Motorola Automates Calibration Facility

Technical Note

Maintaining valuable test equipment for optimum performance usually requires an enormous amount of time. Proper procedure requires the equipment to be calibrated routinely to assure functionality and accuracy in obtaining measurements. At Motorola's Space & Systems Technology Group (SSTG) in Arizona, this challenge is not taken lightly. Within their large operation where complex communication, radar and tactical electronic equipment for defense, commercial, and space applications are produced, the Calibration Facility is responsible for maintaining all of the test instrumentation. The lab is accountable for the calibration, adjustment, and repair of literally thousands of different models of test equipment from numerous manufacturers. To accomplish their task efficiently, calibration software development personnel proceeded to automate any calibration procedure that could save time over manual methods. Using VEE, implementing their solutions was greatly simplified.

Before an automated VEE calibration application is designed, a list of criteria is consulted to determine the feasibility of the request to include:

- the quantity of the particular instrument,
- bus controllability;
- whether the calibration measurement is intensive;
- is there a similar program already in place;
- is the required equipment available to perform calibration and adjustment as outlined in the service manual.

If the instrument meets this and other criteria, the test equipment gurus are off and running.

Designing the User Interface

Initially Jeff Davis and Dave Hamilton, two of Motorola's Software Developers, invested a considerable amount of thought in their program design. They wanted all of their test applications to have a common look and feel so that a user could consistently perform tests, using multiple programs, on various units under test (UUT) without a separate learning curve for each tool. Implementing attractive, user-friendly GUIs was simple using HP VEE's built-in graphical displays. VEE provided allowed the developers to insert detailed setup drawings from their extensive graphics library into easily interpreted Panel Views.

VEE IEEE-488 and VXI instrument control objects, to/from file objects, datasets, and graphic objects were the keys to efficient implementation and uniformity. A key to making the GUI common to all the different programs was the ability to have as many panels as you want, to show and hide them as the user makes selections, and VEE ability to modify itself during runtime through the use of the import library function.

TEST LEVEL - Allows user to select/deselect individual tests or perform test maintenance functions, and shows the operator which test equipment is used for measurements.

Utilizing these concepts Jeff and Dave developed a top-level architecture as a standard shell from which all of their HP VEE applications would emerge. Generally each test starts with a "menu" allowing the technician to select from several options. A setup panel allows the user to choose among devices when different models are available. A notes panel

passes and loads a file for the user to track important items, or add notes for documentation purposes. In many instances, stored data, such as power sensor factors, are accessed by the user whenever a power meter is used. This access function allows one to create, revise, model and view tabular and/or graphic data on power sensors and other measurement transducers that are stored in a common library. VEE handles these routines with ease.

VEE Instrument Manager identifies the address of all instruments that are available on the bus, allowing the operator to configure instruments at a glance. Within each program, test specifications are checked to evaluate flatness, harmonic distortion, gain, modulation, or other parameters, as applicable to each instrument. Data such as oscilloscope waveforms, spectrum/network analyzer traces, and discrete multimeter measurements are gathered from all types of equipment. Measurement data, test results, PASS/FAIL status, and other test criteria is present at all times during the test so that the operator can make selections to continue or stop testing whenever a parameter is questionable.

All of the programs have an ALLTEST feature built into them that selects the logical test order and sequences testing. The operator can specify test order, remove tests, short-cycle tests, and retest failures only. At the end of a calibration, the technician can print all test results, or filter the results based on PASS/FAIL criteria and immediately determine a unit's functionality. Results can then be cleared for the next test sequence.

VEE Contribution to the Bottom Line
So, how does VEE save time and, ultimately, reduce cost?

During application development:

Jeff answers, *"Some of VEE built-in objects are incredibly powerful as stand-alone functions. For example, little manipulation of the built in graphic objects is necessary to build robust functionality. Once a programmer builds a sophisticated XY display panel, it can often be reused in other programs removing the need to design, build, and debug similar graphic routines. Displaying multiple waveforms and coordinate traces usually requires coding separate routines or devoting engineering time to making a really smart generic graphic display routine. VEE provides these "smart" displays at a mouse-click on a pull-down menu."*

Dave continues, *"The same goes for to/from file/dataset programming. There's no need to track file pointers, dimension arrays, or convert data types because VEE provides this built-in functionality for you. I also like the inherent block diagram that is created when you program in VEE. It is so much easier and faster to visualize the program execution and flow with this approach as opposed to common text languages such as C or BASIC."*

Use of the custom calibration applications reduces cost through minimizing valuable technician time in incrementally measuring parameters, statistically analyzing data, and documenting results. In turn, the automated calibration efficiently assures that each piece of equipment is functioning accurately, or identifies the need for repair when the instrument does not meet specifications. Since dozens of these calibration programs are used on "PC Instrument Controllers," dispersed throughout the three facilities, the runtime version of VEE was utilized as an inexpensive means for duplicating the applications. Additional benefits were then achieved from the security which prevented unauthorized modifications to released programs, and smaller program size which resulted in less consumption of computer system resources.

The users enthusiasm is reflected in Jeff's comment, *"Our technicians LOVE us because we build custom calibration programs that do EXACTLY what they are supposed to do".*

Unlike generic programs that tend to provide either functions that go unused or inherent shortcomings, the technicians who use the VEE programs are involved in the design from the beginning. In short, VEE has provided the tool to turn a PC into a functional instrument controller, in an environment that is easy to use and understand.

[**Developer profiles:**

Jeff Davis, Motorola SSTG
Test Equipment Facility, Software Developer
My involvement with test instrumentation programming began back in 1986. I have instrument control and programming experience with HP BASIC, Visual Basic, and some other programming languages. My first experience with HP VEE came during Revision 2.3 when it was supported only on workstations. I liked it then, I love it now, and

we will continue to use HP VEE for all of our instrument control programming requirements. There are other environments out there that claim to compete with HP VEE. You won't find them on my hard drive.

Dave Hamilton, Motorola SSTG

Test Equipment Facility, Software Developer

I have been writing instrument control software for about 15 years. Most of this software used to be written in HP BASIC. I started using HP VEE about 4 years ago and the advantages are enormous. HP VEE provides a blend of ready to use powerful objects such as graphs, root level commands, and math functions. HP VEE has transformed many tedious tasks such as I/O transfers into the very quick and easy. Conversion of data types? You don't even have to think about that anymore.

DISPLAY FUNCTION - Typical display objects exhibiting results stored in datasets.

SETUP CHANGE - Typical graphic panel that shows the operator that a setup change is needed.

Imagine plugging an oscilloscope into your laptop PC, measuring a waveform, saving the data into a spreadsheet, and then unplugging the scope. That's the ease of use that FireWire will bring to design and test engineers.