

TECHNOLOGY UPDATE

SCSI DEVELOPMENT SYSTEMS

In chip-level designs, for example, you have to develop firmware to control the basic operation of the SCSI IC. Peripheral-controller designs typically include a single μ P to manage the SCSI interface and provide the control function. The portion of the firmware dedicated to the interface responds to bus activity and controls the flow of data to and from the peripheral.

Host designs include a dedicated μ P or, in some cases, the host CPU manages the SCSI IC. The firmware handles SCSI transactions such as instigating or responding to bus activity and completing data transfers.

For both chip- and board-level host implementations, you also have to develop operating-system device drivers.

The SCSI testing and debugging tools available all share one common feature—they connect to the unit under test via the SCSI bus and thus provide true functional testing. Passive tools simply monitor or capture and analyze bus activity. Active tools actually emulate a host or a peripheral device. Some tools have both passive and active capabilities. Ultimately your application—and your budget—will determine which tool you choose.

Which tool to use?

If you require minimal data-capture capabilities and don't want to spend too much money, the SCSI Byte Grabber from Rancho Technology may fulfill your needs. The product functions as the physical interface between a host and a peripheral. It passively monitors all SCSI control and data signals except for one—the REQ signal. Because it has control of this signal, the Byte Grabber can control all SCSI bus activity and make the bus operate in a single-step mode. Front-panel LED indicators let you monitor the bus's control signals,



Analysis and emulation software from Pacific Electro Data allows you to stimulate bus activity, capture all SCSI transactions, and analyze the results.

and a 2-digit hexadecimal display lets you see the data lines. Although limited in capabilities, the \$380 device offers a low-cost way of testing a SCSI design.

If you need more data-capture ability but want *relatively* low-cost testing, consider the Flexstar FS600 SCSI Bus Monitor. The FS600 can passively capture 8k bytes of SCSI bus activity, operates at SCSI bus speeds of 1.5M bytes/sec, and costs \$1800. The bus monitor includes a parallel-printer port so that you can print the captured data. The monitor will output your choice of raw control and data signals and disassembled bus phases with or without the captured data bytes.

More analysis is possible

For more extensive analysis needs—and corresponding higher cost—Ancot, Pacific Electro Data, and Peer Protocols all offer SCSI testing tools. Products from all three companies allow you to capture and analyze SCSI bus activity

based on a variety of conditions. All of the tools employ event triggering and time stamping; they don't needlessly capture data into limited-size buffers when the SCSI bus is idle. The products use time stamping to provide information such as time elapsed during a test, time elapsed since last event, and time elapsed between any two events.

Ancot's Model DSC-202 analyzer includes a 68008 local μ P and comes in a stand-alone case. You control the Ancot product via a terminal or a personal computer connected via one of two serial ports. The other port can connect directly to a printer.

Pacific Electro Data's PED-4000 Series and Peer Protocols' 2000, 3000, and 5000 Series each use a personal computer as a host for the development system. The products include an IBM personal-computer-compatible add-in board and software.

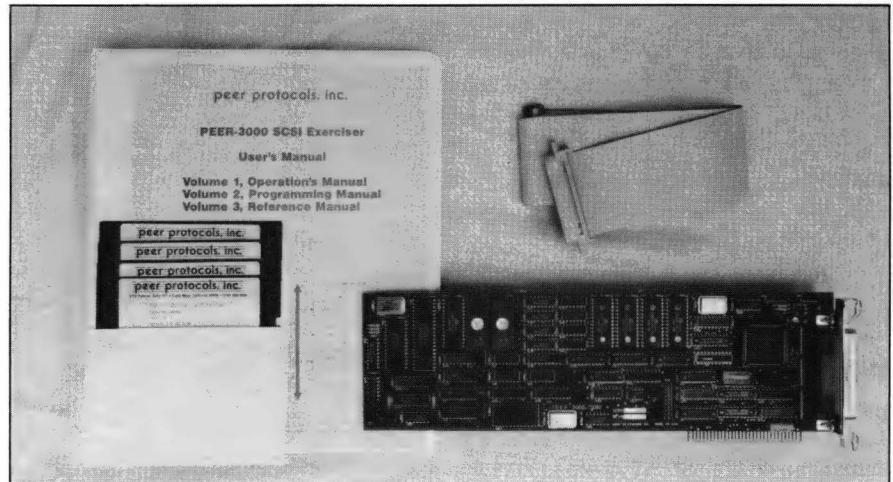
You have a choice of controlling the Ancot, Pacific Electro Data, and Peer Protocol analyzers via

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menus or by developing your own control programs. The analyzers can selectively capture activity based on trigger conditions: You can choose to capture all data transmissions or only selected portions. The menu interfaces of all the products allow a fair amount of flexibility in controlling the capture operation. Furthermore, because you have the option of developing your own control programs, you can set the products to selectively capture almost any conceivable event or events.

Peer Protocols' analyzers capture bus activity based on bus-phase changes. Because several signal transitions occur between phase changes, some engineers may construe this capture approach as a potential weakness. Not so, says company president Herbert Silverman. He believes that, provided the hardware is working, you don't need analysis at the individual control-signal level to debug either the software or the firmware. The prod-



Triggered by bus-phase transitions, the Peer Protocols Peer-2000 can analyze bus activity and provide time stamps with 1- μ sec resolution.

ucts from Peer Protocols all provide 1- μ sec resolution time stamps corresponding to phase changes.

The \$995 Peer-2000 occupies a half-slot in a personal computer and adequately tests low-end asynchronous SCSI operation. The board does not include a dedicated capture buffer, and therefore the PC's DMA capability limits the product's abil-

ity to capture data being transferred at fast rates. The Peer-2000 reliably captures data at the 1.25M-byte/sec rate prevalent in many SCSI-peripheral designs.

The \$2995 Peer-3000 and the \$4995 Peer-5000 feature identical analysis capabilities (the higher-priced Peer-5000 includes a μ P that improves performance during emu-

Don't ignore other tools for SCSI testing

The prolific growth in SCSI usage in the computer industry has spawned a market for various types of specialized test equipment. Tools for debugging SCSI software and firmware designs are by no means the only ones available to aid engineers. Designers can use other test equipment for evaluation and acceptance testing of SCSI peripherals, for factory testing, for evaluating I/O subsystem performance, and for several others.

Numerous companies offer test systems specifically designed to test disk and tape drives, for instance. You'll find test systems capable of testing one drive or capable of simultaneously testing as many as 4000 drives. These types of units satisfy roles such as burn-in and incoming-inspection testing. Companies that offer such products include Adaptec (Milpitas, CA), AVA Instrumentation Inc (Ben Lomand, CA), Brian Instruments Inc (Fullerton, CA), Cambrian Systems Inc (Westlake Village,

CA), Flexstar (Milpitas, CA), I-Tech (Eden Prairie, MN), JCS Technology Inc (Los Gatos, CA), Peer Protocols (Costa Mesa, CA), Santa Cruz Digital (Santa Cruz, CA), and Wilson Laboratories Inc (Orange, CA).

Another company, I/O Xel Inc (Santa Clara, CA), sells disk-drive performance-evaluation tools. The \$1200 SCSI Benchmark, for example, lets you benchmark a disk drive's performance. The company also recently introduced a multiple-drive real-time performance-evaluation tool.

Despite the proliferation of SCSI chips, a few designers may still be forced to build SCSI-compatible interfaces with discrete-logic or semicustom-IC techniques. For these designers, Hewlett-Packard (Palo Alto, CA) offers a SCSI-specific add-on, the Preprocessor Interface Module, for its series of logic-analyzer products.

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lation). The products have 128k-byte RAM buffers and can capture asynchronous bus operations at 4M-byte/sec rates and synchronous operations at 5M-byte/sec rates.

The Model DSC-202 analyzer from Ancot captures bus activity based on signal changes rather than phase changes. For \$5650, you get the basic product capable of captur-

ing 32,000 16-bit events, but no time-stamping capability. The time-stamping option costs \$1200 and makes the trace memory 56 bits wide. The analyzer will also capture

State_Analysis_Sample_Printout

11-03-88 22:57:01

| DELTA TIME | EXTRN | SSETS//EC | DATA | BUS | BUS | ID | NUM | NUM | LINE |
|----------------|-------|-----------|-----------|-----|---------|-------|-----|------|------|
| MM:SS:MILLISEC | 43210 | TYLNGDQK | P76543210 | HEX | PHASE | CNDTN | IT | REQs | ACKs |
| 00:00:000.0018 | 11111 | 000000000 | 000000000 | 000 | BUS CLR | NORM | | 0000 | 0000 |
| 00:00:006.2979 | 11111 | 010000000 | 010000000 | 080 | ARBTRN | NORM | | 0000 | 0000 |
| 00:00:000.0145 | 11111 | 011100000 | 010000000 | 080 | SELECT | ATTN | | 0000 | 0000 |
| 00:00:000.0213 | 11111 | 001100000 | 110000001 | 181 | SELECT | ATTN | 7 | 0 | 0000 |
| 00:00:000.0309 | 11111 | 011100000 | 110000001 | 181 | SELECT | ATTN | 7 | 0 | 0000 |
| 00:00:000.0119 | 11111 | 010100000 | 110000001 | 181 | INTER | ATTN | 7 | 0 | 0000 |
| 00:00:000.3423 | 11111 | 010001011 | 100000000 | 100 | COMMAND | NORM | 7 | 0 | 0001 |
| 00:00:000.0296 | 11111 | 010001011 | 100000000 | 100 | COMMAND | NORM | 7 | 0 | 0001 |
| 00:00:000.0630 | 11111 | 010001011 | 100000000 | 100 | COMMAND | NORM | 7 | 0 | 0001 |
| 00:00:000.0285 | 11111 | 010001011 | 100000000 | 100 | COMMAND | NORM | 7 | 0 | 0001 |
| 00:00:000.0285 | 11111 | 010001011 | 100000000 | 100 | COMMAND | NORM | 7 | 0 | 0001 |
| 00:00:000.0285 | 11111 | 010001011 | 100000000 | 100 | COMMAND | NORM | 7 | 0 | 0001 |
| 00:00:004.5575 | 11111 | 010001111 | 100000000 | 100 | STATUS | NORM | 7 | 0 | 0000 |
| 00:00:000.2608 | 11111 | 010011111 | 100000000 | 100 | MSG IN | NORM | 7 | 0 | 0000 |
| 00:00:000.0253 | 11111 | 000000000 | 000000000 | 000 | BUS CLR | NORM | | 0000 | 0000 |

(a)

Phase_Analysis_Sample_Printout

11-03-88 22:51:19

| DELTA TIME | BUS | PHASE | INFORMATION | EXTRN | LINE |
|----------------|-------------|-------|---------------------------------|-------|-------|
| MM:SS:MILLISEC | | | | 43210 | NUM |
| 00:00:000.0018 | BUS | FREE | 00000000 | 11111 | 0000 |
| 00:00:006.3124 | ARBITRATION | | 10000000 Device 7 won. | ATN | 11111 |
| 00:00:000.0213 | SELECTION | | 10000001 Initiator 7, Target 0. | ATN | 11111 |
| 00:00:000.3851 | COMMAND | | 00 - Test Unit Ready | | 11111 |
| 00:00:000.0296 | COMMAND | | 00 00 00 00 00 | | 11111 |
| 00:00:004.7060 | STATUS | | 00 - Good Condition | | 11111 |
| 00:00:000.2608 | MESSAGE IN | | 00 - Command Complete | | 11111 |
| 00:00:000.0253 | BUS | FREE | 00000000 | 11111 | 0007 |
| 00:00:024.9962 | ARBITRATION | | 10000000 Device 7 won. | ATN | 11111 |
| 00:00:000.0216 | SELECTION | | 10000001 Initiator 7, Target 0. | ATN | 11111 |
| 00:00:000.3892 | COMMAND | | 25 - Read Capacity | | 11111 |
| 00:00:000.0282 | COMMAND | | 00 00 00 00 00 00 00 00 | | 11111 |
| 00:00:000.3100 | COMMAND | | 00 | | 11111 |
| 00:00:003.0449 | DATA IN | | 00 00 A0 2B 00 00 02 00 | | 11111 |
| 00:00:003.4184 | STATUS | | 00 - Good Condition | | 11111 |

(b)

Sample state- and phase-analysis printouts from the PED-4000 demonstrate the type of analysis SCSI development tools can perform. Transitions in the state of SCSI signals generated the data in the state-analysis printout (a). The phase-analysis report (b) depicts data gathered based on transitions in bus phases.

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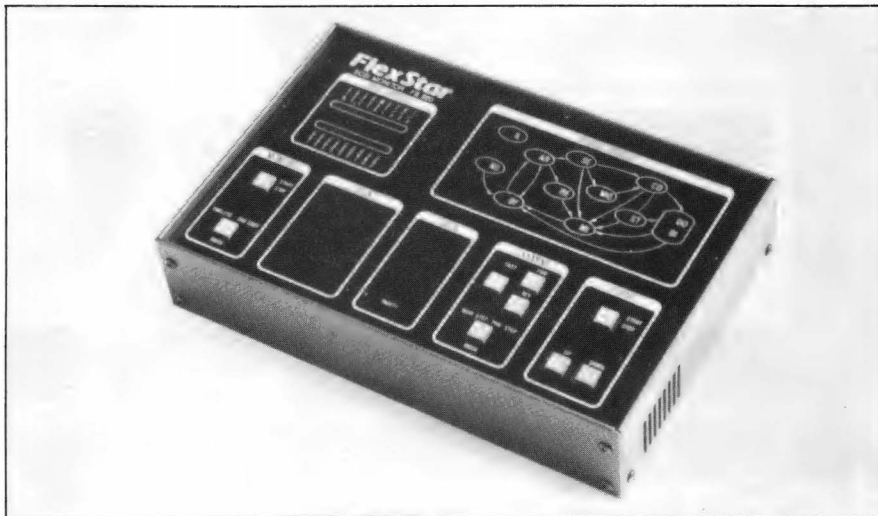
eight external inputs along with the SCSI signals.

The Ancot analyzer offers 50-nsec resolution and can capture asynchronous or synchronous bus operations at speeds of 4.5M bytes/sec. You control the DSC-202 via menus stored in its ROM or with C programs that you can download. EEPROM stores current setup parameters. You can upload, view, or print the analyzed data in a structured Pascal-like format or in either hexadecimal or binary formats.

Pacific Electro Data's PED-4000 Series of analyzers also captures data based on signal state changes. The PED-4001 costs \$3950 and includes the personal-computer add-in board and the state-analysis program. The product includes time stamping, provides 100-nsec resolution, includes five external inputs, and has a $2k \times 32$ -bit capture buffer. You can capture asynchronous or synchronous bus activity with the PED-4001, but the resolution limits the capture of data to about 2.5M-byte/sec transfer rates. The company also offers a \$295 phase-analysis program, the PED-4002, for the PED-4001.

The PED-4000 Series includes a proprietary procedural programming language that you can use to set up complicated test sequences. The company has also just begun to offer an analyzer product with 50-nsec resolution. The PED-4501 costs \$5950 and includes an $8k \times 32$ -bit capture buffer. The new product employs a user interface and programming interface similar to the PED-4001.

Although all of these analyzer products offer powerful capabilities, your application may demand a development tool that actively stimulates bus activity along with monitoring it. Adaptec, along with Ancot, Pacific Electro Data, and Peer



An 8k-byte buffer captures SCSI bus activity in the Flexstar bus monitor. The product includes a parallel-printer port, so that you can subsequently print the data.

Protocols, offers a number of development systems that can actively emulate host and peripheral devices.

Adaptec's marketing philosophy, or approach, is different from the other three vendors, however. Adaptec's analyzers are an adjunct to its active-emulation development systems, which Adaptec considers the basic tools for testing and debugging. Ancot's, Pacific Electro Data's, and Peer Protocols' active-emulation products are software options to the previously described analyzers that the three companies sell.

Both initiator and target emulation packages are available. In real-world applications, a host computer is typically an initiator and a peripheral is typically a target. The SCSI spec, however, allows any device to initiate bus activity and any device to respond.

The emulation products from all four companies include a similar set of features. The initiator emulators include a library of test routines typical of host activity or communication with peripherals such as disk and tape drives. You can control the

emulation via menus. You can also use the menus to develop new tests based on routines in the library or on routines you define at the SCSI command level. In fact, the menus allow you to set up tests representative of virtually any SCSI environment.

You can also use programming languages to control the emulation. Adaptec, Ancot, and Peer Protocols offer C; Pacific Electro Data provides a proprietary procedural language. During software testing, you will find that the menus offer the flexibility to quickly change emulation parameters and to create new tests. The programming languages ultimately offer more flexibility, however, and can also be useful to set up standard test sequences for testing or evaluating peripherals.

The target emulation packages operate in the same manner as the initiator emulation products. However, they include libraries that simulate disk or tape drives, and you can use the menu interface to develop emulations of virtually any peripheral. In addition, you can use the programming languages to set

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up emulations.

The initiator and target emulators provide a vehicle to simulate a working product and test your design in the early debugging stages. The emulators also allow you to fully test your finished product. For example, you can have a target emulator generate selective bus-parity errors and ensure that your host software handles those errors properly. In fact, the ability of the emulators—both initiators and targets—to generate improper conditions is of more importance than the simulation of working products in many testing applications.

Anco's active-emulation package includes target and initiator and costs \$3100. The product supports asynchronous data transfers of 1.5M bytes/sec. The menus allow you to select from standard test routines stored in EPROM. You can store test routines that you design in EEPROM, too.

Peer Protocols sells its initiator and target emulation packages separately. Each program costs \$500 and will work with any of the company's analyzer boards. The Peer-5000 includes a local μ P and doesn't require host intervention to execute an emulation; the product can therefore simulate the operation of fast peripherals with little SCSI command overhead.

To add initiator and target emulation to Pacific Electro Data's PED-4001, you have to pay \$795 for each capability. The PED-4001 can transfer data asynchronously at 1.5M bytes/sec. The company currently doesn't offer an emulation package for the PED-4501, but it expects to introduce one during the first quarter of 1989. The product will include a second add-in board and software.

Adaptec's line of SCSI development tools are the most extensive of any of the manufacturers—in-

The screenshot shows a graphical user interface for the SCSI Program Generator. It consists of two main windows. The top window, titled 'Function Pick Window', contains a list of test functions: readcap (0,0x00000000,0), readr (0x0000,0x0000), reset (), --> seek (0x0000), sense (0x0000), testur (), and a separator line followed by End, PgDn, ; Enter, Esc, a..z, ^Group. The bottom window, titled 'Test Sequence Edit', shows a sequence of commands: begin {, reset (), > readcap (0,0x00000000,0), and } end. To the right of the top window is a label 'ELEMENT PICK' and to the right of the bottom window is a label 'INSERT MODE'.

Tools such as the SCSI Program Generator from Adaptec provide easy program creation and execution by allowing you to pick from a list of more than 300 test functions. The program then places these functions into an executable test program.

cluding analyzer and active-emulation products. You can choose from the \$10,500 SDS-1, \$14,500 SDS-2, or \$18,500 SDS-3 system. All of the products require a host IBM-compatible personal computer; as an option, Adaptec offers the products bundled with Compaq and Wyse computers.

The SDS-1 offers target emulation only and supports asynchro-

nous data transfers. The SDS-2 and SDS-3 include both initiator and target emulation. The former can only handle 1.8M-byte/sec asynchronous data transfers, whereas the latter can transfer data either in asynchronous (1.8M bytes/sec) or synchronous (5M bytes/sec) modes.

The \$4950 SDS-210 analyzer board is an accessory for the SDS-1 or the SDS-2; the SDS-3 accepts the

For more information . . .

For more information on the SCSI test and development products discussed in this article, contact the following manufacturers directly, circle the appropriate numbers on the Information Retrieval Service card, or use EDN's Express Request service.

Adaptec Inc
691 S Milpitas Blvd
Milpitas, CA 95035
(408) 945-8600
FAX 408-262-1845
TWX 910-338-0060
Circle No 351

Anco Corp
1755 E Bayshore Rd, Suite 18A
Redwood City, CA 94063
(415) 363-0667
FAX 415-363-0735
Circle No 352

Flexstar Corp
606 Valley Way
Milpitas, CA 95035
(408) 946-1445
Circle No 353

Pacific Electro Data Inc
14 Hughes, Suite B205
Irvine, CA 92718
(714) 770-3244
Circle No 354

Peer Protocols Inc
3176 Pullman, Suite 101
Costa Mesa, CA 92626
(714) 662-1929
FAX 714-662-1437
Circle No 355

Rancho Technology Inc
8632 Archibald Ave, Suite 109
Rancho Cucamonga, CA 91730
(714) 987-3966
TLX 362087
Circle No 356

\$4950 SDS-310 analyzer. All of these analyzers can capture 64k bytes of data and include a set of features similar to the products from Ancot, Pacific Electro Data, and Peer Protocols. The SDS-3 system also includes support for SCSI-2 features such as command queuing. Another key feature of the SDS-3 is its menu-driven Program Generator for developing test programs.

The Adaptec products also all include capability for testing differential SCSI operation, in addition to being able to test the more popular single-ended operation. SCSI specifies a choice of single-ended or differential bus transceivers. Even though the other products don't include this capability, you can buy single-ended-to-differential converters, which typically cost \$200 to \$500, so that you can attain this capability.

Adaptec's prices also include two days of training (in Adaptec's facility) in the use of its SCSI development tools. As more designers address SCSI for the first time, this type of training will certainly ease the learning process. Peer Protocols has also perceived a need for customer training, and the company offers a 2-day training class (for as many as three people) for \$1200.

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