Tips for Reusing Existing 4142B Program for Agilent E5270A Parametric Measurement Mainframe

Agilent E5270 Series of Parametric Measurement Solutions

Technical Overview

Agilent E5270A 8 Slot Parametric measurement Mainframe with 4 SMU plug-in modules

Introduction

Agilent E5270 series instruments are GPIB command compatible with the Agilent 4142B Modular DC Source Monitor. The Agilent E5270A Parametric Measurement Mainframe is replacing the 4142B with a similar concept of eight-channel plug-in modules.

If the existing 4142B program runs on the E5270A with few or no modifications, it will save appreciable engineering time and cost when migrating to the new E5270A.

The existing 4142B program written for HPSMU and MPSMU is 100% compatible with the E5270A, but programs written with a mixture of the 4142B's HVU, HCU, VSVMU, AFU and RELAY CONTROL modules may not run on the E5270A without modification.

However, many GPIB command sets of the 4142B are commonly used by several plug-in measurement modules including unsupported modules, which means it would be troublesome and time consuming to identify the incompatible portions in the existing 4142B program.

Because of this, the important first step for successfully migrating to the E5270A is to systematically check existing 4142B program code written for unsupported 4142B modules to find incompatible program lines or portions.

The purpose of this technical overview is to provide an example of a systematic approach for finding non-operative 4142B program modules or lines in the E5270A instrument, and finally to make it possible to run the modified program with the E5270A. This helps when checking the throughput improvement of the E5270A over the 4142B in your real test environment by running the modified program with both instruments.

This also helps when rewriting

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any incompatible portion of your 4142B program by using a new functionality of the E5270A in the actual migration phase after the initial investigation.

Steps for Finding Unsupported 4142B Modules

To run the existing 4142B program on the E5270 series instruments, the first step is to pinpoint incompatible portions of the 4142B program modules, and then to delete (or bypass or comment out) these incompatible portions or to modify them before running them on the E5270A.

To find program incompatibility, first check the unsupported GPIB command set. Many GPIB command sets of the 4142B are commonly used by several plug-in measurement modules including the E5270 incompatible modules, so a careful approach is the key even to finding incompatible program modules in the existing 4142B program.

The following steps outline a systematic approach for finding program modules that are incompatible with E5270 series instruments;

1. Check if any of the following plug-in modules exist in the 4142B system hardware:
HVU, HCU, VSVMU, AFU and RELAY CONTROL modules.

2. Check if the program contains any GPIB command sets that are unique to these unsupported modules.

3. Check the program title, program description, and explanation or comment section of the program for names or symbols associated with these unsupported modules. Also, check the program lines for names or symbols used as a parameter for specifying the slot number of these 4142B modules or a comment explaining the relation of these 4142B modules to a specific slot number.

4. If any of the above conditions are not applicable, i.e. all parameters are assigned by an actual number with no explanations or comments, then you may have to check the program code line by line, with the setup parameters such as voltage, current or slot number as keys to judge the program compatibility. Nevertheless, this case should be very rare because maintaining the program or system is very difficult with this approach, some information is usually included as shown in the previous step. Another approach, at this stage, would be to run the existing program with the E5270A. Because the E5270 series instruments show the error number and description on the display line, this would be one of the easiest and most effective ways of locating incompatible portions of the program.

The above four steps are set out in flow diagram format in Figure 1.

An explanation of each step follows.

STEP 1. Checking for non-supported plug-in modules in system hardware

The E5270 series supports HPSMU and MPSMU plug-in modules. Therefore, the first step is to check if the existing 4142B program uses any of the unsupported 4142B modules.

If the hardware configuration of the 4142B system includes any of the unsupported modules shown in Table 1, the 4142B program might not be compatible with the E5270 series. In this case, proceed to step 2.
If the 4142B system does not include any of the unsupported plug-in modules, then the existing 4142B program is 100% compatible with E5270 series instruments. In this case, set the E5270A configuration the same as for the 4142B and apply the program to the E5270A.
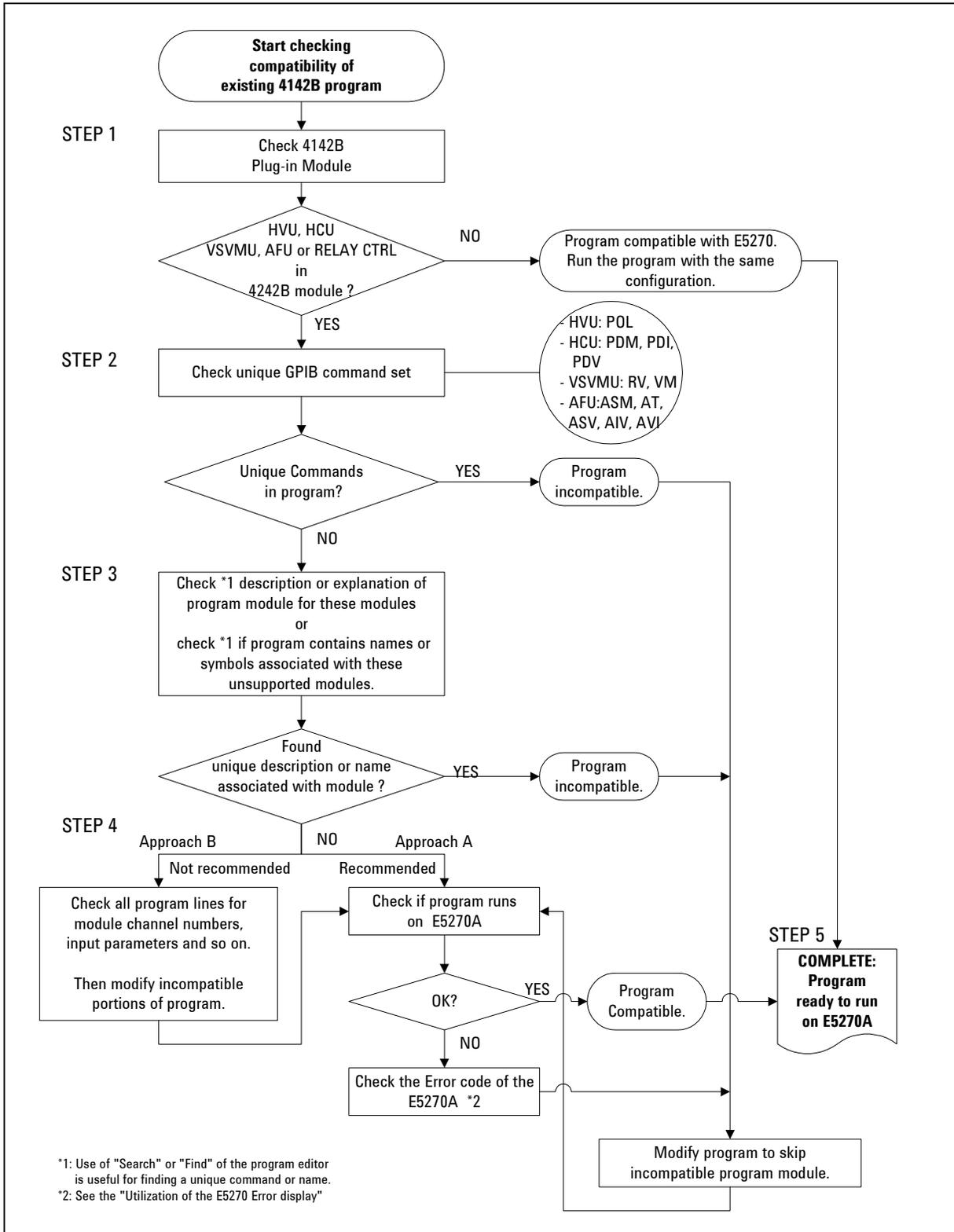
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Start checking compatibility of existing 4142B program

STEP 1

Check 4142B Plug-in Module

HVU, HCU VSVMU, AFU or RELAY CTRL in 4242B module ?

NO → Program compatible with E5270. Run the program with the same configuration.

YES

STEP 2

Check unique GPIB command set

- HVU: POL
- HCU: PDM, PDI, PDV
- VSVMU: RV, VM
- AFU:ASM, AT, ASV, AIV, AVI

Unique Commands in program?

YES → Program incompatible.

NO

STEP 3

Check *1 description or explanation of program module for these modules or check *1 if program contains names or symbols associated with these unsupported modules.

Found unique description or name associated with module ?

YES → Program incompatible.

NO

STEP 4

Approach B
Not recommended

Approach A
Recommended

Check all program lines for module channel numbers, input parameters and so on.

Then modify incompatible portions of program.

Check if program runs on E5270A

OK?

YES → Program Compatible.

NO

Check the Error code of the E5270A *2

Modify program to skip incompatible program module.

STEP 5

COMPLETE: Program ready to run on E5270A

*1: Use of "Search" or "Find" of the program editor is useful for finding a unique command or name.
*2: See the "Utilization of the E5270 Error display"

Figure 1.   Flow diagram for finding unsupported modules in 4142B program

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STEP 2. Checking unique GPIB command set

If the 4142B program includes any GPIB commands shown in Table 2 below, that are not supported by the E5270A, that portion of the program will not run with E5270 series instruments.

Procedure:

1. Search the 4142B program for the commands shown in Table 2.
    If you find any of these commands, then it means that this portion of the program cannot run properly with the E5270 series instruments. Disable this program module when you apply the program to the E5270A.

2. The other portion of the program is not necessarily compatible with the E5270A.
    Even if your program does not include any of the unsupported command sets, it does not mean your program can run on the E5270A.

Some of the GPIB commands are commonly used by the unsupported 4142B plug-in modules and SMUs as listed in Table 3 (see appendix). This table indicates that checking compatibility from the unsupported unique GPIB command level is not very effective. Hence, the next step 3 is necessary for further verifying whether the 4142B's program can run on the E5270A.

Table 1: Supported and unsupported module types for 4142B

Supported Modules	Unsupported 4142B Modules
HPSMU (200 V/1 A)	VSVMU *1
MPSMU (100 V/200 mA)	HCU
	HVU
	AFU *2
	RELAY CONTROL *3

*1: Most of the VSVMU functionality can be realized using the MPSMU.

*2: The linear search or binary search measurement of the E5270 series can be
used for replacing the Vth measurement.

*3: RELAY CONTROL can be migrated using the digital I/O of E5270 series instruments.

Table 2 : 4142B GPIB commands not containing in E5270 series instruments

Plug-in Module	Commands
AFU	ASM, AT, ASV, AIV, AVI
HCU	PDM, PDI, PDV
HVU	POL
VSVMU	VM
RELAY CONTROL	ERC *4

*4: This does not support the Agilent 16087A and Agilent16088B Module Selector.
The E5270 series returns an error for these controls.

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STEP 3. Checking program description, comment or code to find unsupported modules

This step checks the program description or comment portion or program code of your program for detecting unsupported 4142B plug-in modules.

A typical program includes an explanation of what the program does or an instruction for running the program. This portion is important not just as an instruction for running the program, but also for maintaining the program. An example program is listed in the appendix section for explanatory purposes.

Lines 1 through 5 of the first program are such an example of the program description or explanation.
Line number 3 says " ! This module tests high power FET using MPSMU, HPSMU, HVU", from which you can easily understand that this program requires the unsupported HVU module. In other word, this portion of the program does not run with E5270 series instruments, so you have to delete this part or rewrite it.

Sometimes the program description does not include information on unsupported modules. In this case, you have to check the program code to find this information.

Program lines 100 through 140 of example program 1 assign the measurement modules for device connection. In this example, the module name for each device terminal is shown as a line comment for correct maintenance and operation of the program.

In the next example, lines 100 through 140 of program 2 assign the device connection in a relative way using variables that use a part of the name of the plug-in modules.

Both examples include a unique name of the unsupported 4142B modules, so you can easily know if this portion of the program is incompatible with the E5270 series. You can find the name easily by searching the unique name.

How to find unique name associated with unsupported module

You can easily check if the unique name is in the program by using the "Search" or "Find" function of the program editor.

For example, to check the unique HVU command "POL" for HVU usage, search the word "POL" as the keyword. If the 4142B program includes the keyword you specified, then the program line skips to that line and you can check the program adjacent to that line.

You could use the following as example keywords to search for specific modules in addition to the unique command shown in Table 2:

- AFU : AFU, analog feedback, 41425
- HCU : HCU, HCSMU, high current, HC, 41422, 10 A
- HVU : HVU, HVSMU, high voltage, HV, 41423, 1000 V
- VSVMU : VS, VSU, VM, VMU, 41424, Differential
- RELAY CONTROL : Relay, Control, (#)300, 16087, 16088

There is a case where you cannot rely on this approach, as is shown in example program 3; instead of using a unique name associated with the plug-in module, it assigns module information using direct numbers. If this is the case, you will have to take a different approach to checking program compatibility. STEP 4 gives some suggestions.

STEP 4. Use of E5270's ERROR display or line-by-line check of program code

Step 4 in Figure 1 indicates the following two possible choices:

A. Try to run the program on the E5270A using E5270's ERROR display features

B. Check the program lines for parameters that are not compatible with the E5270A's SMU

Both approaches are not perfect solutions, but compliment each other if used properly depending on the situation. These two approaches, A and B,

are explained next.

Approach A: Run program and check error in E5270 display

Approach A is further broken down in the flow diagram in Figure 2.

The following are the suggested steps for approach A:

1. Set the configuration of the E5270A SMU module the same as that of the target 4142B system where the program is to be exported.

2. Run the program on the E5270A.

3. Check if an error is indicated in the E5270A display.

4. If any error is reported, then run the program a line at a time, and find the program line that generates the error in the E5270A error indicator.

5. Check if the error is related to the unsupported 4142B module.   If it is, then skip that module or modify the program for the E5270A. For example, a larger parameter that exceeds the SMU's maximum value can be considered for the HCU or HVU.   A larger slot number than 8 can be judged for the VSVMU.

6. Repeat this process until the program runs without any errors.

Approach B: Check the program code line by line

Approach B may be not so efficient if you start from scratch, unless you are very familiar with the 4142B's GPIB command.   If you combine this approach B with the method shown in A, the area for checking will be narrowed down, so this method will be more effective than just repeating approach A.

The following are a few key points that are worth to checking:

1. Check if the program parameter for voltage or current is larger than the SMU's
   - HVU :   If the voltage is between 200 V and 1,000 V, then this is for the HVU
   - HCU :   If the current is more than 1 A, then this is for the HCU

2. Check the slot/channel assignment
   - VSVMU :   If the module slot number is larger than 11, then this is for the VSVMU
   - All the modules :
     o Check if the channel number assigned in the program is for the unsupported 4142B module in the actual 4142B hardware configuration.
     o This is an inverse check of the above.   Check if the channel number of the unsupported 4142B module in the actual 4142B configuration is used in the

program.
   o If the above is true, then the program module cannot be run by the E5270A.

3. Check the program parameters
   - RELAY CONTROL :   if the first parameter of the ERC command is "1", then this is not supported in the E5270 series.

STEP 5. RUN program on E5270A

Now the existing 4142B program, modified to skip the incompatible portion, is ready to run on the E5270A.

The E5270A should have a much faster measurement speed or shorter measurement time than the 4142B.   Typical improvements in measurement speed of the E5270A over the 4142B are shown for reference.

- SPOT measurements (Medium current range – 10 mA) :   5.1 times

- SPOT measurements (Low current range – 1 nA) : 2.3 times

- SWEEP measurements (Low to medium current) : 3.3 times
  Note: You can find this information on the Agilent web site by the following steps :
  1. Go to http://www.agilent.com/see /parametric
  2. Search "Quick search" for E5270.

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3. In the "Application Notes & Technical Papers" section, click for the "<u>Several times faster throughput than Agilent 4142B</u> ".

If you can not obtain similar improvements, then check the following points.

- Is there any fixed wait time inserted in the program? The fixed wait time reduces the effect of the high speed of the E5270A.

- Is there any use of unnecessarily long HOLD or DELAY TIME parameters? Additional HOLD or DELAY TIME reduces the high measurement speed features of the E5270A.

- Is there any use of unnecessarily long integration time, such as power line cycle (PLC) integration? The E5270A is faster even using the PLC integration time, but the effectiveness is reduced.

- Is the display of the E5270A enabled? If the display of the E5270A enabled, the measurement speed is halved (slower). The display must be turned off (default setting of the E5270A) when the program is running except during debugging.

- Is a high-speed GPIB card used? Generally speaking, then PCI bus GPIB card is fast enough to enjoy the E5270A speed capability. However, the PCMCIA type GPIB card is slower and it may adversely affect the measurement speed of the E5270A. The USB/GPIB interface such as the Agilent 82357A is not recommended if your application requires maximum throughput rather than easy interfacing. The 82357A USB/GPIB interface may not show any speed advantage of the E5270A over the 4142B.

By taking account of the above points, you should be able to achieve faster throughput with the E5270A.
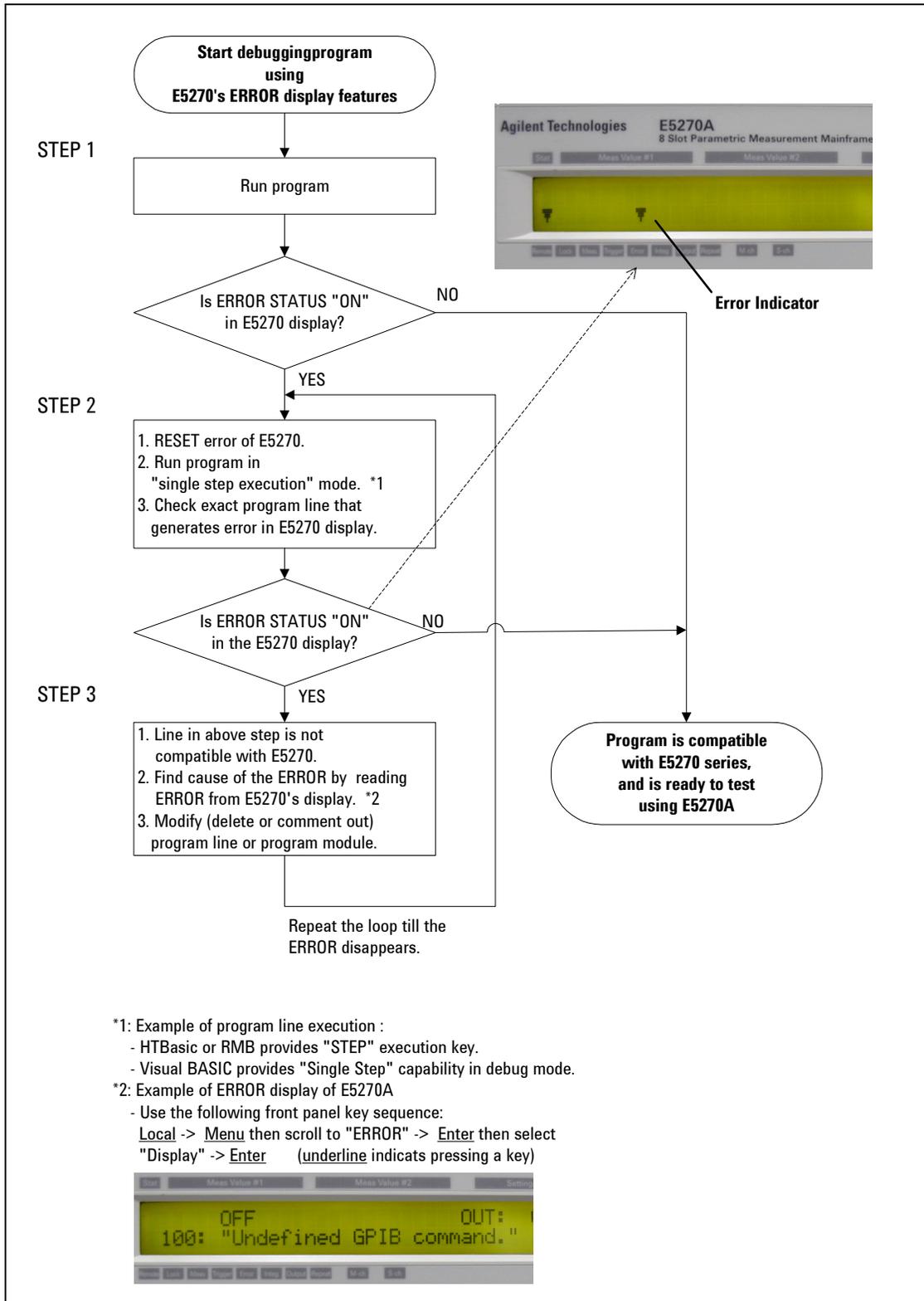
Figure 2.   Tips for program debugging using E5270A's ERROR display features

Conclusion

The GPIB code of the E5270 series is compatible with the 4142B for supported measurement modules. Therefore, the 4142B program written only for the SMU can be run without any change in the 4142B program.

However, if you try to run the existing 4142B program that is written with a mixture of unsupported 4142B modules such as the HCU, HVU or VSVMU, you will need to take a systematic approach for detecting and skipping the incompatible portions of the program.

This technical information provides effective approaches for finding incompatible 4142B program modules or lines as a start point for migrating to the E5270 series from the 4142B.

This information should help when investigating throughput improvement by changing from the 4142B to E5270 while re-using the existing 4142B program on the E5270 series. 4142B users can effectively delete, comment out or skip incompatible portions of the 4142B program using this approach and compare the improvement in the real test environment, to attain better throughput.

This approach is also effective when exporting the existing program to E5270 series instruments for rewriting incompatible portions to replace with the E5270 SMUs, for example, VSVMU to SMUs or AFU to binary search or linear search function of the E5270 SMUs.

Note that showing how to rewrite the existing 4142B program for the E5270 series is beyond the scope of this technical information, and it is not covered.

The same approach is also effective for Agilent E5272A or E5273A 2-channel Source/ Monitor Unit.

Appendix :

Table 3 : The GPIB command set commonly used between the 4142B modules

Command	SMU	VSVMU	HVU	HCU	AFU
ASM					X
ASV					X
AT					X
AVI					X
AIV					X
BDV	X		X		
CA	X	X (VS)	X	X	X
CL	X	X (VS)	X	X	
CN	X	X (VS)	X	X	
DI	X		X		
DV	X		X		
DZ	X		X	X	
FL	X		X		
IN	X	X (VS)	X	X	
PDI	X (with HCU)			X	
PDM				X	
PDV	X (with HCU)			X	
PI	X		X	X	
POL			X		
PV	X	X (VS)	X		
PWI	X		X		
PWV	X	X (VS)	X		
RI	X		X		
RV		X (VM)			
RZ	X	X (VS)	X	X	
TI	X	X (VS)	X	X	
TST?	X	X	X	X	X
TV	X	X (VS)	X	X	
VM		X (VM)			
WI	X		X		
WM	X	X (VS)	X	X	
WSI	X		X		
WSV	X	X (VS)	X		
WV	X	X (VS)			

Example program 1:

```
*******************************

1    ! Example 1
2    ! Sample program for Hi-speed SPOT measurements
3    ! This module tests high power FET using MPSMU, HPSMU,
HVU
4    ! Module slot# is assigned for each module name
5    !
10 ASSIGN @Agt4142 TO 717
20 !
30 INTEGER Fmt,Source,Drain,Gate,Sub
40 INTEGER Range_2v,Range_20v,Range_1000v,Range_i
60 !
70 Fmt=5              !1:ASCII with Header <,>
100 Drain=2           !2:HPSMU in slot2
110 Drain_hv=8        !8:HVSMU in slot8
120 Gate=4            !4:MPSMU in slot4
130 Source=6          !6:HPSMU in slot6
140 Sub=3             !3:MPSMU in slot3
150 Range_2v=11       !11: 2 V Limited Auto Ranging
160 Range_20v=12      !12:20 V Limited Auto Ranging
170 Range_1000v=17    !17:1000V Limited Auto Ranging
180 Range_i=15        !15:10 uA Limited Auto Ranging
...
240 OUTPUT @Agt4142;"FMT ";Fmt
250 OUTPUT @Agt4142;"CN ";Drain_hv,Gate,Source,Sub
290 OUTPUT @Agt4142;"DV ";Source,Range_2v,Vs,Icomp_s
300 OUTPUT @Agt4142;"DV ";Sub,Range_2v,Vsub,Icomp_sub
310 OUTPUT @Agt4142;"DV ";Gate,Range_20v,Vg,Icomp_g
320 OUTPUT @Agt4142;"DV ";Drain_hv,Range_1000v,Vd,Icomp_d


*******************************
```

Example program 2:

```
*******************************

1    ! Example 2
2    ! Sample program for Hi-speed SPOT measurements
3    ! This module tests high power FET using MPSMU, HPSMU,
and HVU
4    ! Module address is assigned in the main program and passed
by COM block
5    !
10 ASSIGN @Agt4142 TO 717
20 !
21 COM A_hpsmu1,A_hpsmu2,A_mpsmu1,A_mpsmu2,A_hvu
30 INTEGER Fmt,Source,Drain,Gate,Sub
40 INTEGER Range_2v,Range_20v,Range_1000v,Range_i
60 !
70 Fmt=5                  !1:ASCII with Header <,>
100 Drain=A_hpsmu1        !HPSMU1 address
110 Drain_hv=A_hvu        !HVSMU address
120 Gate=A_mpsmu1         !MPSMU1 address
130 Source=A_hpsmu2       !HPSMU2 address
140 Sub=A_mpsmu2          !MPSMU2 address
```

```
150 Range_2v=11                !11: 2 V Limited Auto Ranging
160 Range_20v=12               !12:20 V Limited Auto Ranging
170 Range_1000v=17    !17:1000V Limited Auto Ranging
180 Range_i=15        !15:10 uA Limited Auto Ranging
...
240 OUTPUT @Agt4142;"FMT ";Fmt
250 OUTPUT @Agt4142;"CN ";Drain_hv,Gate,Source,Sub
290 OUTPUT @Agt4142;"DV ";Source,Range_2v,Vs,Icomp_s
300 OUTPUT @Agt4142;"DV ";Sub,Range_2v,Vsub,Icomp_sub
310 OUTPUT @Agt4142;"DV ";Gate,Range_20v,Vg,Icomp_g
320 OUTPUT @Agt4142;"DV ";Drain_hv,Range_1000v,Vd,Icomp_d


*******************************
```

Example program 3:

```
*******************************

1    ! Example 3
2    ! Sample program for Hi-speed SPOT measurements
3    ! This module tests high power FET
4    ! Module address is assigned directly in each command line
5    !
10 ASSIGN @Agt4142 TO 717
60 !
...
240 OUTPUT @Agt4142;"FMT 5"
250 OUTPUT @Agt4142;"CN 8, 4, 6, 3"
290 OUTPUT @Agt4142;"DV 6,11,0,1"                    ! 0V 1A
comp
300 OUTPUT @Agt4142;"DV 3, 11, 0, 0.1"               ! 0V
100mA comp
310 OUTPUT @Agt4142;"DV 4, 12, 3, 1E-5"              ! 3V
10uA comp
320 OUTPUT @Agt4142;"DV 8, 17, 1000, 0.001"   ! 1000V 1mA comp
```

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