How to Optimize Measurement Speed of Your DAQ

KEYSIGHT

Data Acquisition (DAQ) hardware has its limitations at some point in terms of measurement accuracy and speed. There is a tradeoff between measurement accuracy and speed. If accuracy is secondary to measurement and transactional speed, there are a few things for you to consider.

There are many Data Acquisition systems out there in the market. Developers often choose large DAQ mainframe systems for incremental performance but at a very high cost. Often times, it is an investment overkill, paying a whole lot more for measurement performance that you do not need.

This white paper will show you how to optimize the measurement speed of a mid-range DAQ system, Keysight's DAQ970A system, to meet most of your design validation tests. You will learn how to choose the right hardware and configuration settings that will help you optimize your measurement and transactional speed.

Figure 1. Keysight's DAQ970A mainframe and its interface modules

Keysight's DAQ970A introduces the DAQM900A 20-channel Solid State multiplexer capable of switching 450 ch/sec and measure maximum voltage of 120 V.

Choosing the Right Hardware

The mid-range mainframe DAQ970A provides 3 slots for interface modules. This mainframe has LAN and USB interfaces for remote connections. In terms of reading speed over the interface, the LAN and USB can transmit remotely easily 5000 readings per second. It can achieve higher reading speeds if not for the throughput limitations within the other parts of the data acquisition system.

So, where is the speed bottleneck in the DAQ system? The DAQ mainframe does not contribute to the speed bottleneck. The bottleneck comes from the mechanical switching speeds within the multiplexer interface modules. Figure 1 shows a selection of up to 8 types of interface modules and the DAQ970A mainframe. Table 1 shows the module selection guide. You will notice that the model DAQM900A module has the fastest scanning speed of 450 channels per second because it uses Solid State switches. The rest of the other modules have slower scanning speeds of 250 and 80 channels per second because they are using Reed Relay and Armature switches respectively. Armature switches have better power handling capability than Reed relay switches.

Table 1. DAQ970A module selection table guide.

Model description	Type	Speed (Ch/sec)	Max (Volts)	Max (Amps)	Bandwidth	Thermal Offset	Comments
DAQM900A 20 ch Solid State multiplexer	2-wire armature (4-wire selectable)	450	120 V	0.02 A	10 MHz	< 4 µV	
DAQM901A 20 ch Armature Multiplexer + 2 current channels	2-wire armature (4-wire selectable)	80	300 V	1 A	10 MHz	0 µV	Built-in cold junction reference. 2 additional current channels (22 total)
DAQM902A 16 ch Reed Multiplexer	2-wire armature (4-wire selectable)	250	300 V	50 mA	10 MHz	< 4 µV	Built-in cold junction reference
DAQM903A 20 ch Actuator/ GP Switch	SPDT/form C	120	300 V	1 A	10 MHz	< 1 µV	
DAQM904A 4 x 8 Matrix	2-wire armature	120	300 V	1 A	10 MHz	< 1 µV	
DAQM905A Dual 4 ch RF Mux 50 Ω	Common low (unterminated)	60	42 V	0.7 A	2 GHz	< 4 µV	1 GHz bandwidth through BNC-to-SMB adapter cable
DAQM907A Multifunction Module	Two 8-bit digital I/O ports 26-bit event counter Two 16-bit analog outputs		42 V 42 V ±12 V	400 mA 10 mA	100 kHz		Open drain Selectable input threshold Max 40 mA total output per frame
DAQM908A 40 ch Armature Multiplexer	1-wire armature (common low)	60	300 V	1 A	10 MHz	< 1 µV	Built-in cold junction reference. No four-wire measurements

Tips in Configuring Your Hardware to Increase Your Reading Speed

Reducing the system overhead

One of the ways to optimize your measurement speed is to reduce unnecessary system overhead. During an automated test, you do not need the DAQ mainframe's displays and annunciators to be running. All these take processing time from the DAQ system. You can disable the entire front panel display using a remote command. When disabled, the entire front panel display goes blank and all display annunciator except for ERROR are disabled.

Select the DAQ Digital Multimeter resolution

Selecting the digital multimeter (DMM) resolution will give you the level of detail that you need. You will want just enough precision but if you set say 6.5 digits and all you need is 5.5 digits, you will waste processing time and hence unnecessary slack in measurement time.
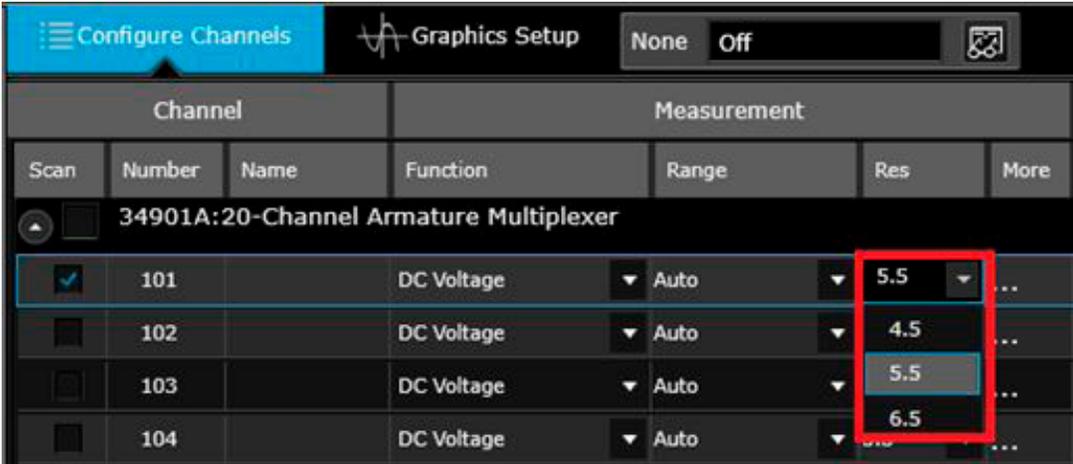

Figure 2. DAQ DMM resolution settings using BenchVue DAQ software.

Select the DAQ DMM range

Normally if you make an unknown measurement using a DMM, you would use Auto-range by default. This means no messing with range settings and always getting results. The engineers that design the DMMs have spent a lot of time designing the range switching algorithm so that you don't have to worry about range setting.

However, if you want to optimize your measurement speed, it is good to know that although Auto-range provides measurement convenience, it also takes time to decide on the correct range to use for every measurement. Test engineers will optimize measurement speed by selecting a specific range.
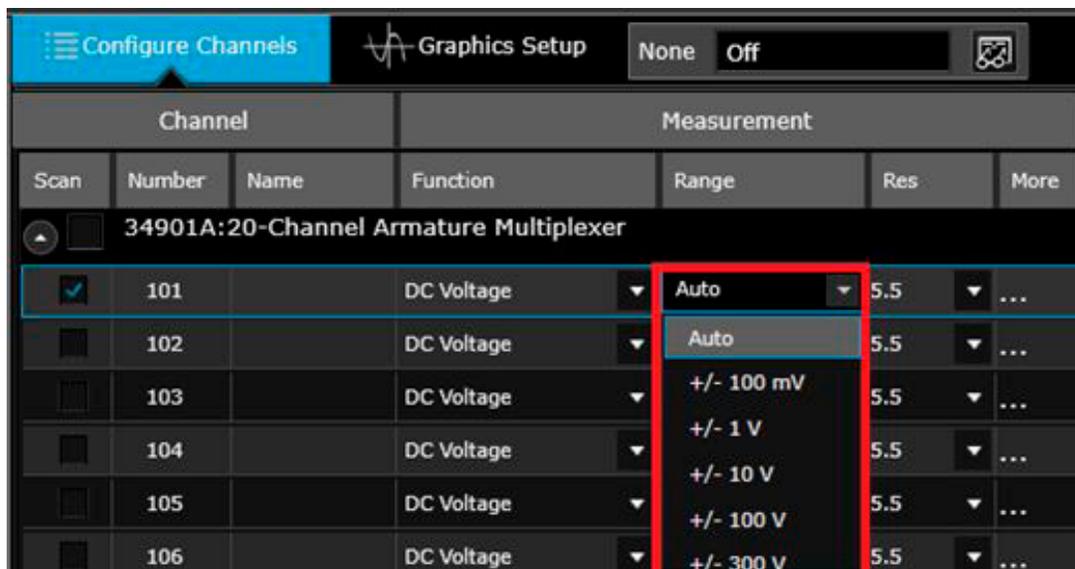

Figure 3. DAQ DMM range settings using BenchVue DAQ software.

Selecting the correct Power Line Cycle (PLC) integration time

PLC integration time's purpose is to reject power-line related noise present with DC signals on the input. The DAQ970A typically sets the number of PLC to be 1 by default. You can select the correct PLC number to effectively remove the noise as well as optimize your measurement speed. Normally, you will need to run some statistical tests to find the optimum setting. This means savings of a few hundred milliseconds per reading.
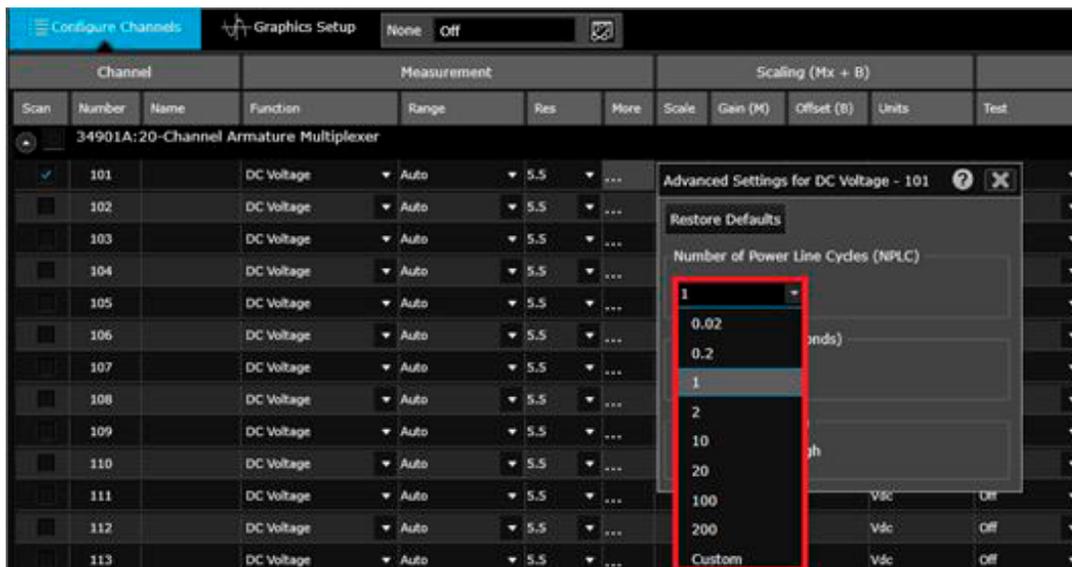

Figure 4. DAQ DMM PLC settings using BenchVue DAQ software.

How to improve transactional speed

You can optimize the DAQ's transactional speed by reducing its transactional latency. Instead of sending one command per transaction, you can concatenate several commands into one string per transaction to reduce transactional latency. For example, sending "ROUT:CLOS (@1001);:ROUT:OPEN (@1001);:ROUT:OPEN?(@1001)," will send three commands in a single string to the DAQ system. Rather than using three different transactions, which include transaction time and latency, sending only one single transactional command can save you 50% of the transaction time.

When making temperature measurements

When reading temperature sensors, the DAQ needs to perform signal conditioning and go through a mathematical voltage to temperature conversion to get proper readings. All these processes will take up measurement time.

To optimize measurement speed, make sure you select the type of sensor good enough for your accuracy requirements. Thermocouple sensors are very versatile and rugged but not as accurate as RTD sensors. Thermocouple sensors' measurement speed are faster than RTD sensors because they output voltage whereas RTD sensors are resistive transducers.

Thermocouple measurements need thermocouple reference junctions to obtain absolute temperature measurements. To optimize measurement speed, measure thermocouple reference junctions less frequently.

If you are a programming savvy test engineer, you can perform all the voltage to temperature conversion in your computer rather than in the DAQ system itself. You will need to understand the Seebeck coefficient conversion method as stated in this application note, Practical Temperature Measurements.

When making resistance measurements

A DMM normally should source current and measure voltage to make a resistance measurement. If you use a constant current source, you can use the DAQ's DMM to measure only the voltage and pre-configure the input to calculate using Ohm's law to convert it into resistance measurement. By just measuring the voltage, you can optimize the resistance measurement speed.
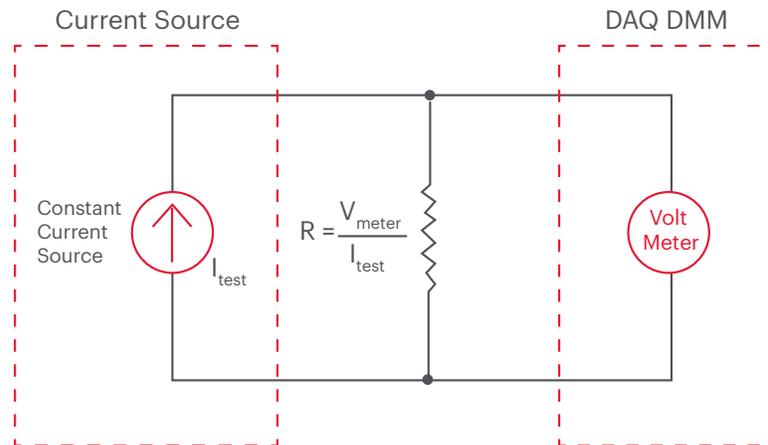

Figure 5. Resistance measurement using constant current source.

Conclusion

This paper has shown you how to optimize your DAQ system for throughput, scanning speed and accuracy. Selecting the right module interface is important to the type of measurement and throughput you require. Understanding the type of signal you are measuring and configuring your hardware to optimize your measurement so that there is little loss in test efficiency. As a result of optimized test solution, you can realize cost savings in the long run, higher throughput means higher sales revenue and better equipment utilization.

For more information about the Keysight's DAQ system solutions, please go to:
http://www.keysight.com/find/daq

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