TEK TM 500 TM 5000

SEP 23 1985

USER NEWSLETTER
SUMMER 1985

TM NOTES
TEST AND MEASUREMENT

Select the Right System for the Highest Return

Consider the Alternative: Test and Measurement Automation

Are you making manual tests and measurements? Are they too slow? Do they require too much labor? Are they too unreliable because of poor repeatability or operator errors?

Test and measurement automation may offer a solution. Finding an automated solution to a test and measurement problem is a three-step process:

1. Is the test or measurement suitable for automation?
2. What kind of system would be best—a specific-application system or a general-purpose system?
3. Which particular system is best for your needs?

This article suggests guidelines for answering these questions while focusing on computer-controlled test and measurement instrumentation that uses the IEEE Standard 488 communications bus.

The articles on pages 2 and 4 describe two systems at opposite ends of the spectrum of possible system solutions. One is GURU, a low-cost, highly versatile, general-purpose solution for users who want to use their IBM PC or IBM PC compatible personal computers to run individually selected test and measurement instruments. The other system is the MP 2902 Audio Measurements Package, a set of high-performance, programmable audio instruments run by a controller designed specifically for test and measurement systems.

Also In This Issue

When Is the Cost of a System Justified?

One way to identify and prioritize test and measurement automation opportunities, is to *ask yourself these questions:*

1. Which operations have the highest labor costs? Cutting high labor costs is a major automation benefit, but don't forget to consider the

Continued on page 6

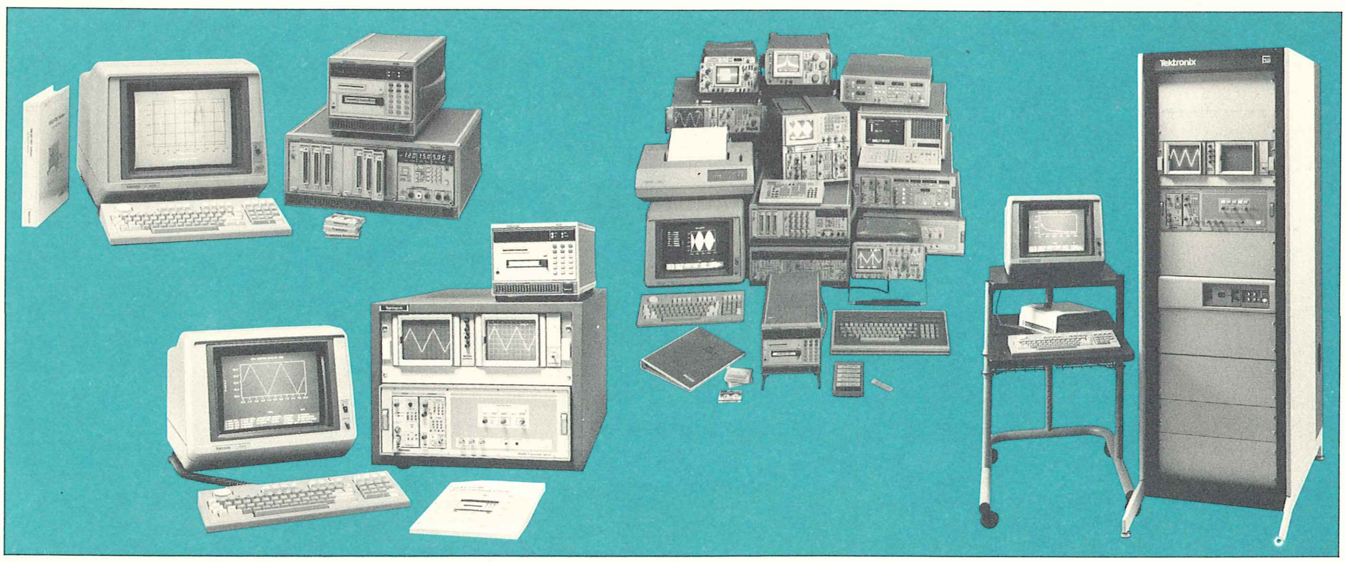

Figure 1. A wide range of IEEE Standard 488 test and measurement systems are available to meet specific and general-purpose automation needs. The Tektronix systems shown here, left to right, are: MP 2901 Inspection Test Station Measurement Package; MP 2101 Acquisition/Processing Measurement Package; a few of the many configurable Tektronix test and measurement instruments; and the MS 3101 Acquisition/Processing Measurement System.

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GURU Links IBM PC to GPIB Instruments . . . at Low Cost

Low Cost Combines with Hardware and Software Flexibility

Tektronix GURU (GPIB Users Resource Utility) is a low-cost hardware and software tool that transforms your IBM PC into a versatile, low-cost, instrument controller. Compatible with Tektronix and other manufacturers' GPIB equipment, GURU opens the door to many applications that previously didn't justify a systems investment. (Refer to figure 1.)

On the system-solution spectrum, GURU provides basic controller functions for the smallest front-end investment.

Versatility Starts with the Hardware

On the hardware side, GURU allows you to use an IBM PC (IBM XT, IBM AT, or IBM-compatible computer) to control IEEE Standard 488 (GPIB) test and measurement instruments. The GURU hardware components are the GURU GPIB Interface Board (which is inserted in the PC) and a GPIB cable (for connecting the GPIB instruments to the IBM PC). You may connect any GPIB instrument or GPIB input/output device to your IBM PC to develop a system shaped to your specific application needs.

GURU Software Provides a Variety of Tools

A GURU manual that combines detailed hardware and software reference material with tutorial information takes the beginning user from basic GPIB concepts to applications programming.

Users may access all GURU GPIB commands from the IBM PC's **MICROSOFT BASICA** language. Thus, users who are programmers can readily develop BASIC language application programs. (Refer to figure 2.)

TPG.BAS, the GURU Test Procedure Generator, is the right tool if you want to develop test and measurement programs quickly, without coding. TPG.BAS allows users to generate a program that runs a specific test or measurement sequence without writing

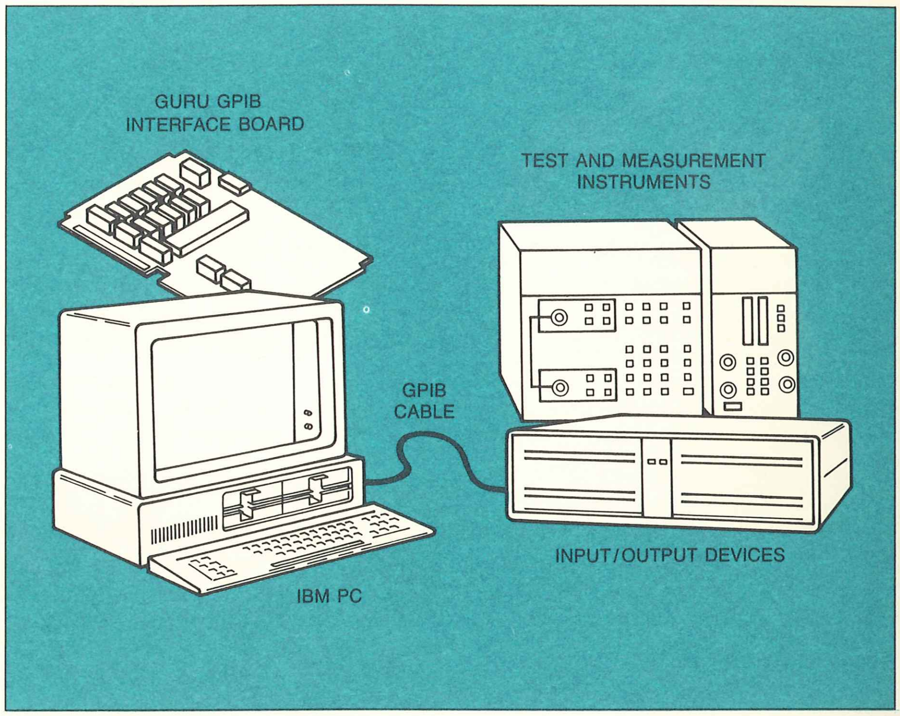

Figure 1. GURU hardware, consisting of a GPIB interface board and GPIB cable hardware, unites the powerful and versatile IBM PC with the world of GPIB test and measurement instruments.

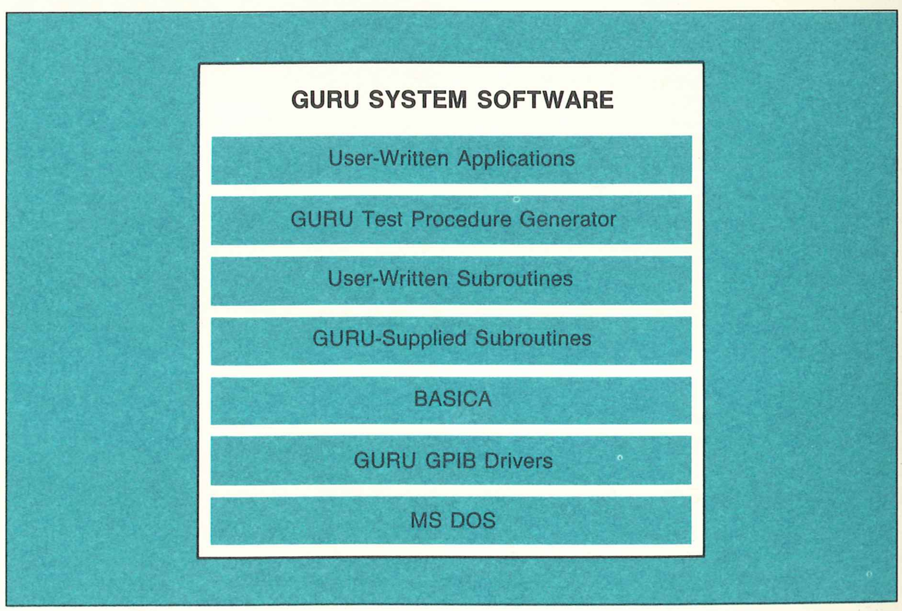

Figure 2. GURU's wide range of system software opens the IBM PC controlled GPIB test and measurement system to users with various levels of programming skills.

a single line of code. You need to know only the details of the test to be performed and the equipment to be used. TPG.BAS walks you through the test program generation process step by step, allowing you to choose items from easy-to-use, self-explanatory menus.

The test procedure generation process begins when you enter the Main Menu and select an appropriate menu item (refer to figure 3). After telling GURU what equipment is included, you can move to the Function Menu (refer to figure 4), the primary tool for developing a test procedure program. The menu includes all the individual steps that might be used in any test procedure. For example, pressing the W key adds a "wait for operator input" step to the procedure. GURU automatically asks the system operator for the information needed at each step.

TEK DIG.BAS, the GURU Digitizer program, provides menu items that allow users who have included digitizers in their systems to:

- Select a digitizer.
- Change the digitizer settings.
- Learn settings from a digitizer or restore them from a disk file.
- Acquire a waveform from the digitizer.
- Store waveform data on a disk or display it.
- Recall waveform data from the disk.

These additional functions extend the flexibility of your GPIB system to include a wide range of waveform measurements.

BASIC Subroutines Extend GURU Power

For users who want to code their own applications programs, GURU supplies **SUBS.BAS,** a set of BASIC language subroutines (refer to figure 5). These subroutines perform functions common to many test and measurement applications. The subroutines are designed for user-written applications programs, thus reducing your software effort. Each subroutine is thoroughly explained in detailed GURU documentation.

For more information about GURU, check the appropriate box on the reader reply card.

```
          TPG.BAS  V1.0 - a test procedure generator in BASIC

MAIN MENU:

              (1)  Create a new procedure
              (2)  Modify a procedure

              (3)  Execute a procedure
              (4)  Single step a procedure

              (5)  List available procedures
              (6)  Rename a procedure
              (7)  Delete a procedure

              (8)  Utilities
              (9)  Quit - return to BASIC

Selection:? 1_
```

Figure 3. The GURU Test Procedure Generator Main Menu is the starting point for developing automatic test procedures for a system that uses GPIB test and measurement instrumentation.

```
step # 0

What function do you want this step to do?

     (P)  Print a message to the operator
   * (W)  Wait for operator input: (y)es (n)o (Q)uit or [enter]

     (S)  Send a command to a device
   * (N)  Numeric acquisition and test
   * (A)  ASCII string acquisition and test

     (D)  Delay for a given number of seconds

     (B)  Branch to step #__ conditional or non-conditional
     (C)  Chain to another procedure

     (E)  End procedure - return to main menu.

   * These input commands control the branch condition.

function:
```

Figure 4. The GURU Function Menu lists the test procedure steps you can use to generate a test program for your specific application.

```
Subroutines menu:                          Status:

 (1)  select a device                      Current device = 7D20
 (2)  serial poll a device                 Last poll =  65
 (3)  send message to a device             Last message = ID?
 (4)  get a response from a device         Last response =ID TEK 7D20
 (5)  get a number from a device           Last number =  3.1415
 (6)  test a number for tolerance          TEST% =  0
 (7)  test a number for range
 (8)  compare strings
 (9)  check for bus error
 (10) acquire waveform data (ascii)
 (11) acquire waveform data (binary)
 (12) store waveform data on disk          Last filename = b:test.wfm
 (13) recall waveform data from disk
 (14) graph waveform data                  Current waveform = test.wfm
 (15) waveform statistics
 (16) put bus into idle state

 enter selection (FUNC%):? 14_
```

Figure 5. Item 14 on this Subroutines Menu graphs waveform data.

MP 2902 Performs a Variety of Audio Tests. . .without Programming

MP 2902 Ties Together a Package of Benefits

The Tektronix MP 2902 Audio Measurements Package *automatically* performs a wide variety of complex audio tests and measurements, without requiring you to write a single line of code. (Refer to figure 1.) The MP 2902's position in the system-solution spectrum is high performance for a specific application area (audio measurements).

The MP 2902 offers the benefits of automated top-of-the-line audio analysis equipment without the high cost of software development. For even the most complex tests, the MP 2902 speeds testing, provides fast and low-cost documentation, allows operation by lower skill operators, and ensures measurement procedures are consistent from day to day.

Producing automated test procedures for GPIB audio test equipment was time-consuming and difficult until Tektronix introduced **Audio Test Procedure Generation** software. Audio TPG is a tool which simplifies converting manual tests into software and eliminates the need for software coding, in most cases.

The MP 2902 hardware includes a distortion analyzer, oscillator, and color computer display terminal. The package software includes a test procedure generator that greatly simplifies the creation of test programs. Non-programmers need no software training to use Audio TPG to generate test procedures that may be easily converted to BASIC programs. Programmers appreciate Audio TPG's creation of documented, error-free BASIC code.

MP 2902 Hardware Unites Programmability and High Performance

The MP 2902 components are designed to work together and are selected to make measurements to international standards. Under the direction of the 4041 System Controller (designed specifically to control GPIB test and measurement instruments), the AA 5001 Programmable Distortion Analyzer, the SG 5010 Programmable

Figure 1. The MP 2902 Audio Measurements Package offers the hardware and software needed to create a variety of audio tests, quickly and easily. At low cost, it automatically documents test results in graphic or tabular form.

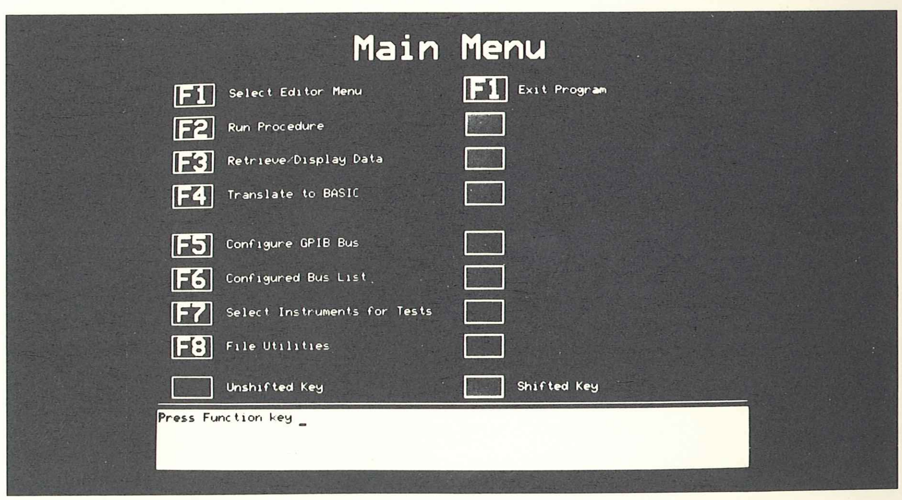

Figure 2. The Audio Test Procedure Generator Main Menu structure is simple. You first see the Main Menu when initializing the MP 2902. This menu is the starting point for a sequence of easy-to-use interactive menus.

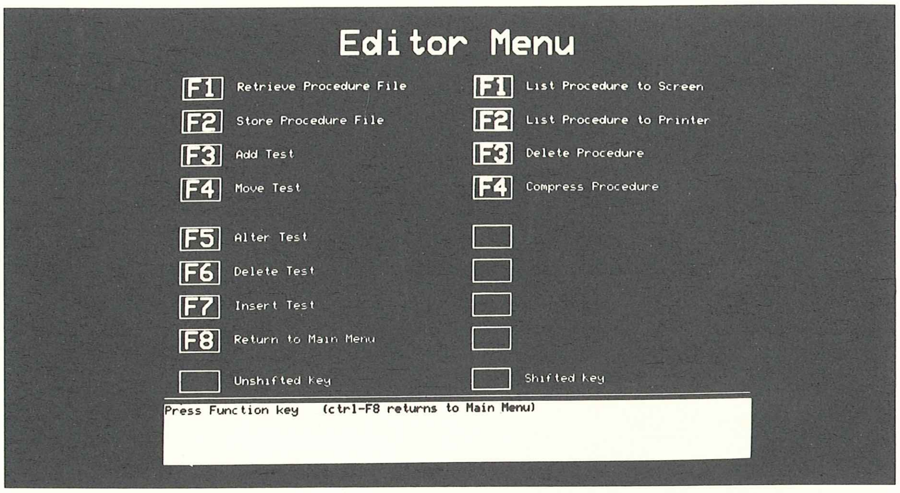

Figure 3. The Editor Menu lists the steps you can take to change the test procedure.

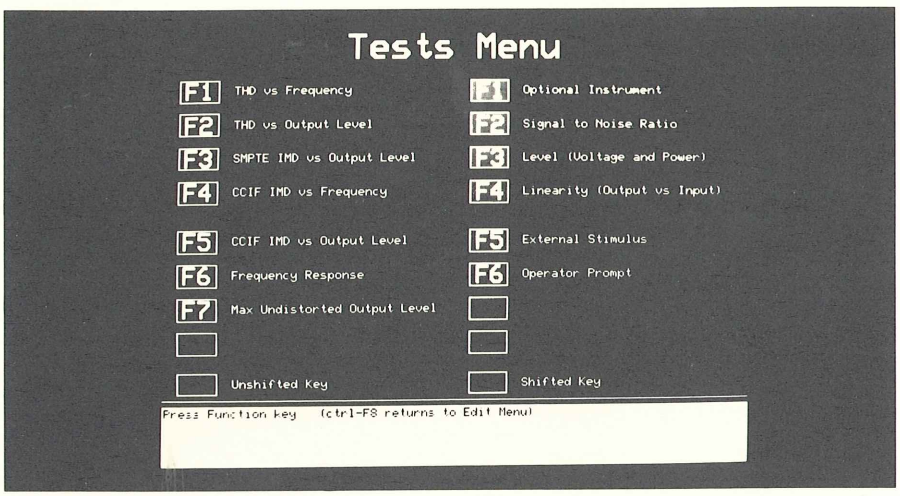

Figure 4. The Audio TPG Tests Menu lists the tests that are stored in the MP 2902, for retrieval, editing, or execution.

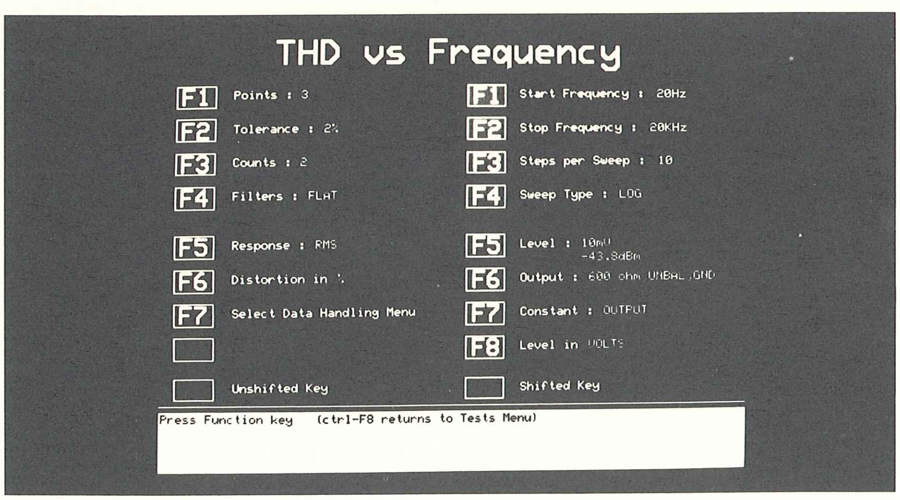

Figure 5. This THD versus frequency tests menu is an example of MP 2902 test menus. The menu lists the parameters and actions you may choose for a specific test.

Oscillator, and the optional DC 5010 Universal Counter-Timer set up and make frequency response, distortion (THD + N and SMPTE, DIN and CCIF IMD) versus frequency or level, power computed from voltage, and signal-to-noise measurements. Adding optional equipment makes automatic switching possible as well.

Using MP 2902 test and measurement instruments ensures extremely low residual noise and distortion, permitting measurements on top-grade professional and consumer equipment. This package provides fully balanced analyzer input, balanced or unbalanced oscillator output, floating or grounded, 50/150/600 Ω to match all types of audio equipment.

Software or manual control selects the synthesized frequency stimulus to four or more digits with 0.01% accuracy, offers fully programmable filter and detector selection to accommodate a wide variety of measurement standards, and provides high-level oscillator output to test headroom and clipping thresholds of line level devices. The oscillator offers burst, squarewave, and amplifier modes.

With Audio TPG, you first create a sequence of tests by following interactive screen menus displayed on the 4105 Computer Display Terminal. The test sequence consists of the steps in the manual test procedure. (You direct Audio TPG through the 4105 keyboard.)

The first menu in the sequence is the Main Menu, shown in figure 2. After creating the test procedure database, you can select a translation sequence to automatically convert the test procedure database to a BASIC program or you can execute the test procedure. The result of translation is a complete BASIC program that has utility routines to support data logging and merging of tests. You can modify the program to meet your unique test requirements.

To add, delete, or change steps in the test procedure, you call the Editor Menu (figure 3) and select the appropriate user keys on the keyboard. The Editor Menu then automatically displays the Tests Menu (figure 4), which lists the audio tests you can select for editing. Picking an item on this menu displays the parameters and actions available for a specific test. Figure 5 shows the test menu for THD-versus-frequency tests.

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MP 2902 Simplifies Results Documentation

At your command, Audio TPG stores test data on tape or other storage medium . This data can be retrieved and displayed in tabular or graphic form, or printed in tabular form. Figure 6 shows a display of a frequency-dividing network's frequency response.

For more information about the MP 2902 Audio Measurements Package, check the appropriate box on the reader reply card.

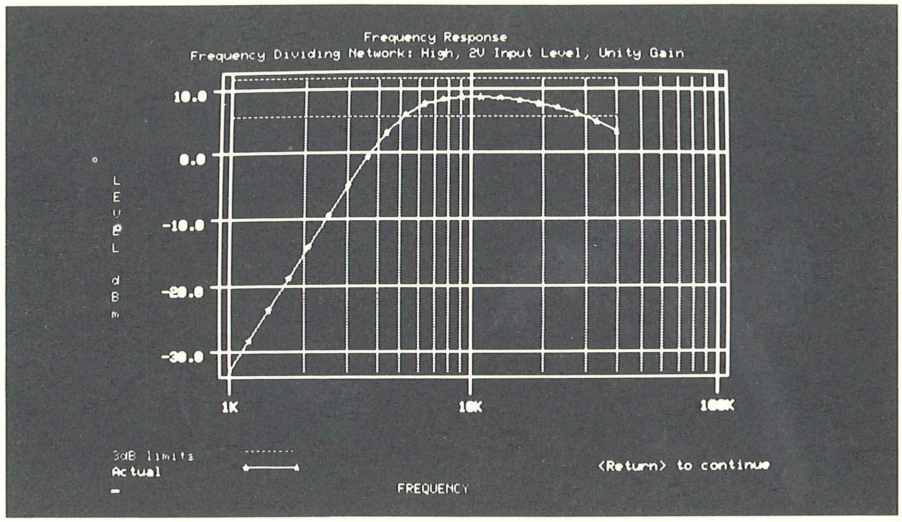
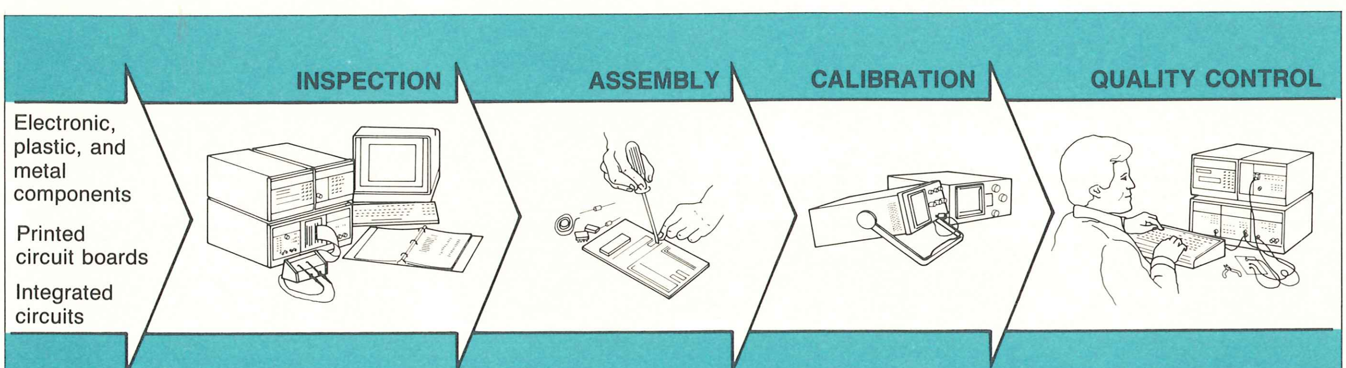


Figure 6. In this graph, the MP 2902 plots a frequency dividing network's frequency response, from 1 kHz to 40 kHz. The dashed lines represent the ± 3 dB points at a 10-kHz reference frequency. The user entered the graph subtitle when the test was created.

Continued from page 1 . . .

impact of a faster process: Can downstream operations handle the higher throughput, and must upstream operations increase their output?

2. Which operations have caused quality problems? Quantifying the savings due to better quality (lower costs of scrap, reject, rework, and field failures) is difficult but important to estimate. Two advantages of automation that improve quality are consistent processing and data recording. Consistency is inherent in automation: Systems don't get tired or careless. Automation makes massive amounts of performance data available for analysis and for use in correcting quality problems. An alternative approach is to *flowchart and analyze your operations.* Look for high levels of repetitive activity; low levels of mechanical activity; high levels of data referencing, retrieving, and recording; and high concentrations of manual test and measurement equipment. Figure 2 shows a simplified example and analysis.



	INSPECTION	ASSEMBLY	CALIBRATION	QUALITY CONTROL
Repetitive?	Medium	High	High	High
Mechanical?	Medium	High	Medium	Low
Data quantity?	Low	Low	High	High
Test and measurement instrument use?	Medium	Low	High	High

Figure 2. In this simplified work-flow diagram and analysis, quality control is the most likely candidate for test-and-measurement automation. High levels of repetition and instrument use, plus large amounts of data, qualify this operation for automation. A high level of mechanical activity usually disqualifies an operation for automation using computer-controlled test-and-measurement equipment.

Once you have evaluated your operations for automation opportunities, and found one or more, decide whether the savings justify the expense.

If, after a thorough economic analysis, a system is justified, how should you select a system?

The first issue here is the *kind* of system: Should it be a monolithic or a modular system? In a few applications, a monolithic system may be the best solution if it uniquely answers specific needs. Otherwise, a modular system (a system of replaceable, programmable instruments run by a computer) is the way to go because it offers application flexibility (you can select special-purpose instruments for special applications).

What are the Checkpoints for Selecting a System?

By far the best approach to building modular systems is selecting instruments compatible with the IEEE Standard 488 (GPIB). Instruments built to this standard of electrical and mechanical compatibility can communicate with each other without special programming. The criteria summarized in the sidebar below will help you select from among the many IEEE Standard 488 instruments on the market today.

Product Evaluation is a Prime Candidate for Automation

When you're looking for automation opportunities, don't overlook the new-product-introduction flow. Product evaluation groups perform well defined tests (such as reliability and electromagnetic interference) on many products. Automation here can provide high payback with no risk of interfering in the manufacturing process. An additional benefit is that tests written for product evaluation often can be directly transferred to production use.

Selecting System Components

Performance and functionality. *Define the performance you need. For example, you may need a 4½-digit digital multimeter having 0.01% accuracy and a 5-MHz function generator that can provide a counted burst of square waves.*

Level of instrument programmability. *Programmable instruments may be talkers only, listeners only, or talker/listeners. That is, they may send information, receive information, or both send and receive information over the IEEE Standard 488 communications bus that connects all the instruments and the computer. Talker/listeners are best because they simplify programming, troubleshooting, and system maintenance.*

Compare the programmable (GPIB-accessible) features to the manual (front-panel accessible) features. They aren't always the same. You may need both to cover all your applications.

Instrument intelligence. *An instrument's intelligence (local processing power) allows it to do tasks that would slow the system computer. For example, some multimeters can average measurements and some oscilloscopes can perform Fast Fourier Transformations and then pass the results to the computer.*

Some instruments have the ability to store front-panel settings. These settings can be recalled by a command from the computer, making the system faster and more efficient. Also, more instrument intelligence allows you to use a less intelligent (and less expensive) controller. To reduce system cost, some manufacturers offer controllers that can be used only to run programs, not to develop them. If you build several similar systems, you can use one controller to develop programs and the other (less expensive) controllers to run them.

Command language. *The instrument's command language (not the controller's) should have powerful multifunction commands as well as commands for individual functions. For example, a single initialization command (called INIT in Tektronix instruments) should set all of an instrument's functions to an initial state. Initializing all functions individually might require you to program several hundred characters.*

SET? is another Tektronix example. With just this one query, you can ask an instrument to report all its current settings, letting you decide which you would like to change. HELP aids new users. This command tells an instrument to list all the commands that the instrument recognizes. Because the commands are mnemonic, the list helps new users find the right command.

Speed. *At first, the system speed issue seems simple: How fast can the system set up the equipment, make measurements, process the data, and record it? Looking more closely reveals that system speed is made up of many individual speeds: CPU (central processing unit), controller bus-transfer, instrument bus-transfer, local instrument processing, and instrument measurement speeds.*

Evaluate each application to decide which speeds to optimize. For example, if you need to make 1,000 voltage measurements and average them, buying a high-speed digital multimeter with lots of local processing power is investing in speed where it matters most. (Because the digital multimeter sends only one number—the calculated result—to the controller, bus-transfer speed isn't important here.) When controller speed is important, ask the controller manufacturer to run a time trial on your application.

Personal computers or system controllers? *Because of their lower price compared to system controllers, personal computers are popular for some IEEE Standard 488 system applications. Tektronix has designed the GURU hardware and software package for these users.*

The initial hardware cost of PCs is low. However, the longterm cost may be much higher. Developing software for PC-controlled systems is considerably more difficult. A PC requires detailed instructions to control messages on the IEEE Standard 488 bus. A controller performs this function automatically. For sophisticated programmers who have simple applications, the PC route may be better. For anyone who has complex applications, the system controller route is better.

Software availability. *Almost all instrument controllers can be programmed in BASIC, an easy-to-learn language that works well for most applications. Language enhancements are usually available on firmware modules (plug-in ROMs). Using these enhancements is much easier than developing your own BASIC software, and the extra cost is small.*

Documentation (manuals and other aids) and technical support (applications engineers) should also be available.

Memory size. *How much memory will you need? Typical applications require 64 to 128 Kbytes of RAM. Simple applications, using one instrument, might require only 16 Kbytes. Very complex applications might require 512 Kbytes or more. With most controllers, you can add RAM as you need it, at low cost.*

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The TM 500 Family

TM 500 is a family of manual Tektronix test and measurement instruments. They are mechanically and electrically compatible with each other. They are designed for compactness and modular mounting in eight mainframes. TM 500 instruments can function individually or in combination. The TM 500 family includes: digital counters, digital multimeters, power supplies, pulse generators, function generators, oscilloscopes, oscilloscope calibration instruments, and audio/low-frequency plug-ins.

Publisher's Statement

TM Notes informs TM 500/TM 5000 users and owners about new Tektronix instruments and about instrument applications.

For further information, contact Tektronix, Inc., P.O. Box 500, Beaverton, OR 97077. Phone (503) 644-0161. TWX 910-467-8708. Cable TEKTRONIX. Subsidiaries and distributors worldwide.

The TM 5000 Family

TM 5000 is a family of programmable, IEEE Standard 488 (General Purpose Interface Bus or GPIB) compatible test and measurement instruments. The TM 5000 family includes: digital counter/timers, power supplies, signal generators, function generators, a digital multimeter, an audio distortion analyzer, an RF scanner, and a multifunction interface system. Commands that control TM 5000 instruments conform to the Tektronix Standard Codes and Formats, ensuring quick-to-learn, easy-to-remember, and compatible programming.

For further information:

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