REEDHOLM

SUPPORT NOTE

SN-151

System Performance Verification

Introduction

Verifying performance of a Reedholm test system requires little more than running a few maintenance utilities. All were designed for operators without formal training in electronics. However, most customers have operators perform day-to-day validation and assign the ones assuring traceability to line maintenance personnel.

Regardless of who runs the utilities, the following table shows the recommended interval and time that it takes to execute them.

<table>
<tr><th>Utility</th><th>Frequency</th><th>Time(min)</th></tr>
<tr><td>Main Diagnostics</td><td>Per shift</td><td rowspan="2">5</td></tr>
<tr><td>Self-Calibration</td><td>90 days</td></tr>
<tr><td>SCal Measurements</td><td rowspan="4">Annually</td><td>15</td></tr>
<tr><td>CMM Calibration</td><td>10</td></tr>
<tr><td>HV Calibration</td><td rowspan="2">5</td></tr>
<tr><td>HIP Calibration</td></tr>
</table>

It is extremely rare when the utilities do not flag system problems that show up later during product testing. Also, executing day-to-day utilities provides continual traceability to standards labs.

Proper system operation should be confirmed often enough to prevent accumulation of defective data. If it only takes a few minutes to run the routine utilities, time lost assuring data quality is vanishingly small compared to production test times.

How Often?

Scheduling for routine verification depends on use of the system and type of testing performed. A system being used for 24/7 production testing would need to be confirmed more often than one used for engineering characterization during the first shift. On the other hand, if destructive testing is being performed, questionable data cannot be replaced by re-testing, so it might be important to check every wafer.

It only takes a few minutes to run the main diagnostics, and a few minutes more for self-calibration. So even though self-calibration does not need to be done more often than every 90 days, some customers run it along with main diagnostics.

For non-destructive testing, verification should be done prior to each lot unless several lots can be handled per shift. Then validating at the start of a shift should be enough.

Event Driven Verification

In addition to scheduled verification, the system should be checked whenever a probe is changed. This is a good time to install the loopback diagnostic card and confirm the prober analog cable connections.

Any time test data is questionable enough to halt probing, diagnostic tests should be run. Instrumentation failures will usually be detected without removing or replacing the probe card. However, if the test data problems point to contact problems, the loopback should be used to confirm that the prober analog cable is undamaged.

Basic Diagnostic Testing

The main diagnostics are a series of self-tests that confirm operation of all system resources including the matrix and prober analog cable.

Diagnostic testing starts with the switching matrix relays. Some of the matrix tests include measurement of the prober analog cable, including the probe card connector if the loopback card is installed. Operation of the other instrument modules is confirmed after the matrix tests.

Tests requiring the loopback card can be eliminated from the default set of tests so that instrument operation can be confirmed without replacing the probe card. Figure 1 shows the startup screen for the main diagnostic, in which the modules to test and the tests to execute are selected.

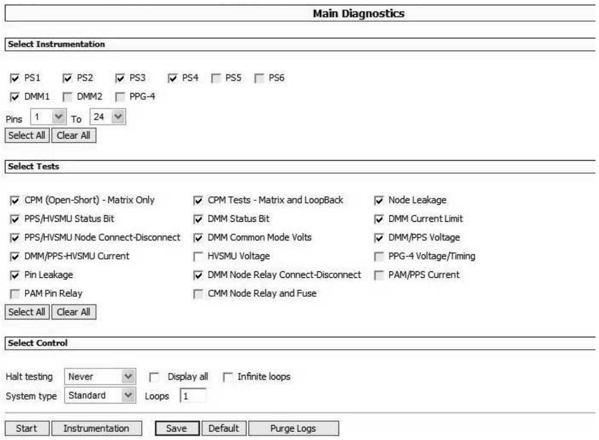

Figure 1 - Main Diagnostic Screen

DMM #1 (DMM16)

Range	Measured Value: Gain Factor	Measured Value: Offset	Test Limits: Gain Factor	Test Limits: Offset
250mV	999.571m	-52.9079u	1.0 ± .0006	1.1E-3
500mV	999.824m	-53.125u	1.0 ± .0006	1.1E-3
1V	999.875m	-62.635u	1.0 ± .0006	1.4E-3
2.5V	999.941m	-117.476u	1.0 ± .0006	1.5E-3
5V	999.961m	-148.051u	1.0 ± .0006	1.7E-3
10V	999.926m	-247.878u	1.0 ± .0006	2.2E-3
25V	999.943m	-1.10677m	1.0 ± .0006	3.6E-3
50V	999.963m	-1.45158m	1.0 ± .0006	6.0E-3
100V	999.912m	-2.37268m	1.0 ± .0006	9.4E-3
100nA	999.964m	-2.97878p	1.0 ± .0040	.33E-9
1uA	999.661m	-24.3885p	1.0 ± .0030	.43E-9
10uA	1.00012	-270.679p	1.0 ± .0010	4.3E-9
100uA	999.937m	-2.70061n	1.0 ± .0010	4.3E-8
1mA	1.00002	-24.6913n	1.0 ± .0010	4.3E-7
10mA	1.00007	-244.02n	1.0 ± .0010	4.3E-6
100mA	999.936m	-2.68132u	1.0 ± .0010	4.3E-5
1A	1	-28.9351u	1.0 ± N/A	4.3E-4

Pausing - Press <Enter>

Figure 2 - DMM-16 Calibration Constants

Traceability with Frequent SelfCal

The self-calibration software and Self Calibration Module (SCM) are used to generate correction constants for the programmable supplies and multimeters in the system. They eliminate the need to manually calibrate the standard instruments in the system, whose potentiometers are considered "set and forget." The SCM provides a straightforward way to prove system accuracy and repeatability, so it fits well with quality assurance standards such as ISO9000 and its successors. Additional information on the SCM can be found in datasheet DS-11106 and support note SN-115 at the Reedholm website.

Two constants are calculated for each range of each instrument, one for offset and one for gain-related errors. Use of the self-calibration software on a routine basis almost eliminates the offset, or percentage or range error, which is the largest error contributor for the lower ranges. The gain error is reduced, but not as much as offset, since the same precision wire-wound resistors are used on the SCM as used elsewhere, so gain drift is quite small.

When running the self-calibration software, the internal digital multimeter measures outputs of the SCM. Once the DMM correction constants have been calculated and applied, it is used to measure the outputs of the programmable supplies.

Correction constants are calculated for all instruments and are stored to disk for later retrieval by the applications software. Figure 2 shows the correction constants generated for a DMM-16 module. Those for the forcing modules have a similar appearance when printed.

When running self-calibration software, Qualification Limits are selected, since they represent the expected limit of error over a calibration period of 90 days and a temperature variation of ±5°C. Failing these limits does not indicate repair is needed, since the self-calibration correction constants adjust for the gain or offset error.

Not selecting Qualification Limits invokes a tighter set of Manufacturing Limits that represent the expected limit of error immediately after manual calibration and within 8 hours/±1°C after SCal is run. Those limits are only intended for use at Reedholm to ensure proper calibration on a new module or after a repair.

What does indicate remedial action is when the word Fail appears next to a set of measurements. That indicates that the gain related error is >2%, or that the offset related error is >0.8% of range. For example, on the 10V range, failures would be reported for a gain related error over 200mV or an offset related error over 80mV. In most cases this is an indication that module repair is required.

A special test lead set, provided with the SCM, avoids inaccuracies that would be introduced by thermally generated voltages, series resistance, external noise pickup, and leakage resistance. This is especially important when measuring the precision 10MΩ resistor on the SCM. This is described in the support note on the test lead set, SN-116.

Verification of SCM Values

Instrument accuracy specifications apply for 90 days, so that should be the minimum period between SelfCal operations until history is built. Once SelfCal behavior is known, time between calibrations can be extended. That being said, most customers put the system on the same one-year cycle as used for other metrology tools.

During calibration, outputs of the SCM are measured and recorded using an external transfer digital multimeter with these minimum accuracies:

- Voltages, ±0.25V to ±100V: <±0.01% inclusive of offset, so 0.005% of value + 0.00125% of range on 1V range is needed for ±0.01% at 0.25V.
- 10kΩ resistance: <±0.011%.
- 10MΩ resistance: <±0.041%

Figure 3 shows the output of the utility used when measuring the twenty SCM outputs, which are stored to disk for later use by the self-calibration software.

Eighteen voltages are measured and recorded, equating to both voltage polarities for each of the nine voltage ranges on the DMM. Then the two precision resistors are used along with the SCM voltages to calibrate the eight DMM current ranges.

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Self Cal Module S/N ---> [                    ]   Date -----> [Feb 2, 2003]
Operator --------------> [                    ]   Time -----> [ 6:20:21 PM]
Tester ID -------------> [REEDHOLM]

VOLTAGES ENTERED:
Range      Positive       Negative
-------    -----------    ------------
 250mV        247.5m         -247.5m
 500mV          495m           -495m
   1V           990m           -990m
 2.5V          2.475          -2.475
   5V           4.95           -4.95
  10V            9.9            -9.9
  25V          24.75          -24.75
  50V           49.5           -49.5
 100V             99             -99

RESISTANCES ENTERED:
Range      Actual
-------    -----------
  10K            10k
  10M            10M

Overwrite SelfCal.DAT (Y/N)? N
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Figure 3 - SCM Measurements

In addition, if the system configuration contains a capacitance meter or high voltage option, those instruments are calibrated. The calibration software walks the user through the steps involved.

The technicians would also get involved in daily operations if initialization errors were reported. There are checkout utilities they can use to investigate analog and digital issues. Hookup is used for analog troubleshooting and Address Test is used for digital issues.