High Voltage Power Supply Test

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1. Overview and Test Setup

Fig 1. Overview of high voltage power supply test stand

High voltage power supply does not have a local control. The device is software controlled via ethernet connection. Here is the IP address setting procedure to enable ethernet control:

1. Plug in the power cord to the crate，but do not turn on the power switch located on the front of the crate；

2. Use MUSEControl to establish communication:

Ignore the warning about no modules being found, go to system and click on configuration to set IP address.

3. Input the IP address in the lab VIEW interface and control the HV module.

If this is not done in this order, MUSEControl will not establish communication and the configuration will come back to its default settings.

High Voltage Module and Crate

Three High Voltage Modules were tested one by one. Only slot 1 (the second slot from the left) of Wiener crate was enabled and the module has to be inserted into this slot.

The EHS F6vvx)1–F is a 16-channel high voltage power supply module in 6U Eurocard format. The 16-channel module is added at two 8-channel modules, which are controlled independently of each other. The outputs RTN- floating GND - and HV of each channel are both floating against each other and against module GND. The EHS F6vvx)1–F is made to be mounted into a 19" crate. The powered system crate ECH xx8 (19" rack) carries up to 8 modules. It is also possible to supply the modules separately with the necessary power.

The modules we have tested are EHS F605P-F200, which have maximum output voltage 500V and maximum out current 15mA according to the ISEG manual EHSF6vvx_03_eng.

Fig 2. HV module

Breakout Box and SHV Cable

The breakout box made by Ralf Ehrlich and Jason Gran (University of Virginia) is connected with the HV module. The 16 output ports located on the back of the breakout box are connected to a load box via SHV cable.
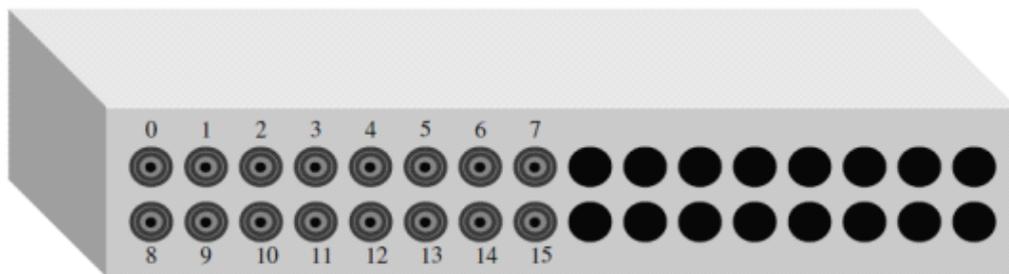
Fig 3. Back view of the breakout box

The SHV cable is a triaxial cable. The central wire is the source, the inner shell can float and the outer shell is grounded for safety.

High Voltage Load Box

The high voltage load box was made by Hank Connor at Fermi Lab. It has 7 optional resistor and the smallest one is 40 $k\Omega$, which was chose for the test. So the maximum test current we can have is 12.5mA. The outer shell of the breakout box is grounded.

The settings are shown in Fig 4. Press reset button after any changes, the red warning light will be turned on. The HV load box can also read the current and voltage, which might be inaccurate.
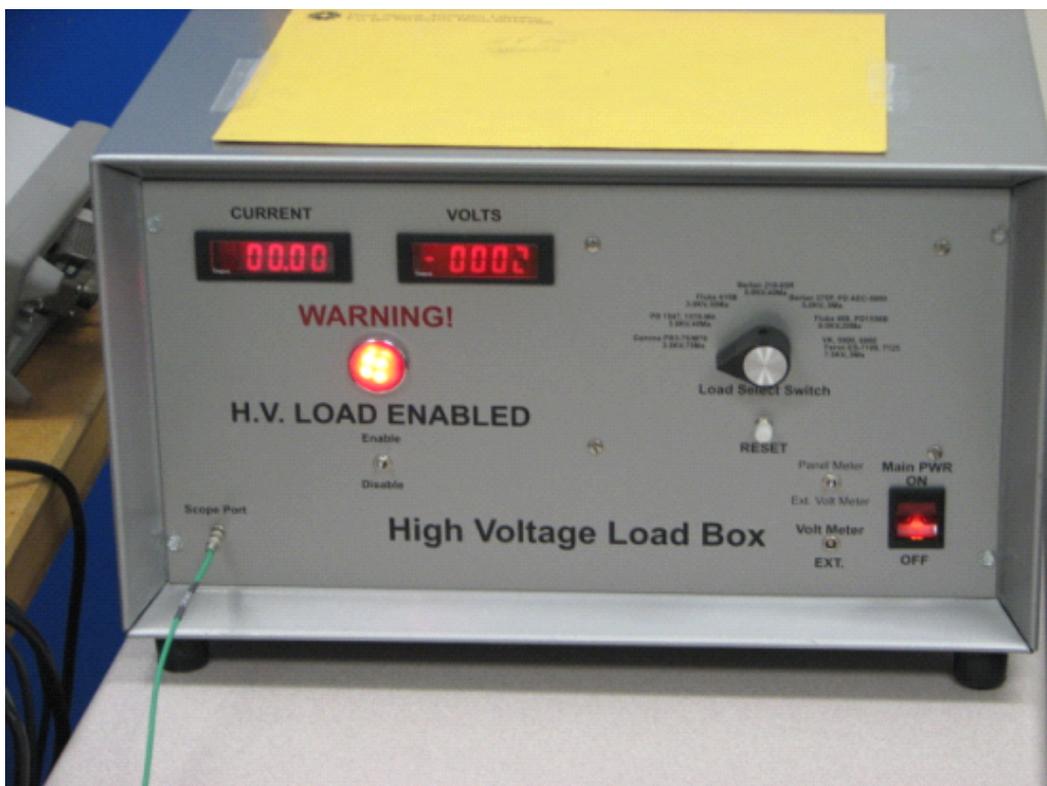
Fig 4. Front view of breakout box

Software Interface

The labVIEW 8.6 program named PL506_NOVA_Interface.vi was made for this test and future monitoring, which can monitor and control six low voltage power supplies and one high voltage module simultaneously.
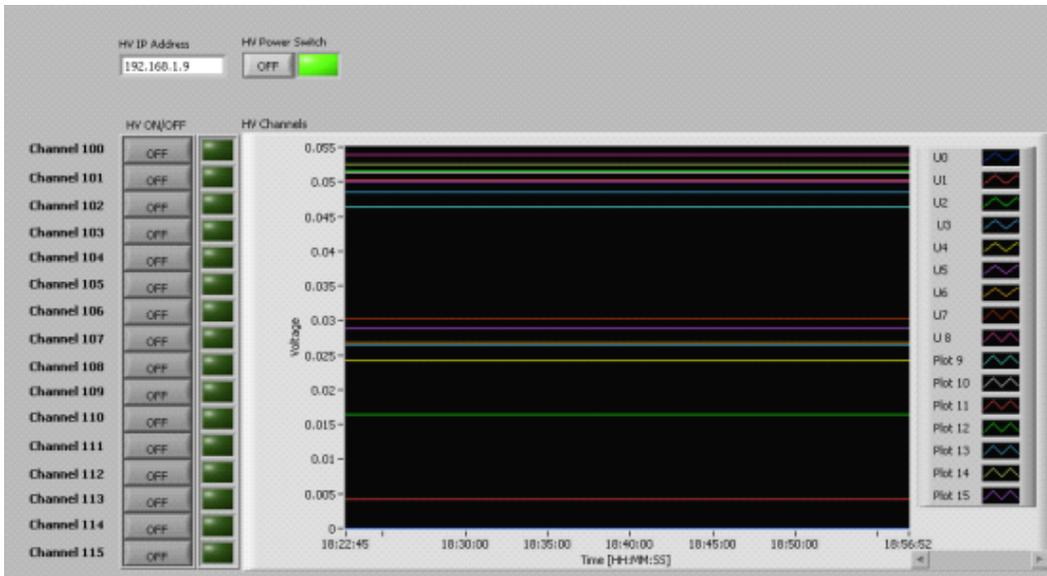
Fig 5. HV module monitoring interface

Since HV modules cannot be showed in MUSEControl Interface, configuration settings can only be done with labVIEW. For hardware protection, the output voltage of each channel cannot exceed 500V and the ramp speed cannot exceed 5V/s.

Voltage for each channel can also be set individually as shown in the Fig 6.
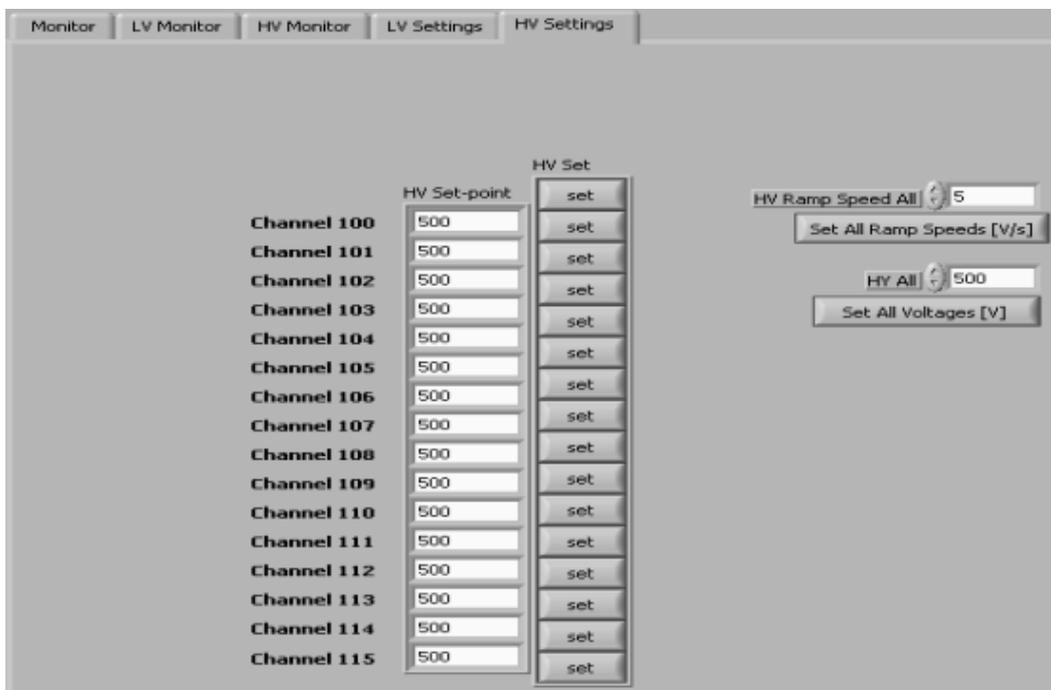
Fig 6. HV module setting interface

2. Test Process and Result

Every channel was turned on and tested one by one, the same procedure was repeated three times. Current and Voltage read by both labVIW interface and load box were recorded. Ripple and frequency were measured by NI- Scope supported by PXI-5152. The sequence of the tables is based on the order when they were measured.

Successful Ramp up of All Channels

Serial No. 74181				
Channel	Voltage by labview(V)	Voltage by load box(V)	Current by labview(mA)	Current by load box(mA)
0	500.0	490	12.51	12.5
1	500.0	491	12.51	12.5
2	500.0	490	12.51	12.5
3	500.0	489	12.51	12.5
4	500.0	490	12.51	12.5
5	500.0	490	12.51	12.5
6	500.0	490	12.51	12.5
7	500.0	491	12.51	12.5
8	500.0	489	12.51	12.5
9	500.0	489	12.51	12.5
10	500.0	489	12.51	12.5
11	500.0	490	12.51	12.5
12	500.0	489	12.51	12.5
13	500.0	490	12.51	12.5
14	500.0	490	12.51	12.5
15	500.0	489	12.51	12.5
All channels read 500.0V when they were turned on simultaneously.				

Table 1. Test result of module 74181

Serial No. 74179			
Channel	Voltage by labview(V)	Voltage by load box(V)	Current by labview(mA)	Current by load box(mA)
0	500.0	490	12.51	12.5
1	500.0	490	12.51	12.5
2	500.0	490	12.51	12.5
3	500.0	490	12.51	12.5
4	500.0	490	12.51	12.5
5	500.0	490	12.51	12.5
6	500.0	490	12.51	12.5
7	500.0	490	12.51	12.5
8	500.0	490	12.51	12.5
9	500.0	490	12.51	12.5
10	500.0	490	12.51	12.5
11	500.0	490	12.51	12.5
12	500.0	490	12.51	12.5
13	500.0	490	12.51	12.5
14	500.0	490	12.51	12.5
15	500.0	490	12.51	12.5
All channels read 500.0V when they were turned on simultaneously.				

Table 2. Test result of module 74179

Serial No. 74180			
Channel	Voltage by labview(V)	Voltage by load box(V)	Current by labview(mA)	Current by load box(mA)
0	500.0	490	12.51	12.5
1	500.0	490	12.51	12.5
2	500.0	489	12.51	12.5
3	500.0	490	12.51	12.5
4	500.0	489	12.51	12.5
5	500.0	491	12.51	12.5
6	500.0	491	12.51	12.5
7	500.0	490	12.51	12.5
8	500.0	490	12.51	12.5
9	500.0	492	12.51	12.5
10	500.0	488	12.51	12.5
11	500.0	490	12.51	12.5
12	500.0	490	12.51	12.5

13	500.0	489	12.51	12.5
14	500.0	490	12.51	12.5
15	500.0	490	12.51	12.5
All channels read 500.0V when they were turned on simultaneously.				

Table 3. Test result of module 74180

Ripple Measurement

NI-Scope Soft Front Panel was used for this part of test. Details information including ripple amplitude and switching frequency were recorded.
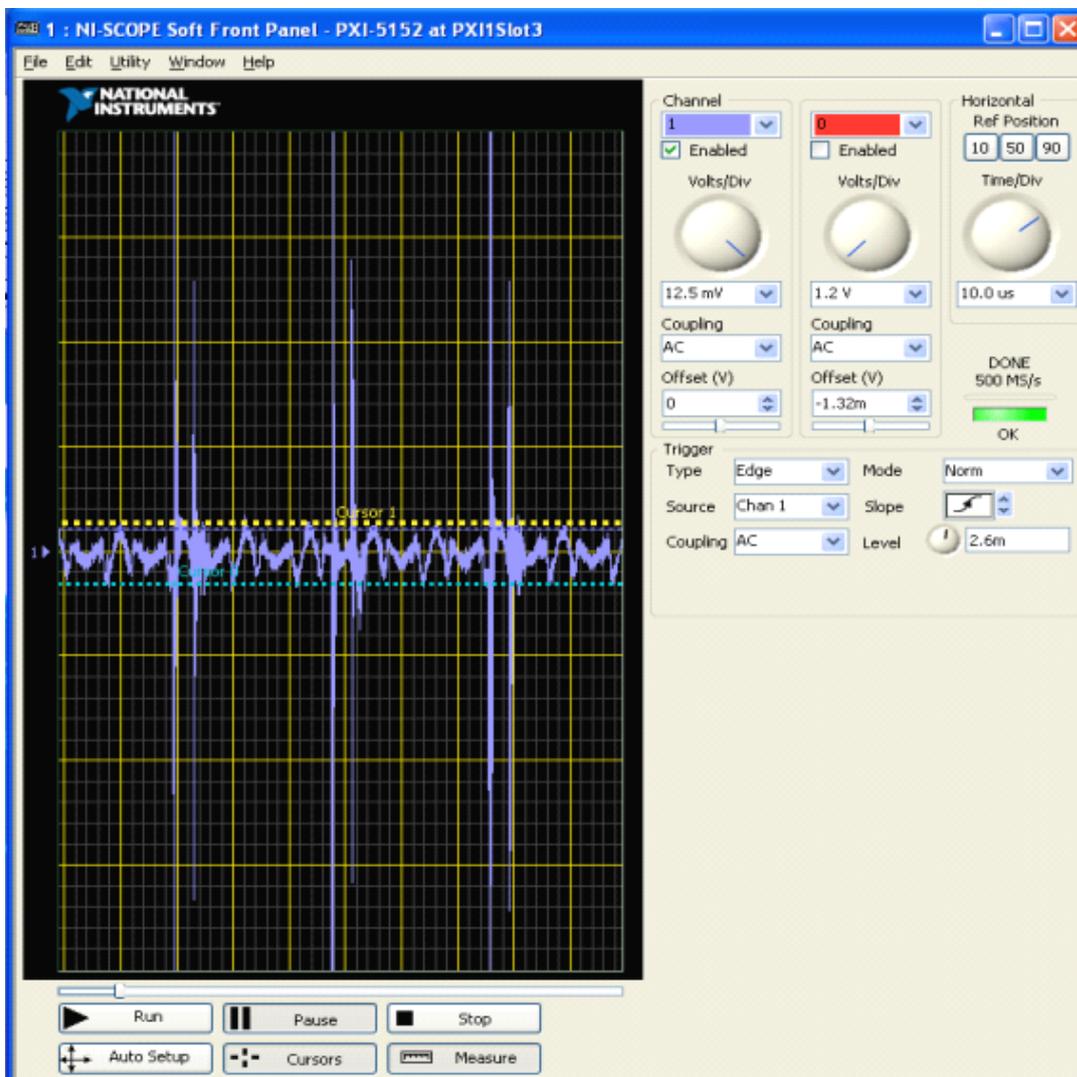
Fig 7. Software interface for ripple and switching frequency measurement

Serial No. 74180

Channel	Ripple(mV)	Switching Frequency(kHz)	Voltage Peak to Peak(mV)	Voltage RMS(mV)
0	3.05	35.81	86.37	4.54
1	3.13	35.81	105.27	4.08
2	3.21	36.15	98.40	4.32
3	3.13	36.15	73.48	3.90
4	2.65	36.15	70.47	4.41
5	2.89	35.81	87.66	4.32
6	2.65	35.14	100.55	4.77
7	3.21	35.14	81.64	3.85
8	3.13	35.81	99.69	4.64
9	3.21	35.14	87.23	3.75
10	3.29	35.81	95.82	4.24
11	4.09	35.14	90.23	3.87
12	3.45	36.50	109.57	4.65
13	3.85	34.50	89.38	4.37
14	3.29	36.15	103.55	4.32
15	2.89	35.14	107.85	4.82

Table 4. Ripple measurement of module 74180

Serial No. 74181

Channel	Ripple(mV)	Switching Frequency(kHz)	Voltage Peak to Peak(mV)	Voltage RMS(mV)
0	3.29	35.81	93.67	4.89
1	2.57	35.81	99.69	4.61
2	2.81	36.15	88.95	4.57
3	2.33	35.81	90.66	4.67
4	2.73	35.47	85.51	4.21
5	2.81	36.15	103.55	4.66
6	3.37	35.81	103.98	3.95
7	3.85	35.81	88.95	4.08
8	3.45	35.81	85.51	3.95
9	3.05	35.81	90.23	3.94
10	3.53	35.81	109.57	4.58
11	2.81	35.81	94.10	4.55
12	3.45	36.15	92.81	3.50
13	2.73	35.47	92.38	4.59
14	3.29	35.81	100.55	4.84
15	3.05	35.81	100.55	4.56

Table 5. Ripple measurement of module 74181

Channel	Ripple(mV)	Serial No. 74179 Switching Frequency(kHz)	Voltage Peak to Peak(mV)	Voltage RMS(mV)
0	3.13	36.15	98.68	4.10
1	2.89	35.81	91.52	4.32
2	2.81	35.81	109.57	4.18
3	2.65	35.47	91.95	4.01
4	3.29	35.81	93.24	3.44
5	2.73	35.81	93.40	4.90
6	3.13	35.81	109.57	4.65
7	3.13	35.14	91.09	4.49
8	2.73	36.15	103.12	4.55
9	2.73	35.14	109.57	4.36
10	3.53	35.14	94.96	4.52
11	3.53	35.81	81.64	4.01
12	3.13	35.81	109.57	4.56
13	3.21	35.47	88.95	4.15
14	2.81	36.15	107.85	4.51
15	3.21	36.15	92.38	4.13

Table 6. Ripple measurement of module 74179

3.   Problems

Breakout Box

The output port of channel 7 and 14 are loose, which makes it hard to hook the SHV cable and might cause danger. Fixing this highly recommended.

Cross Talk Between Channels

This problem was first discovered when testing channel 9 of module 74181. The behaviour of channel 0 to 8 were monitored when channel 9 was being ramped up.

As channel 9 was ramped up to 387V, the voltage of channel 6 began to increase obviously. When channel 9 reached 500.0V, channel 6 also reached its maximum value 0.314V.
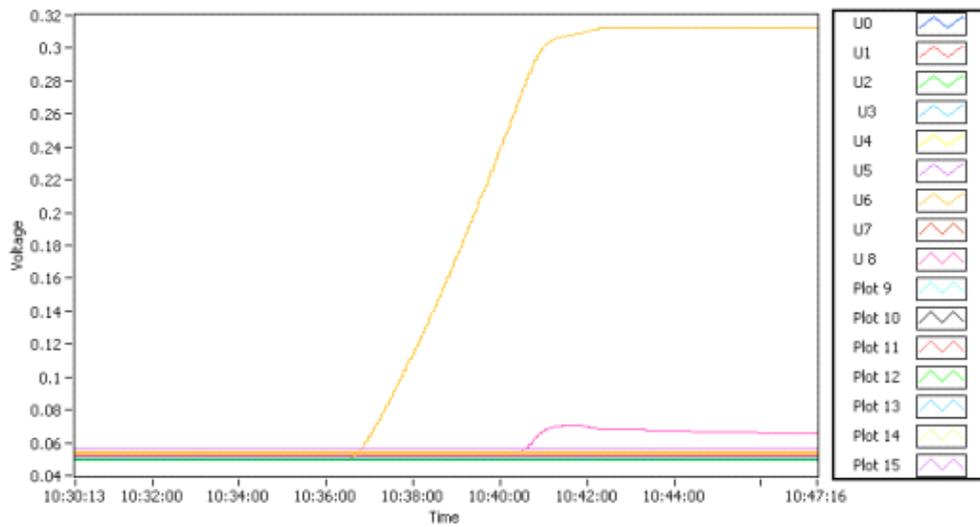
Fig 8. Cross talk between channels of module 74181

These channels are not very well isolated, which is not a serious problem though. Turning on all channels were tried for each module and voltage accuracy for every channel met the requirement as written in manual EHS86vvx_03_eng.pdf

Voltage Jump

This problem was discovered when testing channel 5 of module 74181. This also might be a problem of the HV module or just losing connection.
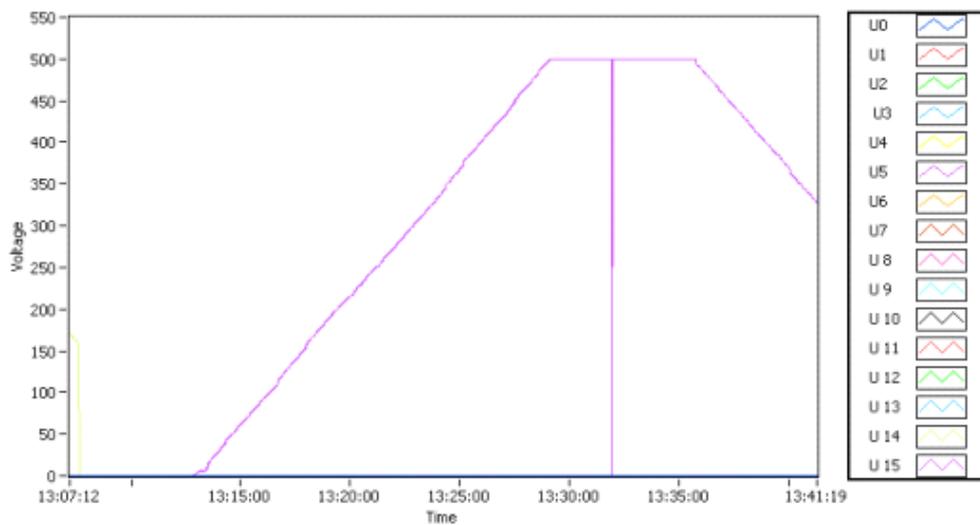
Fig 9. Voltage jump of channel 5 of module 74181