable threshold, channel positioning, and timing tick marks.

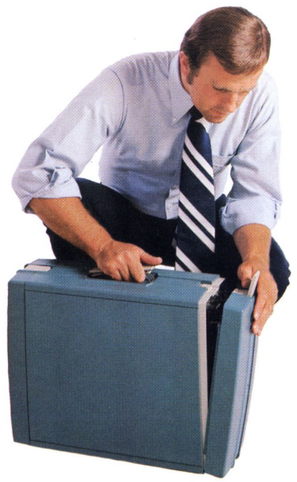
As a member of the portable TM 500 Series family, the LA 501W can be set up for the bench, rackmounted, mounted on the Scope-Mobile Cart, or packed in the TM 515 Traveler Mainframe.

Depending on the number of compartments in the mainframe you choose, you can have an extra-portable, down-to-business logic analyzer or a logic analysis configuration with a real-time scope and additional plug-in capability.

Word Recognition. The WR 501 recognizes words up to 17 bits long when the qualifier and 16 selectors are used. It triggers synchronously—when the conditions set by the word selectors and qualifier are valid at the clock transition—and asynchronously—when the conditions set by the word selector are met. An asynchronous filter eliminates spurious triggers for data not valid during a minimum word time. The word recognizer can delay by words or events up to 99,999.

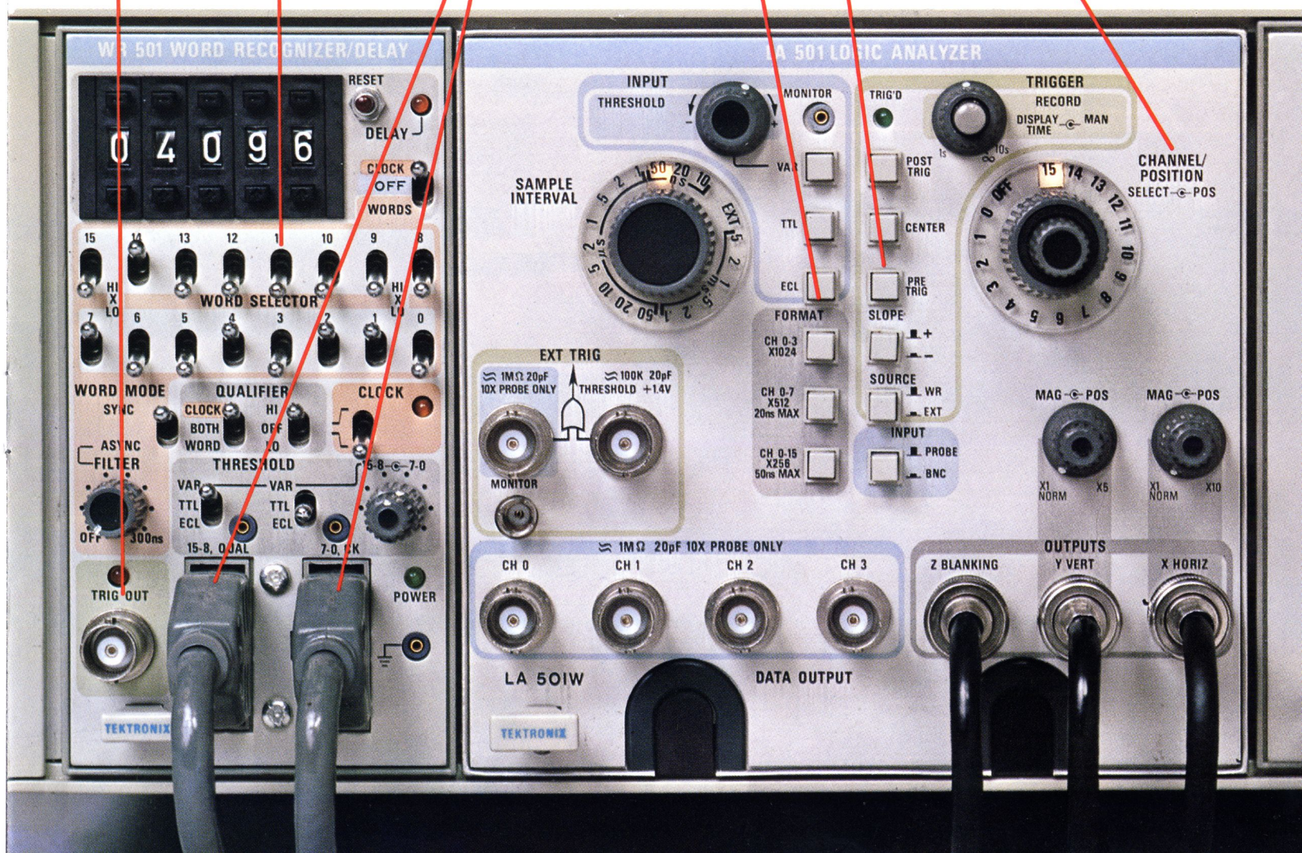
Probes. Data is acquired via high input impedance probes (1 M Ω paralleled by 5 pF) that minimize circuit loading. Each probe has an independently selectable logic threshold for TTL, ECL, and variable (± 10 V) levels. The available P6450 passive probe allows you to acquire data separate from the trigger data.

Display Characteristics. The channel position control lets you move one channel next to another for easy timing comparisons. Biphase tick marks help you interpret the timing diagram in terms of highs and lows. X10 horizontal and X5 vertical magnifiers and position controls enable you to perform detailed analyses on any portion of the display.



For field portability, try the TM 515 Traveler Mainframe. It's a durable power module mainframe, yet as attractive as carry-on luggage. You can pack the LA 501, the WR 501, and the SC 502, for example, and have a complete logic analysis system in a suitcase.

LA 501W shown actual size.



Configurable Logic Analyzers

Choose the 7D01.

The 7D01 operates as a dual-wide plug-in in any 7000-Series mainframe with crt readout. The 7000 Series comprises 3 and 4 compartment mainframes, including one model with up to 500 MHz bandwidth and another with multimode storage (bistable, variable persistence, and fast mesh transfer) and 1000 cm/μs stored writing speed. There are over 30 plug-ins—including sampling, spectrum analyzer, differential, multitrace, and other digital units—to choose from.

All mainframes feature large, bright crts and easy-to-read displays. Crt readout, an invaluable aid for logic analysis, displays the time interval between the trigger and the word selected with the 7D01 cursor. The selected word is also displayed as 1s and 0s in 3-bit or 4-bit binary format.

In a 4-compartment mainframe like the 7904, it's possible to have a logic analyzer and an oscilloscope in the same package. And the system capabilities can be expanded by adding one or two 7000-Series plug-ins (depending on mainframe size).

Or the LA 501W.

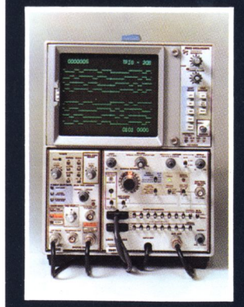
The LA 501W or the LA 501 and WR 501 operate as plug-ins in 4, 5, or 6 compartment TM 500 power module mainframes.

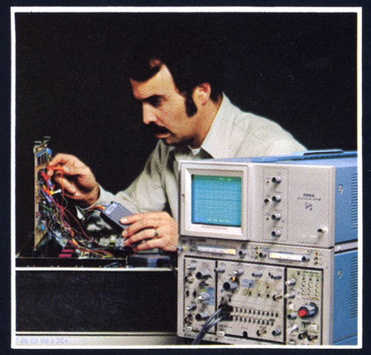
To optimize system capabilities, choose from over 35 general and special purpose plug-ins (including DMMs, counters, oscilloscopes, monitors, and even blank plug-ins for custom circuits).

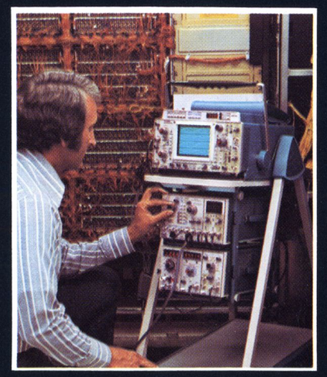
This allows you to choose the configuration best suited to your application. For example, you could power the LA 501W with the 4-compartment TM 504 mainframe. Now you can add another TM 500 module like the DM 502 Digital Multimeter for additional capability.

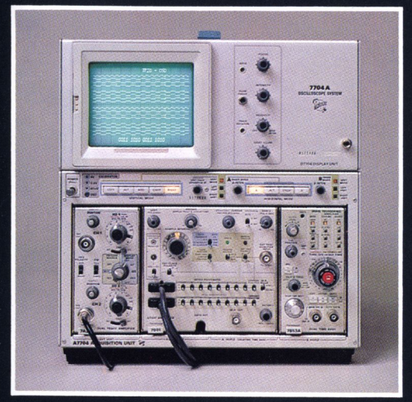
And you can use the TM 500 building-block concept to advantage by expanding your logic analysis capabilities as your needs grow. Start with the 16-channel LA 501. Then, when you need word recognition or digital delay, add the WR 501 Word Recognizer and you have the LA 501W logic analysis package. If you already own the LA 501, you can have it upgraded into an LA 501W.

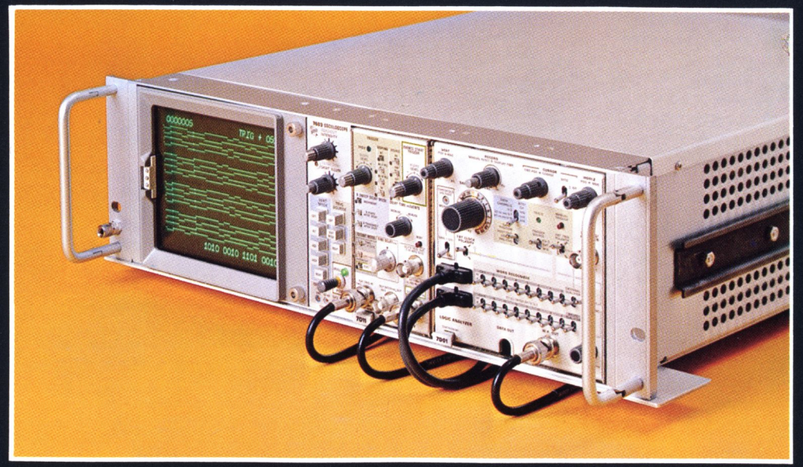
The LA 501W in the TM 515 Traveler Mainframe. A complete logic analysis system in a suitcase.

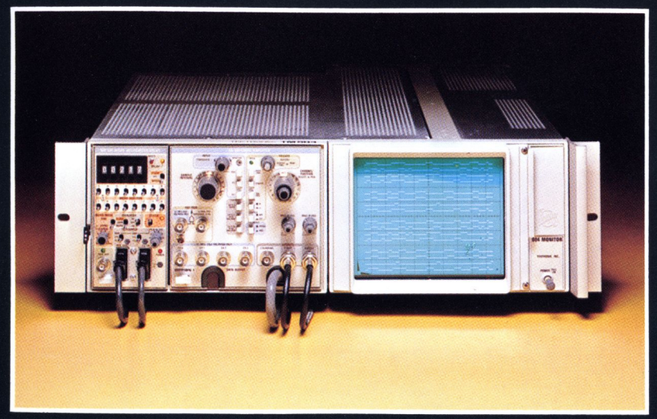












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