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Maintenance special issue

Selecting digital multimeters

Omni 4 logic analyzer

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Look inside a typical modern videotape recorder and you'll find five functional circuit groups: power supply, mechanical subassemblies, audio circuits, video circuits and the digital control circuits. Although each section can be repaired with common test equipment, there are occasions when specialized test equipment is required.

Common circuits

The power supply can usually be analyzed adequately with a general-purpose oscilloscope, voltohm-meter and a capacitance checker. The mechanical subassemblies, such as motors, pulleys, gear linkages and rotating heads, can generally be checked for proper operation by visual inspection. The servo motors may require an oscilloscope, a torque meter or a wow-and-flutter meter. Quad tape machines also may require pressure gauges.

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Performance at a glance

- *Self-contained, portable logic analyzer*
- *Full-function personal computer*
- *50ns data collection capability*
- *Stores 1,024 bus cycles, 16 bits per cycle, per test*
- *Upgradable to monitor 36 simultaneous signals*
- *Signature analysis and instruction disassembly*
- *Disk storage of setups and test data*
- *Optional pattern generator and EPROM programmer*

The audio circuits can be checked with an oscilloscope. However, there is often the need for more specialized test equipment such as frequency counters, signal generators and distortion meters.

Although a technician may be able to repair video circuits using a general-purpose scope, four pieces of specialized video test gear usually come into play: a color monitor, color-bar test pattern generator, vectorscope and a waveform monitor. Sometimes a sync generator or procamp also may be necessary.

Although most of the circuits mentioned can be repaired with the listed equipment, there is one class of circuits that may require specialized test equipment—digital circuits. Unlike audio and video signals, digital signals are both fast and slow. It's also necessary to view more than one signal at a time, and this

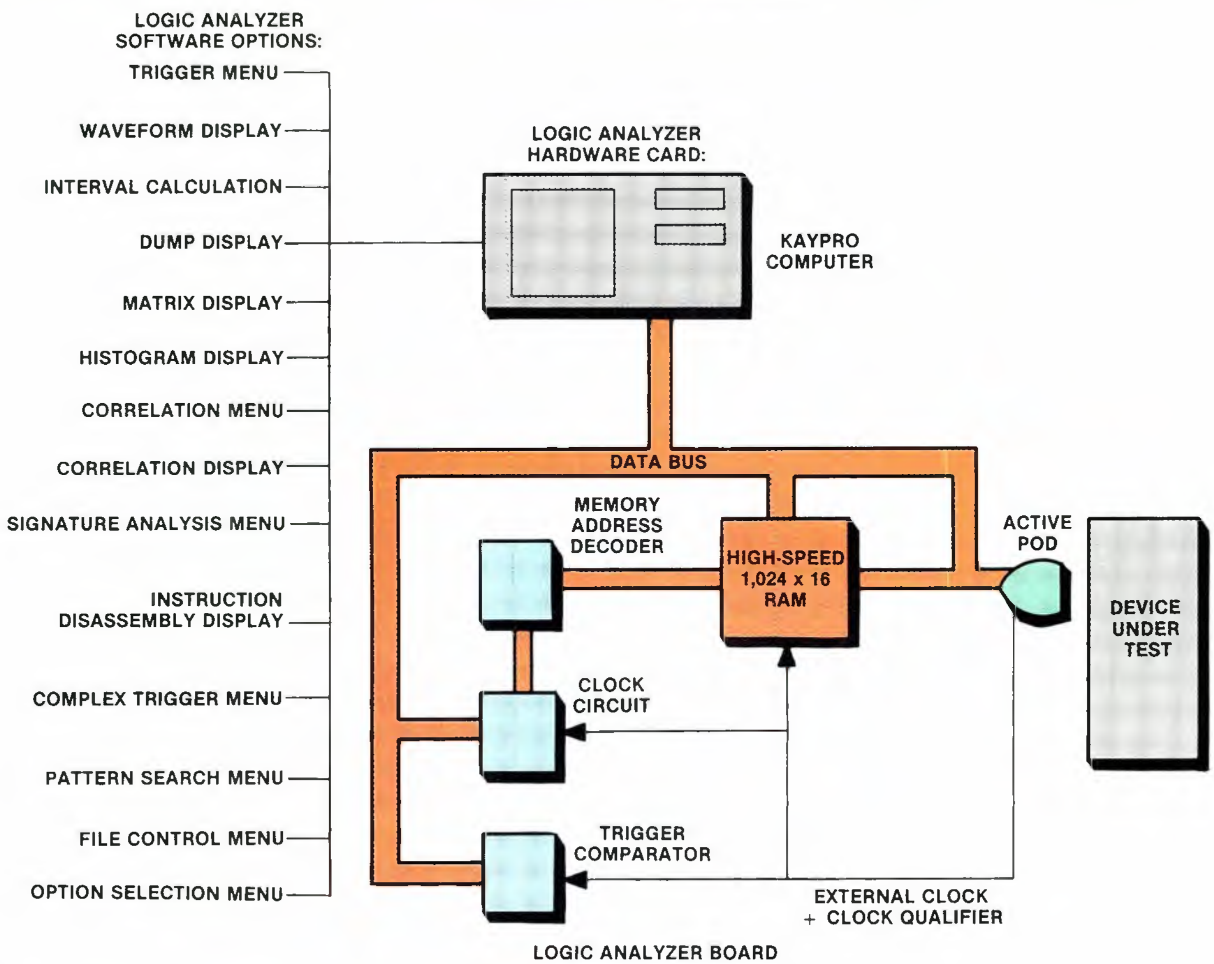

Figure 1. *Block diagram showing available menus and display options.*

sometimes makes digital control circuits difficult to troubleshoot.

For years, the computer industry has realized the need to view multiple signals at once. It is only recently that broadcast engineers, faced with the need to repair complex equipment, have looked beyond the standard list of test equipment. One of the devices making its way into broadcast stations is the Omni 4 logic analyzer, made by OmniLogic.

The analyzer allows monitoring of numerous signal or data lines at one time. In one regard, it is much like a multichannel oscilloscope. However, the device goes far beyond what a scope could do for effective troubleshooting.

The analyzer is composed of a computer and sophisticated software that allows you to examine the internal workings of microprocessor-based equipment. Through the use of test probes, called *pods*, the device can monitor data lines to help isolate defective components.

Construction

The logic analyzer comes completely contained within a Kaypro brand 2-X portable computer. The computer contains the standard package of hardware: processor, detachable keyboard, high-resolution video display, two floppy disk drives, parallel printer interface and an internal 300-baud modem. A special logic analyzer also is added. Additional storage is provided under the disk drives for the diskettes, logic analyzer connectors and interconnecting cables. The complete assembly makes the logic analyzer portable, and it's only slightly more bulky than most portable scopes.

Software

The analyzer comes with all of the standard Kaypro software: operating system, word processor, spreadsheet, database manager and modem controller. Software manuals also are provided. Special proprietary programs are supplied to execute the analysis functions. This software is the heart of effective troubleshooting. (See Figure 1.)

The various tests are selected from a menu displayed on the CRT screen. Selection is made by pressing a single key. If you get confused or lost, the various functions are explained through a help command. By pushing "?" combined with the feature's letter, you bring up an explanation of the desired command.

Hardware

The logic analyzer board, mounted inside the computer, provides the interface circuitry and test circuits. Active circuitry is contained within the test pods, which connect to the device under test (DUT). Spring-loaded microclips provide the connections between the interface pods and the DUT. Where possible, dip clips can be attached to the DUT. The dip clips make the interconnection with the logic analyzer much easier.

The microclips use color-coded wire, which helps identify the individual leads. Even so, writing down the clip color-coding and IC pin numbers helps avoid confusion. It's not unusual to have 16 or 32 leads running around, which can lead to interconnection errors.

The interface pods use active circuitry to present a high-impedance load to the DUT. The impedance is greater than 1 MΩ combined with less than 5pF capacitance. Two pod types can be purchased. The standard pod uses TTL logic-level circuitry. A CMOS pod also is available. Most troubleshooting applications require the TTL pods.

The logic analyzer board relies on high-speed random access (RAM) chips and a programmable comparator. The comparator acts as the high-speed trigger circuit. The analyzer is capable of detecting pulse durations as short as 10ns.

The internal processor clock permits the analyzer to store the waveform timing information in 50ns increments, which is a 20MHz clock rate. The internal clock is capable of being set in a 1-2-5 sequence, much like an oscilloscope horizontal sweep rate control. The clock can be varied over a range from 50ns to 32ms. An external clock input allows the logic analyzer to store information in

```
   CHANNELS                      F  E  D  C  B  A  9  8  7  6  5  4  3  2  1  0      SIGNAL
1) ACTIVE PROBES                                                  0  0  0  0  0
2) ACTIVE GLITCH
 RECOG GROUPINGS              :  . . Z . .  :  . . Y . .  :  . . X . .  :  . . W . .  :
3) TRIGGER EVENT                 X  X  X  X  X  X  X  X  X  X  X  X  X  X  X  X
4) GLITCH EVENT (G)                                                  X  X  X  X

5) TRIGGER QUAL:        X             D) RECOG MODE: UNLATCHED
6) TRIGGER POINT:       512           E) RECOG FUNCTION: 6
7) OCCURRENCE #:        1                1-ZYXWG                           ..........
8) DELAY:               0                2-(ZYXW) + G             :      Z = FEDC :
9) TIMEOUT:             0                3-(ZY) \ XW              :      Y = BA98 :
A) CLK QUALIFY:         X                4-(ZY) + (XW)            :      X = 7654 :
B) EXT CLOCK:           X                5-ZY(X + W)              :      W = 3210 :
C) SAMPLE RATE:         1.0ms         -> 6-EXTERNAL              (1)       ..........
```

Figure 2. *Trigger menu set to display channels 0, 1, 2, 3, 4. The display will be triggered by an external pulse and the clock rate is 1ms.*

synchronization with the DUT. The external clock mode is used when performing instruction disassembly or when capturing data from externally clocked logic circuits.

A total of 1,000 16-bit samples can be captured per test. This data, along with all of the setup information, can be stored on floppy disk for later analysis. Each floppy disk can store up to 40 sets of data, including all of the appropriate setup information.

Features

When troubleshooting digital circuitry, it may be necessary to study a lot of information about the circuit under test before actually connecting the test equipment. For example, when we faced repairing a parallel-to-serial converter circuit in our transmitter, we had to review the circuit schematic and theory of operation, and then look at TTL data books to obtain pin numbers and signal names for the suspected ICs. A list of the necessary interconnections between the logic analyzer and the DUT also was made. Only then were we ready to begin running some tests.

Digital circuits use timing pulses to keep the information in sync, much like video waveforms. However, unlike video, which relies on a single sequential sync pulse, digital circuits typically have several signals all occurring at the same time. As many as 18 simultaneous signals may be used to trigger the analyzer.

The trigger setup panel, shown in Figure 2, provides 15 triggering categories, with multiple choices available within each category. When using the analyzer, you can call up onto the video display detailed explanations about each of the 15 categories by pushing the "?" key and the category number. This self-instruction feature helps you get quickly into actual circuit analysis.

Even though we had some idea about

how the circuit worked in the remote control, we first had to derive a valid trigger configuration. The data analyzer's display works in real time. Therefore, it was necessary to modify the triggering inputs until we were correctly capturing the data. The trigger setup was then stored on disk so it could be called back at any time quickly and reliably.

When the logic analyzer is properly connected and the trigger is programmed, the operator pushes "G" to begin capturing the data. As soon as the trigger occurs, and 1,000 samples have been collected, the logic analyzer displays the DUT waveforms. The *names* option permits the operator to create individual names to identify each line of data. The displayed waveforms can be printed for later examination, as shown in Figure 3. A movable cursor permits scrolling through the data. You can calculate the timing intervals between signals by using the calculate command.

The logic analyzer provides a powerful correlation feature, which can be used to locate differences between the data of a known-good unit and a faulty DUT. Tests can be performed on a working piece of equipment with the results stored on disk. Later on, if that equipment fails, the previously stored good data can be compared bit by bit with the current bad data. Any differences can then be easily spotted and analyzed to discover likely circuit failures.

Other features

The analyzer will display data in numerous forms using the option menu and the dump display. For example, data can be displayed in hexadecimal, octal, decimal or binary. (See Figure 4.) Instruction disassembly can be performed on microprocessor programs. Histograms that show the addresses being used by software also can be displayed as shown in Figure 5. Data can be searched for various patterns using the locate command.

Several broadcast equipment manufacturers are producing equipment that permits the device's microprocessor to *free run* through its address space. This hardware feature permits the owner to apply the powerful techniques of *signature analysis* to troubleshooting. The device's signature analysis feature stores up to 14 circuit signatures at once. By capturing and storing signatures from known-good equipment and then comparing these signatures with signatures from a bad board, a technician can quickly narrow down a circuit fault to a small region on the printed circuit board. The test also could be used to easily generate and store fresh signatures each time a circuit board is updated.

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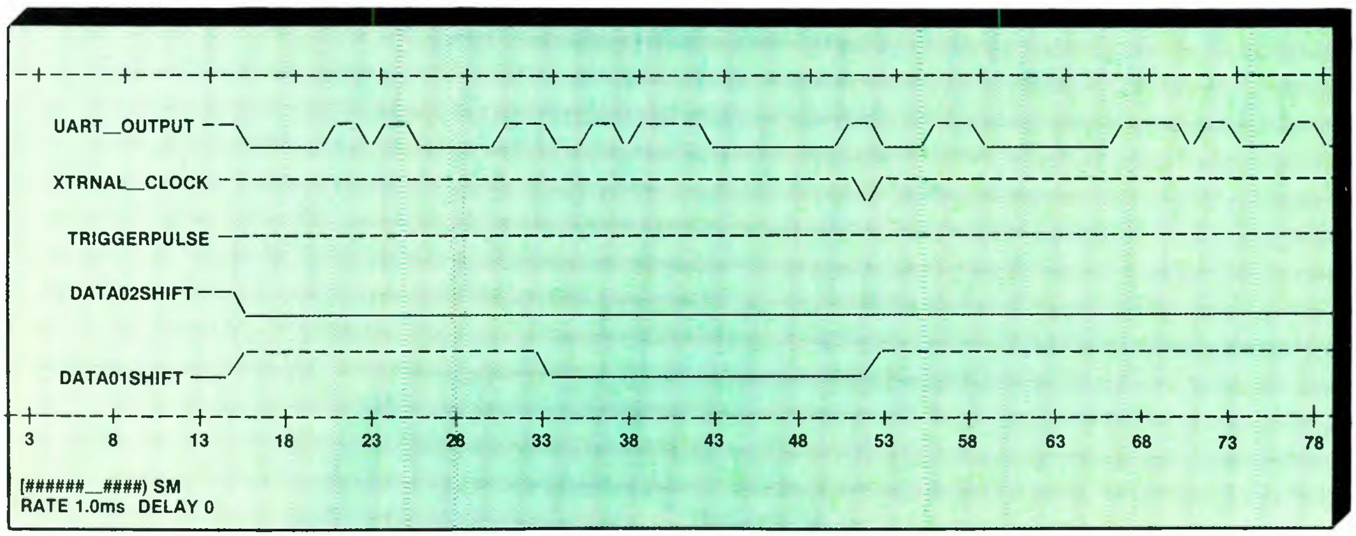


Figure 3. *Printout of waveform display with operator-programmed names for each channel.*

0111	0110	0001	0001	0111	0110	0011	0010	1100	1000	1011	1110
0111	0110	0011	0010	0111	0110	0011	0010	1100	1011	1011	1111
0111	0110	0011	0010	0111	0110	0011	0010	1101	1001	1000	0000
0111	0110	0011	0010	0111	0110	0011	0010	1110	1101	1000	0001
0111	0110	0011	0010	0111	0110	0011	0010	0100	111	1000	0010
0111	0110	0011	0010	0111	0110	0011	0010	1111	1011	0001	0011
0111	0110	0011	0010	0111	0110	0011	0010	1110	1001	0001	0100
0111	0110	0011	0010	0111	0110	0011	0010	0111	0110	0001	0010
0111	0110	0001	0010	0111	0110	0011	0110	0111	0110	0011	0011
0111	0110	0011	0010	0111	0110	0011	0010	0111	0110	0011	0011
0111	0110	0011	0010	0111	0110	0011	0010	0111	0110	0011	0011
0111	0110	0011	0010	0111	0110	0011	0010	0111	0110	0011	0011
0111	0110	0011	0010	0111	0110	1001	0010	0111	0110	0011	0011
0111	0110	0011	0010	0000	1101	1011	1000	0111	0110	0011	0011
0111	0110	0001	0010	1100	0010	1011	1001	0111	0110	0011	0011
0111	0110	0011	0010	0100	0101	1111	1010	0111	0110	0011	0011
0111	0110	0001	0010	0000	0000	1111	1011	0111	0110	0011	0011
0111	0110	0011	0010	1110	0001	1011	1100	0111	0110	0011	0011
0111	0110	0011	0010	1001	0010	1111	0000	0111	0110	0011	0011
0111	0110	0011	0010	1100	0000	1111	0001	0111	0110	0011	0011
0111	0110	0011	0010	0000	0101	1011	1101	0111	0110	0011	0011

(####__######) SM
RATE EXTERNAL DELAY 0
FIRST: –50 LAST: 12

Figure 4. *Typical dump display of binary data.*

Continued from page 136

The analyzer comes complete, and no options are required to immediately begin learning about digital circuitry. A pattern-generator option is available, which can be used to provide digital patterns to exercise a circuit. An EPROM programmer also is available for those wishing to make backup copies of the EPROM used in much of today's equipment.

The analyzer's computer portion can be serviced by local Kaypro repair depots. The logic analyzer portion can be repaired by the owner or returned to the company for servicing. The logic analyzer card is mounted on the top of the computer boards and is easy to install and remove. Replacement microchips and active circuit pods also are available from the company.

Instruction manual

The instruction manual is nearly 200 pages long. The instructions are clearly written and contain numerous illustrations. The manual is designed with edge-stripes that can be used to open the book to the appropriate heading. In addition to the detailed instructions, a quick-start chapter gets a new operator up and running within minutes. For example, our staff was able to begin capturing data from a camera microprocessor card in less than 20 minutes after receiving the logic analyzer.

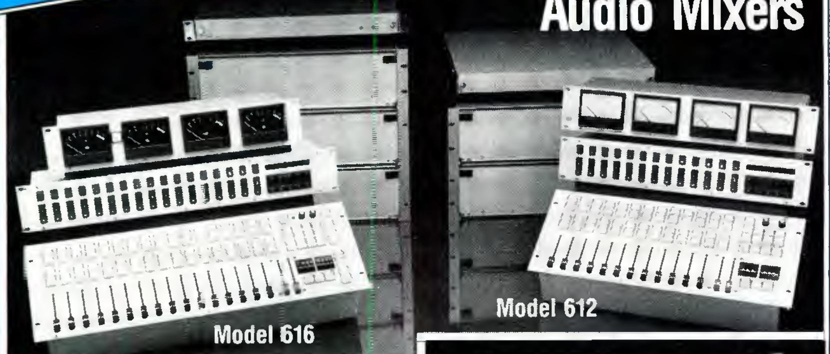
Logic analyzer is shown connected to a routing switcher for troubleshooting.

The technician is performing tests with the analyzer. Note the two impedance interface pods that connect the analyzer to the equipment under test.

1) START OF RANGE: 0 1111
2) END OF RANGE: 1 1111
3) NUMBER OF ACCUMULATIONS: 1
4) RANGE SCALING FACTOR: 5

SAMPLES	% FREQ OF LAST SAMPLE	% CUMULATIVE FREQUENCY
100 +		
40-99	47 ##########	47 ##########
20-39		
10-19		
5-9		
4		
3	7 ##	7 ##
2	45 #########	45 #########
1		

Figure 5. *Histogram display showing percent of activity of circuit under test.*



Operator training

Some engineers may be intimidated by the prospect of using such a device to troubleshoot their equipment. Most other troubleshooting techniques require only one or two test leads and maybe a couple of traces on a scope. The prospect of looking at eight or more scope traces or a display filled with binary or hexadecimal digits might send the engineer running to the phone for help.

However, because today's equipment is becoming so complex, different troubleshooting techniques have to be learned. These new techniques often require sophisticated test equipment. The key to repairing the new broadcast gear is to get this new generation of test equipment into the hands of maintenance engineers and give them a chance to learn how to effectively use it.

If you have ever been faced with repairing a complex microprocessor device, you have some idea of how difficult it can be. Scopes, logic probes and counters are often insufficient to effect repairs. On the other hand, if you learn how to use a logic analyzer, you can drastically cut that repair time. In some cases, repairs may be impossible without such a device. To be effective, however, the engineer needs time to become thoroughly acquainted with the equipment.

The Omni 4 logic analyzer provides troubleshooting capability not available in other devices. It's not a simple device. Modern test equipment seldom is. However, properly used, it can help you repair complex broadcast equipment.

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