Adaptable Medical Device Test Platform, cDAQ does it all!

Author(s):
Timothy Nolan, Data Science Automation, Inc., CLA/CTA/CLED/CPI,

NI Product(s) Used:
NI cDAQ-9133
NI 9263
NI 9265
NI 9477
NI 9425
USB-6000
LabVIEW 2016

Category:
Electronics and Semiconductor

The Challenge
Design an integrated test platform, adaptable for testing a wide variety of commercial products.

The Solution
Data Science Automation

Introduction
For 25 years, Data Science Automation® (DSA) has been a premier automation systems integrator, leveraging commercial off-the-shelf tools in the design and implementation of custom-engineered, complete, and highly-adaptive solutions in laboratory automation, embedded/new product development, manufacturing and test automation. The company provides an extensive array of automation engineering, programming, consulting & training services to dramatically improve research, manufacturing, government & business operations. DSA is fast and methodical, staffed with exceptional, multi-disciplinary, NI Certified professionals that consistently apply CSIA-certified best practices to deliver the lowest total cost of ownership.

Our customer opted to have one of our CLED/CLA LabVIEW developers produce a reusable and adaptable architecture for use on multiple systems with the same basic hardware layouts.

Modernize the Testing
DSA's client has been using a legacy test system, with a non-maintained code base, and non-standard connector scheme. Adding new tests was difficult and problematic, and the user was responsible for a high level of knowledge regarding the system in order to adjust outputs throughout the test. Furthermore, the client was about to expand their product line, and the current tester would not be sufficient to test the new systems, nor would it be cost effective to recreate a new test fixture for each item to be tested. Therefore, the goal of DSA was to create a test platform that would be flexible and expandable into the upcoming product line changes.

Design with the Future in Mind
The cDAQ-9133, with the built in Windows environment was the first choice for the customer, as it allowed compact and portable implementation of the system. We build the cDAQ, and accessory hardware into a self-contained electronics box, with zero insertion force (ZIF) connectors for all of the system I/O (Voltage and Current outputs, 24V Sinking Digital Input and Output.) This allowed the customer to only create a custom cable solution from the ZIF to their device under test, and keep the DAQ self-contained and transferrable between products.

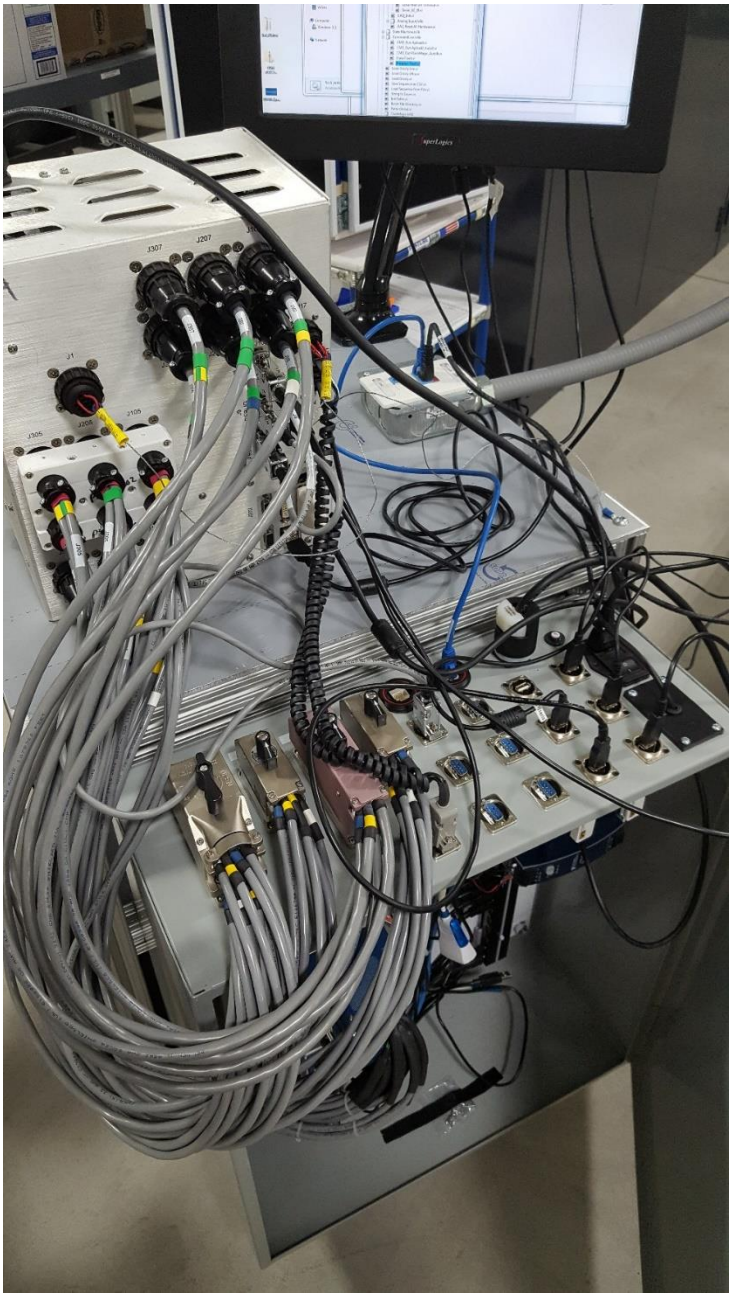

Figure 1 Custom cabling solution from the electronics box

Likewise, the testing procedure was designed to be easily updated and modified by the end user. The client had much more training and experience with LabVIEW, rather than TestStand, and so the test sequence system was written in LabVIEW for this implementation.

A main focus for DSA is to educate and empower our customer. To that end, refinements in test protocol often arise during manufacturing testing, and we needed to provide them a straightforward method for updating the test procedure to reflect these changes. Each product had a corresponding spreadsheet file, which listed the parameters to be used in the test. These parameters included the text to display to the end user, which images to load during user prompts, what serial commands to be used, timeout durations, and any other numeric or string variable used in the specific test step.

8		Step_2_1_ProgramFlash	Serial Response	Confirm Successful Programming	Flash_Write_Successful.jpg		30
9		Step_2_1_AploadJProgram_Instruct	Instruction	Set DIP switch SW1 position 7 to OFF. All else are ON	Grizzly_CPU_POST.jpg		30
10		Step_2_1_AploadJProgram	Serial Response	Confirm Successful Programming	AploadJ_Successful.jpg		30
11		Step_2_1_CheckCRC	Serial Response	J6	9E9	menu	30
12	XXXXXX	UART Tests	TRUE				
13		Step_2_2_2_UART0-1_Test	Serial Response	J6	uart	PASSED	120
14		Step_2_2_4_UART3-4_Test	Serial Response	J6	duart	PASSED	120
15	XXXXXX	Flash Tests	FALSE				
16		Step_2_2_5_AT25DF641_U226	Serial Response	J6	spi0	PASSED	60
17		Step_2_2_6_AT25DF642_U255	Serial Response	J6	spi1	PASSED	30
18		Step_2_2_7_16MB_U226_U255 _SPI1_CS0-CS1	Serial Response	J6	drive D	PASSED	30
19		Step_2_2_8_Ferroelectric_RAM	Serial Response	J6	feram	PASSED	30
20		Step_2_2_9_PMIC_I2C-0x90	Serial Response	J6	pmic	PASSED	30
21		Step_2_2_10_64Mx16NOR_FLASH	Serial Response	J6	nor	PASSED	30
22		Step_2_2_11_Serial_EEPROM_256_8	Serial Response	J6	eeprom	PASSED	30
23		Step_2_2_13_Audio_J14_J15_Test	Analog Value	J6	audio 1	audio 2	audio 3

Figure 2 Example Test Spreadsheet

Each test was defined in the test procedure we were working from and remained completely self-contained. Each step that had pre-requisites for running, e.g. power or serial connection, would be checked for that status before execution.

Ease of Use

The user experience was divided up into three levels of access, Operator, Engineer, and Administrator. Operator was the main functionality, allowing the operator to select what product to run, what tests to run on the product, and providing a traceable printout of results, to satisfy documentation requirements.

The Operator screen consisted of a Tree Control, listing all of the tests, by test group. The operator could RUN or SKIP any individual test, or test group, merely by touching that line on the Touch-Operated screen integrated into the system.

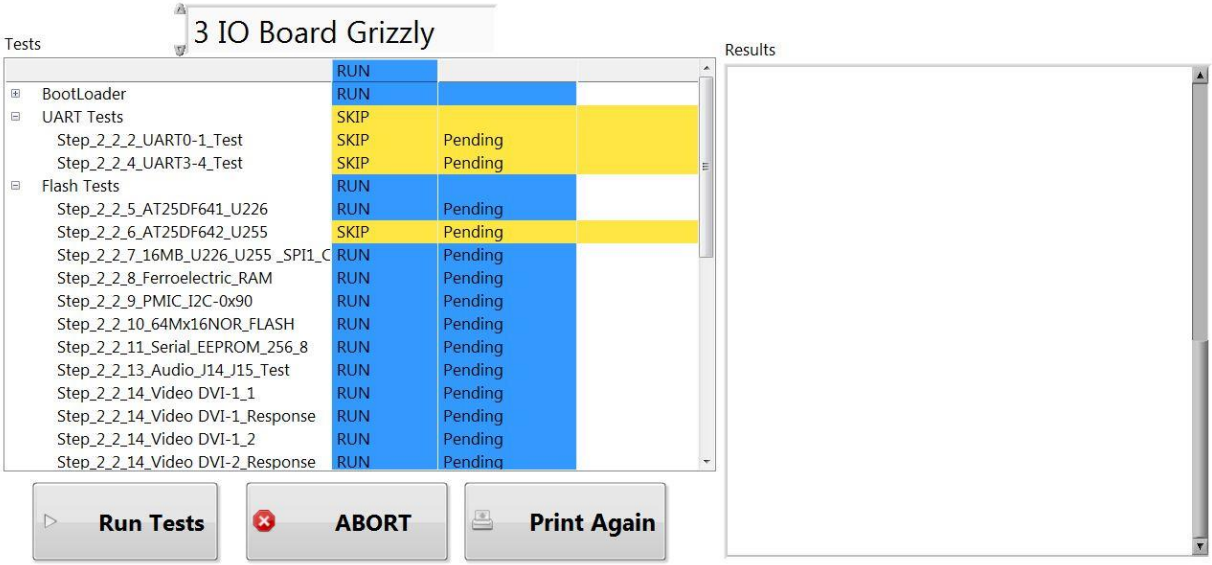

Figure 3 Operator Screen, with single step skipped and skipped group example

As a Test was run, a detailed report of test results would be populated on the right side of the screen, which ultimately was printed to the test report output sheet. In addition, the Tree control would update on which step was in progress, and the high-level PASS/FAIL status of each step and step group.

The Engineering screen allowed more detailed interaction with the Device Under Test (DUT). This required a second level of login, and allows the user to arbitrarily set and read I/O levels, program the device, and send/received serial communications with the processor built into the DUT.

The final Administrator level was designed to be the user manager, and to set the location for electronic backup copies of the printed reports.

Integrating with External Programs
The client was able to leverage the power of LabVIEW to interact with a number of third party executables. These enabled running of CMD-line batch files for erasing memory, calling the Texas Instrument executable to pass direct commands to the microprocessor. In addition, some higher level loading of binary files to the multi9ple processors on board the DUT was managed, using LabVIEW's command line interface, and ActiveX technology to interact with open references to the EXEs.

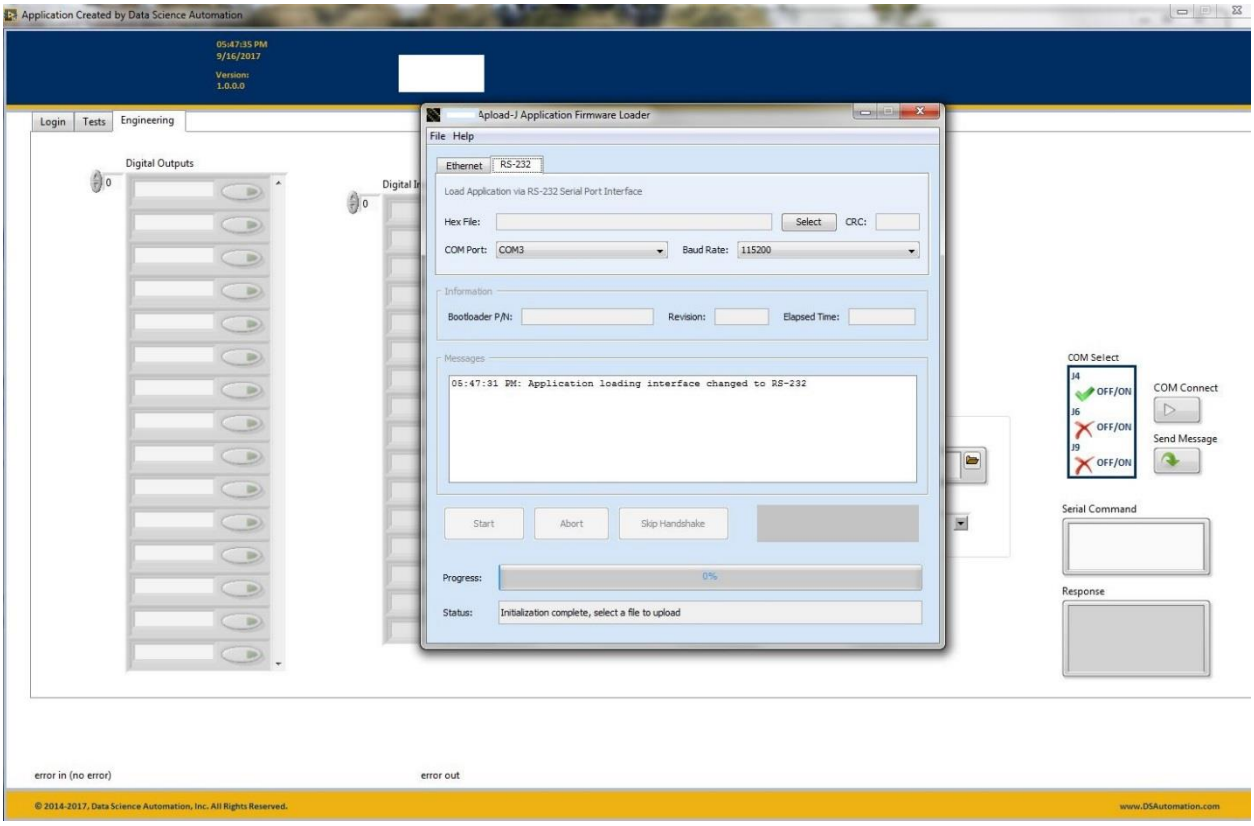

Figure 4 LabVIEW passing connection and hex file parameters to third party EXE

Ease of Maintenance
Another benefit of a modular hardware and test procedure is that the platform is extensible, even using the same deployed code and EXE. Adding new steps, new parameters, or even a whole other suite of tests is possible by the end user (so long as no new unique test cases are needed.) In addition, the dynamic nature of calling the test instructions and pictures by string name in the spreadsheet allows the end user to modify and customize their user experience without requiring programmer interaction, or a recompile of the code.

Conclusion
The combination of the hardware support for third-party devices and the adoption by National Instruments of multiple industrial hardware communication protocols greatly reduced the time-to-production of the test stands. In addition, several projects are already in planning phases to leverage this platform for the rest of the product line. The Manufacturing test platform has already surpassed even the Research and Development test bench the customer had, for flexibility and ease of use.

The highly scalable and adaptable architecture developed will allow our customer to save time and money on future assembly stand bring-up. The customer made use of custom training to make them the experts on the solution delivered so that they could leverage their internal LabVIEW resources going forward.

Contact Information
Timothy Nolan, Manger, Product Engineering
375 Valley Brook Road, Suite 106, McMurray, PA 15317
tdn@DSAutomation.com
(724)942-6330
www.DSAutomation.com