

Agilent E5070B/E5071B ENA Series RF Network Analyzers

SAW Bandpass Filter Measurements

Second Edition



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Sample Program

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Application Programs

This chapter describes sample programs (VBA programs) based on actual measurement examples.

Basic measurement (measuring a band-pass filter)

Example 1-1 shows a sample program (VBA program) that demonstrates how to perform the basic measurement of the bandpass filter. You can find the source file of this program, named “apl_bsc.vba“, on the sample program disk. This VBA program consists of the following standard module.

Object name	Module type	Content
mdlBscMeas	Standard module	Performs the basic measurement of the bandpass filter.

Overview of the program

The sample program performs full 2-port calibration using the 85032F calibration kit, measure a band-pass filter (center frequency: 947.5 MHz), and calculates and displays its bandwidth, insertion loss, and so on. This measurement is the same as "Example of measuring a band-pass filter" in *Installation/Quick Start Guide* of the E5070B/E5071B. Therefore, for information on the flow of the measurement, the connection of the standard, and so on, refer to the description of *Installation/Quick Start Guide*.

Description of the program

When you run this VBA program, reset is performed, the measurement conditions are automatically set, and a message "Perform the full 2-port calibration." is displayed. To perform the full 2-port calibration, click the **Yes** button; to skip it, click the **No** button.

To perform the calibration, follow the onscreen messages to connect each standard of the Agilent 85032F calibration kit to the specified port, and click the **OK** button to measure the calibration data. Click the **Cancel** button to return to the beginning of the calibration. You cannot skip the isolation calibration. When the calibration data measurement for all standards is complete, a message "All calibration data completion." is displayed, and the calibration coefficient is calculated.

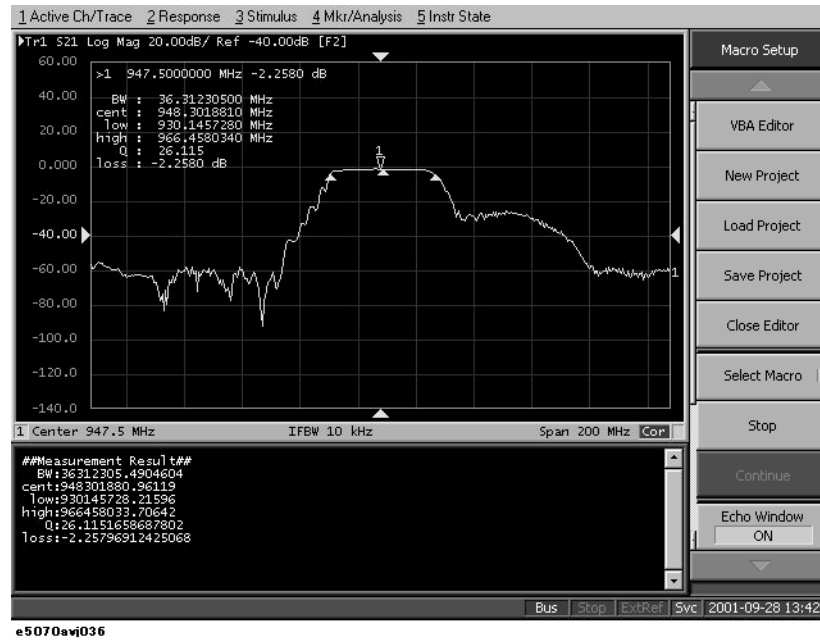
NOTE

When you cancel the calibration data measurement before completing the measurement of necessary calibration data, the settings condition may not be returned to its former state.

Then, a message "Connect DUT, and then press [Macro Setup]-Continue button." is displayed in the instrument status bar in the lower part of the LCD display. Connect a DUT, and perform **[Macro Setup] - Continue**. After the measurement, the search result is displayed in the echo window, as shown in Figure 1. If no bandwidth search target is found, only the result of the insertion loss obtained with the marker is displayed.

Figure 1

Example of the display after executing the program in Example 1-1



The basic measurement program (object name: mdlBscMeas) is described in detail below. Line numbers are added for description purpose only, and do not appear in the actual program source code.

- Lines 120 to 160 Store the sweep center value (947.5 MHz), the sweep span value (200 MHz), the number of measurement points (401), the IF bandwidth (10 kHz), the power level (-10 dBm) into the variables Center, Span, Nop, IfBw, and Pow, respectively.
- Lines 170 to 210 Stores the number of traces (1), the measurement parameter (S21), the data format (log amplitude), the calibration kit number (4: 85032F), and the save file name (State08.sta) into the variables, NumTrac, Par, Fmt, CalKit, and File, respectively.
- Line 250 Returns the E5070B/E5071B to the preset state.
- Lines 290 to 300 For channel 1, turns on the continuous trigger startup mode to on and sets the trigger source to the bus trigger.
- Lines 320 to 360 For channel 1, sets the sweep center value to the Center variable, the sweep span value to the Span variable, the number of measurement points to the Nop variable, the IF bandwidth to the IfBw variable, and the power level to the Pow variable.
- Lines 380 to 410 For channel 1, sets the number of traces to the NumTrac variable, the measurement parameter to the Par variable, and the data format to the Fmt variable, respectively.
- Line 450 Stores the calibration kit number for channel 1 to the CalKit variable.
- Line 460 Stores 1 and 2 to the Port variable that indicates ports used for the full 2-port calibration.
- Line 480 Calls the Calib_Solt procedure (lines 1200 to 2130). For information on the Calib_Solt procedure, see the description later.

- Lines 520 to 530 Saves the instrument setting and the calibration coefficient into a file whose name is specified with the File variable.
- Line 580 Displays a message that prompts you to connect a DUT (Device Under Test) in the instrument status bar in the lower part of the LCD display, and waits for the operation of **[Macro Setup] - Continue** after the connection.
- Lines 620 to 630 Generates a trigger to start a single sweep and waits until the measurement finishes (1 is read out with the **SCPI.IEEE4882.OPC** object).
- Line 650 For trace 1 of channel 1, executes the auto scale to set the optimum scale.
- Lines 690 to 710 Displays marker 1, and moves it so that the stimulus value becomes equal to the value of the Center variable. Then, reads out the response value of marker 1 and stores it into the MkrVal variable.
- Line 730 Enables the error handling routine starting from Bw_Err (lines 890 to 950). If a runtime error occurs, the program goes to the error handling routine.
- Lines 750 to 770 Sets the bandwidth definition value to -3 dB and the bandwidth search result display to on, reads out the bandwidth search result (bandwidth, center frequency, Q value, and insertion loss), and stores it into the BwData variable.
- Lines 790 to 840 Based on the bandwidth search result, stores the bandwidth to the Bw variable, the center frequency to the Cent variable, the Q value to the Qfac variable, and the insertion loss to the Loss variable, respectively. Then, goes to the processing starting from Skip_Bw_Err.
- Lines 880 to 960 Defines a runtime error handler. Reads out and displays the error number and error message of the error that occurred, and stores 0 to the Bw, Cent, and Qfac variables and the response value of marker 1 (the MkrVal(0) variable) to the Loss variable. Then, finishes the error handling and proceeds to the next processing.
- Lines 1000 to 1010 Calculates the 2 (higher and lower) cutoff frequencies from the values in the Bw and Cent variables and stores them into the CutLow and CutHigh variables.
- Lines 1030 to 1110 Displays the search result (the values of the Bw, Cent, CutLow, CutHigh, Qfac, and Loss variables) in the echo window.
- Lines 1130 to 1160 Displays the message asking you whether you want to perform measurement again. Click the **Yes** button to return to the DUT connection section. Click the **No** button to terminate the program.
- Procedure: Calib_Solt (lines 1200 to 2130).
- Lines 1260 to 1300 Displays the message that prompts for the execution of the full n-port calibration (specified with the SoltType variable). Click the **Cancel** button to cancel the calibration.
- Lines 1320 to 1410 Sets the calibration type to the full n-port calibration for the port specified with the Port variable.
- Lines 1450 to 1520 Displays the message that prompts for connecting the open standard to the specified port. Starts the measurement of the open calibration data
-

initiated by clicking the **OK** button after the connection and waits for the completion of the measurement. Click the **Cancel** button to return to the beginning of the calibration.

Lines 1540 to 1610 Displays the message that prompts for connecting the short standard to the specified port. Starts the measurement of the short calibration data initiated by clicking the **OK** button after the connection and waits for the completion of the measurement. Click the **Cancel** button to return to the beginning of the calibration.

Lines 1630 to 1700 Displays the message that prompts for connecting the load standard to the specified port. Starts the measurement of the load calibration data initiated by clicking the **OK** button after the connection and waits for the completion of the measurement. Click the **Cancel** button to return to the beginning of the calibration.

Lines 1750 to 1840 Displays the message that prompts for connecting the thru standard between the specified ports. Starts the measurement of the thru calibration data initiated by clicking the **OK** button after the connection and waits for the completion of the measurement. Click the **Cancel** button to return to the beginning of the calibration.

Lines 1880 to 2060 When the calibration type is not the full 1-port calibration (a value other than 1 is specified for the SoltType variable, displays the message asking you whether you want to measure the isolation calibration data. When the **Yes** button is clicked, displays the message that prompts for connecting the load standard to the specified 2 ports (specified with the Port(I-1) and Port(J-1) variables). Starts the measurement of the isolation calibration data initiated by clicking the **OK** button after the connection and waits for the completion of the measurement. Click the **Cancel** button to return to the beginning of the calibration.

Lines 2080 to 2090 Calculates the calibration coefficients from the measured calibration data and turns on the error correction function. Then, displays a calibration completion message.

Example 1-1

Measuring a band-pass filter (object name: mdlBscMeas)

```
10| Sub Main()  
20|  
30| Dim Par As String, Fmt As String, File As String  
40| Dim Center As Double, Span As Double, IfBw As Double, Pow  
As Double  
50| Dim Bw As Double, Cent As Double  
60| Dim CutLow As Double, CutHigh As Double  
70| Dim Qfac As Double, Loss As Double  
80| Dim MkrVal As Variant, BwData As Variant  
90| Dim Nop As Long, NumTrac As Long, CalKit As Long, Buff As  
Long  
100| Dim Port As Variant, Error As Variant  
110|  
120| Center = 947500000#           'Center freq           : 947.5 MHz  
130| Span = 200000000#           'Span freq           : 200 MHz  
140| Nop = 401                   'Number of points    : 401  
150| IfBw = 10000#               'IF bandwidth        : 10 kHz  
160| Pow = -10                   'Power level         : -10dBm  
170| NumTrac = 1                 'Number of traces     : 1
```

```

180|     Par = "S21"                'Meas. parameter   : S21
190|     Fmt = "MLOG"              'Data format      : Log Mag
200|     CalKit = 4                 'Calibration kit  : 85032F
210|     File = "State08.sta"      'Saved file name  : State08.sta
220|
230|     '''Presetting the E5070B/E5071B
240|
250|     SCPI.SYSTem.PRESet
260|
270|     '''Setting measurement conditions
280|
290|     SCPI.INITiate(1).CONTinuous = True
300|     SCPI.TRIGger.SEQuence.Source = "BUS"
310|
320|     SCPI.SENSE(1).FREQuency.Center = Center
330|     SCPI.SENSE(1).FREQuency.Span = Span
340|     SCPI.SENSE(1).SWEep.POINTs = Nop
350|     SCPI.SENSE(1).BANDwidth.RESolution = IfBw
360|     SCPI.Source(1).POWer.LEVel.IMMEDIATE.AMPLitude = Pow
370|
380|     SCPI.CALCulate(1).PARAmeter.Count = NumTrac
390|     SCPI.CALCulate(1).PARAmeter(1).DEFine = Par
400|     SCPI.CALCulate(1).PARAmeter(1).SElect
410|     SCPI.CALCulate(1).SELected.Format = Fmt
420|
430|     '''Performing full 2-port calibration
440|
450|     SCPI.SENSE(1).CORRection.COLLect.CKIT.Select = CalKit
460|     Port = Array(1, 2)
470|
480|     Calib_Solt 1, 2, Port
490|
500|     '''Saving state & cal data
510|
520|     SCPI.MMEMory.STORE.STYPE = "CST"
530|     SCPI.MMEMory.STORE.STATE = File
540|
550|     '''Connecting DUT
560|
570|     Meas_Start:
580|     Prompt ("Connect DUT, and then press [Macro Setup]-Continue
button.")
590|
600|     '''Performing single sweep
610|
620|     SCPI.TRIGger.SEQuence.SINGLE
630|     Dmy = SCPI.IEEE4882.OPC
640|
650|     SCPI.DISPlay.WINDow(1).TRACe(1).Y.SCALE.AUTO
660|
670|     '''Analyzing the results
680|
690|     SCPI.CALCulate(1).SELected.MARKer(1).STATE = True
700|     SCPI.CALCulate(1).SELected.MARKer(1).X = Center
710|     MkrVal = SCPI.CALCulate(1).SELected.MARKer(1).Y
720|
730|     On Error GoTo Bw_Err
740|

```

```

750|     SCPI.CALCulate(1).SElected.MARKer(1).BWIDth.THReshold = -3
760|     SCPI.CALCulate(1).SElected.MARKer(1).BWIDth.STATe = True
770|     BwData = SCPI.CALCulate(1).SElected.MARKer(1).BWIDth.DATA
780|
790|     Bw = BwData(0)
800|     Cent = BwData(1)
810|     Qfac = BwData(2)
820|     Loss = BwData(3)
830|
840|     GoTo Skip_Bw_Err
850|
860| Bw_Err:
870|
880|     Error = SCPI.SYSTem.Error
890|     MsgBox "Error No:" & Error(0) & " , Description:" &
Error(1)
900|
910|     Bw = 0
920|     Cent = 0
930|     Qfac = 0
940|     Loss = MkrVal(0)
950|
960|     Resume Skip_Bw_Err
970|
980| Skip_Bw_Err:
990|
1000|     CutLow = Cent - Bw / 2
1010|     CutHigh = Cent + Bw / 2
1020|
1030|     ECHO "##Measurement Result##"
1040|     ECHO "  BW:" & Bw
1050|     ECHO "cent:" & Cent
1060|     ECHO " low:" & CutLow
1070|     ECHO "high:" & CutHigh
1080|     ECHO "  Q:" & Qfac
1090|     ECHO "loss:" & Loss
1100|     SCPI.DISPlay.TABLE.TYPE = "ECHO"
1110|     SCPI.DISPlay.TABLE.STATe = True
1120|
1130|     Buff = MsgBox("Do you make another measurement?", vbYesNo,
"Bandpass fileter measurement")
1140|     If Buff = vbYes Then
1150|         GoTo Meas_Start
1160|     End If
1170|
1180| End Sub
1190|
1200| Private Sub Calib_Solt(Chan As Long, SoltType As Long, Port
As Variant)
1210|
1220|     Dim Dmy As Long, I As Long, J As Long, Buff As Long
1230|
1240| Cal_Start:
1250|
1260|     Buff = MsgBox("Perform the full " & SoltType & "-port
calibration.", vbOKCancel, "Full" & SoltType & "-port calibration")
1270|
1280|     If Buff = vbCancel Then

```

```

1290|         GoTo Cal_Skip
1300|     End If
1310|
1320|     Select Case SoltType
1330|         Case 1
1340|             SCPI.SENSE(Chan).CORREction.COLLECT.METHOD.SOLT1 =
Port(0)
1350|         Case 2
1360|             SCPI.SENSE(Chan).CORREction.COLLECT.METHOD.SOLT2 =
Port
1370|         Case 3
1380|             SCPI.SENSE(Chan).CORREction.COLLECT.METHOD.SOLT3 =
Port
1390|         Case 4
1400|             SCPI.SENSE(Chan).CORREction.COLLECT.METHOD.SOLT4 =
Port
1410|     End Select
1420|
1430|     For I = 1 To SoltType
1440|
1450|         Buff = MsgBox("Connect the Open standard to Port " &
CStr(Port(I - 1)) & ".", _
1460|             vbOKCancel, "Full" & SoltType & "-port
calibration")
1470|         If Buff = vbOK Then
1480|             SCPI.SENSE(Chan).CORREction.COLLECT.ACQUIRE.OPEN =
Port(I - 1)
1490|             Dmy = SCPI.IEEE4882.OPC
1500|         Else
1510|             GoTo Cal_Start
1520|         End If
1530|
1540|         Buff = MsgBox("Connect the Short standard to Port " &
CStr(Port(I - 1)) & ".", _
1550|             vbOKCancel, "Full" & SoltType & "-port
calibration")
1560|         If Buff = vbOK Then
1570|             SCPI.SENSE(Chan).CORREction.COLLECT.ACQUIRE.Short =
Port(I - 1)
1580|             Dmy = SCPI.IEEE4882.OPC
1590|         Else
1600|             GoTo Cal_Start
1610|         End If
1620|
1630|         Buff = MsgBox("Connect the Load standard to Port " &
CStr(Port(I - 1)) & ".", _
1640|             vbOKCancel, "Full" & SoltType & "-port
calibration")
1650|         If Buff = vbOK Then
1660|             SCPI.SENSE(Chan).CORREction.COLLECT.ACQUIRE.Load =
Port(I - 1)
1670|             Dmy = SCPI.IEEE4882.OPC
1680|         Else
1690|             GoTo Cal_Start
1700|         End If
1710|     Next I
1720|
1730|     For I = 1 To SoltType - 1

```

```

1740|         For J = I + 1 To SoltType
1750|             Buff = MsgBox("Connect the Thru standard between
Port " & CStr(Port(I - 1)) & _
1760|                 " and Port " & CStr(Port(J - 1))
& ".", vbOKCancel, "Full" & SoltType & "-port calibration")
1770|             If Buff = vbOK Then
1780|
SCPI.SENSE(Chan).CORREction.COLLECT.ACQUIRE.THROUGH = Array(Port(I -
1), Port(J - 1))
1790|                 Dmy = SCPI.IEEE4882.OPC
1800|
SCPI.SENSE(Chan).CORREction.COLLECT.ACQUIRE.THROUGH = Array(Port(J -
1), Port(I - 1))
1810|                 Dmy = SCPI.IEEE4882.OPC
1820|             Else
1830|                 GoTo Cal_Start
1840|             End If
1850|         Next J
1860|     Next I
1870|
1880|     If SoltType <> 1 Then
1890|         Buff = MsgBox("Do you measure the Isolation
(Optional)?", vbYesNo, "Full" & SoltType & "-port calibration")
1900|         If Buff = vbYes Then
1910|             For I = 1 To SoltType - 1
1920|                 For J = I + 1 To SoltType
1930|                     Buff = MsgBox("Connect the Load standard to
Port " & Port(I - 1) & " and Port " & Port(J - 1) & ".", _
1940|                         vbOKCancel, "Full" &
SoltType & "-port calibration")
1950|                     If Buff = vbOK Then
1960|
SCPI.SENSE(Chan).CORREction.COLLECT.ACQUIRE.ISOLation =
Array(Port(I - 1), Port(J - 1))
1970|                         Dmy = SCPI.IEEE4882.OPC
1980|
SCPI.SENSE(Chan).CORREction.COLLECT.ACQUIRE.ISOLation =
Array(Port(J - 1), Port(I - 1))
1990|                         Dmy = SCPI.IEEE4882.OPC
2000|                     Else
2010|                         GoTo Cal_Start
2020|                     End If
2030|                 Next J
2040|             Next I
2050|         End If
2060|     End If
2070|
2080|     SCPI.SENSE(1).CORREction.COLLECT.SAVE
2090|     MsgBox "All calibration data completion."
2100|
2110| Cal_Skip:
2120|
2130| End Sub

```
