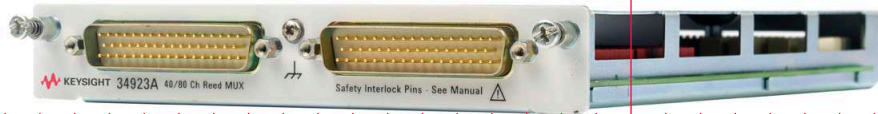Achieve Accurate Two Wire
Resistance Measurements with the
Keysight 34923A & 34924A Multiplexers

Application Note

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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.

Figure 1. 34980A Multifunction Switch/Measure System

Figure 2. 34923A 40/80 Channel Reed Multiplexer for the 34980A.

Figure 3. 34924A 70 Channel Reed Multiplexer for the 34980A.

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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 resitstance 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.
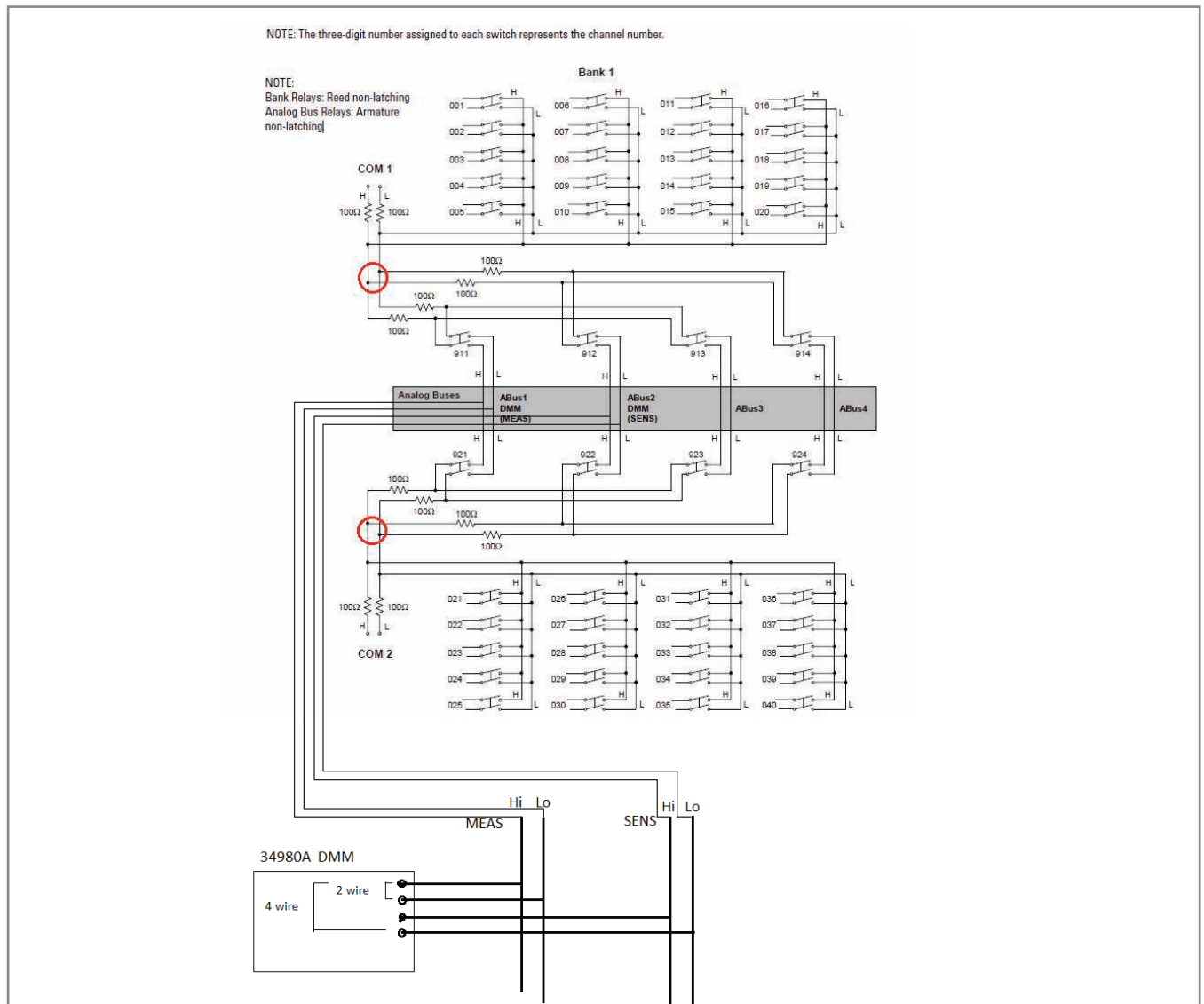

Figure 4. 34923A 40 channel reed multiplexer.

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.

```
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
```

Ordering information

Model	Description		
Mainframe - holds up to 8 plug-in modules			
34980A	Multifunction switch/measure mainframe	Comes standard with "DMM" option, BenchLink data logger software, user guide on CD-ROM, power cord and quickstart package.	
34832A	BenchLink data logger pro software	Upgrade your complimentary software package to add limit checking and decision making for more complex applications.	
Multiplexer modules		**Module connectors**	**Optional terminal blocks, cables, connector kits**
34923A	40/80 channel reed multiplexer	2- 50 pin Dsub, Male	3492xT Terminal block with screw connectors
			Y1135A - 1.5 m 50-pin M/F Dsub cable Y1136A - 3 m 50-pin M/F Dsub cable Y1139A - 50-pin female solder cup connector kit
34924A	70 channel reed multiplexer	2- 78 pin Dsub, Male	3492xT Terminal block, option 001 for solder connections, option 002 for screw connectors
			Y1137A - 1.5 m 78-pin M/F Dsub cable Y1138A - 3 m 78-pin M/F Dsub cable Y1140A - 78-pin female solder cup connector kit

Software Information

Supported Systems	Microsoft Windows 98 SE/NT/2000/XP
Software drivers	IVI-C and IVI-COM for Windows NT/2000/XP Labview
Compatible programming tools and environments	Keysight VEE Pro, Keysight T&M toolkit (requires Visual Studio.NET) National Instruments Test Stand, Measurement Studio, LabWindows/CVI, Labview, Switch Executive Microsoft Visual Studio.NET, C/C++, Visual Basic 6
Keysight IO Libraries	Version 14 or greater

Keysight BenchLink data logger software	
Operating system	Windows 2000 SP4, XP SP2
Controller	Recommended: Pentium® 4, 800 MHz or greater, minimum: Pentium III, 500 MHz

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