FLUKE®

Mobile calibration keeps the Space Shuttle's instruments A-OK

Application Note

Testing Functions
Case Study

Tools: Fluke PM 6681 Timer/Counter, Hart 7103 and 7341 Temperature Baths, Fluke 189 and 289 Digital Multimeters, Fluke MET/CAL Software

Operator: Steven J. Bidwell, Calibration Engineer, United Space Alliance (USA)

Measurements: Timing signals, temperature calibration, transducer output, paperless automation

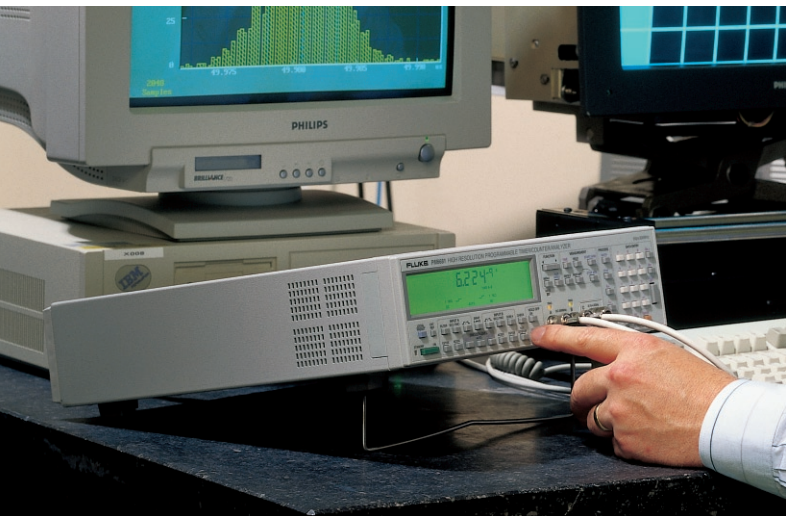
The United Space Alliance (USA) is a spaceflight operations company and a joint venture between The Boeing Company and Lockheed Martin Corporation. Among the tasks performed by USA is the calibration of instruments that supply data about conditions aboard NASA's Space Shuttles.

Steven J. Bidwell is a calibration engineer at USA. "I am not an ABET-certified Engineer," he reveals, "but a technical operations specialist in the metrology field who works in the IPC In-Place Calibration engineering group." In this capacity, Bidwell participates in writing in-place calibration procedures for shuttle instrumentation. "We direct the measurements and how they will be performed, and we analyze any information we get and keep historical records," Bidwell explains.

USA's calibration lab is based at the Kennedy Space Center (KSC), and the calibration group currently performs work at KSC, the Cape Canaveral Air Force Station (CCAFS), NASA's Shuttle Logistics Depot and the Dryden Flight Research Facility (DFRF). Asked about the mobile setup that allows calibration to take place at these various sites, Bidwell notes, "We don't actually have a mobile setup; we have several. We have mobile vans that carry about ninety percent of the equipment we could use at KSC, CCAFS and other locations."

The equipment and its reliability

Bidwell describes the demands placed on the mobile equipment used by the IPC group. He says, "Being a mobile calibration lab, we perform many of our measurements in less-than-ideal environments. The equipment has to perform in heat, cold, wind, high humidity and all sorts



Using MET/CAL® software to automate the calibration process.

of varying conditions." The calibration engineer further explains that the equipment used by the group must supply the required precision to ensure accurate, first-time calibrations.

Among the equipment USA's IPC group uses in its mobile calibrations are Tektronix TDS5104B DPOs (digital phospor oscilloscopes), Fluke PM 6681 Timer/Counters, Hart Temperature Bath models 7103 and 7341, and Fluke 189 and 289 DMMs (handheld digital multimeters). All play roles in calibrating instruments as well as in monitoring some mechanical conditions (e.g., bolt torque). Following are details of some of the calibrations USA's technicians perform using these tools and procedures developed by Bidwell and others to ensure the reliability and safety of the shuttles.

The Fluke PM 6681 Timer/Counter is used by USA's IPC group to measure a variety of timing signals, mainly in radar applications used for orbiter tracking.[1] Of course, the success of any mission and the lives of onboard personnel depend on orbiter tracking and the precise execution of required maneuvers. Systems to accomplish these things include microwave scan beam landing systems, often called MLSs.

According to NASA's Website,[2] an orbiter has three onboard MLSs, which are airborne Ku-band (15.35 GHz to 17.25 GHz) receiver/transmitter navigation and landing aids. The MLS units transmit slant range, azimuth and elevation to ground stations along runways used for the landing phase of missions and, if necessary, for return-to-launch-site aborts. Bidwell notes that his group uses the PM 6681 Timer/Counter to measure MLS signals as well as other complex radar signals. In general, these signals locate the orbiter in three-dimensional space.

Baths from Fluke's Hart Scientific division are used to calibrate temperature-measuring devices. Says Bidwell, "As you can imagine, there are a lot of temperature sensitive items that the orbiter depends on. There are literally thousands of them strewn about the Space Center, and we use the baths to simulate the temperatures that those devices are going to see. Then, we measure the output to make sure everything is as expected."

The calibration engineer explains that prior to lift off all of the onboard temperature sensors are tied back to the Launch Control Complex (LCC), typically via 4 mA to 20 mA loops. So, when launch control personnel want to know the temperature of something, they have confidence in the readings because they know that USA's calibration team has performed a thorough end-to-end test between the device on the shuttle and the readout in the LLC.

Bidwell reveals that recently he and his colleagues, working with a co-op student from the University of Florida, automated the group's temperature baths. "Now, we can take a number of baths and automate a run of temperatures," he says. "As you can imagine, we have some lollipop gauges and transducers that measure temperature ranges of environments for people, electronics and payloads, among other things.

"To do those calibrations one at a time takes quite a bit of time. So, we've automated that process using three or four baths. We can bring the baths up, check that they're stable, take readings off them and move through the calibration much more rapidly than we did before. We run them at different temperatures. We can change the temperatures depending on the test protocol, and we can run many transducers at once."

Fluke 189 and 289 DMMs play many roles in USA's mobile calibration operations. When, prior to a launch, for example, someone reports to the LCC that the external tank (ET) is at 15 psi, LCC personnel know that reading can be trusted because USA's IPC team went on site, pressurized the transducer that records that pressure and performed an end-to-end calibration of the control loop. In other words, the team uses the DMMs to check transducer output, when procedure allows.

One somewhat unique use of a DMM entails monitoring a strain gauge measurement that correlates with the torque on bolts. Such DMM readings are used, for example, to calibrate the torque on the bolts that hold the ET and orbiter to one another and also the torque on bolts

that will hold the orbiter to the transport vehicle, the Boeing 747 that's used to bring the orbiter back to KSC if it lands at DFRF or another remote landing site.

MET/CAL® software at United Space Alliance

Fluke MET/CAL® Calibration Management Software helps metrology labs automate their calibration processes. Bidwell explains that using MET/CAL software for automating calibration is one area where USA is expanding its offerings to NASA. The calibration engineer says, "We're really trying to see what we can do to automate because NASA is asking for more automation and more paperless performance of calibrations than we have used in the past."

MET/CAL software is written for PCs running the Microsoft® Windows® operating system. It generates and writes test results to a SQL database. It also enables a user to create and edit calibration procedures for a wide range of standards. The software supports the creation of calibration reports and certificates and makes data available to word processing, spreadsheet and other software applications.

At USA, Bidwell reveals, MET/CAL software has been used to perform automated calibrations of data logging computers for the LCC, and, now, plans include using the software to support the calibration of DMMs, dc electronic loads, and power supplies. He adds, "We have Hart Scientific DEWK Thermo-Hygrometer temperature/humidity monitors that will automatically (using MET/CAL) insert temperature and humidity data into data sheets when calibrations are performed."

The calibration engineer observes that NASA has and always will strive to achieve more with fewer resources, and USA works hard to be at the forefront of that endeavor. "Automation using MET/CAL will mean faster, more reliable data gathering and easier interfacing to paperless databases," Bidwell acknowledges. "The software gives us a solid platform from which to create an integrated, KSC-wide effort to meet our customer's mandate.

"We also find that MET/CAL makes automating electronic procedures and retrieving archived data for analysis easy—both up-front and when it is required after the fact. If you find a need to comb through your data, MET/CAL is a great platform from which to do it," he concludes.

[1]The orbiter is the airplane-like component of a space shuttle sans the two solid rocket boosters and the external fuel tank (ET), which carries fuel for a launch.

[2]Visit http://spaceflight.nasa.gov/shuttle/reference/shutref/orbiter/avionics/gnc/msbls.html

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