How to Drive the Agilent Technologies Microwave Matrix and Transfer Switch via the E8483A Microwave Switch/Step Attenuator Driver

Product Note

Agilent Technologies

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E8483A introduction

The Agilent E8483A switch/step attenuator driver is a C-size, 2-slot, register-based VXI module. It can control up to six switches and/or attenuators. The module provides room to install up to three single-pole multithrow microwave switches, or you can mount the switches and/or attenuators externally to the VXI module in a location closer to your DUT. The microwave switches and attenuators are not included with the E8483A and must be ordered separately.

The E8483A provides +24 V drive signals to control the 87104/06 series microwave switches and 84904/06/07K/L series programmable step attenuators. Cables for connecting the E8483A to the drive circuitry of the switches and attenuators are included with the E8483A.

Features

- C-size, 2-slot, register-based
- Controls any Agilent 87104/87106 series microwave switch (switching up to 26.5 GHz). For details please refer to Appendix A.
- Controls any Agilent 84904/06/07K/L programmable step attenuator (programmable in 1- or 10-dB steps up to 90 dB, up to 40 GHz). For details, please refer to Appendix A.

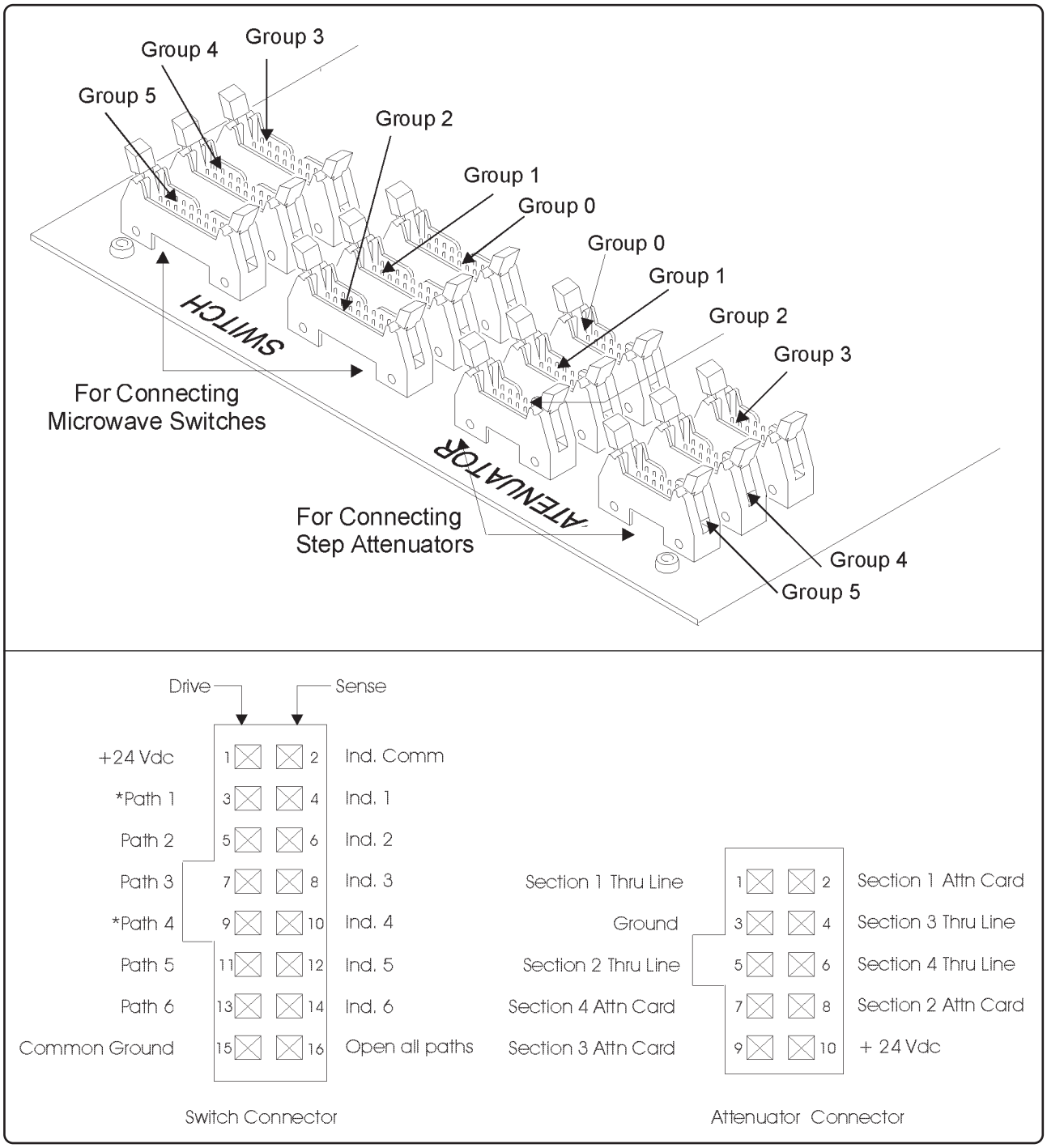
General information

VXI characteristics	
VXI device type:	Register-based, A16, slave only
Size:	C
Slots:	2
Connectors:	P1/P2
Shared memory:	None
VXI busses:	None

Instrument drivers ***Visit www.agilent.com/find/inst_drivers for driver availability and downloads***	
Command module firmware:	Downloadable
Command module firmware rev:	A.11.01
I-SCPI Win 3.1:	No
I-SCPI Series 700:	No
C-SCPI LynxOS:	No
C-SCPI Series 700:	No
Panel Drivers:	No
VXIplug&play Windows® framework:	No
VXIplug&play Windows 95/NT® framework:	Yes
VXIplug&play HP-UX framework:	No

The E8483A contains the control, drive, and power circuitry for controlling both microwave switches and step attenuators. Any combination of up to six devices (switches or attenuators) can be controlled by an E8483A. The module includes six 16-pin ribbon cable connectors for connecting up to six microwave switches, and six 10-pin ribbon cable connectors for connecting up to six step attenuators. Figure 1 shows the pin definition of the connectors.

Figure 1. Switch and attenuator connector pin definition.



Note: Do not connect a microwave switch and a step attenuator to the connectors within the same group. That is, if you have connected a switch to the 16-pin Group 0 connector, then you can not connect an attenuator to the 10-pin Group 0 connector.

Modern automated test systems demand higher accuracy and performance than ever before, and flexibility is essential in the signal routing applications. Together with the E8483A VXI module, Agilent provides the D-SCPI and plug&play drivers for Agilent 87104/6 series microwave switches and 84904/6/7K/L series programmable step attenuators.

The control circuitry (See Figure 2) also allows the control of other Agilent microwave switches and attenuators by using VXI direct IO methods. The following sections will introduce the controlling methods for Agilent 87406B coaxial matrix switch and 87222C/D/E coaxial transfer switches with an Agilent E8483A.

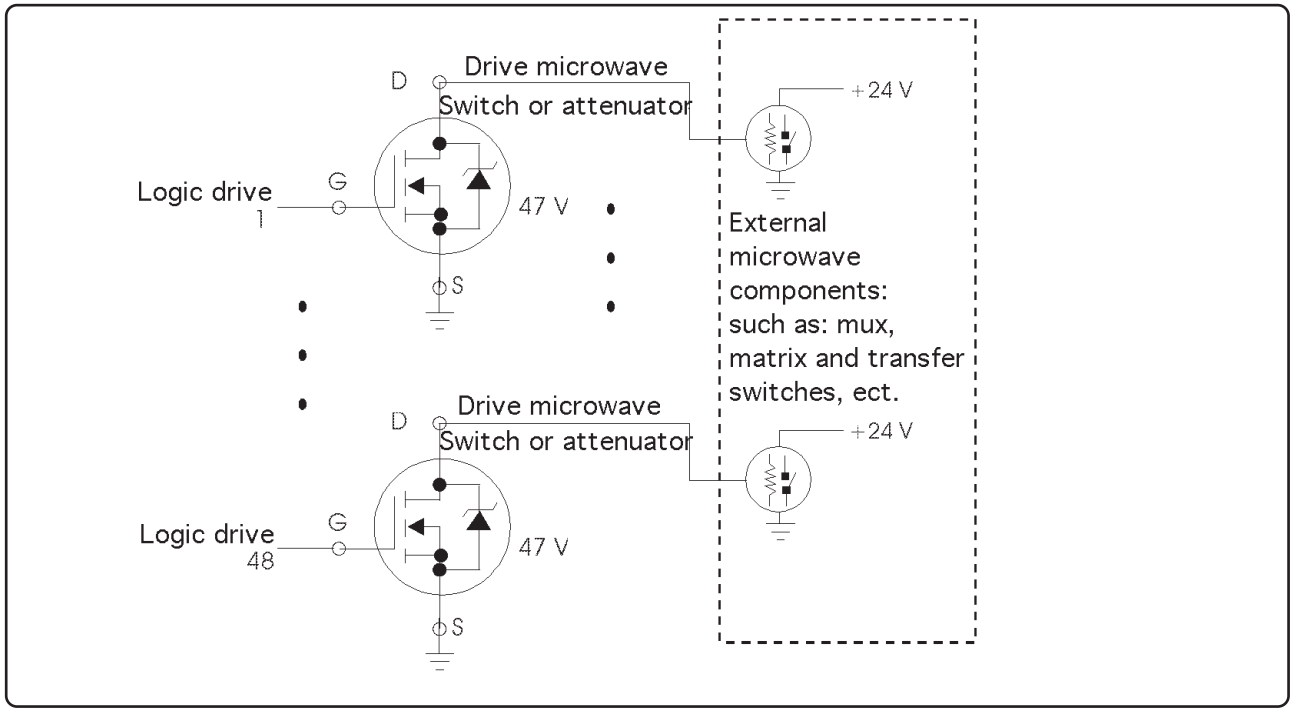


Figure 2. Agilent E8483A simplified drive circuits

How to drive microwave matrices via E8483A

1. Agilent 87406B description

The Agilent 87406B matrix switch provides the durability and reliability required for automated test and measurement, signal monitoring and routing applications. Below is a brief specifications list. For details, please refer to Appendix B.

- 3 x 3, 2 x 4 and 1 x 5 blocking matrix configurations
- Magnetic latching
- Make-before-break or break-before-make operation
- Repeatability for more than 5 million cycles
- Isolation, typically > 100 dB at 20 GHz
- Opto-electronic indicators and interrupts
- Terminated ports

Figures 3 and 4 show the Agilent 87406B configured for blocking 2x4 and 3x3 applications.

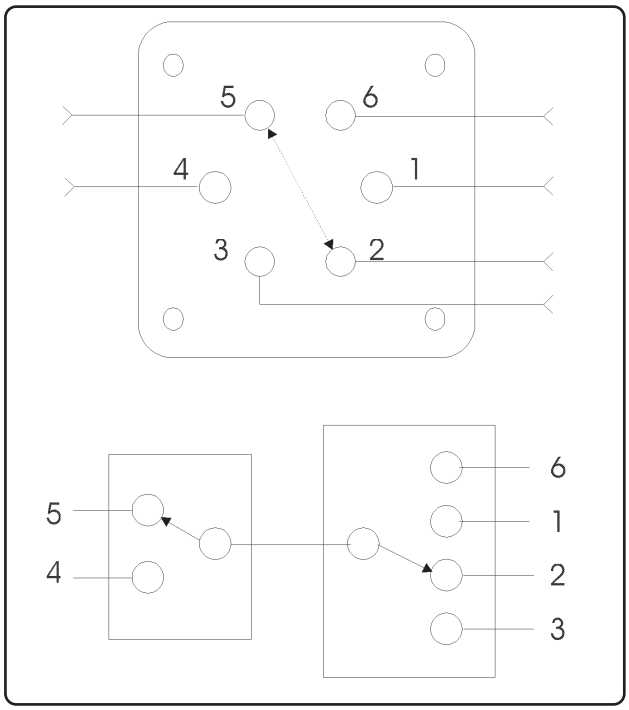


Figure 3. Matrix switch configured for 2x4 blocking application (RF path 5 to 2 shown)

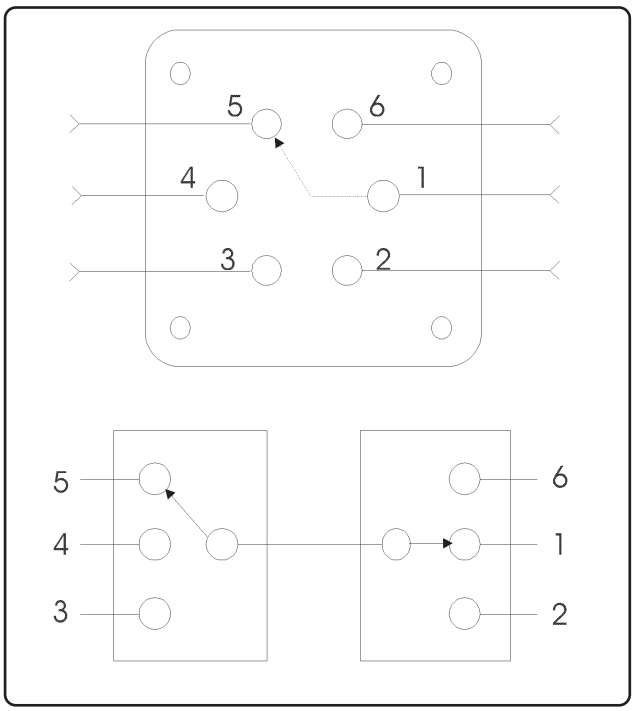


Figure 4. Matrix switch configured for 3x3 blocking application (RF path 5 to 1 shown)

2. Connecting and programming guide

- **Connecting Agilent 87406B to E8483A:**
  As Agilent 87406B's power and control circuit share the same pin assignments with Agilent 87106A/B/C. You can use the same ribbon cable for 87106A/B/C to connect an 87406B to an E8483A.
- **The switch/attenuator control register:**
  There are three switch/attenuator control registers.
  Switch/attenuator control register 1 (base + 0x10)
  Switch/attenuator control register 2 (base + 0x12)
  Switch/attenuator control register 3 (base + 0x14)
  These registers are used to control switches to close/open and set step attenuators to different values. Table 1 shows the control registers details.

The numbers shown in the register map indicate the channel number to be written to. Writing to the switch control registers enables you to close the desired channel. For example, writing a "1" to bit 2 of the control register 0x10 to close group 0 channel 2 (Port 2) of mux switch. For matrix switch 87406B, write 0x12 to control register 0x10 to make RF path 5 to 2 connected in Figure 3.

Note: Write a "1" to bit 7 (of 0x10, 0x12, 0x14) to open all (OA) the channels of group 0, 2, 4. Write a "1" to bit 15 (of 0x10, 0x12, 0x14) to open all the channels of group 1, 3, 5.

Table 1: Control register descriptions

		Group 1								Group 0							
0x	BITS	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
10	PORT#	OA	X	6	5	4	3	2	1	OA	X	6	5	4	3	2	1
		Group 3								Group 2							
0x	BITS	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
12	PORT#	OA	X	6	5	4	3	2	1	OA	X	6	5	4	3	2	1
		Group 5								Group 4							
0x	BITS	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
14	PORT#	OA	X	6	5	4	3	2	1	OA	X	6	5	4	3	2	1

Table 2: Control pattern for a 2x4 matrix

Path to Path	Patterns written to the register (87406B is connected to group 0,2,4)	Patterns written to the register (87406B is connected to group 1,3,5)
5 to 6	0x30	0x3000
5 to 1	0x11	0x1100
5 to 2	0x12	0x1200
5 to 3	0x14	0x1400
4 to 6	0x28	0x2800
4 to 1	0x09	0x0900
4 to 2	0x0A	0x0A00
4 to 3	0x0B	0x0B00

Table 3: Control pattern for a 3x3 matrix

Path to Path	Patterns written to the register (87406B is connected to group 0,2,4)	Patterns written to the register (87406B is connected to group 1,3,5)
5 to 6	0x30	0x3000
5 to 1	0x11	0x1100
5 to 2	0x12	0x1200
4 to 6	0x28	0x2800
4 to 1	0x09	0x0900
4 to 2	0x0A	0x0A00
3 to 6	0x24	0x2400
3 to 1	0x05	0x0500
3 to 2	0x06	0x0600

- **Programming examples:**

Example 1: using VISA to control an 87406B as a 2x4 matrix in Figure 3 and a 3x3 matrix in Figure 4. (Suppose we connect one 87406B in 2x4 configuration to switch group 0 and another in 3x3 configuration to switch group 3.) For 87406B controlling details, please see 87406B user's manual. For other path connection, please refer to Table 2 and Table 3.

```
#include <visa.h>
#include <visatype.h>
#include <vpptype.h>

#define E8483 "VXI0::28::INSTR" /* Assume logic address is 28 */

void main()
{
        ViSession defaultRM, vi;
        ViStatus errStatus;

        /* Open session to VXI device at E8483 address 28 */
        errStatus = viOpenDefaultRM(&defaultRM);
        if(errStatus!=0){
            printf("Failed to open default resource manager, ask for technical support. \n");
            return;
           }
        errStatus = viOpen(defaultRM,E8483,VI_NULL,VI_NULL,&vi);
        if(errStatus!=0){
            printf("Failed to open E8483, ask for technical support. \n");
            return;
           }

        /* make RF path 5 to 2 connected in figure 3 */
        errStatus = viOut16(vi, VI_A16_SPACE, 0x10, 0x12);
        if(errStatus!=0){
            printf("Failed to run viOut16, ask for technical support. \n");
            return;
           }

        /* make RF path 5 to 1 connected in figure 4 */
        errStatus = viOut16(vi, VI_A16_SPACE, 0x12, 0x1100);
        if(errStatus!=0){
            printf("Failed to run viOut16, ask for technical support. \n");
            return;
           }

        viClose(vi);
          viClose(defaultRM);
}
```

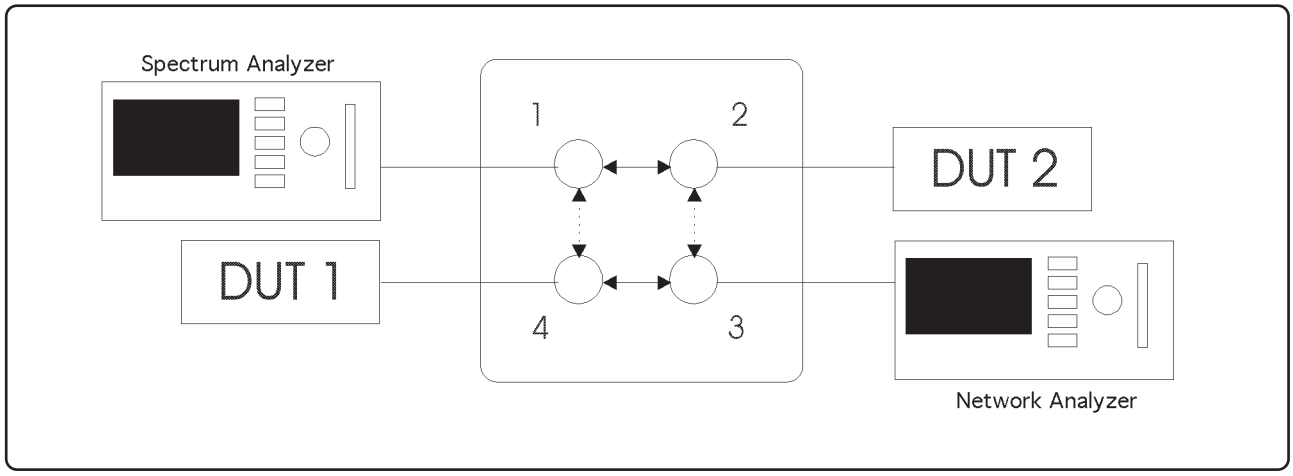
How to drive Agilent microwave transfer switches via E8483A

1. Transfer switch description

With innovative design and careful process control the Agilent 87222C/D/E meets the requirements for highly repeatable switching elements in test instruments and switching interfaces. Below is a brief specification list. For details please refer to Appendix C.

- Repeatability for more than 5 million cycles < 0.03 dB
- Isolation, typically >90 dB at 26.5 GHz , 40GHz and 50 GHz
- Opto-electronic indicators and interrupts
- Magnetic latching

The Agilent 87222C/D/E transfer switches can exchange two signals between two inputs and two outputs. Either transfer switch can connect two different instruments with two devices under test (DUT). Once switched, the signals are exchanged between the two instruments and the two DUTs. The exchanged signals allow complete network and spectrum analysis on two devices with a single switch and one test setup. See Figure 5 for an example of this application.



	DUT1	DUT2
Network analyzer	◄——► Position A	◄- - -► Position B
Spectrum analyzer	◄- - -► Position B	◄——► Position A

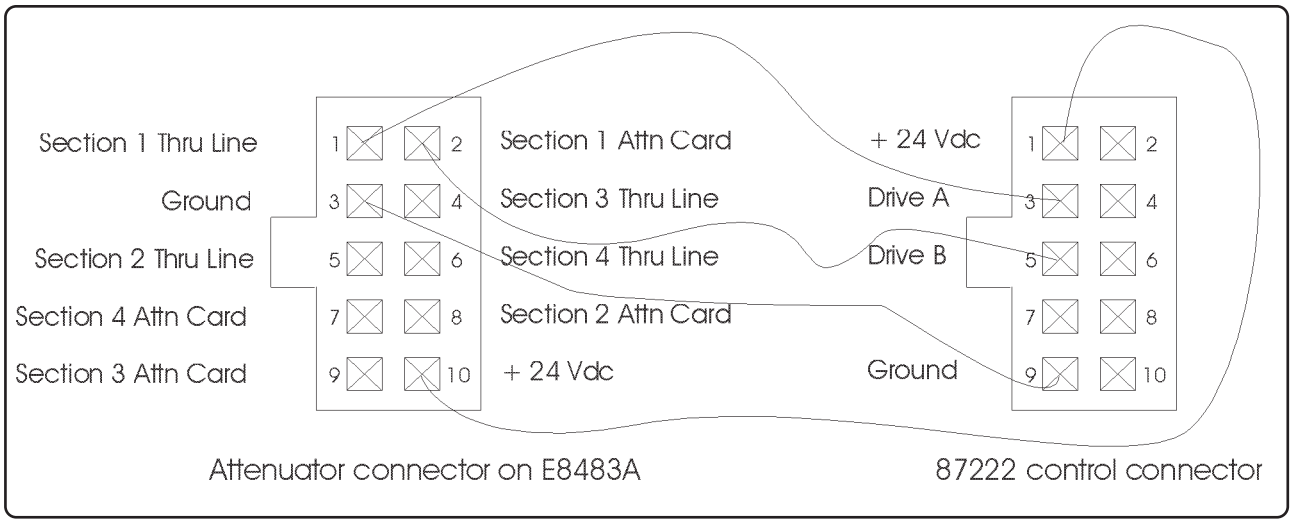
Figure 5. Switching two instruments and two DUTs

2. Connecting and programming guide

• Connecting Agilent 87222C/D/E to E8483A:

As Agilent 87222C/D/E's power and control circuit uses 10-pin ribbon cable connectors, make a special ribbon cable, as seen in Figure 6, to connect one of the connectors for attenuator groups on E8483A.

Note: Don't use the cable provided with E8483A



Pin # of connector on E8483A	Pin # of 87222 connector
1	3
2	5
3	9
10	1

Figure 6. Connecting 87222C/D/E to the E8483A connector

• The switch/attenuator control register

Please refer to the "switch/attenuator control register section" for 87406B applications. For the 87222C/D/E control pattern, please refer to Table 4.

Position	Patterns written to the register (87222 is connected to group 0,2,4)	Patterns written to the register (87222 is connected to group 1,3,5)
A	0x01	0x0100
B	0x02	0x0200

• Programming examples:

Example 2: using VISA to control 87222C/D/E to switch two instruments and two DUTs. (Suppose we connect one 87222 to attenuator group 0 in the E8483A.) For 87222C/D/E controlling details and other applications, please see 87222C/D/E product user's manual.

```
#include <visa.h>
#include <visatype.h>
#include <vpptype.h>

#define E8483 "VXI0::28::INSTR"      /* Assume E8483A logic address is 28 */

void main()
{
        ViSession defaultRM, vi;
        ViStatus errStatus;

        /* Open session to VXI device at E8483 address 28 */
        errStatus = viOpenDefaultRM(&defaultRM);
        if(errStatus!=0){
              printf("Failed to open default resource manager, ask for technical support. \n");
              return;
             }
        errStatus = viOpen(defaultRM,E8483,VI_NULL,VI_NULL,&vi);
        if(errStatus!=0){
              printf("Failed to open E8483, ask for technical support. \n");
              return;
             }

        /* make RF path to position A in figure 5 */
        viOut16(vi, VI_A16_SPACE, 0x10, 0x1);
        if(errStatus!=0){
              printf("Failed to run viOut16, ask for technical support. \n");
              return;
             }

        /* make RF path to position B in figure 5 */
        viOut16(vi, VI_A16_SPACE, 0x10, 0x2);
        if(errStatus!=0){
              printf("Failed to run viOut16, ask for technical support. \n");
              return;
             }

        viClose(vi);
        viClose(defaultRM);
}
```

Appendix A. Agilent microwave switch/attenuator specifications

Single-pole multi-throw microwave switches	
Configuration:	
87104A/B/C:	SP4T terminated
87106A/B/C:	SP6T terminated
Connectors:	SMA
Impedance:	50 Ω
Frequency range:	DC to 26.5 GHz
Life and repeatability:	5x10E6
Power average/peak:	1 W/50 W

Programmable step attenuators

Model	**Frequency range (GHz)**	**Atten/steps**	**Insertion loss@ 0 dB**	**SWR Maximum**
84904K	DC to 26.5	0-11 / 1 dB steps	0.8 dB + 0.04 dB/GHz	1.3 to 1.8
84904L	DC to 40	0-11 / 1 dB steps	0.8 dB + 0.04 dB/GHz	1.3 to 1.8
84906K	DC to 26.5	0-90 / 10 dB steps	0.8 dB + 0.04 dB/GHz	1.3 to 1.8
84906L	DC to 40	0-90 / 10 dB steps	0.8 dB + 0.04 dB/GHz	1.3 to 1.8
84907K	DC to 26.5	0-70 / 10 dB steps	0.6 dB + 0.03 dB/GHz	1.25 to 1.7
84907L	DC to 40	0-70 / 10 dB steps	0.6 dB + 0.03 dB/GHz	1.25 to 1.7

Note: For more detailed information about microwave switches and step attenuators, please refer to *Agilent RF & Microwave Test Accessories catalog*. literature number 5968-4314EN

Appendix B. Agilent microwave switch/attenuator specifications

Model	**87406B**
Configuration	SP6T
Features	3x3, 2x4 and 1x5 blocking matrix configurations Make-before-break or break-before-make operation Terminated Ports Opto electronic indicators Self interrupting drive circuit and interrupts
Impedance	50 ohms
Frequency range	dc to 20 GHz
Insertion loss (dB)	0.34 dB + 0.033 x frequency (GHz) maximum
SWR	1.21 maximum from dc to 4 GHz 1.35 maximum from 4 to 10 GHz 1.5 maximum from 10 to 15 GHz 1.7 maximum from 15 to 18 GHz 1.9 maximum from 18 to 20 GHz
Isolation (dB)	100 dB minimum to 12 GHz 80 dB minimum from 12 to 15 GHz 70 dB minimum from 15 to 20 GHz
Input power	
Average	1 W
Peak	50 W (10 µs max)
Switching time (max)	15 ms
Repeatability (max)	0.03 dB
Life (min)	5,000,000 cycles
RF Connectors	SMA (f)

Appendix C. Agilent microwave transfer switch specifications

Model	**87222C**
Configuration	4-Port
Features	Opto-electronic indicators and interrupts TTL/5V CMOS compatible Unterminated
Impedance	50 ohms
Frequency range	dc to 26.5 GHz
Insertion loss (dB)	0.2 dB + 0.025x frequency (GHz)
SWR	1.10 maximum dc to 2 GHz 1.15 maximum 2 to 4 GHz 1.25 maximum 4 to 12.4 GHz 1.40 maximum 12.4 to 20 GHz 1.65 maximum 20 to 26.5 GHz
Isolation (dB)	120 dB –2.0x frequency (GHz)
	80 dB minimum from 12 to 15 GHz 70 dB minimum from 15 to 20 GHz
Input power	
Average	1 W
Peak	50W
Switching time (max)	15 ms
Repeatability (max)	0.03 dB
Life (min)	5 million cycles
RF Connectors	SMA (f)

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For more detailed information about microwave switches and step attenuators, order related Agilent literature:

E8480A Technical Specifications
literature number: 5988-1408EN

E8481A Technical Specifications
literature number: 5988-1406EN

E8482A Technical Specifications
literature number: 5988-1407EN

E8483A Technical Specifications
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