Upgrading Motion Control System on Product Testing and Validation Machinery

Opto 22 Embeds SNAP Motion Control Subsystem in Production Equipment to Control, Monitor and Gather Operational Data

In the center of Opto 22's Temecula, California factory sits the G4 Handler, a large machine used for final assembly and testing of all of the company's G4 modules—single point input/output modules used mainly for applications involving the sending and receiving of digital signals. Since the introduction of the G4 modules in the mid-1980s, Opto 22 has sold millions of these modules and 20 years later, they remain one of the company's best selling products.

G4 Handler testing modules

Like most Opto 22 modules, G4's are guaranteed for life. In order to make this guarantee, the company must submit the modules to rigorous testing before they're shipped to customers. The G4 Handler is the machine used to perform these tests. Built by Opto 22 Manufacturing Engineer Ron Schmidt, the machine individually tests each and every G4 module, not once but twice. Performing these tests requires large trays with fifty G4 modules at a time to be loaded into the G4 Handler. The trays move back and forth and left and right on X and Y axes, while the machine puts each one through several tests. These include an in-rush current test, minimum and maximum current load tests, as well as inductive, capacitive, and resistive tests, which ensure that the modules can handle signals for varying types of electrical equipment such as transformers, power supplies, motors, and lights.

An embedded hi-pot machine applies voltage for many of the G4 modules' various tests

"The G4 Handler even tests the small LED on each module that lets you know when it's operating," says Schmidt.

G4 IO modules

However, all of this testing first relies on the trays of modules moving fluidly back and forth. Accomplishing this required the use of multiple servos—electric motors coupled with a position feedback device used to affect mechanical motion for a specified distance. Recently, the servos on the G4 Handler, in service for close to two decades, needed to be replaced. Unfortunately, Schmidt and the maintenance engineers at Opto 22 could not find an economical replacement.

The decision was made to replace the G4 Handler's servo motors with stepper motors. This approach is somewhat uncommon, but

for Opto 22's purposes it was a viable and much more affordable option.

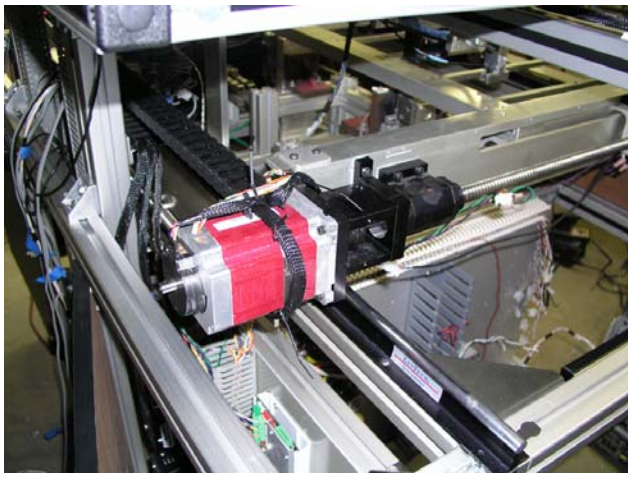
Another reason for switching to steppers was because the G4 Handler upgrade coincided with the release of Opto 22's SNAP PAC Motion Control Subsystem, which is specifically designed for use in motion control applications that utilize steppers, such as winding, cut-off, assembly, and packaging.

Combining a SNAP PAC programmable automation controller, a SNAP Motion Communication Module, a SNAP Motion Breakout Board, and PAC Control—the control programming component of Opto 22's PAC Project™ software suite—the SNAP Motion Control Subsystem accomplishes multi-axis stepper motor control along with traditional analog, digital, and serial-based automation. The subsystem was developed in late 2006 and introduced early in 2007 as part of Opto 22's flagship SNAP PAC System product line.

"With operation of the G4 Handler machine already including a host of digital functions and now with a clear need for stepper motion as well, we knew it was an ideal opportunity to test drive the Motion Subsystem in a quirky and unique situation where we would be embedding Opto 22 SNAP PAC I/O in a machine used to test Opto 22 G4 I/O," says Schmidt.

First Steps

Schmidt worked with Opto 22 Design Engineer Nick Riley, who developed the Motion Subsystem, to match the G4 Handler's servos to equivalent stepper controllers that had enough torque to adequately move the G4 Handler components.



G4 Handler stepper motor

"For verification purposes, we also needed steppers that included encoders," explains Riley. "The encoders convert the movement of the stepper motor into a pulse that can be measured and used to confirm that the steppers are, in fact, where they're supposed to be."

Meanwhile, Schmidt began dismantling the G4 Handler—first stripping out the servos and then redressing the belts and harnesses that enable the machine to move trays of modules side to side and back and forth. Next, the machine's *mistic* I/O system was removed and replaced with the new SNAP PAC System's more dense and versatile multi-channel I/O.

"That older generation *mistic* system was used mainly for digital functions that take place within the G4 Handler, like powering on and off, and activating the machine's reject arm—a small component that removes and dumps any G4 module that fails testing," says Schmidt.

According to Schmidt, switching to the new SNAP PAC System's high-density modules saved significant space, as they provided 16 times the density of the old system. The overall consolidation benefit was considerable and Schmidt was able to condense the functionality of six single-channel bricks down to a single rack. Indeed, thanks to the new SNAP PAC System's high I/O density, Schmidt was able to replace one entire 16-channel I/O brick with just one 16-channel SNAP module.

SNAP Motion Control Subsystem

Other functions handled by the SNAP PAC include activating a bolt feeder that inserts a small securing screw into each G4 module, control of the air cylinders that rise up and down as they apply the high voltage test heads to the modules, and miscellaneous analog functions.

The SNAP PAC System also controls the Motion Control Subsystem. The Motion Communication Module resides on the same rack as the digital and analog modules and uses an RS-485 serial interface to connect to a breakout board that, in turn, connects to and drives the

G4 Handler's stepper motors to move the tray tables on the X and Y axes based on the commands sent by the SNAP PAC.

"In this application, one of the major benefits of using the SNAP PAC System—and one that our customers who have similar motion control needs appreciate most—is the ability to consolidate all I/O functions in a single platform," says Schmidt. "In other words, you don't need need multiple devices or components to handle typical digital points—like a machine's limit switches—and then another system for recording analog readings—like machine temperatures—and then a third system to execute the machine's motion control. With the Opto platform, all sensor and component interfacing and all control is performed by a single system, and all functions are defined using a single development environment."

The SNAP Motion Control Subsystem was programmed with PAC Project, the programming suite used with Opto 22 SNAP PAC Systems. PAC Project includes programming software that features both scripting and flowcharting, an HMI development application, debugging tools, and the OptoMotion command set, which supports several Magellan™ Motion Processor commands. Kathy Spignese from Opto 22's Product Support Team used these OptoMotion commands to specifically define the parameters of the G4 Handler's motion processes, including position, velocity, acceleration, and time delays for the trays of modules as they move back and forth into proper position for testing.

"For the stepping, I programmed the Motion Subsystem to position the trays underneath the test heads so, in succession, each G4 module can be properly tested," explains Spignese. "I was also able to specify smooth stops or abrupt stops as needed."

G4 Handler testing modules

Spignese has also programmed the SNAP PAC to record production data, specifically module test results (i.e., pass/fails) and this data will be made available to Opto 22 production supervisors and other authorized personnel. Specifically, the OptoDataLink component of PAC Control will enable data exchange between the SNAP PAC System and company enterprise databases—like Microsoft® SQL Server® and Microsoft Access. In this instance, possessing a multi-domain control system like the SNAP PAC, with its data acquisition capabilities as well as connectivity and data integration software tools, has proved most beneficial.

While outfitting the G4 Handler with the Motion Control Subsystem, Schmidt made a few other changes to make the machine more efficient and easier to use, including making all the controls more accessible. Previously, the G4 Handler's machine controls consisted of a collection of switches and indicators situated in various locations on the machine. However, during the motion control upgrade, a good deal of internal space was saved through rewiring these controls to an OptoTerminal-G70 operator interface terminal. The terminal serves as a centralized control interface—installed at shoulder level—from which all machine controls are more easily reached. It also aids greatly when training operators on how to use the G4 Handler.