Tektronix, Inc. Company Confidential

field engineering news

October/December 1979

In this issue....

NEW DIRECTIONS SEEN FOR *FEN*

Field Engineering News' new format is only the first of the changes planned by its new editor, Ken Arthur.

As part of a restructuring of Tektronix' marketing organization, responsibility for **FEN's** publication was assigned to Technical Communications Services (TCS) at the beginning of FY000. TCS also publishes an in-house technical review and assists Tektronix authors in preparing technical papers/slide shows and technical articles for the trade press.

FEN's goals, according to its new editor, are to be more useful and interesting to the Tektronix sales engineer, and to carry much of the information now communicated to the sales force through various newsletters. By achieving these objectives, **FEN** can concentrate most of the SE's "required reading" in a single publication and relieve marketing departments of a drain on their technical-writing and graphics-production resources.

In the near future George Dunn, TCS manager, plans to visit a number of field offices to gather first-hand information on the SE's needs and preferences as they pertain to **FEN's** future directions.

Immediate plans for **FEN** include expanded coverage of the Tektronix sales organization. **FEN's** traditional role has been that of relaying technical reference data from marketing, service, and sales support units to the field engineer. This kind of information flow is indispensable to the field and will, of course, be sustained in future issues. But Ken believes a steady diet of reference material makes dull reading. He plans to offset this material with more stories about people, programs, and activities of the Tektronix sales organization. "We want SE's to feel that **FEN** is **their** paper. To do this, though, we will need a lot of participation from the field," he states.

Continued

At the present time, there are no established channels for reporting news of sales force activities, according to Ken. His first order of business is to establish a network of sources. "There are a lot of interesting things going on out there that have no way to get back to us," he explains, "nor to other SE's. It will be **FEN's** job to identify these stories and share them with the sales force."

Meanwhile, **FEN** will introduce new features — technology articles aimed at enhancing the SE's technical expertise and profiles of various support units which explain their relevance to the SE's day-to-day activities (see the report on Contract Administration and the GPIB article in this issue). ■

Promotions

LARRY LONGWAY APPOINTED GOVERNMENT CONTRACTOR ACCOUNT MANAGER

The selection of Larry Longway as Government Contractor Account manager was announced recently by Duane Bowans, Government Accounts Group manager.

Larry brings to this position a variety of experience with Tektronix, most recently as an Army Account Specialist working out of the Huntsville field office. In this post he covered the Army Missile Command and coordinated a number of sales programs involving major contractor customers. Prior to his work as an Army Account Specialist, he spent several years as an SE in the Ft. Lauderdale field office. During that time he was responsible for negotiating contracts with large companies, and proved himself a top salesman in other ways. Prior to his field experience, Larry spent several years in Beaverton in a variety of positions.

In his new position, Larry will focus attention on those major Government contractors who are judged critical to the success of Tektronix' sales program goals. Larry will work with the field sales force to coordinate sales programs aimed at selected government contractors across the United States. He will also provide training in program management as it relates to government contractors and the government acquisition process.

Larry will be based at the Irvine field office and will report to Duane. ■

DALLAS AND HOUSTON GET NEW DISTRICT SALES MANAGERS

Mike Mertes and Rocco Papalio have been chosen to manage the Dallas and Houston districts, respectively, according to Jim Jacobs, Area Sales Manager (Midwest) at Dallas.

Mike Mertes comes to Tektronix from the Atlanta headquarters of Micromeritics, where he held the position of regional sales manager. Prior to that, Mike was a sales engineer for Packard Instrument Company.

Rocco Papalio was a sales engineer in the Tektronix Denver field office with major account responsibility for Unirad, Inc. Rocco joined Tektronix as a Tektronix display cruiser representative after a career with the U.S. Air Force. ■

Training Operations

AUDIOTAPE COST-TRANSFER POLICY

In transferring audiotape duplication charges, Training Operations' policy has been to initiate a cost transfer only when a request totalled twenty tapes or more. The intent of this policy was to discourage unnecessary orders of the total audiotape inventory.

Commencing AP004, we will transfer costs on a **quarterly** basis for **cumulative** orders of twenty tapes or more. This change will more accurately identify the major users and assess them accordingly. ■

NEW VIDEOTAPES

833 Operation 1 (of 2): Asynchronous Systems introduces data-communication-network testing. Physically describes 833. Demonstrates front-panel setting for monitoring asynchronous system. Demonstrates terminal testing.

Running time: 19 min. 068-0095-00

833 Operation 2 (of 2): Synchronous Systems; BERT illustrates monitoring of synchronous systems with testing of IBM 3275 terminal. Demonstrates assembly and modification of test messages. Demonstrates BERT (Bit Error Rate Testing). Describes HDLC (High-level Data Link Control) and NRZI (Non-Return to Zero Inserted) operation. Describes 833 internal diagnostic routines.

Running time: 23 min. 068-0096-00

Pulsed RF Measurements investigates basic pulsed RF characteristics and their measurement in both the time and the frequency domains.

This tape is the fourth and last in the Spectrum Analyzer Concept Series: **"Spectrum Analyzer Concepts"** (068-0070-00), **"AM Measurement"** (068-0072-00), **"FM Measurement** (068-0089-00), and the newest, **"Pulsed RF Measurement."** The tapes average ten minutes in length and introduce the viewer to spectrum analyzer design, the appearance of familiar time domain waveforms when viewed in the frequency domain, and to three general application areas.

The first tape, **"Spectrum Analyzer Concepts,"** was nominated for an award at this year's International Television Association convention in Dallas.

Running time: 10 min. 068-0097-00

For more information about new videotapes, call Herb Doumitt, 74-868, ext. 6203. ■

Warranty Committee

COMMITTEE OK'S WARRANTY POLICY CHANGES

In an August 3, 1979 meeting, the Warranty Policy Committee agreed to these changes, according to its chairman, Stan Kouba:

- Options with product nomenclature, such as the 8002F38 and the 4051F10, are to have the same warranty as the base product.
- When, after the 90-day on-site **system** warranty has expired, on-site service is requested and is available for system **components** that are warranted for one year at the service center (for example, the 7912AD and 603 Monitor), the customer is to be invoiced for labor and zone charges. The parts will be warranted at the customer's site for the remaining nine months. This differs from the September, 1978 decision which specified that the customer would also be invoiced for parts (except crt's).

Both changes are effective immediately and will be included in the Warranty Policies Manual when it is updated. ■

Provisioning Documentation

NEW CONTRACT RECEIVED

Tektronix has received the following new government contract which includes provisioning:

Contract No.	DAABO7-79-C-1997
Customer	Ft. Monmouth, NJ
Product Type	Tektronix 475 Option 04 (OS-261/C) ■

NEW PUBLICATIONS

C-30B Instruction Manual	070-2825-00	$ 7.00
CP57003 TEK SPS BASIC V02 R7912 Driver Package Software Manual	070-2744-00	7.00
CP57004 TEK SPS BASIC V02 DPO Driver Package Software Manual	070-2739-00	7.00
CP57006 TEK SPS BASIC V02 7912AD Commands Package Software Manual	070-2745-00	7.00
CP57007 TEK SPS BASIC V02 High-Level Support Package Software Manual	070-2738-00	7.00
CP57008 TEK SPS BASIC V02 Assembly Level Support Package Software Manual	070-2741-00	7.00
DM501A Instruction Manual	070-2749-00	7.00
S-3200 Series 4K PRAM (015-0346-00) Instruction Manual Addendum to Pattern RAM Manual (070-3261-00)	070-3368-00	5.00
015-0375-00 Signal Buffer/Mask Unit for S-3200 Series Instruction Manual	070-3369-00	8.00
1803 Test Station Wire List Instruction Manual	070-3370-00	50.00
1804/1804A/1805 Test Station Wire List Instruction Manual	070-3371-00	50.00
606B Operators Manual	070-2820-00	7.00
7A16P Programming Aid Reference Card	070-2981-00	1.00
7B90P Programming Aid Reference Card	070-2982-00	1.00
832/833 RS-232 Interface HEX-ASCII Conversion Chart Reference Card	062-4370-00	1.00
832/833 RS-232 Interface HEX-EBCDIC Conversion Chart Reference Card	062-4369-00	1.00

■

Spectrum Analyzers

COMB GENERATOR AIDS IN SPECTRUM ANALYZER DEMONSTRATION, CALIBRATION

The 067-0885-00 Microwave Comb Generator shown in figure 1 is an excellent aid in showing off the extensive capability of spectrum analyzers like the 7L12, 7L13, 7L18, and the new 492.

Figure 1. Tektronix Microwave Comb Generator (067-0885-00).

The name *"comb generator"* is given to a class of generators whose output frequencies are harmonically related (and hence equally spaced).

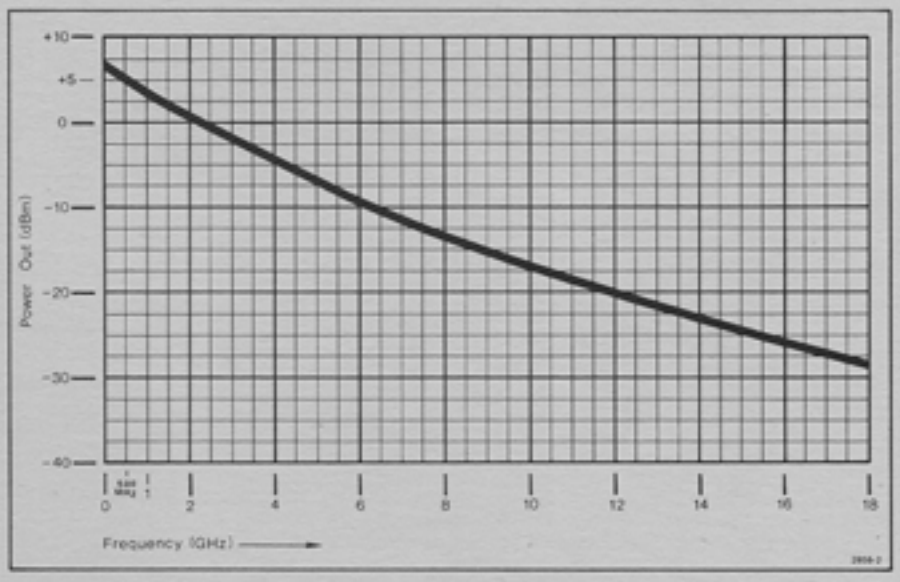


Figure 2. Graph of power output vs. frequency.

Generally, comb generators are crystal oscillator-multiplier chains putting out about 0.5 to 1 watt in the 100MHz to 500MHz frequency range. This power is then applied to a step-recovery-diode harmonic generator whose output can extend up to 18GHz at power levels of -30dBm (figure 2).

HOW TO USE IT

Because the comb generator is crystal controlled, and hence very

Continued

stable, you can show off our narrowest resolution bandwidths and low residual FM (figure 3).

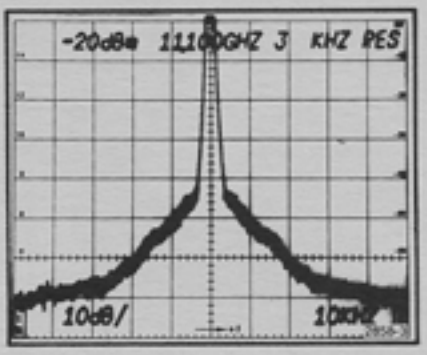


Figure 3. Demonstrating spectrum analyzer resolution and stability.

The comb generator can be frequency-modulated with TM500 plug-ins like the SG502 audio oscillator or any of the TM500 function generators (figure 4).

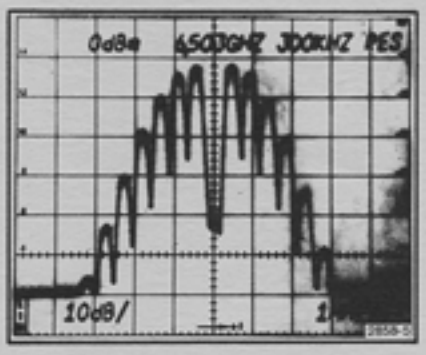


Figure 4. Display of FM signal.

You can pulse modulate the comb generator with various pulse generators such as the PG502 (figure 5). A word of caution about pulse modulation: A pulse width of 10 microseconds or wider is necessary to obtain a good symmetrical pulse spectrum. The comb generator will not handle pulses less than about 10 microseconds with good fidelity, although its output can be used in non-measurement applications.

The comb generator is an excellent tool for calibrating and troubleshooting spectrum analyzers. Use it in obtaining spectrum photographs from a normally operating instrument over the entire

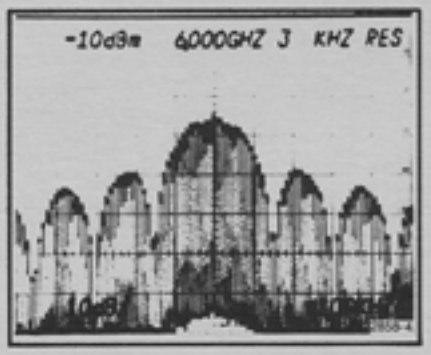


Figure 5. Display of pulse-modulated signal.

microwave frequency range. You can then periodically check sensitivity and frequency response against this reference signature.

You can also use the comb generator to check center-frequency accuracy; or, if you modulate it with an SG502, you can check any span/division accuracy. In this application the comb generator acts like the frequency-domain equivalent of a time mark generator.

AVAILABLE FOR CUSTOMER SALE

As a final attraction, note that the comb generator is available for sale to customers, and that you get sales credit.

Your Customer Service Representative has ordering information on the comb generator and it is listed in the Numerical Parts Register. For additional information, contact Len Garrett, d.s. 58-741, ext. 7815. ■

GPIB ARTICLE RECOMMENDED FOR SE'S

The **Engineering News** article reprinted on the following pages will help you prepare for new product training scheduled later in FY000, continue your professional technical education, and give you the background to help sell Tektronix GPIB-compatible gear.

The term "GPIB" covers both a specification (IEEE Standard 488-1975) and concepts (interfacing and programmability). This article, the first of a two-part series, describes the IEEE 488 hardware details. The interface specification is complicated because the GPIB is described by a *very* detailed standard. Don't get lost in these details — just keep in mind that the GPIB helps your customers easily add computing power to their test and measurement procedures, by interconnecting instruments with desktop or other computing devices.

The next article will focus on the communications aspects of the bus, which make it easier for customers to develop their own systems for complex testing.

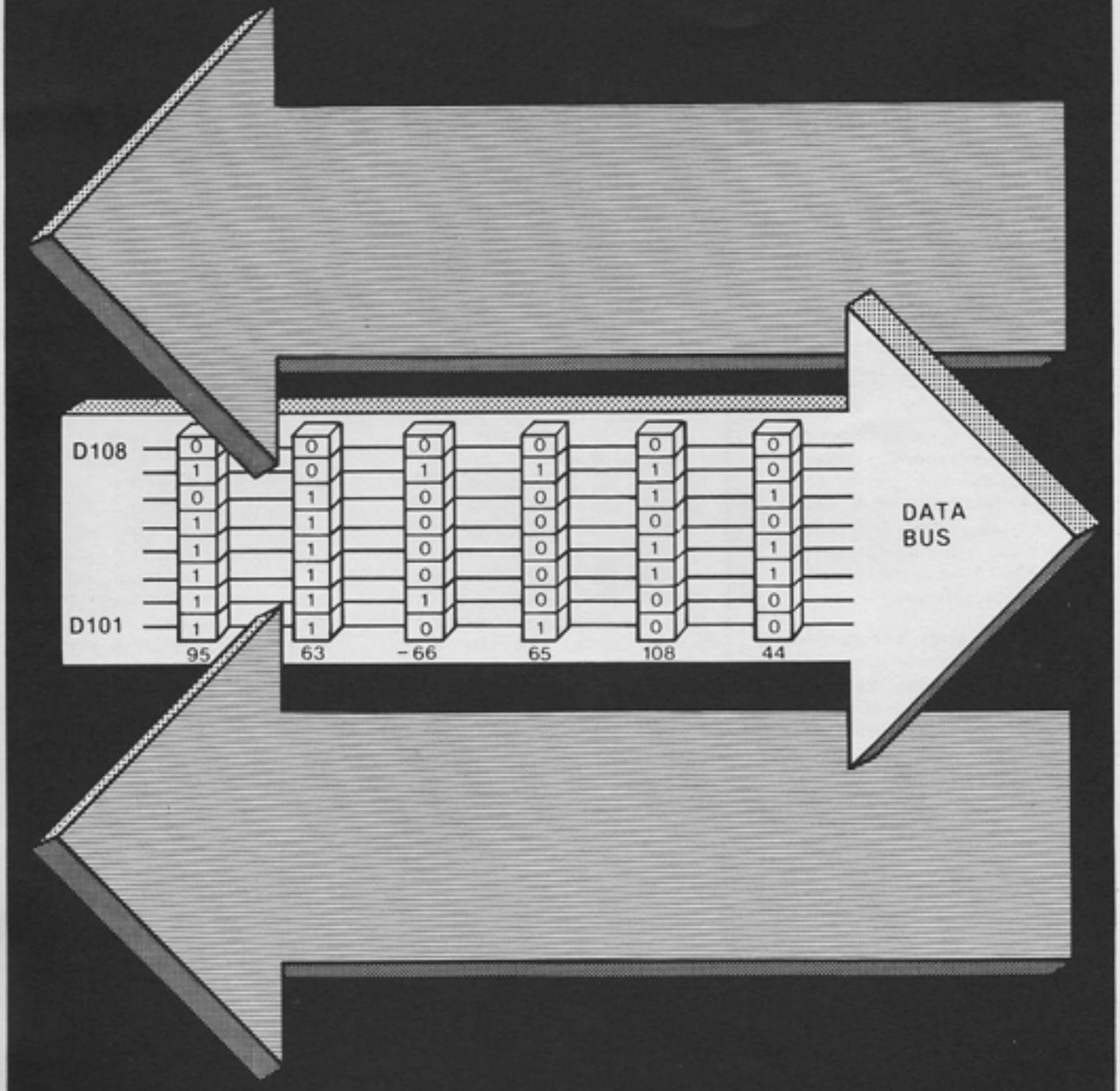
Jim Geisman
Corporate Marketing

REPRINT

ENGINEERING NEWS

COMPANY CONFIDENTIAL

AUGUST • SEPTEMBER 1979



GPIB System Concepts

GPIB SYSTEM CONCEPTS

Arnold Farley, TM 500 Manuals, ext. 1552 (Walker Road).

This series of articles describes the digital interface specified in IEEE Standard 488-1975, "Standard Digital Interface for Programmable Instrumentation." At Tektronix, the digital interface is commonly called the General Purpose Interface Bus (GPIB).

This first article discusses signal-line definitions. The next article will discuss interface functions and the protocol for transferring data between instruments on the bus.

WHAT IS THE GPIB?

The GPIB is a digital interface that allows efficient communication between the components of an instrumentation system.

The primary purpose of the GPIB is to connect self-contained instruments to other instruments or devices. This means that the GPIB is an interface system independent of device functions.

There are four elements of the GPIB: mechanical, electrical, functional, and operational.

Of these four, only the last is device-dependent. Operational elements state the way in which an instrument reacts to a signal on the bus. These reactions are device-dependent characteristics and state the way in which the instruments use the GPIB via application software.

Mechanical Elements. The standard defines the mechanical elements : cables and connectors. Standardizing the connectors and cables ensures that GPIB-compatible instruments can be physically linked together with complete pin compatibility.

The connector has 24 pins, with 16 assigned to specific signals and eight to shields and grounds. Instruments on the bus may be arranged in a linear or star configuration.

Electrical Elements. The voltage and current values required at the connector nodes for the GPIB are based on TTL technology (power source not to exceed +5.25V referenced to logic ground). The standard defines the logic levels as follows. Logical 1 is true state, low-voltage level ($\leq$+0.8V), signal line is **asserted.** Logical 0 is false state, high-

BACKGROUND

The General Purpose Interface Bus (GPIB) is a control bus that interfaces with a microcomputer (processor) and external peripheral devices.

Prior to the original development of the GPIB by Hewlett-Packard in 1975, the CAMAC (Computer Automated and Measurement Control) interface was developed by the nuclear industry. The IEEE promulgated this interface under several standards: Std 583 (Basic CAMAC), Std 595 (CAMAC), and Std 596 (Parallel CAMAC). CAMAC was comprised of a rigorously-specified mainframe (chassis) housing 25 plug-in modules. Outside of the nuclear industry and some electrical power companies, CAMAC was rarely used in industrial applications. The Parallel CAMAC transmitted data at a rate near 5 megabits/second over 86 lines. The major obstacles to its acceptance has been its expense and impracticality for microprocessor control.

The GPIB was developed as a control bus for instruments. This interface is oriented toward system configurations that use a variety of peripherals. Any type of 8-bit data is sent or received over the data bus in a byte-serial, bit-parallel fashion. Bus extenders can be used, at reduced data rates, to interface with common carriers. The GPIB is a very practical and inexpensive means to transmit or receive data from microcomputers over relatively short distances (up to 20 meters without bus extenders).

INTERFACE FUNCTION	SYMBOL
Source Handshake	SH
Acceptor Handshake	AH
Talker or Extended Talker	T or TE
Listener or Extended Listener	L or LE
Service Request	SR
Remote-Local	RL
Parallel Poll	PP
Device Clear	DC
Device Trigger	DT
Controller	C

Table 1. The ten major interface functions for the GPIB.

voltage level ($\geq$+2.0V), signal line is **not asserted.**

Messages can be sent over the GPIB as either active-true or passive-true signals. Passive-true signals occur at a high-voltage level and must be carried on a signal line using open-collector devices. Active-true signals occur at a low-voltage level.

Functional Elements. The functional elements of the GPIB cover three areas:

Ten interface functions that define the use of specific signal lines so that an instrument can receive, process, and send messages (the ten interface functions - with their allowable subsets - provide an instrumentation system with complete communications and control capabilities).

The **specific protocol** by which the interface functions send and receive their limited set of messages.

The **logical and timing relationships** between allowable states for the interface signal lines.

INTERFACE FUNCTIONS

Not every instrument on the bus has all ten functions (listed in table 1), because only those functions important to a particular instrument's purpose need be implemented.

A TYPICAL SYSTEM ON THE GPIB

Figure 1 illustrates an example of the GPIB and the nomenclature for the 16 active signal lines. Only four instruments are shown, but the GPIB can support up to 15 instruments connected directly to the bus. However, more than 15 devices can be interfaced to a single bus if they do not connect directly to the bus but are interfaced through a primary device. Such a scheme can be used for programmable plug-ins housed in a mainframe where the mainframe is addressed with a primary address code and the plug-ins are addressed with a secondary address code.

The instruments connected to a single bus cannot be separated by more than 20 meters (total cable length) and at least one more than half the number of instruments must be in the power-on state. To maintain the electrical characteristics of the bus, a device load must be connected for each two meters of cable length. Although instruments are usually spaced no more than two meters apart, they can be separated farther if the required number of device loads are lumped at any one point.

CONTROLLERS, TALKERS, AND LISTENERS

A **talker** is an instrument that can send data over the bus; a **listener** is an instrument that can accept data from the bus. No instrument can communicate until it is enabled to do so by the controller in charge of the bus.

A **controller** is an instrument that determines, by a software routine, which instrument will talk and which instruments will listen during any given time interval. The controller also has the ability to assign itself as a talker or listener whenever the program routine requires. In addition to designating the current talker and listeners for a particular communication sequence, the controller has the task of sending special codes and commands (called **interface messages**) to any or all of the instruments on the bus.

Continued on page 5

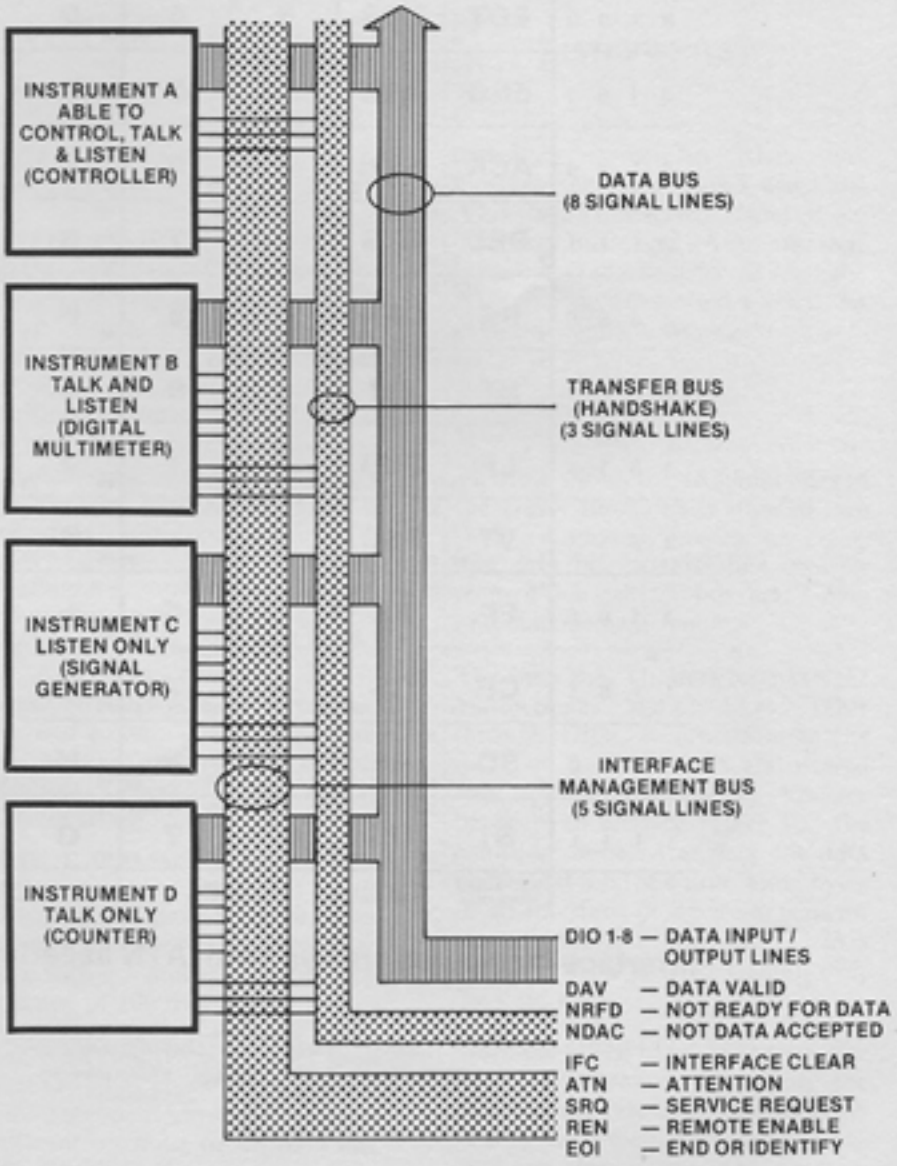


Figure 1. A typical system using the general purpose interface bus (GPIB).

ASCII & IEEE 488 (GPIB) CODE CHART

B7 B6 B5 BITS / B4 B3 B2 B1	0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
	CONTROL		NUMBERS SYMBOLS		UPPER CASE		LOWER CASE	
0 0 0 0	0 NUL 0 0	20 DLE 10 16	40 SP 20 32	60 0 30 48	100 @ 40 64	120 P 50 80	140 ` 60 96	160 p 70 112
0 0 0 1	1 GTL SOH 1 1	21 LLO DC1 11 17	41 ! 21 33	61 1 31 49	101 A 41 65	121 Q 51 81	141 a 61 97	161 q 71 113
0 0 1 0	2 STX 2 2	22 DC2 12 18	42 " 22 34	62 2 32 50	102 B 42 66	122 R 52 82	142 b 62 98	162 r 72 114
0 0 1 1	3 ETX 3 3	23 DC3 13 19	43 # 23 35	63 3 33 51	103 C 43 67	123 S 53 83	143 c 63 99	163 s 73 115
0 1 0 0	4 SDC EOT 4 4	24 DCL DC4 14 20	44 $ 24 36	64 4 34 52	104 D 44 68	124 T 54 84	144 d 64 100	164 t 74 116
0 1 0 1	5 PPC ENQ 5 5	25 PPU NAK 15 21	45 % 25 37	65 5 35 53	105 E 45 69	125 U 55 85	145 e 65 101	165 u 75 117
0 1 1 0	6 ACK 6 6	26 SYN 16 22	46 & 26 38	66 6 36 54	106 F 46 70	126 V 56 86	146 f 66 102	166 v 76 118
0 1 1 1	7 BEL 7 7	27 ETB 17 23	47 ' 27 39	67 7 37 55	107 G 47 71	127 W 57 87	147 g 67 103	167 w 77 119
1 0 0 0	10 GET BS 8 8	30 SPE CAN 18 24	50 (28 40	70 8 38 56	110 H 48 72	130 X 58 88	150 h 68 104	170 x 78 120
1 0 0 1	11 TCT HT 9 9	31 SPD EM 19 25	51) 29 41	71 9 39 57	111 I 49 73	131 Y 59 89	151 i 69 105	171 y 79 121
1 0 1 0	12 LF A 10	32 SUB 1A 26	52 * 2A 42	72 : 3A 58	112 J 4A 74	132 Z 5A 90	152 j 6A 106	172 z 7A 122
1 0 1 1	13 VT B 11	33 ESC 1B 27	53 + 2B 43	73 ; 3B 59	113 K 4B 75	133 [5B 91	153 k 6B 107	173 { 7B 123
1 1 0 0	14 FF C 12	34 FS 1C 28	54 , 2C 44	74 < 3C 60	114 L 4C 76	134 \ 5C 92	154 l 6C 108	174 | 7C 124
1 1 0 1	15 CR D 13	35 GS 1D 29	55 - 2D 45	75 = 3D 61	115 M 4D 77	135] 5D 93	155 m 6D 109	175 } 7D 125
1 1 1 0	16 SO E 14	36 RS 1E 30	56 . 2E 46	76 > 3E 62	116 N 4E 78	136 ^ 5E 94	156 n 6E 110	176 ~ 7E 126
1 1 1 1	17 SI F 15	37 US 1F 31	57 / 2F 47	77 UNL ? 3F 63	117 O 4F 79	137 UNT _ 5F 95	157 o 6F 111	177 RUBOUT (DEL) 7F 127
	ADDRESSED COMMANDS	UNIVERSAL COMMANDS	LISTEN ADDRESSES		TALK ADDRESSES		SECONDARY ADDRESSES OR COMMANDS	

Interface messages are sent with ATN asserted.

KEY

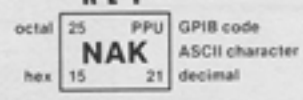


Figure 2. ASCII & IEEE 488 (GPIB) Code Chart.

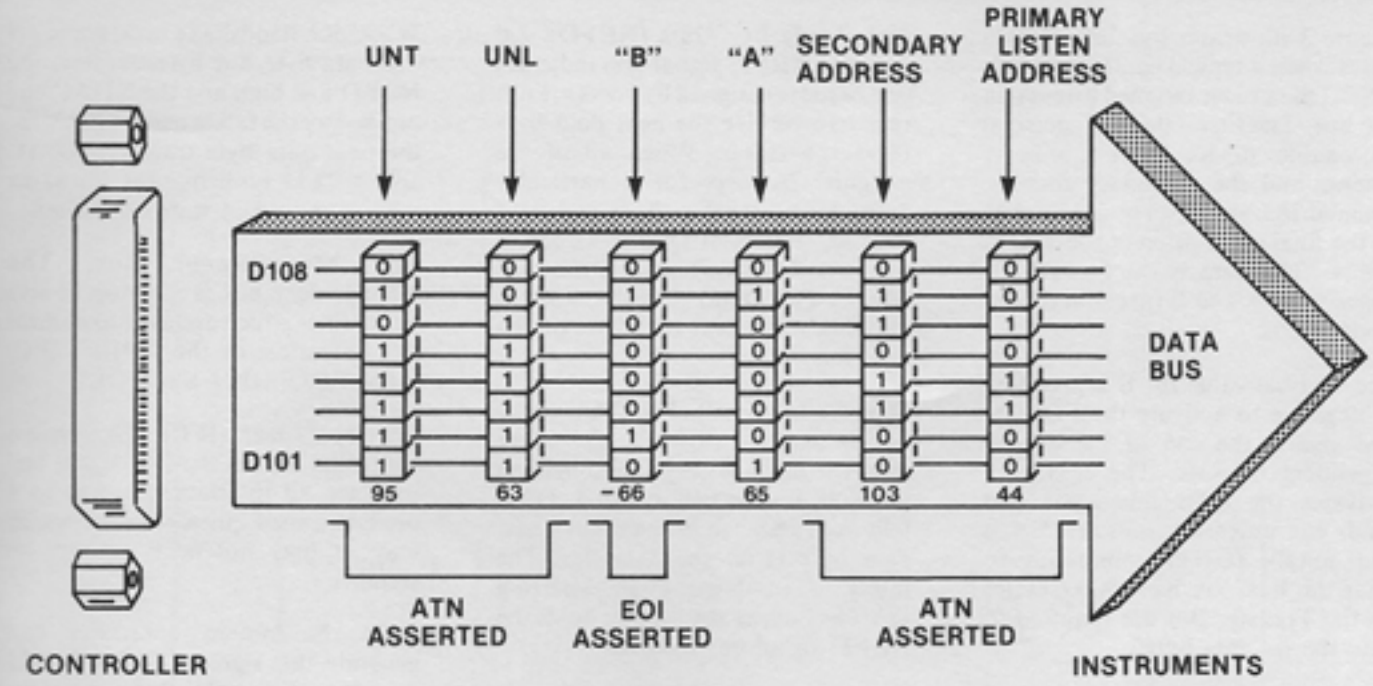


Figure 3. An example of data byte traffic on the GPIB.

Continued from page 3

INTERFACE MESSAGES

The IEEE standard specifies that the interface messages, as shown in figure 2, ASCII & IEEE 488 (GPIB) Code Chart, be used to address and control instruments interfaced to the GPIB. Interface messages are sent and received only when the controller asserts the ATN bus line. The user can correlate interface message coding to the ISO 7-bit code by relating data bus lines DI01 through DI07 to bits 1 through 7, respectively.

Interface messages include the primary talk and listen addresses for instruments on the bus, addressed commands (only instruments previously addressed to listen respond to these commands), universal commands (all instruments, whether they have been addressed or not respond to these), secondary addresses for devices interfaced through their primary instrument, and secondary commands. At present, the standard classifies only two interface messages as secondary commands, Parallel Poll Enable (PPE) and Parallel Poll Disable (PPD). (Parallel Poll Enable means that *after* the controller configures the system for a parallel poll (PPC command), all instruments respond at the same time with status information on receipt of PPE.)

DEVICE-DEPENDENT MESSAGES

The IEEE 488-1975 does not specify coding of device-dependent messages, messages that control the device's internal operating functions. After addressing (via interface messages) a talker and listener(s), the controller unasserts the ATN bus line. When ATN becomes false, any commonly-understood 8-bit binary code may be used to represent a device-dependent message.

The standard recommends that the alphanumeric codes associated with the numbers, symbols, and upper case characters (decimal 32 to decimal 94) in the ASCII Code Chart be used for device-dependent messages. One example of a device-dependent message is the ASCII character string

MODE V; 2.5MV; FREQ 1E3

which may tell an instrument to set its front-panel controls to the voltage mode, with 2.5 millivolt output at a frequency of 1000Hz.

When 8-bit binary codes other than the ISO 7-bit code are used for device-dependent messages, the most significant bit must be on data line DI08 (for bit 8).

To summarize the difference between interface and device-dependent messages, remember that any message sent or received when the ATN line is asserted (true) is an interface message. Any message (data bytes) sent or received when the ATN line is unasserted (false) is a device-dependent message.

GPIB SIGNAL LINE DEFINITIONS

Figure 1 shows the 16 signal lines of the GPIB functionally divided into three component busses: an eight-line data bus, a three-line transfer control (handshake) bus, and a five-line management bus.

The Data Bus. The data bus has eight bidirectional signal lines, DI01 through DI08. Information, in the form of data bytes, is transferred over this bus. A handshake sequence between an enabled talker and the enabled listeners transfers one data byte (eight bits) at a time. Data bytes in an interface or device-dependent message are sent and received in a byte-serial, bit-parallel fashion over the data bus.

Since the GPIB handshake sequence is an asynchronous operation, the data transfer rate is only as fast as the slowest instrument involved in a data byte transfer at any one time. A talker cannot place data bytes on the bus faster than any one listener can accept them.

Figure 3 illustrates the flow of data bytes when a typical controller sends ASCII data to an assigned listener on the bus. The first data byte, decimal 44, enables device 12 as a primary listener and the secondary address, decimal 108, enables a plug-in device as the final destination of the data to follow. The data is the two ASCII characters, A and B (decimal 65 and decimal 66).

The decimal value for B is specified as negative to activate the EOI line and signify the end of the device-dependent message. The controller activates the ATN line again and sends the universal unlisten (UNL) and untalk (UNT) commands to clear the bus. Six handshake cycles on the Transfer Bus are required to send the six data bytes.

The Transfer Bus (Handshake). Each time a data byte is sent over the data bus, an enabled talker and all enabled listeners execute a handshake sequence via the **transfer bus**. The transfer-bus signal lines are defined below. Figure 4 illustrates the basic timing relationship between the three signals. The ATN line is shown to illustrate the controller's role in the process. A flowchart for the handshake sequence is shown in figure 5.

Not Ready For Data (NRFD). An asserted NRFD signal line indicates one or more assigned listeners are not ready to receive the next data byte from the talker. When all of the assigned listeners for a particular data byte transfer have released NRFD, the NRFD line becomes unasserted (high). The RFD message (Ready For Data) tells the talker it may place the next data byte on the data bus.

Data Valid (DAV). The DAV signal line is asserted (low) by the talker after the talker places a data byte on the data bus. When asserted, DAV tells each assigned listener that a new data byte is on the data bus. The talker is inhibited from asserting DAV as long as any listener holds the NRFD signal line asserted.

Not Data Accepted (NDAC). Each assigned listener holds the NDAC signal line low-true (asserted) until the listener accepts the data byte currently on the data bus. When all assigned listeners accept the current data byte, the NDAC line becomes unasserted, telling the talker to remove the data byte from the bus. The DAC message (Data Accepted) tells the talker that all assigned listeners accepted the current data byte.

When one handshake cycle transfers one data byte, the listeners reset the NRFD line high and the NDAC line low before the talker asserts DAV for the next data byte transfer. NDAC and NRFD both high at the same time is an invalid state on the bus.

The Management Bus. The management bus is a group of five signal lines which are used to control the operation of the GPIB: IFC, ATN, SRQ, REN, and EOI.

Interface Clear (IFC). The system controller asserts the IFC signal line to place all interface circuitry in a predetermined quiescent state which may or may not be the power-on state.

Only the system controller can generate this signal. IEEE 488-1975 specifies that only three interface messages (universal commands) be recognized while IFC is asserted: Device Clear (DCL), Local Lockout (LLO), and Parallel Poll Unconfigure (PPU).

Attention (ATN). A controller asserts the ATN signal line when instruments connected to the bus are being enabled as talkers or listeners and for other interface control traffic. As long as the ATN signal line

Continued on page 8

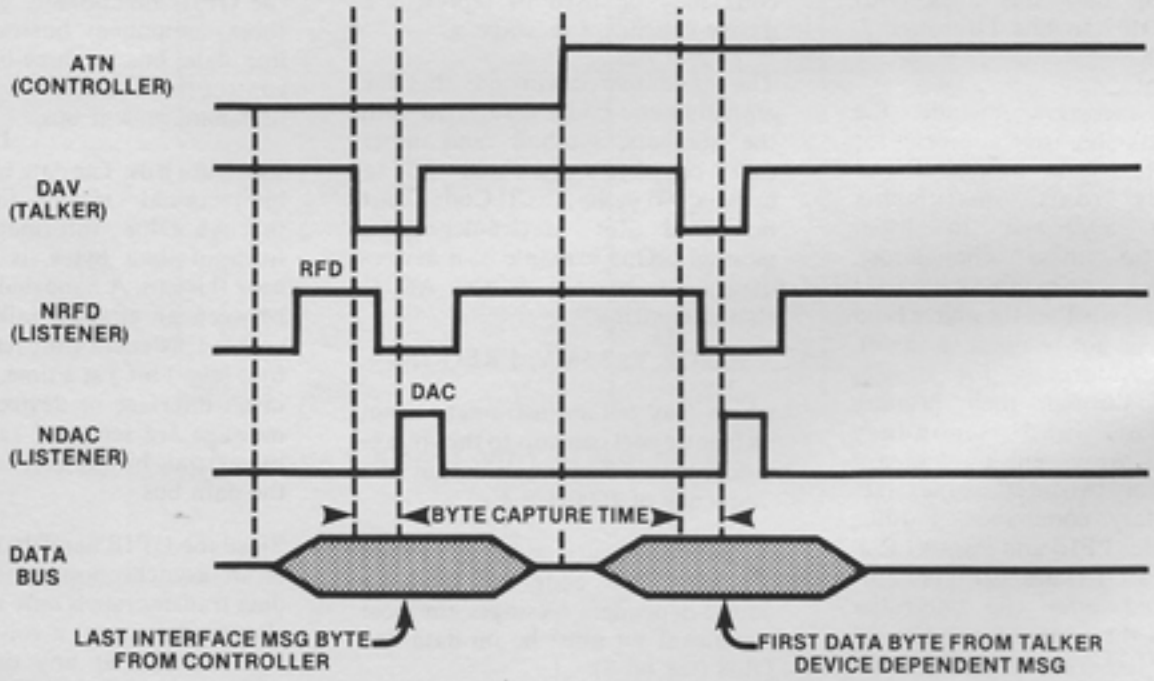


Figure 4. A typical handshake timing sequence (idealized). Byte capture time is dependent on the slowest instrument involved in the handshake.

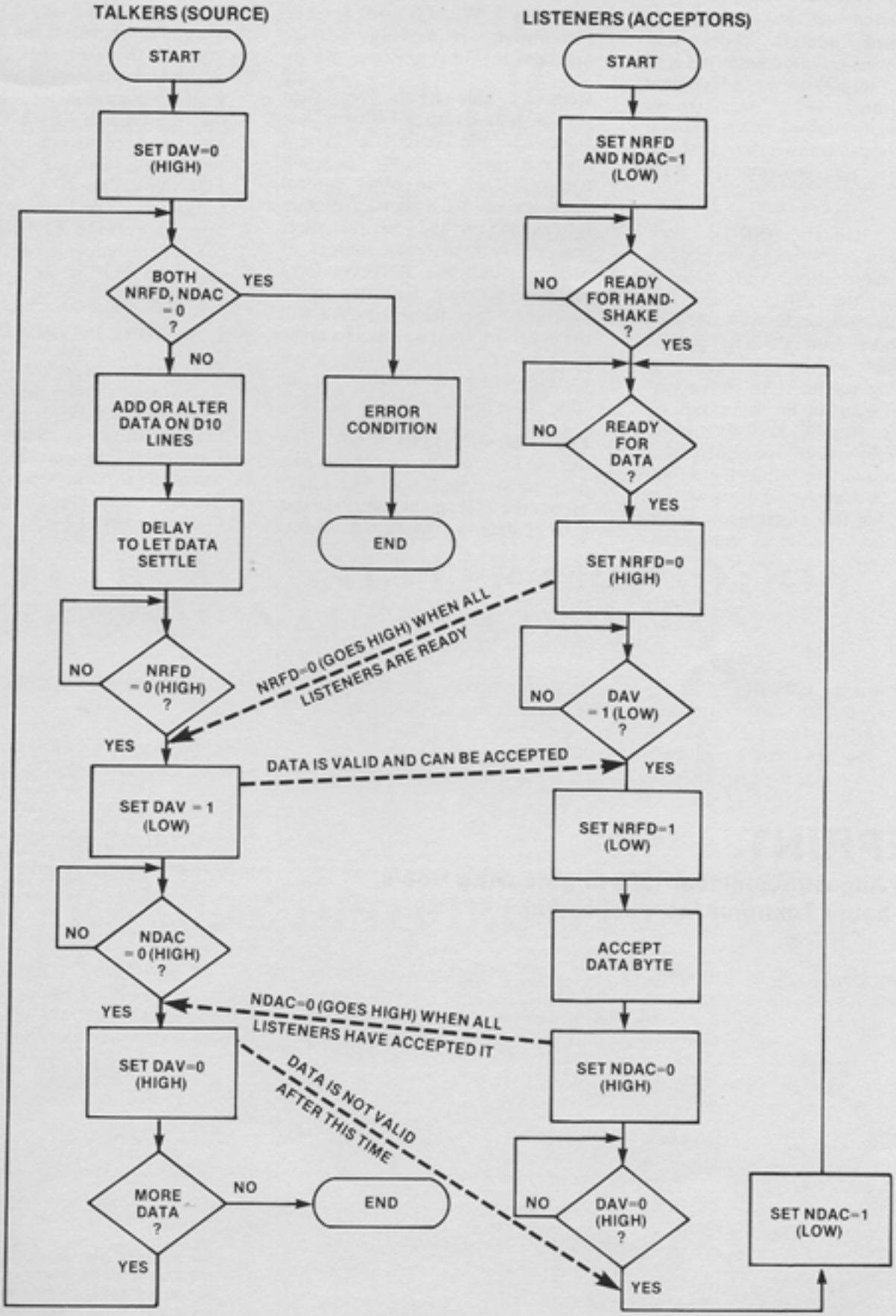


Figure 5. The handshake flow chart.

Continued from page 6

is asserted (ATN = 1), only instrument address codes and control messages are transferred over the data bus. With the ATN signal line unasserted, only those instruments enabled as a talker and listener(s) can transfer data. Only the controller can generate the ATN signal.

Service Request (SRQ). Any instrument connected to the bus can request the controller's attention by asserting the SRQ line. The controller responds by asserting ATN and executing a serial poll to determine which instrument is requesting service. (An instrument requesting service identifies itself by asserting its DI07 line after being addressed.) After the instrument requesting service is found, program control is transferred to a service routine for that instrument. When the service routine is completed, program control returns to the main program. When polled, the instrument requesting service unasserts the SRQ line.

Remote Enable (REN). The system controller asserts the REN signal line whenever the interface system operates under remote program control. Used with other control messages, the REN signal causes an instrument on the bus to select between two alternate sources of programming data. A remote-local interface function indicates to an instrument that the instrument will use either information input from the front-panel controls (Local) or corresponding information input from the interface (Remote).

End or Identify (EOI). A talker can use the EOI to indicate the end of a data-transfer sequence. The talker asserts the EOI signal line as the last byte of data is transmitted. In this case, EOI is essentially a ninth data line and must observe the same setup times as the DI0 lines. When the controller is listening, it assumes that a data byte received is the last byte in the transmission (if the EOI signal line has been asserted). When the controller is talking, it may assert the EOI signal line as the last byte is transferred. The EOI signal is also asserted with the ATN signal if the controller conducts a parallel polling sequence. EOI is not used during serial polling.

FOR MORE INFORMATION

For detailed information on GPIB specifications, refer to IEEE 488-1975 (Revised 1978), published by the Institute of Electrical and Electronics Engineers, 245 East 47th Street, New York, New York 11117. To borrow a copy, call ext. 241 (Town Center). □

REPRINT

From August/September 1979 Engineering News, an in-house Tektronix,Inc. publication.

Published by the Technical Publications Department for the benefit of the Tektronix engineering and scientific community in the Beaverton, Grass Valley, and Wilsonville areas.

CHART COMPARES DIGITAL AVERAGING BW'S OF TEK SPECTRUM ANALYZERS

Ken Andrews, FDI Specialist in the Irvine, California field office has made a comparison of the 7L5's digital-averaging filter bandwidth with that of the 7L18 and new 492 Spectrum Analyzers. Ken took the 7L5 figures from Morris Engelson's application note on random noise, which includes a chart plotting the 7L5's post-detection bandwidth vs sweep speed.

Len Garrett, who forwarded Ken's chart to FEN, says it should prove useful in answering the question, "How do the bandwidths of video filters (like those in the 7L12, 7L13, etc.) compare with the noise-smoothing bandwidths offered by digital storage?" ■

Time/Div. (Sec.)	Digital Average Filter bw (3 dB)	
	7L5	7L18 & 492
10	2.125 Hz	4.25 Hz
5	4.25 Hz	8.5 Hz
2	10.6 Hz	21.2 Hz
1	21.25 Hz	42.5 Hz
0.5	42.5 Hz	85 Hz
0.2	106.25 Hz	212.5 Hz
0.1	212.5 Hz	425 Hz
50 ms	425 Hz	850 Hz
20 ms	1.06 KHz	2.12 KHz
10 ms	2.125 KHz	4.25 KHz
5 ms	4.25 KHz	8.5 KHz

Digital averaging has a noise-smoothing effect similar to that of a video filter. The equivalent bandwidth of the digital averaging "filter" is a function of sweep speed, and is shown in the above chart for the Tektronix 7L5, 7L18 and 492 Spectrum Analyzers.

SPECTRUM ANALYZER PROMOTION PROGRAM INAUGURATED

7000-Series oscilloscope owners are potentially qualified spectrum analyzer customers. To improve Tektronix' visibility as a supplier of high-performance, plug-in spectrum analyzers, we are now shipping a spectrum analyzer color catalog with each 7603 mainframe shipment.

It will be difficult to measure results accurately, so please let FDI Marketing know about any spectrum analyzer purchases you believe resulted from this promotion.

Marketing Communications

LITERATURE DISTRIBUTED

Automated Test Systems

- S-3280 ECL Automated Test System brochure, 8 pages, 4-color (AX-4198).

Display Monitors

- 606B Monitor data sheet, 2 pages, 2-color (AX-4216).

Medical Products

- Portable Patient Monitors literature folder, 6 pages plus literature pocket, 4-color (AX-4143).
- Portable Patient Monitors price list (A-3668-6).

Spectrum Analyzers

- "Pulsed RF Spectrum Analysis," application note, 8 pages, b & w (AX-4217).
- "Spectrum Analyzer Workbook," 10 pages, 4-color cover (A-4209).
- "Spectrum Analyzer Seminars," 4 pages, 4-color (A-4223).
- "Distortion Measurement Using the Spectrum Analyzer," 24 pages, b & w (no number assigned).

7000-Series Oscilloscopes

- Signal Standardizer Calibration Fixture data sheet, 1 page, b & w (A-4247).
- Oscilloscope Plug-ins folder, 2 pockets, embossed, 2-color (AX-4100).

Tekscope

- Volume 11, Number 2, 1979. ■

CURRENT AD SCHEDULE

Portables/Cable Testers

"Complete Your Electronic System....," 1 page, b & w
- 1979-1980, International Countermeasures Handbook

Medical

"Accurate Vital Signs....," 1 page, 4-color
- October, Anesthesiology

"Work with Confidence....," 1 page, 4-color
- November, Anesthesiology
- November, Journal of Pediatrics
- November/December, Perinatology/ Neonatology

Signal Processing Systems

"You Can't Beat the System....," 1 page, 4-color
- October, Physics Today
- October, Laser Focus
- October, Industrial Research/Design
- November, Physics Today
- November, Industrial Research/Design
- 1980, Laser Focus Buyers Guide

TM500

"Three New TM500 Digital....," 1 page, 4-color
- October, Industrial Research/Design
- October 11, Electronic Design
- November, Computer Design
- November, Electronic Products
- November 5, EDN
- November 8, Electronics

"Waveform Versatility....," 1 page, 4-color
- October 5, EDN

"TM500 Pulse Generator....," 1 page, 4-color
- October 11, Electronics
- November 8, Electronic Design

Cable Testers

"Locate Water in PIC Cable....," 1 page, 4-color
- October 1, Telephone Engineering and Management
- October 29, Telephony
- November 1, Telephone Engineering and Management

Yellow Page ad, 2-1/2 x 1 column, b & w
- 1980, Instrumentation, Equipment and Supplies

"Save Time and Money....," 1 page, 4-color
- October 15, Telephone Engineering and Management

Display Monitors

"Tektronix Has the OEM Displays....," 2 pages, b & w
- October 5, EDN

"No Matter Where You Look....," 2 pages, b & w
- November 5, EDN
- November 22, Electronic Design

Logic Analyzers

"Tektronix Thinks...." (see logic), 1 page, 4-color
- October 5, EDN
- October 25, Electronics

"All Logic Analyzers Handle....," 2 pages, 4-color
- November, Computer Design
- November 8, Electronics
- November 20, EDN

"Tektronix Thinks...." (connect probes), 1 page, 4-color
- October, Computer Design
- October 25, Electronic Design

Spectrum Analyzers

"Tektronix Performance....," 2 pages, b & w plus 4-color
- October, Defense Electronics
- October, Microwaves

"A Spectrum Analyzer with....," 2 pages, 4-color
- November, Microwaves
- November/December, R.F. Design

Lab Scopes

"Flexibility....," 1 page, 4-color
- October 11, Electronic Design
- November, Industrial Research/Design
- November 5, EDN
- November 8, Electronics
- November 22, Electronic Design

Microprocessor Development Labs

"Compare Our Microprocessor Design....," 2 pages, 2-color
- October 1, Electronic News
- October 11, Electronics
- October 25, Electronic Design
- October 29, Electronic News
- November 8, Electronics
- November 12 & 26, Electronic News
- November 22, Electronic Design

"Meet the Microprocessor Challenge....," 1 page, b & w
- October 20, EDN

"A Chip Builder's....," 2 pages, 4-color
- October, Canadian Electronics

TV Test Instruments

"The Answer Worth....," 1 page, 4-color
- October, Broadcast Engineering

"Clearly the Best....," 1 page, 4-color
- October, Broadcast Communications
- October, Broadcast Management and Engineering
- October, Canadian Broadcaster
- November, Broadcast Communications

"No Softy....," 1 page, 4-color
- November, Broadcast Management and Engineering

Telequipment

"Choose a Telequipment....," 1 page, b & w
- October, AFSM Journal

"Lots of Scope....," 1 page, b & w
- October, AFSM Journal
- October 25, Electronics
- November 22, Electronics

"Teach with Telequipment....," (postcard)

Coop Mailings to:
- High School Science Teachers
- Industrial Arts/Vocational Education Teachers
- University Science & Research Labs

Recruiting

"A Place to Be....," 1 page, 4-color
- October, Datamation
- October, IEEE Spectrum
- November 8, Electronics

"A Place to See....," 1 page, 4-color
- November 8, Machine Design

Storage Oscilloscopes

"Tektronix Storage Scopes....," 2 page, 4-color
- October, Electronics
- October 20, EDN
- October 22, Design News
- October 25, Electronic Design
- November, Industrial Research/Design
- November 19, Design News
- November 20, EDN
- November 22, Electronic Design
- November 22, Electronics

T900

"The Price Was Right....," 1 page, b & w
- October, Canadian Broadcaster

"Six Ways to Help....," 1 page, b & w
- November, IEEE Spectrum

MDL Sales Training

"Four Workshops Give....,"
- October, EE Times
- November 5, EE Times
- November 20, EDN

Semiconductor Test Systems

"The People Who've Led the Way....," 1 page, 4-color
- November, Electronic Business
- November 5, EDN
- November 8, Electronic Design
- November 12, Electronic News

Digital Service Instruments

"First the 832, Now the 833....," 2 pages, 4-color
- November, Data Communications
- November, Telecommunications
- November 5, Telephony

Catalog Pages, 2 pages, b & w
- 1980, Data Communications Buyer's Guide ■

NEW ADS

Digital Service Instruments

"Data Communications service costs will never be the same." 1 page, 4-color.

"First the 832 — Now the 833." 2 pages, 4-color.

Aimed at field service managers of data communications manufacturers, these ads describe the capabilities of the 832 and the new 833 Data Communications Testers. The ads emphasize the testers' portability, their ease of use, and their suitability for first-line service personnel.

The ads will appear in **Data Communications, Telecommunications, Telephony, Electronic Business** and **Journal of the Association of Field Service Managers.** ■

Storage Oscilloscopes

"Tektronix Storage Scopes — Choose the one to match the job." 2 pages, 4-color.

This new ad stems from a corporate effort to spotlight Tektronix as the company offering the industry's broadest selection of storage scopes. The result of a joint effort by Lab Scopes, Portable Scopes, and TM500, the ad initiates a long-term program which emphasizes the variety of portable and lab models, writing speeds, and storage modes available. This program will incorporate new Tektronix storage oscilloscopes as they are introduced.

The new ad targets the broad market of storage scope users and will be run in **Electronics, EDN, Electronic Design, Industrial Research and Development,** and **Design News.** The response literature for this ad will be the **Tektronix Storage Scope Selection Guide** now under development. ■

T900 Oscilloscopes

"The price was right and the trace was bright." 1 page, b & w.

This new T900 testimonial ad explains the advantages of T900-Series oscilloscopes as production test instruments.

Aimed at manufacturing, production, and quality control engineers and managers, the ad emphasizes T900 reliability, quality, and price and performance advantages in production test applications. The ad will run in selected issues of **Electronic Packaging and Production,** beginning in October 1979. ■

Semiconductor Test Systems

"The people who've led the way in test and measurement also lead the way in semiconductor test systems." 1 page, 4-color.

This is the first in a series of three one-page, four-color ads that emphasize Tektronix' leading role as a manufacturer of semiconductor tests systems for R&D and component characterization — the company associated with technological advance, and the company to look to for production test systems — the company which has a family of proven, reliable systems that meet users' long-term needs.

Beginning in November, the ads will appear monthly in **Electronic Business, Electronic Design, EDN,** and **Electronic News.** The target audiences are engineers, specifiers, advocates, users, and the managers, brand approvers, and funding approvers to whom they report. ■

Microprocessor Development Labs

"Compare our microprocessor design support...." 2 pages, 2-color.

This new MDL ad stresses two major features of the Tektronix system.

- The depth of Tektronix microprocessor and microcomputer support. The ad lists 17 chips, in a chart representing a broad range of manufacturers that Tektronix supports.
- The breadth of Tektronix service and support which no other vendor can provide.

The ad encourages readers to base their buying decisions on the criteria developed in our ad. ■

TV Instruments

"No Softy." 1 page, 4-color.

This ad promotes the 650HR-series of tv monitors, emphasizing their stability and high resolution. The ad also stresses the idea that 650HR's are **Tektronix** color monitors, widely accepted in the television industry and backed by our extensive service facilities.

The ad addresses chief engineers and technical managers of television broadcast stations. The November issue of **BM/E** will carry the first insertion.

Our primary response will be the 650HR data sheet. ■

Spectrum Analyzers

"A Spectrum Analyzer with unmatched convenience and capability. In one compact package." 2 pages, 4-color.

A November 22 **Microwaves** ad will introduce the new 492 Spectrum Analyzer. That issue will also feature the 492 on its cover. The ad targets spectrum analyzer users and purchasers. We will fill requests for more information with our new 492 brochure, which provides complete technical details (available in late November). ■

MDL Sales Training

"Four workshops give a macro view of microprocessor design." 1 page, b & w (tabloid).

This new ad announces the Winter/Spring schedule for the MDL Workshop program. A new workshop has been added, the **Microprocessor Project Development Workshop.** This session provides the student with an extensive survey of the rapidly changing options in hardware/software microprocessor design. ■

TM 500

This four-color, one-page ad is the newest addition to the TM500 color advertising campaign. It follows the publication of five earlier ads, each focusing on a single generic type of TM500 product: counter, pulse generator, function generator, scope, and digital multimeter.

The new digital multimeter family (DM502A/DM501A/DM505) is the subject of this new ad. The ad features the expanded performance range made available by the introduction of these three new DMM's.

Like the earlier ads in the TM 500 campaign, this ad addresses engineers and other instrument users in various fields: research and development, field service, testing and maintenance and other key market areas. ■

The ad will appear as follows:

October '79	**Electronic Design**
October '79	**Industrial Research & Development**
November '79	**Electronics**
November 5, '79	**EDN**
November '79	**Computer Design**
November '79	**Electronic Products**
December 6, '79	**Electronic Design**
January '80	**Electronics**
and continued insertions into 1980	

DIRECT MARKETING UPDATING MAILING LISTS

Every SE's mailing list of prospects and product users is being updated in a nationwide requalification mailing conducted by the Direct Marketing group. The requalification will assure that every entry on the list has a valid address and is defined with correct product and applications interests.

NEW MAIL LIST CATEGORIES AND ENTRY FORM FORMAT

One mailer has been prepared with new categories for TV Products, and another has already been mailed to those with interests in T & M, IDD, and/or SPS Products. Both pieces feature a new, easy-to-use format, and will give customers and prospects the opportunity to quickly correct their mailing addresses and allow them to indicate their product uses and interests.

The new categories and format will also be used in the Mail List Data Entry Cards included in the 1980 Tektronix product catalogs and on the padded forms used to enter new names onto a list.

Direct Marketing expects a large response. If the return rate is high enough, they will not make a second, follow-up mailing urging non-respondents to send in their updates. Realistically, however, there will be a few non-respondents, and each SE must decide whether to keep individual entries on the list.

New categories and an easier-to-use mailer design should help get a fast, accurate response from those on your mailing list.

THE SE'S PART

Once all returns are in and processed, Direct Marketing will send a computer print-out (**1-liner**) of all those on the SE's lists who did not respond to the requalification mailings. The SE should then return the list with entries marked either "retain" or "delete." Names of those who've moved away or changed companies, or companies who've gone out of business, are examples of "deadwood" that should be cleared away.

Even if it's leaner, a clean new list will ensure more effective direct mail advertising. This will help get better leads, with more conversions to sales.

FOR MORE INFORMATION

For more information on requalifying your list, or for answers to your direct mail questions, call Jim Buchanan, Direct Marketing manager, ext. 7157. ■

MAILING LIST COUPON

Field Engineering News

☐ **ADD**
☐ **REMOVE**
☐ **CHANGE**

Name: _____

Old Delivery Station/Field Office: _____

New Delivery Station/Field Office: _____

Payroll Code: _____

(Required for the mailing list)

MAIL COUPON TO 53-077

Allow four weeks for change.

CONTRIBUTIONS WELCOME

You can help make **FEN** the Tektronix *Sales Engineer's* publication by contributing anything from a full-length article to a short anecdote about your experiences in the field. We are interested in anything **you** think would interest others in the Tektronix sales organization. Don't worry about the spelling, grammar, and syntax — just send a rough draft to Editor, FEN, d.s. 53-077, or call extension 8956 (Merlo Road). We'll do the rest. ■

WHO TO CONTACT

If you want to know more about any of the subjects covered in this issue, write or call the appropriate contact listed below.

Subjects	Name	Delivery Station	Extension
Government Contracts	Don Tucker	51-289	6435
Commercial Contracts	Cathy Anderson	51-289	7637
OEM Contracts	Grethe Larson	63-578	3198
GPIB	Jim Geisman	50-492	6023
New Publications	Larry Spencer	78-848	5487
Audiotapes Videotapes	Herb Doumitt	74-868	6023
Warranty Policy	Stan Kouba	53-028	5582
Provisioning	Don Nordone	51-289	6223
New Ads Current Ad Schedule	Lucille Fitch	76-260	6377
New Literature	Jerry Hogan	76-260	6382
Direct Mail	Jim Buchanan	76-260	7157
Spectrum Analyzers	Len Garrett	58-741	7815

Tektronix is an equal opportunity employer
Field Engineering News
Company Confidential
Editor: Ken Arthur. Graphic Design: Dennis Croft. Typesetting: Jean Bunker.

Published by Technical Publications (part of Technical Communications Services) for the benefit of Tektronix marketing and sales personnel. Questions or contributions should be directed to Editor: Field Engineering News, d.s. 53-077, ext. 8956.

Tektronix®
COMMITTED TO EXCELLENCE