Agilent E5070B/E5071B ENA Series RF Network Analyzers

Front End Module (FEM) Measurement using the E5091A

Second Edition

Agilent Technologies

No. 16000-95013

August 2002

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Sample Program

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Application Programs

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

Measurement using E5091A (measuring FEM)

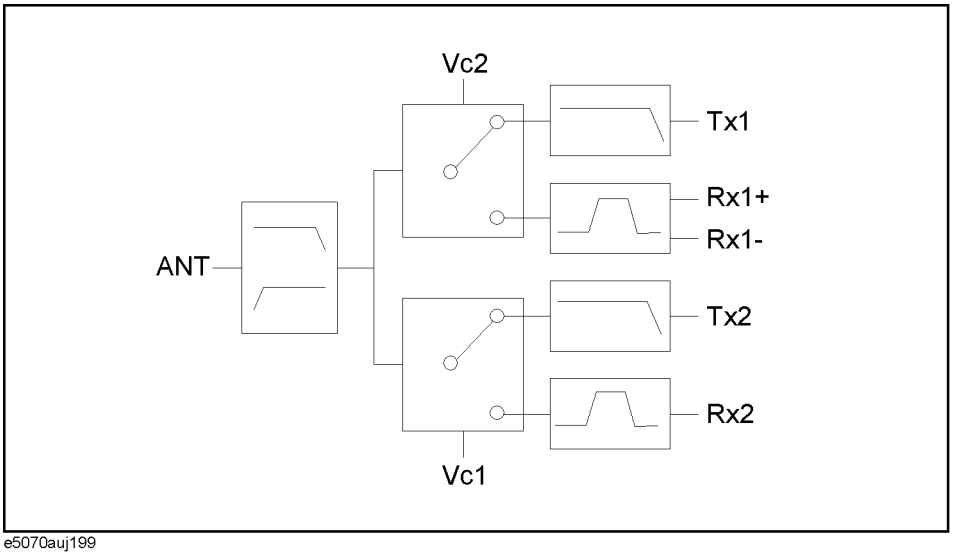
Example 1 shows a sample program of front end module (FEM) measurement as a sample program of measurement using the E5091A. You can find the source file of this program, named apl_fem.vba, on the sample program disk.

NOTE

For the E5070B/E5071B other than that with Option 413 or 414 (4-port S parameter test set), a runtime error occurs because there are parameters that it cannot measure.

Object name	Module type	Description
mdlFemMeas	Standard module	Performs the measurement of FEM.

This program calibrates each channel using the ECal module and then measures the transmission characteristics EGSM:Tx-Antenna (channel 1), EGSM:Antenna-Rx (channel 2), GSM1800:Tx-Antenna (channel 3), and GSM1800:Antenna-Rx (channel 4) of the 6-port dual-band FEM as shown in the below figure.



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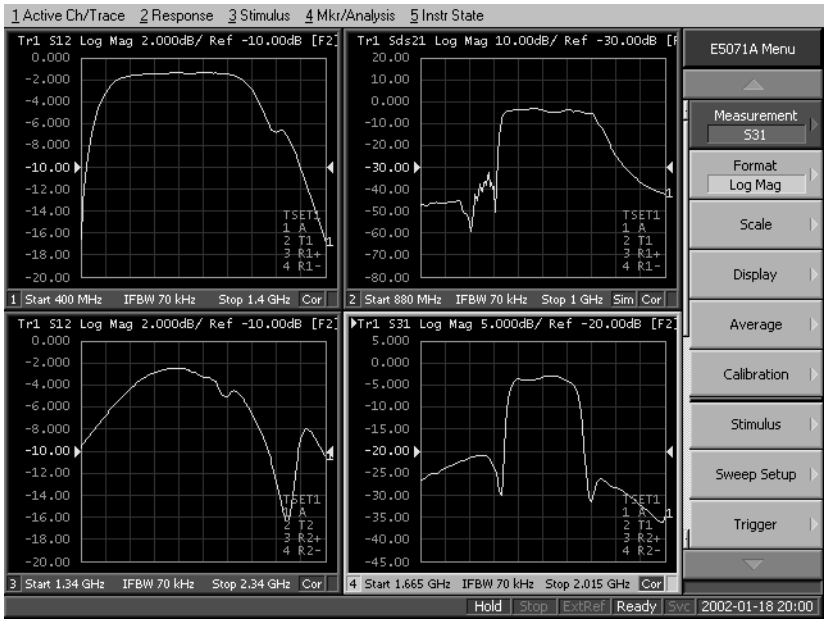
When you start the program, "Connect A and T1 to ECal Module." is displayed. Connect the cables connected to A and T1 of the E5091A to the ECal module and then press the **OK** key to calibrate channel 1. If an error occurs due to a problem in the connection to the ECal module, an error message is displayed. You can execute calibration again by clicking the **Retry** button. If you want to abort the program, click the **Cancel** button. For channels 2 to 4, execute the calibration in the same way.

When the calibration is complete, "Set DUT." is displayed. Connect the DUT (FEM) and the E5091A as shown below and click the **OK** button to start the measurement.

FEM		**E5091A**
Antenna		A
EGSM	Tx	T1
	Rx+	R1+
	Rx-	R1-
GSM1800	Tx	T2
	Rx	R2+
Vc1		Control Line 1
Vc2		Control Line 2

Figure 1 shows a sample display of the LCD screen after the program exits execution.

Figure 1 Example of display after execution of program in Example 1



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

Lines 140 to 330 Sets the ports assigned to Port 1 to Port 4 of the E5091A and the control line setting (the below table) into the variables.

Channel number	Port 1	Port 2	Port 3	Port 4	Control Lines
1	A	T1	R1+	R1-	0 (00000000)
2	A	T1	R1+	R1-	2 (00000010)
3	A	T2	R2+	R2-	0 (00000000)
4	A	T2	R2+	R2-	1 (00000001)

Lines 340 to 660 Sets the settings required for the measurement conditions in the below table to the variables.

Channel number	Sweep range		Number of points	Number of traces	Measurement parameter
	Start	Stop			
1	400 MHz	1.4 GHz	51	1	S12
2	880 MHz	1 GHz	101	1	Sds21
3	1.34 GHz	2.34 GHz	201	1	S12
4	1.665 GHz	2.015 GHz	101	1	S31

Channel number	Fixture simulator		Title
	ON/OFF	Topology	
1	OFF	——	[EGSM] Tx-Antenna
2	ON	SE:1, Bal:3,4	[EGSM] Antenna-Rx
3	OFF	——	[GSM1800] Antenna-Rx
4	OFF	——	[GSM1800] Tx-Antenna

Line 710 Puts the instrument into preset state.

Line 720 Allocate the windows to the upper left, upper right, lower left, and lower right.

Lines 740 to 1020 Repeat the following for channels 1 to 4. Where, Ch is the channel number.

Lines 780 to 810: For the E5091A whose ID is 1, sets the port assigned to port 1 to Port1(Ch-1), the port assigned to port 2 to Port2(Ch-1), the Port assigned to port 3 to Port3(Ch-1), and the port assigned to port 4 to Port4(Ch-1), respectively.

Line 820: Sets the control line of the E5091A whose ID is 1 to Clines(Ch-1).

Lines 860 to 890: Sets the sweep start value to Freq_star(Ch-1), the sweep stop value to Freq_stop(Ch-1), the number of points to Nop(Ch-1), and the number of traces to N_tr(Ch-1), respectively.

Lines 910 to 950: If the fixture simulator function is ON (Fsim(Ch-1) is True), sets the fixture simulator function to ON, the device type to Dev(Ch-1), the port assignment to Tpl(Ch-1), the balance-unbalance conversion to ON, and the measurement

parameter (mix mode S-parameter) to Trc(Ch-1), respectively.

Line 970: If the fixture simulator function is OFF (Fsim(i) is False), sets the measurement parameter (S-parameter) to Trc(Ch-1).

Lines 990 to 1010: Sets the title label to Ttl(Ch-1), the title display to ON, and the continuous startup mode to ON, respectively.

Line 1040 Sets the trigger source to "Bus."

Lines 1050 to 1060 For the E5091A whose ID is 1, sets the property display to ON and the control to ON, respectively.

Lines 1100 to 1120 Recalls the Function procedure: ECal_solt (Lines 1410 to 1770) to execute the calibration of channel 1 with the ECal module (full 2-port calibration of ports A and T1). If the calibration is not completed correctly, aborts the program. For information on the Function procedure: ECal_solt, see the description later.

Lines 1130 to 1210 Executes the calibration of channels 2 to 4 in the same way.

Line 1260 Displays the message that prompts for connecting a DUT (Device Under Test) and waits for clicking the **OK** button after the connection.

Lines 1280 to 1290 Generates a trigger to start a single sweep and waits until the measurement finishes (1 is read out with the **SCPI.IEEE4882.OPC** object).

Lines 1310 to 1330 Executes auto scale for the trace 1 of channels 1 to 4.

Line 1350 Displays the message asking you whether you want to perform measurement again.

Line 1360 If the **Yes** button is clicked, returns to the DUT connection section.

Function procedure: ECal_solt (lines 1410 to 1770).

Line 1460 Clears the error queue.

Lines 1460 to 1480 Displays the message that prompts for connecting the Tset_Port of the E5091A to the ECal module and waits for clicking the **OK** button after the connection.

Line 1500 Enables the error handling routine starting from Ecal_Err (lines 1670 to 1740). If a runtime error occurs, the program goes to the error handling routine.

Line 1540 If solt is 1, executes the ECal command that performs full 1-port calibration on port Ana_port(0) of channel Ch.

Line 1560 If solt is 2, executes the ECal command that performs full 2-port calibration on port Ana_port of channel Ch.

Line 1580 If solt is 3, executes the ECal command that performs full 3-port calibration on port Ana_port of channel Ch.

Line 1600 If solt is 4, executes the ECal command that performs full 4-port calibration on port Ana_port of channel Ch.

Line 1630 Sets the return value of ECal_solt to 0.

Lines 1670 to 1740 Defines a runtime error handler.

Lines 780 to 810: For the E5091A whose ID is 1, sets the port assigned to port 1 to Port1(Ch-1), the port assigned to port 2 to Port2(Ch-1), the Port assigned to port 3 to Port3(Ch-1), and the port assigned to port 4 to Port4(Ch-1), respectively.

Line 1670: Retrieves the error number and error message from the error queue.

Line 1680: Displays the error message.

Line 1700: When the **Retry** button is clicked, the program will disable the error handler routine and then return to the connection part and repeat ECal.

Lines 1720 to 1730: When the **Cancel** button is clicked, the program will set the return value of ECal_solt to the error number and disable the error handler routine.

Example 1 **Measurement of FEM (object name: mdlFemMeas)**

```
 10|  Sub Main()
 20|
 30|    Dim Port1(3) As String, Port2(3) As String
 40|    Dim Port3(3) As String, Port4(3) As String
 50|    Dim Trc(3) As String, Fsim(3) As Boolean, Dev(3) As String
 60|    Dim Tpl(3) As Variant, Ttl(3) As String, Inp_char As String
 70|    Dim Freq_star(3) As Double, Freq_stop(3) As Double
 80|    Dim CLines(3) As Long, Nop(3) As Long, N_tr(3) As Long
 90|    Dim Ch As Long, Res As Long, Buff As Long, Dmy As Long
100|    Dim AnaPort As Variant
110|    '
120|    ' E5091A Setup
130|    '
140|    Port1(0) = "A"       '[Ch1]     Port1: A
150|    Port2(0) = "T1"      '          Port2: T1
160|    Port3(0) = "R1"      '          Port3: R1+
170|    Port4(0) = "R1"      '          Port4: R1-
180|    CLines(0) = 0        '  Control Lines: 0
190|    Port1(1) = "A"       '[Ch2]     Port1: A
200|    Port2(1) = "T1"      '          Port2: T1
210|    Port3(1) = "R1"      '          Port3: R1+
220|    Port4(1) = "R1"      '          Port3: R1-
230|    CLines(1) = 2        '  Control Lines: 2 (Line1:HIGH)
240|    Port1(2) = "A"       '[Ch3]     Port1: A
250|    Port2(2) = "T2"      '          Port2: T2
260|    Port3(2) = "R2"      '          Port3: R2+
270|    Port4(2) = "R2"      '          Port4: R2- (Dummy)
280|    CLines(2) = 0        '  Control Lines: 2 (Line1:HIGH)
290|    Port1(3) = "A"       '[Ch4]     Port1: A
300|    Port2(3) = "T2"      '          Port2: T2
310|    Port3(3) = "R2"      '          Port3: R2+
320|    Port4(3) = "R2"      '          Port4: R2- (Dummy)
330|    CLines(3) = 1        '  Control Lines: 1 (Line0:HIGH)
340|    '
350|    ' Measurement Condition
360|    '                            [Ch1]
370|    Freq_star(0) = 400000000#  ' Start frequency    : 400 MHz
380|    Freq_stop(0) = 1400000000# ' Stop frequency     : 1.4 GHz
390|    Nop(0) = 51                ' Number of points   : 51
400|    N_tr(0) = 1                ' Number of traces   : 1
410|    Fsim(0) = False            ' Fixture Simulator  : OFF
420|    Trc(0) = "S12"             ' Meas. parameter    : S12
430|    Ttl(0) = "[EGSM] Tx-Antenna" ' Title
```

```
 440|    '                            [Ch2]
 450|    Freq_star(1) = 880000000#  ' Start frequency    : 880 MHz
 460|    Freq_stop(1) = 1000000000# ' Stop frequency     : 1 GHz
 470|    Nop(1) = 101               ' Number of points   : 101
 480|    N_tr(1) = 1                ' Number of traces   : 1
 490|    Fsim(1) = True             ' Fixture Simulator  : ON
 500|    Dev(1) = "SBAL"            ' Bal. Device Type   : SE-Bal
 510|    Tpl(1) = Array(1, 3, 4)    ' Topology           : SE:1, Bal:3-4
 520|    Trc(1) = "SDS21"           ' Meas. parameter    : Sds21
 530|    Ttl(1) = "[EGSM] Antenna-Rx" ' Title
 540|    '                            [Ch3]
 550|    Freq_star(2) = 1340000000# ' Start frequency    : 1.34 GHz
 560|    Freq_stop(2) = 2340000000# ' Stop frequency     : 2.34 GHz
 570|    Nop(2) = 201               ' Number of points   : 201
 580|    N_tr(2) = 1                ' Number of traces   : 1
 590|    Fsim(2) = False            ' Fixture Simulator  : OFF
 600|    Trc(2) = "S12"             ' Meas. parameter    : S12
 610|    Ttl(2) = "[GSM1800] Tx-Antenna" ' Title
 620|    '                            [Ch4]
 630|    Freq_star(3) = 1665000000# ' Start frequency    : 1.665 GHz
 640|    Freq_stop(3) = 2015000000# ' Stop frequency     : 2.015 GHz
 650|    Nop(3) = 101               ' Number of points   : 101
 660|    N_tr(3) = 1                ' Number of traces   : 1
 670|    Fsim(3) = False            ' Fixture Simulator  : OFF
 680|    Trc(3) = "S31"             ' Meas. parameter    : S31
 690|    Ttl(3) = "[GSM1800] Antenna-Rx" ' Title
 700|
 710|    SCPI.SYSTem.PRESet
 720|    SCPI.DISPlay.Split = "D12_34"
 730|
 740|    For Ch = 1 To 4
 750|      '
 760|      ' E5091A Setup
 770|      '
 780|      SCPI.SENSe(Ch).MULTiplexer(1).TSET9.Port1 = Port1(Ch - 1)
 790|      SCPI.SENSe(Ch).MULTiplexer(1).TSET9.Port2 = Port2(Ch - 1)
 800|      SCPI.SENSe(Ch).MULTiplexer(1).TSET9.Port3 = Port3(Ch - 1)
 810|      SCPI.SENSe(Ch).MULTiplexer(1).TSET9.Port4 = Port4(Ch - 1)
 820|     SCPI.SENSe(Ch).MULTiplexer(1).TSET9.OUTPut.DATA = CLines(Ch -
1)
 830|      '
 840|      ' Measurement Condition
 850|      '
 860|      SCPI.SENSe(Ch).FREQuency.STARt = Freq_star(Ch - 1)
 870|      SCPI.SENSe(Ch).FREQuency.STOP = Freq_stop(Ch - 1)
 880|      SCPI.SENSe(Ch).SWEep.POINts = Nop(Ch - 1)
 890|      SCPI.CALCulate(Ch).PARameter.Count = N_tr(Ch - 1)
 900|      If Fsim(Ch - 1) = True Then
 910|        SCPI.CALCulate(Ch).FSIMulator.STATe = True
 920|        SCPI.CALCulate(Ch).FSIMulator.BALun.DEVice = Dev(Ch - 1)
 930|        SCPI.CALCulate(Ch).FSIMulator.BALun.TOPology.SBALanced.
PPORts = Tpl(Ch - 1)
 940|        SCPI.CALCulate(Ch).FSIMulator.BALun.PARameter(1).STATe =
True
 950|       SCPI.CALCulate(Ch).FSIMulator.BALun.PARameter(1).SBALanced.
DEFine = Trc(Ch - 1)
 960|      Else
 970|        SCPI.CALCulate(Ch).PARameter(1).DEFine = Trc(Ch - 1)
 980|      End If
 990|      SCPI.DISPlay.WINDow(Ch).TITLe.DATA = Ttl(Ch - 1)
1000|      SCPI.DISPlay.WINDow(Ch).TITLe.STATe = True
1010|      SCPI.INITiate(Ch).CONTinuous = True
1020|    Next Ch
1030|
```

```
1040|    SCPI.TRIGger.SEQuence.Source = "BUS"
1050|    SCPI.SENSe.MULTiplexer(1).DISPlay.STATe = True
1060|    SCPI.SENSe.MULTiplexer(1).STATe = True
1070|    '
1080|    ' Calibration
1090|    '
1100|    AnaPort = Array(1, 2)
1110|    Res = ECal_Solt(1, 2, AnaPort, "A and T1")
1120|    If Res <> 0 Then GoTo Prg_end
1130|    AnaPort = Array(1, 3, 4)
1140|    Res = ECal_Solt(2, 3, AnaPort, "A, R1+ and R1-")
1150|    If Res <> 0 Then GoTo Prg_end
1160|    AnaPort = Array(1, 2)
1170|    Res = ECal_Solt(3, 2, AnaPort, "A and T2")
1180|    If Res <> 0 Then GoTo Prg_end
1190|    AnaPort = Array(1, 3)
1200|    Res = ECal_Solt(4, 2, AnaPort, "A and R2+")
1210|    If Res <> 0 Then GoTo Prg_end
1220|    '
1230|    ' Measurement
1240|    '
1250|  Meas_Start:
1260|    MsgBox "Connect DUT.", vbOKOnly, "Measurement"
1270|
1280|    SCPI.TRIGger.SEQuence.SINGle
1290|    Dmy = SCPI.IEEE4882.OPC
1300|
1310|    For Ch = 1 To 4
1320|      SCPI.DISPlay.WINDow(Ch).TRACe(1).Y.SCALe.AUTO
1330|    Next Ch
1340|
1350|    Buff = MsgBox("Do you make another measurement?", vbYesNo)
1360|    If Buff = vbYes Then GoTo Meas_Start
1370|
1380|  Prg_end:
1390|  End Sub
1400|
1410|  Function ECal_Solt(Ch As Long, Solt As Long, AnaPort As Variant,
TsetPort As String) As Long
1420|    Dim Err_info As Variant
1430|    Dim Buff As Long
1440|
1450|  Ecal_start:
1460|    SCPI.IEEE4882.CLS
1470|
1480|    MsgBox "Connect " + TsetPort + " to ECal Module."
1490|
1500|    On Error GoTo Ecal_err
1510|
1520|    Select Case Solt
1530|      Case 1
1540|        SCPI.SENSe(Ch).CORRection.COLLect.ECAL.SOLT1 = AnaPort(0)
1550|      Case 2
1560|        SCPI.SENSe(Ch).CORRection.COLLect.ECAL.SOLT2 = AnaPort
1570|      Case 3
1580|        SCPI.SENSe(Ch).CORRection.COLLect.ECAL.SOLT3 = AnaPort
1590|      Case 4
1600|        SCPI.SENSe(Ch).CORRection.COLLect.ECAL.SOLT4 = AnaPort
1610|    End Select
1620|
1630|    ECal_Solt = 0
1640|    GoTo Ecal_end
1650|
1660|  Ecal_err:
```

```
1670|    Err_info = SCPI.SYSTem.Error
1680|    Buff = MsgBox("Error: " + Err_info(1), vbRetryCancel)
1690|    If Buff = vbRetry Then
1700|      Resume Ecal_start
1710|    Else
1720|      ECal_Solt = Err_info(0)
1730|      Resume Ecal_end
1740|    End If
1750|
1760|  Ecal_end:
1770|    End Function
```