Testing of the High Voltage Cables to be Used for the Photomultiplier Tubes of the Neutral Particle Spectrometer in Hall C

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Forty high voltage cables were fabricated to provide ~1100 V to the photomultiplier tubes (PMTs) of the Hall C Neutral Particle Spectrometer (NPS). Quality control tests were conducted at 2000 V. This note describes the testing of the cables and the associated hardware and software development.

Figure 1 shows the high voltage connection schematic from a CAEN module to the PMTs connected to that module. Reference [1] gives details on how the connections are made and the voltage ratings of the cables and the components.

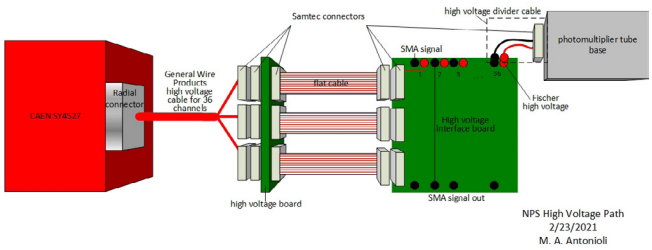


FIG 1. Connection schematic from CAEN high voltage crate to PMT base.

Each cable is ~140 ft. long, has 40 conductors, is terminated with a 52-pin Radiall connector on one end, Fig. 2, and three Samtec connectors on the opposite end, Fig. 3.

FIG. 2. Radiall 52-pin connector; unused sockets circled in red.

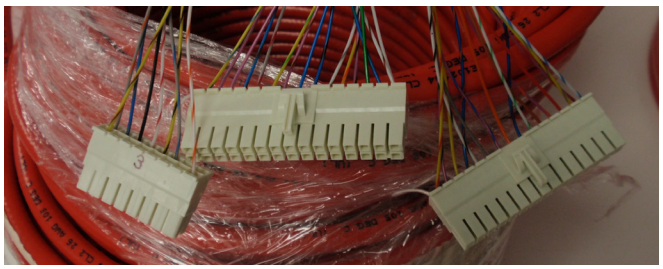


FIG 3. Six PMTs are powered by the small SAMTEC connector; each large one powers fifteen.

The 40 conductors (36 voltage conductors, three return wires, and one safety loop) of the high voltage cable are color-coded for identification, Fig. 4. Reference [2] provides fabrication and color code details.

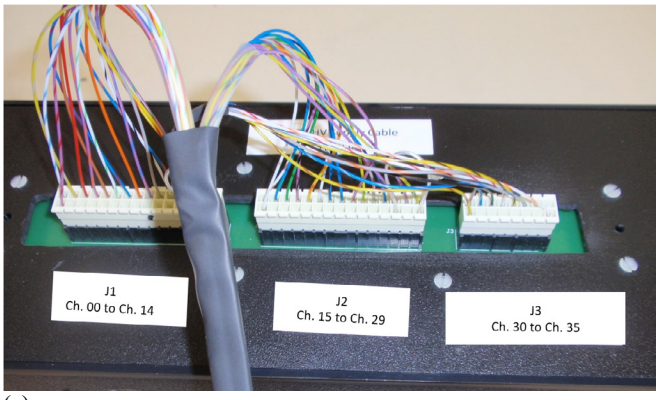
	Radiall 52		Samtec 1 (30pin)	Samtec 2 (30 pin)	Samtec 3 (16 pin)
Channel	Pin Number	Wire color	Pin Number		
HV00	43		30		
HV01	22		29		
HV02	1		28		
HV03	33		27		
HV04	12		26		
HV05	44		25		
HV06	23		24		
HV07	2		23		
HV08	34		22		
HV09	13		21		
HV10	45		20		
HV11	24		19		
HV12	3		18		
HV13	35		17		
HV14	14		16		
HV15	46			30	
HV16	25			29	
HV17	4			28	
HV18	36			27	
HV19	15			26	
HV20	47			25	
HV21	26			24	
HV22	5			23	
HV23	37			22	
HV24	16			21	
HV25	48			20	
HV26	27			19	
HV27	6			18	
HV28	38			17	
HV29	17			16	
HV30	49				16
HV31	28				15
HV32	7				14
HV33	39				13
HV34	18				12
HV35	50				11
Return	11			15	
Return	21				8
Return	32		15		
Safety Loop	42				1

FIG 4. Pinout of Radiall 52-pin and Samtec connectors.

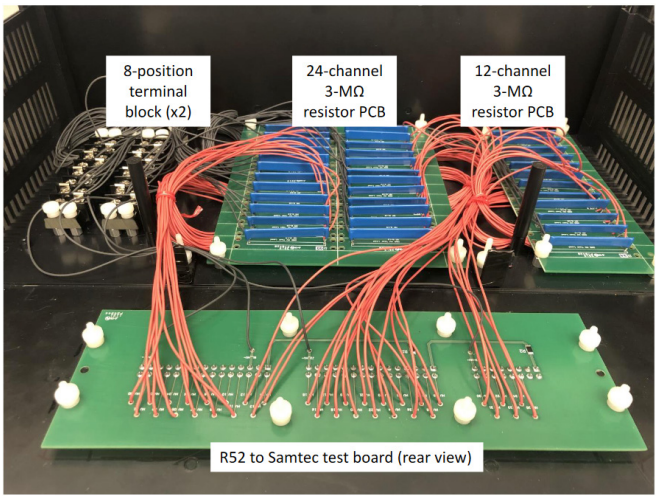
For the cable test, a load box was designed, fabricated, and populated with three PCBs—one with three, board-mount, SAMTEC connectors [3, 4, 5] and two with a total of thirty-six, 3-MΩ resistors [6], Fig. 5.

A 36-channel, CAEN A7030TN high voltage module, serial number 0326, positioned in slot 01 of the CAEN SY4527 mainframe, serial number 0400, supplied 2000 V, Fig. 6.

The flowchart, Fig. 7, shows the execution sequence of the Python program. The program requires the user to input the crate number and the slot number of the high voltage module. Six EPICS process variables are generated for each channel of the module and are set to the values shown in the flowchart.



(a)



(b)

FIG. 5. Load box. (a) Front panel, (b) internal view.

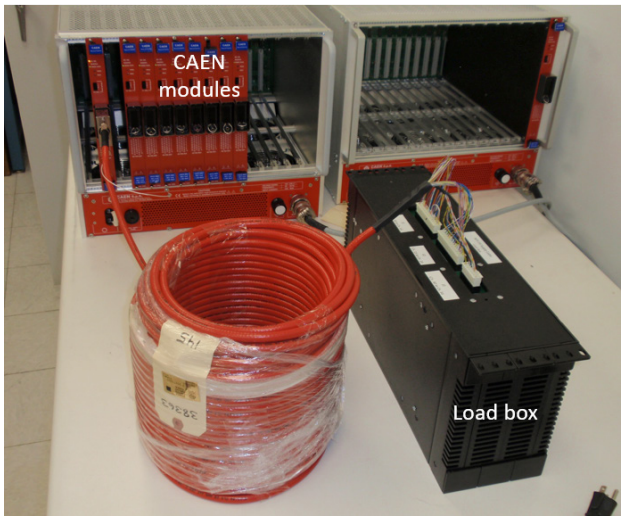


FIG. 6. High voltage cable test station.

The readback voltage, readback current, and status for each channel are logged using CAEN's proprietary software GECO 2020. The status parameter returns a bit number when channel events, such as ramp up or down, power on or off, or a channel trip, occur. Data are analyzed using a Python program, which plots the readback current for each channel.

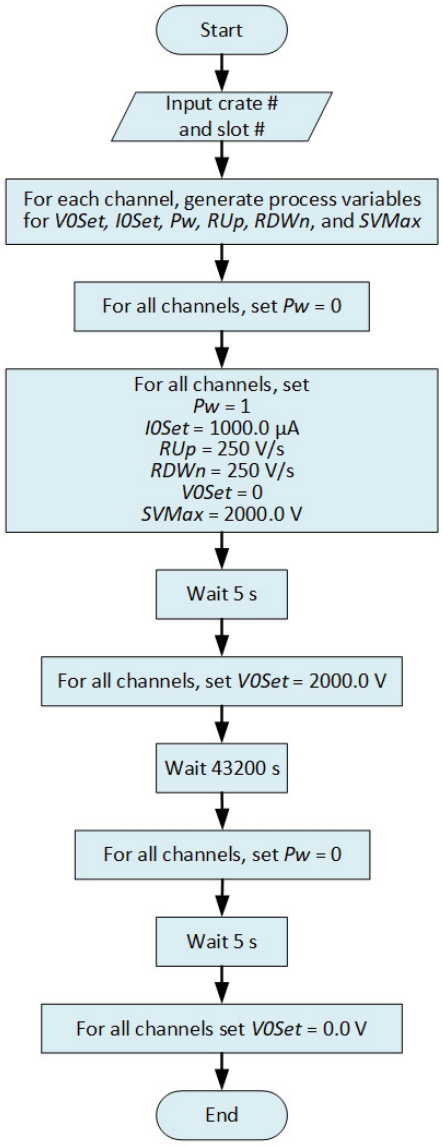


FIG. 7. Flowchart of *radiallTOsamtecTesting-longer.py.*

Figure 8 shows the readback current for cable #14. The readback current for all channels is around 683 µA, red line, which includes set and readback errors and the 1% tolerance for the resistors.

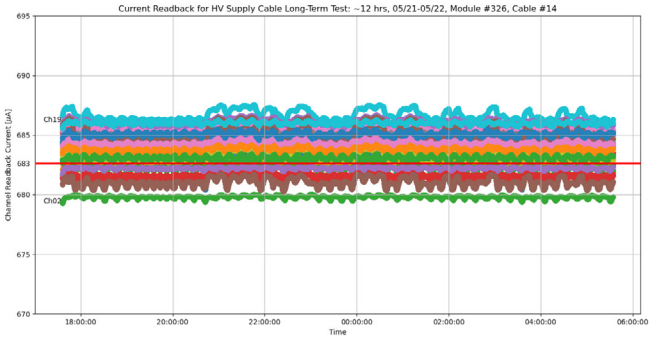


FIG. 8. Readback current for cable #14. Channels #2 and #19 have the lowest and highest currents, respectively. The red line at 683 µA is the expected current.

Tests showed that six cables had loose wires; the Radiall connector pins are prone to being unseated during connection/disconnection. The pins were reseated and the cables were retested.

To conclude, 40 high voltage supply cables were fabricated for the PMTs of the Neutral Particle Spectrometer. Hardware and software to test the cables were developed. None of the cables had electrical shorts.

[1] Aaron Brown et al., *DSG NPS Update*, DSG Talk 2020-25, 2020.

[2] Aaron Brown et al, *NPS Collaborators' Meeting DSG Update*, DSG Talk 2021-06, 2021.

[3] Marc McMullen et al., *Test Chassis for NPS High Voltage Supply Cables*, DSG Talk 2021-09, 2021.

[4] Aaron Brown et al., *DSG NPS Update*, DSG Talk 2021-13, 2021.

[5] Mindy Leffel, Marc McMullen, et al., *Chassis to Test NPS HV Supply Cable*, DSG Talk 2021-21, 2021.

[6] Ohmite, *Slim-Mox Precision Thick Film Planar*, Retrieved from https://www.ohmite.com/assets/docs/res_slimmox.pdf.