

Creating Datalogging Applications in Microsoft Excel

Application Note 1557

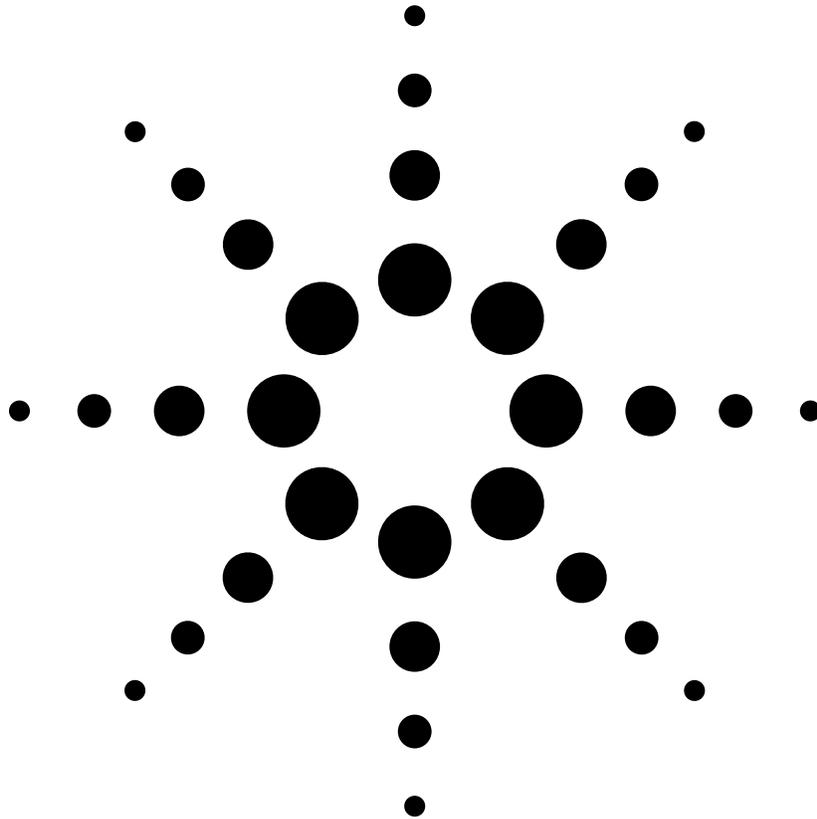


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Agilent Technologies

Introduction

Microsoft® Excel and the Agilent 34980A multifunction switch/measure unit are an ideal combination to use for collecting data and analyzing it. This paper discusses how to structure and create a program in Excel for scanning multiple Agilent 34980A channels. Each channel can be configured independently to measure: temperature, voltage, frequency, resistance, or other physical property. Channels can be scanned sequentially or in an order defined by the user. In addition, this paper covers how to pace the scans, retrieve data and automatically update an Excel worksheet.

You can download a working template to control the 34980A switch/measure unit and 34970A data acquisition unit from www.agilent.com/find/create_datalogger. Included is a tool that creates the channel configuration commands for the instrument. This paper and the code template make an excellent starting point for creating a custom Excel application with the 34980A and 34970A. The discussion and code snippets are centered around the Agilent 34980A, but they also apply to the Agilent 34970A.

Steps for creating a scanning program

Datalogging code for the 34980A in Excel requires six steps:

1. Establish a connection to the instrument
2. Configure the channels
3. Configure the scan
4. Initialize a scan and scan the data
5. Read the data
6. Insert the data into a worksheet

1. Establish a connection to the instrument

Several different methods are available to establish a connection, send commands, and read data. The Excel development environment Visual Basic for Applications lends itself well to VISA COM. Developing the instrument specific connections with VISA COM assures the code will work for both Agilent and National Instruments GPIB cards. Both the Agilent and the National instruments I/O libraries will enable USB and LAN when you use the current software version.

To use VISA COM, first reference the VISA COM Type library. Within the Excel Visual Basic menu select **Tools > References...** and select **VISA COM 3.0 Type Library**. With the reference established make a connection to the 34980A at GPIB address 9, like this:

```
Dim IO_mgr As VisaComLib.ResourceManager
Dim deviceIO As VisaComLib.IMessage
```

```
Set IO_mgr = New VisaComLib.ResourceManager
Set deviceIO = IO_mgr.Open("GPIB0:9")
```

This will create the object deviceIO with methods to send and read strings from and to the instrument. For example, this code will retrieve the instrument identification:

```
Dim strTemp As String
deviceIO.WriteString "*IDN?"
strTemp = deviceIO.ReadString(256)
```

2. Configure the channels

First, we configure the channels to the function, range, and resolution. You can configure one or more channels at the same time. An example of configuring channels 16 through 20 for a resistance measurement:

```
Conf:Res 1E4, (@1016:1020)
```

The first parameter of the command, 1E4 specifies the 10-kohm range and is followed by the channels. We can follow the Configure command with another command to give 5-1/2 digit resolution:

```
Res:NPLC 1, (@1016:1020)
```

Each channel that is part of the scan list requires a configure statement. Typically there is a configure statement for each function. Channels with the same function and range are collected together in the channel list parameter of one configure statement.

NPLC is the integration time expressed as the number of power line cycles (NPLC). The following table shows the integration time in power line cycles versus the resolution in digits or bits. 1 PLC is 16.7 ms when the power line is 60 Hz (and 20 ms for 50 Hz).

NPLC	Integration time 60 (50) Hz	Digits	Bits
0.02 PLC	0.333 (0.4) ms	4 ½	15
1 PLC	16.7 (20) ms	5 ½	20
10 PLC	167 (200) ms	6 ½	24
100 PLC	1.67 (2) sec	6 ½ prec.	26

3. Configure the scan

Once we have all the channels set up, we can configure the scan. We must give the instrument a list of all the channels to include in the scan using the `Route:Scan` command. These are all or a portion of the channels used in the configurations for the different functions and channels.

```
Route:Scan (@1016:1020,1021,1023)
```

For a single sweep no further configuration is required. The default values are set for a single sweep. For multiple sweeps by the instrument, you need to set up the interval and number of scans to configure the scan:

```
' Configure the trigger source
Trigger:Source Timer
' Set the time between scans
Trigger:Timer 3
' Set the number of sweeps
Trigger:Count 5
```

In this example there are five sweeps of the scan list for a complete scan. We use the internal timer to set the interval between sweeps to 3 sec.

4. Initialize the scan

To start the scan we simply send the `Initialize` command. Once initialized, the instrument will start the first sweep of the scan and put the data into memory. Data is put into memory at the end of each reading. The internal Timer will automatically start subsequent sweeps every 3 seconds in the above example.

5. Read the data

`Fetch?` will read the data after the scan is complete (after all sweeps are complete).

The data is returned as a comma delimited list. The data string is parsed into an array of doubles using the VB Split command:

```
Dim rdgs() As Double
Dim strRdgs() As String
Dim numberChannels As Integer
Dim reply As String

deviceIO.WriteString "Fetch?"
reply = deviceIO.ReadString(10000)
strRdgs = Split(reply, ",")
ReDim rdgs(UBound(strRdgs))
For i = 0 To UBound(strRdgs)
    rdgs(i) = Val(strRdgs(i))
Next i
```

Regardless of the order of the channel list, the channels are scanned in sequential order by default and the data is returned in the same order. The command

```
Route:Scan:Ordered OFF
```

will force the instrument to measure the channels in the same order as specified with the `Route:Scan` command, including duplicate channels.

To return a list of channels that correspond to the data, send this command and read as a string. This will return the scan list.

```
"Route:Scan?"
```

For a list of functions that correspond to the data, send this command and read as a string. Scan list is the list returned with the above command.

```
"Function? " & ScanList
```

We can also return the channel and units with each reading by sending a format statement when we set up the scan. These format statements cause the instrument to return the channel, units, and/or time stamp with each measurement.

```
Format:Reading:Unit On
Format:Reading:Channel On
Format:Reading:Time On
```

6. Insert the data into a worksheet

Inserting the data in Excel is done after each sweep. Inserting data into a worksheet is best done with a two-dimensional array. The two-dimensional array is created from the array of doubles and then inserted into the array using a worksheet range to insert as a column. The range is moved one column to the right for each sweep of data with the Column variable.

```
Dim wkSheetArray() As Variant
Dim rng As Range

ReDim wkSheetArray(numberChannels, 0)
For i = 1 To numberChannels
    wkSheetArray(i, 0) = rdgs(i - 1)
Next i

Set rng = ActiveSheet.Range("C3")
Range(rng.Offset(0, Column - 1), _
    rng.Offset(numberChannels, Column-1)).Value= _
    wkSheetArray
```

Using Excel for datalogging

This section addresses how to use the provided example code to configure, log and insert data into Excel. For this discussion, we have assumed you have some experience with Visual Basic for Applications.

Making a connection

To log data in Excel, we have provided a template that will make the connection to the instrument and log data at set intervals. You can download it from www.agilent.com/find/create_datalogger. All of the instrument-specific code is contained in one module.

To run or edit any of the code, first bring up the Visual Basic editor toolbar. In Excel go to menu **View > Toolbars** and select Visual Basic. The Visual Basic toolbar will appear. On the toolbar, click **Run Macro** to show the available routines for setting the I/O and logging data. Click **Visual Basic Editor** to view the code. You can also quickly open Visual Basic with **ALT-F11**.

Creating and configuring a channel list

Before you can log data, you must configure the channels to the desired measurement functions and create a list of channels for the scan list. You do this in the Configure

subroutine, shown in Figure 2, in the instrument-specific module mod34980A. The Excel file contains a worksheet called ScanList to assist you in creating the channel configuration. In the ScanList worksheet, enter the channel or channels, and then select the functions, ranges and other parameters for those channels. The 34980A command string is created to the right on the same row, see Figure 1.

Copy that command, and insert it as a string in the Configure subroutine in Visual Basic. The string is sent to the instrument with the `.WriteString` command. Once you have all the channels configured, create a scan list that contains all the channels from the channel configuration. When you are done, it should look like Figure 2.

Running the application

The application has only three commands for you to use:

- SetIO
- StartMultipleScan
- CancelMultiScan

You can access the commands from the Macro dialog box (Excel menu **Tools > Macro > Macros...** or select **Run Macro** on the Visual Basic toolbar). Before starting a scan, call the SetIO Macro and establish a connection.

Figure 1. Tool to create channel configuration commands for the 34980A

	A	B	C	D	G
10	Channel	Function			34980A SCPI Commands
11	1014	Volts DC	10 V	5 ½	Conf:volt:DC 10,(@1014);:Volt:DC:NPLC 1,(@1014)
12	1015	Temperature TC	J type	°C	Conf:Temp TC,J,(@1015);:Unit:Temp C,(@1015)
13	1016:1020	Temperature TC	B type	°C	Conf:Temp TC,B,(@1016:1020);:Unit:Temp C,(@1016:1020)
14	1004	DC Current	Auto	4 ½	Conf:Curr:DC Auto,(@1004);:Curr:DC:NPLC 0.02,(@1004)
15	1016:1020	Volts AC	Auto	Slow (3Hz)	Conf:volt:AC Auto,(@1016:1020);:Volt:AC:Band 3,(@1016:1020)

Figure 2.

```
Public Sub Configure(Instrument As VisaComLib.IMessage)
    With Instrument
        ' Configure all channels in channel list
        .WriteString "Conf:volt:DC 10,(@1014);:Volt:DC:NPLC 1,(@1014)"
        .WriteString "Conf:Fres 100,(@1015);:FRes:NPLC 1,(@1015)"
        .WriteString "Conf:Res 1E4,(@1016:1020);" & _
            ":Res:NPLC 10,(@1016:1020)"
        ' Set up the scan List
        .WriteString "Route:Scan (@1016:1020,1015,1014)"
    End With
End Sub
```

Connecting to the instrument

Connections to the instrument are done with the form frmFindInstrument. The I/O connection uses VISA COM. Either Agilent IO Libraries Suite 14 or National Instruments VISA COM 3.1 or later must be installed in the PC. To show the connection form, run the Macro **SetIO** from the Macro dialog. The task of the connection dialog is to find available instruments and establish a connection. Specify the type of connection you wish to use; GPIB, USB, or TCPIP then press Find Instrument button.

Starting a scan

Once the 34980A is connected and the channels are configured, we are ready to perform a scan. Click the **Run Macro** button on the Visual Basic toolbar. Select **StartMultipleScan** in the Macro dialog and click **Edit**. This will bring up the code for starting the scan. In the StartMultipleScan routine, edit the variable m_NumberSweeps and m_Interval to set the number of sweeps and time interval.

Go back to Excel, again open the Macro dialog, select the routine StartMultipleScan and click **Run**.

The instrument will be configured and then called repeatedly to start a sweep, read the data and then insert the data into the active worksheet. The location of the data is determined by the constant refRange in the module mod34980A.

Stopping a scan

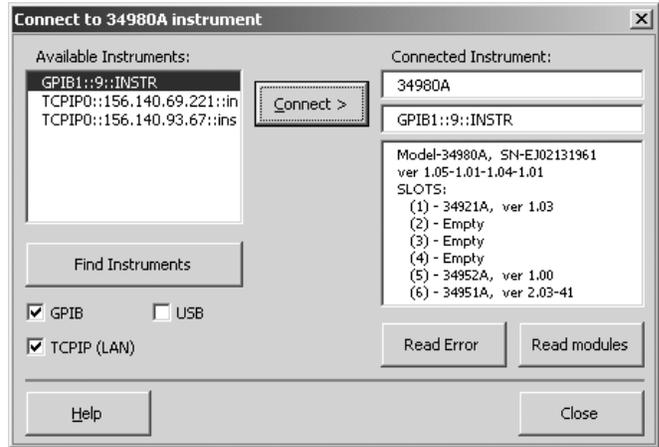
To stop a scan, open the Macro dialog and run CancelMultiScan. This will set the counter variable m_SweepCount to 99999 and end the scan. Alternately, if it does not stop, press CTR-BREAK to stop the code and open the code window at the point of execution.

Code structure for logging data

You can pace multiple sweeps from Excel, or with the 34980A internal timer. The simpler method is to pace the logging from Excel. This implies that the timer in the 34980A is not required, and the trigger source is set to immediate, which is the default. Configure the 34980A for a single sweep of the channel list per trigger. The Excel code will initiate a scan, collect the data and then wait a predetermined length of time before starting the next scan.

Creating the two code structures shown in Figures 4 and 5 allows the code to be stopped at anytime. Figure 4 shows the routine started by the user. Here we configure the channels, configure the scan list, and then create the

Figure 3. Tool to create channel configuration commands for the 34980A



headings for the worksheet. Once the instrument is configured, we rely on a callback to repeatedly call the instrument to perform a scan, read the data and insert that data into the active worksheet. This is shown in Figure 5.

To pace the logging and perform multiple sweeps, Excel provides a callback called Application.OnTime. It calls a routine at a predetermined time. We set the callback to call the subroutine UpdateInstrumentScan. At the end of this subroutine the callback is again initialized for the next sweep.

Figure 4. This configures the 34980A and then gives control to UpdateInstrumentScan

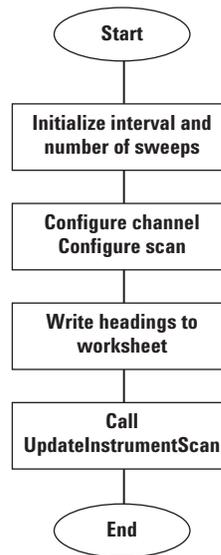
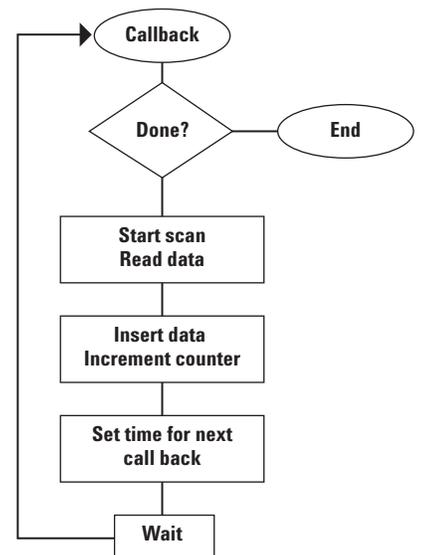


Figure 5. UpdateInstrumentScan is called repeatedly using a timed callback



The callback routine UpdateInstrumentScan is first initialized by the call from the one time configuration. The UpdateInstrumentScan routine will start a single sweep, read the data, and then insert the data into the worksheet. Before the routine exits, it calls itself at a future time using the callback routine Application.OnTime. To end this cycle, a check is made to the counter to see if it is done.

Conclusion

Agilent's 34980A multifunction switch/measure unit offers a flexible architecture ideal for logging both electrical and physical data. You can configure each channel independently for a variety of measurements.

A Visual Basic program can combine the powerful 34980A data capture features with the analysis and graphic display capabilities in Excel.

Related Agilent literature

Publication title	Publication type	Publication number	Web address
34980A Multifunction Switch/Measure Unit	Data sheet	5989-1437EN	http://cp.literature.agilent.com/litweb/pdf/5989-1437EN.pdf
34970A Data Acquisition Unit	Data sheet	5965-5290EN	http://cp.literature.agilent.com/litweb/pdf/5965-5290EN.pdf
Visual Basic Tutorial	Online Tutorial		http://www.agilent.com/find/vb_tutorial



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Printed in the USA March 31, 2005
5989-2722EN

