Software Development to Test cRIO Module 9207 and Results

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This note presents code features that have been completed to test the National Instruments ADC module 9207 and test results
conducted on a single module.

A test stand has been developed to test CompactRIO modules, which are used in several slow control systems of the detectors in Hall B [1]. Code to check the ADC module 9207, a voltage and current input module, has been completed and tests have been conducted.

The LabVIEW-based code was developed to check mean, accuracy, standard deviation, dynamic range difference, offset error, gain error %, differential nonlinearity, and integral nonlinearity.

The code enables the tests to be performed in automatic mode or manual mode. Automatic mode runs all tests for all channels, with either voltage or current inputs. Manual mode runs a single test on just one channel. All results can be sent to Excel in automatic mode, and partial results in manual.

To run voltage tests in automatic mode, 9207 voltage is chosen from the *Module to Test* drop-down menu on the Automatic tab of the user interface, Fig. 1. A 9264 voltage output module injects an input voltage value from −10 V to 10 V, in increments of 1 V,

$$V_{input} \in Integer\{[-10V, 10V]\},$$

a hundred times into each channel 0–7 of the ADC module 9207. The value registered by the 9207 is read back after each input. The mean, accuracy, and standard deviation for each input value of the range is then calculated for each channel.
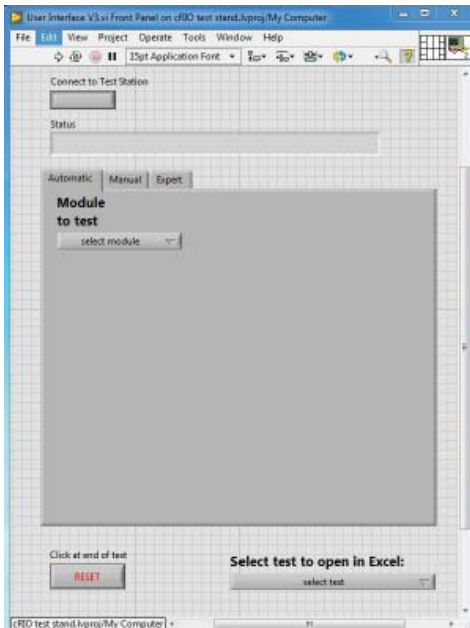
The readback samples are used to compute the measured full scale of each channel. The measured full scale is then used in the calculation of the dynamic range difference, offset error, gain error %, and differential nonlinearity. The previously calculated means are used to compute the integral nonlinearity.

To test current readback of the module, either 9207 current, channels 8–11, or 9207 current, channels 12–15 is chosen. The current test is similar to the voltage test, except current is supplied by a 4-channel 9265 module, in the range of 0–20 mA.

In the manual mode, on the Manual tab the user chooses one test to run, a single channel, number of samples to take, and step-size to use, Fig. 2. If the test is to determine accuracy and standard deviation or integral nonlinearity, start and end values are entered as well. Results for differential nonlinearity, dynamic range difference, gain error %, and offset error are shown on the same tab. Integral nonlinearity, means, accuracy, and standard deviation can be logged in Excel.
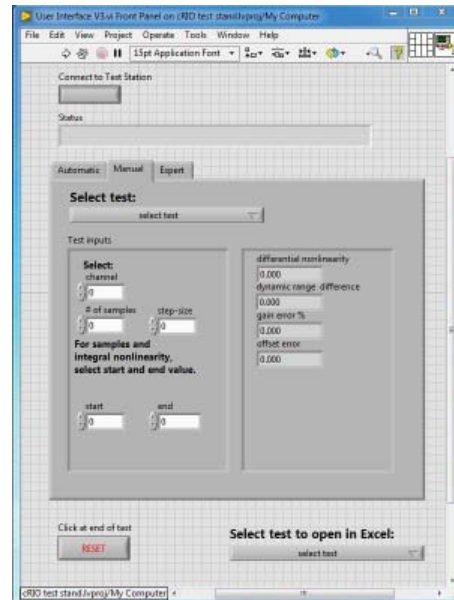

FIG. 2. Tab for manual test where test selections are entered and some results are shown.

Select results of the automatic testing of module 9207 are shown in Tables I (voltage) and II (current).

To summarize, the code to test the ADC module 9207 has worked successfully on the test stand. The test results indicate that the module's performance is acceptable.

FIG. 1. Tab for automatic tests where module is selected.

Voltage test results for 9207 channel 0	
Test	Result [V]
Mean (3 V input)	2.999
Accuracy (3 V input)	0.035
Standard deviation (3 V input)	0.000
Dynamic range difference	0.000
Offset error	0.000
Gain error %	0.004
Differential nonlinearity	0.000
Integral nonlinearity (3 V input)	0.001

TABLE I. Voltage test results of module 9207, channel 0.

Current test results for 9207 channel 8	
Test	Result [mA]
Mean (5 mA input)	4.997
Accuracy (5 mA input)	0.059
Standard deviation (5 mA input)	0.000
Dynamic range difference	0.000
Offset error	0.000
Gain error %	0.051
Differential nonlinearity	0.000
Integral nonlinearity (5 mA input)	0.006

TABLE II. Current test results of module 9207, channel 8.

[1] M.A. Antonioli, et al. *Test Stand for CompacRIO Analog Input Modules*, DSG Note 2017-10, 2017.