Keysight Technologies
Achieve Accurate Two Wire Resistance Measurements with the Keysight 34923A & 34924A Multiplexers
Introduction

This Application Note outlines a method for minimizing the channel path resistance and increasing the accuracy for 2-wire resistance measurements with the 34923A and 34924A reed relay multiplexer modules for the 34980A Data Acquisition unit. This method has the additional benefit of allowing the use of all channels for resistance measurements as in the traditional two wire resistance measurement technique.

The 34923A and 34924A multiplexers have 100 ohm current limiting resistors, as well as backplane relays, PC board trace and internal connector resistances that contribute an offset plus some additional errors to 2-wire resistance measurements. The following is a proposed solution to address this issue.

Abstract

Four wire resistance measurements provide the highest accuracy by eliminating all internal path resistance and DUT lead resistance from the result. Typically, this requires two channels for each measurement. We offer an alternative technique, detailed in this application note, which eliminates the internal path resistance from PC board traces and additional relays in the measurement path.
Proposed Solution

The 40 2-wire channel 34923A topology (Figure 4 below), shows 100 ohm (±5%) current limiting resistors which are in the measurement path to the 34980A Multifunction Switch/Measure built-in DMM for 2-wire resistance measurements. The contact resistances of the backplane relays as well as the PC board and connectors (not shown) are also in the path. The same applies to the 70 2-wire channel 34924A. The traditional method for eliminating these resistances is by using a 4-wire resistance measurement. That method requires two channels per measurement and reduces the total number of measurement channels by half. With the traditional 2-wire resistance measurement, the DMM measurement (MEAS) and sense (SENS) lines are connected in the DMM, as shown in Figure 4 on the previous page. The backplane relays, the current limiting resistor and the backplane trace resistance are included in the measurement path. The resistance these obstacles induce can be removed by making a 4-wire measurement up to the point where analog busses 1 and 2 join, just before the channel relays, shown by the red circles in Figure 4. This is done by configuring the DMM for 4-wire resistance with no channel list and closing backplane relays 911 and 912. Instead of using the scan commands, we recommend using the low level open and close commands to define the configuration and make the measurement. Backplane relays 911 and 912 are closed for scanning bank 1 channels and backplane relays 921 and 922 are closed for scanning bank 2 channels. As a result, the only extraneous resistances in the path are the channel relays, the terminal block trace resistance, and the lead resistance to the DUT. The channel relays are reed relays with very low and repeatable contact resistance. The backplane relays, the 100 ohm current limiting resistor and the backplane and DMM input relay resistances are all removed because a 4 wire resistance measurement is being made through these components of the path.
The trade-off is speed. This is because low level open and close commands must be used rather than the traditional scan commands. With traditional 2-wire resistance scanning with the 34923A/24A, the maximum speed is 530 ch/sec across two banks using the fastest settings - 60Hz power line frequency - using LAN sockets. With this close-measure-open method, the speed is reduced to 93.6 ch/sec. With the default settings including autorange and autozero on, NPLC 1, default channel delay and display on, the speed is 27.3 ch/sec with traditional scanning and is 5.1 ch/sec with the pseudo 4-wire close-measure-open method. The 34980A command sequence for this measurement for the 40 channel 34923A module can easily be extended to the 34924A by simply increasing the loop count, as indicated at right. Scanning shorted channels with this method will typically show < 1 ohm resistance on each channel. This and the DUT lead resistance can usually be measured and then removed from the result using the built-in y = mx + b scaling function of the 34980A, thus providing accurate 2-wire resistance measurements approaching the accuracy of the 4-wire resistance technique.

Conclusion

This method achieves a much more accurate 2-wire resistance measurement scanning when using either the 34923A or the 34924A reed relay multiplexer modules.

Ordering Information

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Module connectors</th>
<th>Optional terminal blocks, cables, connector kits</th>
</tr>
</thead>
<tbody>
<tr>
<td>34980A</td>
<td>Multifunction switch/measure mainframe</td>
<td>2-50 pin Dsub, Male</td>
<td>3492xT Terminal block with screw connectors</td>
</tr>
<tr>
<td></td>
<td>Comes standard with &quot;DMM&quot; option, BenchLink data logger software, user guide on CD-ROM, power cord and quickstart package.</td>
<td></td>
<td>Y1135A - 1.5 m 50-pin M/F Dsub cable</td>
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<td>Y1136A - 3 m 50-pin M/F Dsub cable</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Y1139A - 50-pin female solder cup connector kit</td>
</tr>
<tr>
<td>34923A</td>
<td>40/80 channel reed multiplexer</td>
<td>2-50 pin Dsub, Male</td>
<td>3492xT Terminal block, option 001 for solder connections, option 002 for screw connectors</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Y1137A - 1.5 m 78-pin M/F Dsub cable</td>
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<tr>
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<td></td>
<td></td>
<td>Y1138A - 3 m 78-pin M/F Dsub cable</td>
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<td></td>
<td></td>
<td></td>
<td>Y1140A - 78-pin female solder cup connector kit</td>
</tr>
<tr>
<td>34924A</td>
<td>70 channel reed multiplexer</td>
<td>2-78 pin Dsub, Male</td>
<td></td>
</tr>
</tbody>
</table>

CONF:FRES configures the DMM for 4-wire resistance independent of the channels being used.

ROUT:OPEN ($1921,1922)
ROUT:CLOS ($1911,1912)

For i=1 to 20,

\[ A = 1000 + i \]

ROUT:CLOS (@,A,)
READ?

Read the DMM 4-wire resistance value for channel 1000 + i.

ROUT:OPEN (@,A,)
End loop

ROUT:OPEN ($1911,1912)
ROUT:CLOS ($1921,1922)

For i = 1 to 20,

\[ A = 1020 + i \]

ROUT:CLOS (@,A,)
READ?
ROUT:OPEN (@,A,)
End loop
Software Information

<table>
<thead>
<tr>
<th>Supported systems</th>
<th>Microsoft Windows 98 SE/NT/2000/XP</th>
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</thead>
<tbody>
<tr>
<td>Software drivers</td>
<td>IVI-C and IVI-COM for Windows NT/2000/XP Labview</td>
</tr>
<tr>
<td>Keysight IO Libraries</td>
<td>Version 14 or greater</td>
</tr>
<tr>
<td><strong>Keysight BenchLink data logger software</strong></td>
<td></td>
</tr>
<tr>
<td>Operating system</td>
<td>Windows 2000 SP4, XP SP2</td>
</tr>
<tr>
<td>Controller</td>
<td>Recommended: Pentium 4, 800 MHz or greater, minimum: Pentium III, 500 MHz</td>
</tr>
</tbody>
</table>

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