NIM-HV-PSU PRESENTATION

Vihtori Virta

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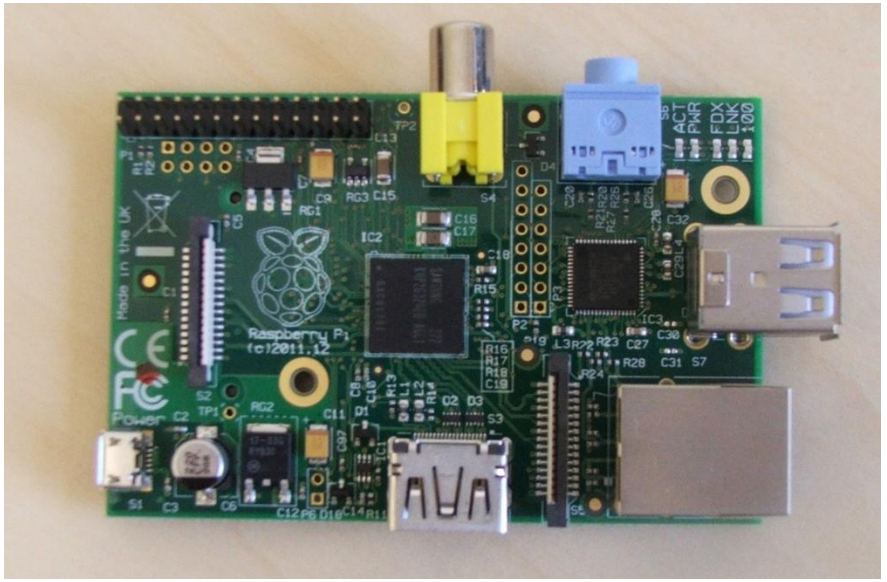
Content

- Display Board
- High Voltage Board
- 3D Model
- Mechanical Design
- What was learnt during the project

Display board

- Display board works as a user interface between:
  - Control unit (Raspberry Pi)
  - High Voltage Board



Regulator and Fuse

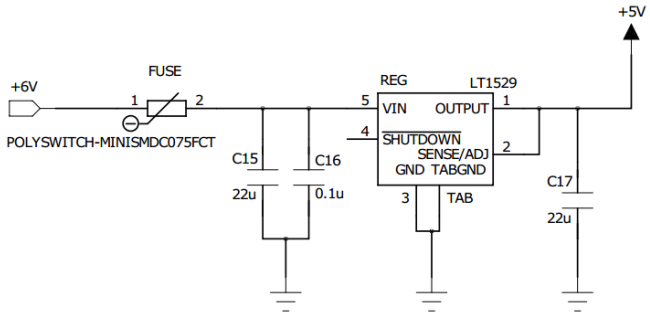
- Fuse / Polyswitch

Max Voltage	Max Current	Current-Hold	Current-Trip	R Min/Max	Time to Trip
13,2 V	100A	750mA (Max)	1,5A	0,110-0,450Ω	0,2s

- Regulator

Dropout Voltage	Output Current	Quiescent current
0,4 V at Iout = 1,5A	3A	50 µA

- Power dissipation
- (Vin-Vout)*Iout = (6V-5V)*1,5A = 1.5W



Power analysis

- Display Board

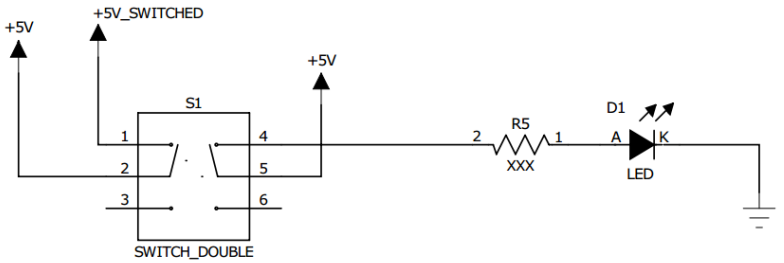
Component	Current Draw
Raspberry Pi	700-1000 mA
Display	330 mA (max)
DAC	1,3 mA
ADC	1,5 mA
Other components	<100 mA
Total (Worst Case)	~1450 mA

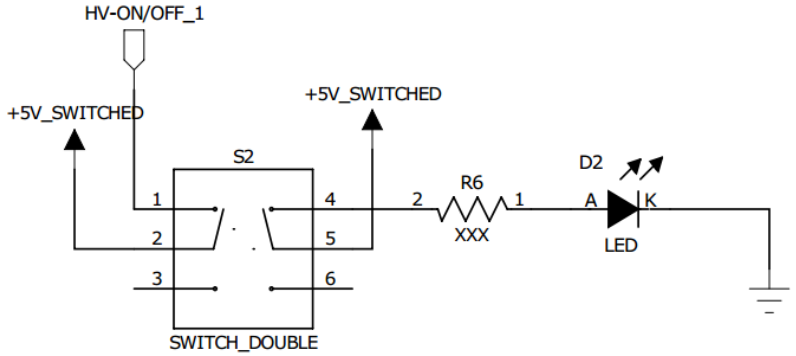
- HV Board

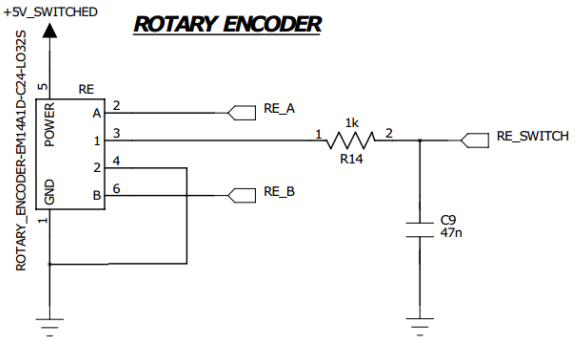
Component	Current Draw
Ultravolt AA modules	1350 mA with Full load and Max Eout

Switch and rotary encoder functionality

- "Top Switch"
  - Power on
  - LED indicates that PSU is on
- Other switches
  - HV channels on
  - LED indicates that the channel is on
- Rotary encoder
  - 2-bit quadrature code

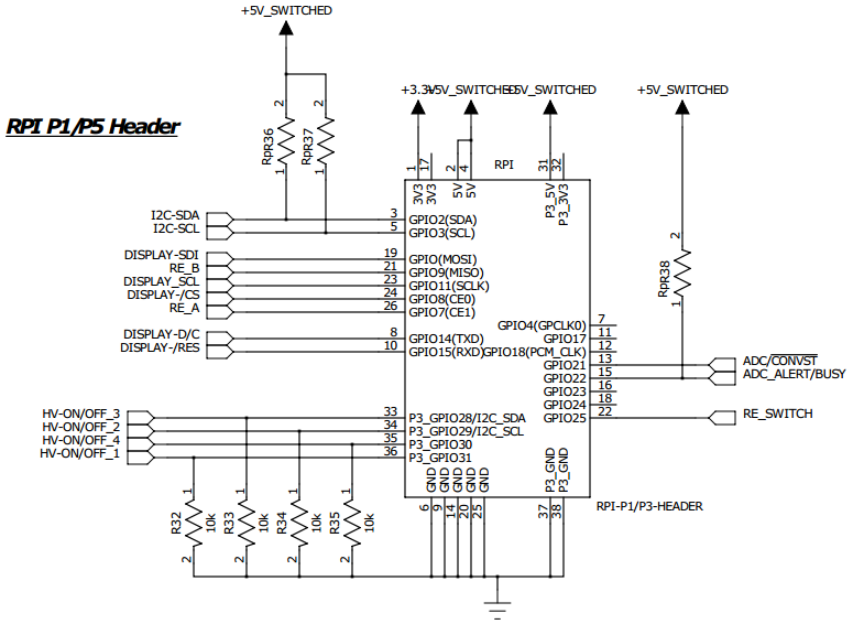




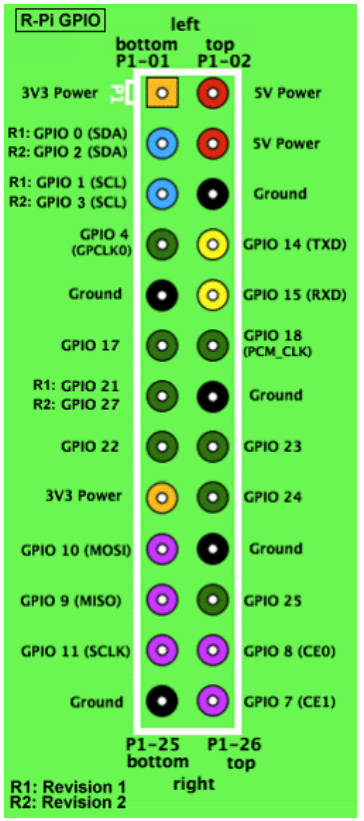


RPI Connection

- GPIO voltage levels are 3.3 V and are not 5 V tolerant.
- No over-voltage protection on the board

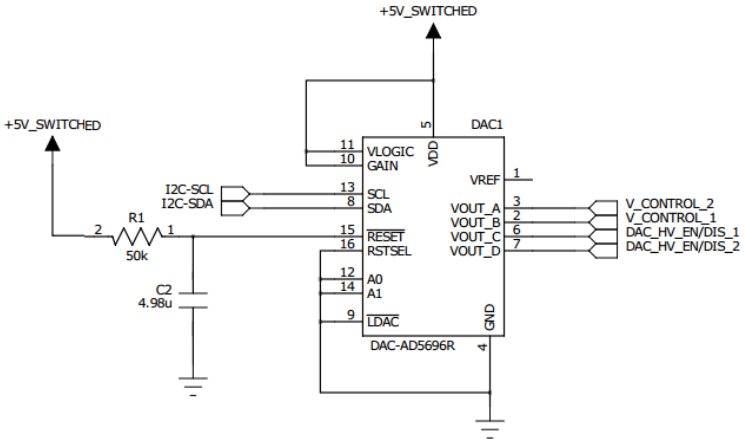


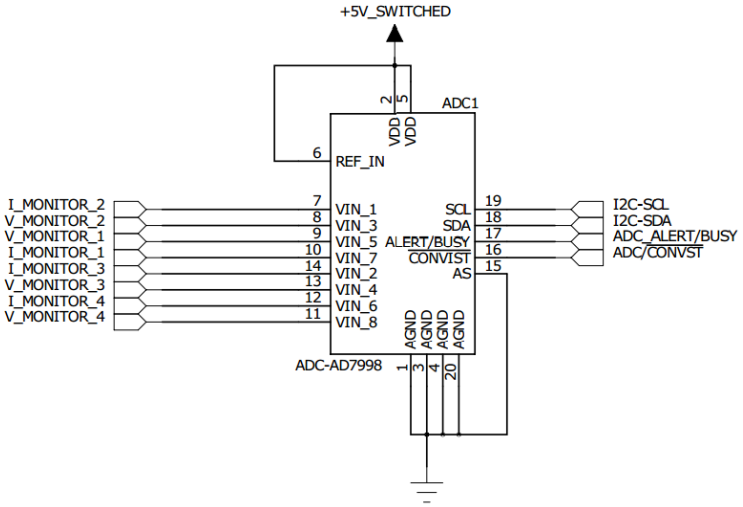
Pin Number	Pin Name Rev2
P5-01	5V0
P5-03	GPIO28
P5-05	GPIO30
P5-07	GND
P5-02	3.3 V
P5-04	GPIO29
P5-06	GPIO31
P5-08	GND



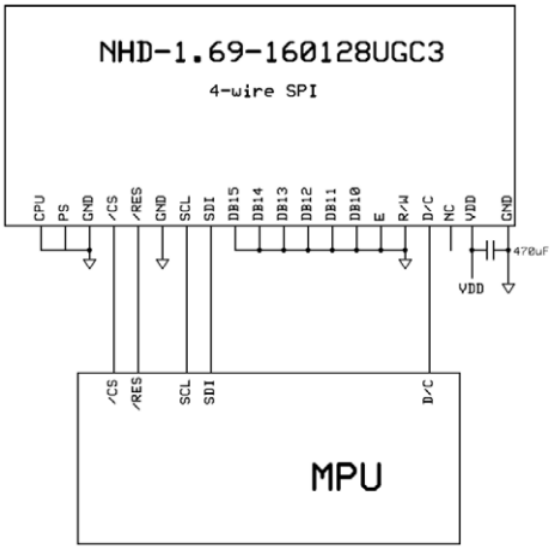
ADC and DAC Connection

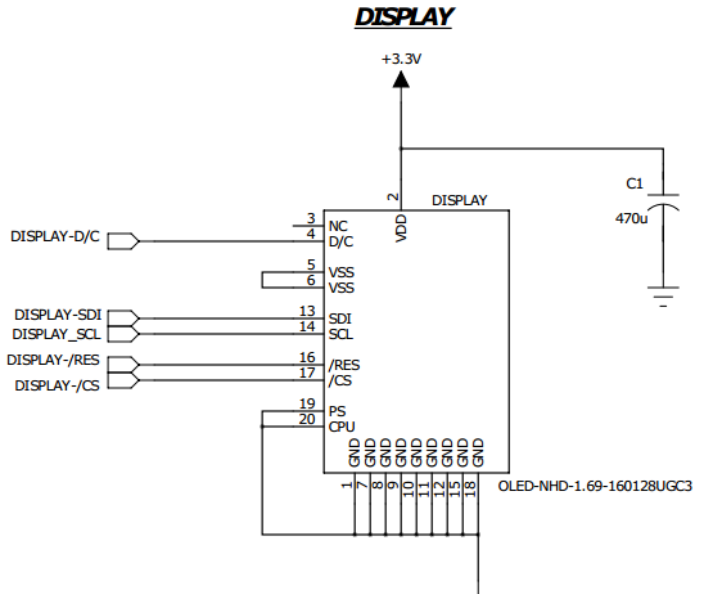
- DAC
  - Reset delay: 300 ms
  - To make sure that RPI wakes up first
- ADC
  - Reference pin must have 1µF and 0.1µF Capacitors





Display connection



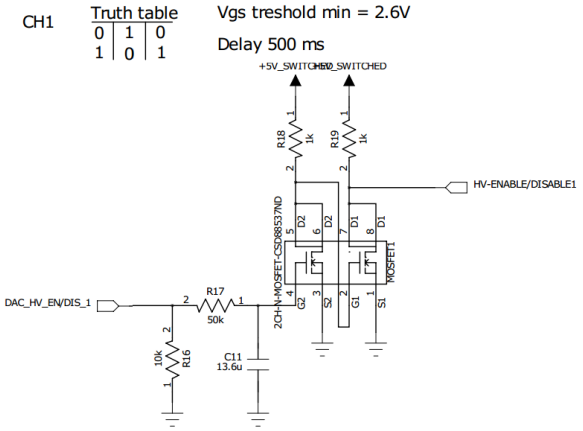


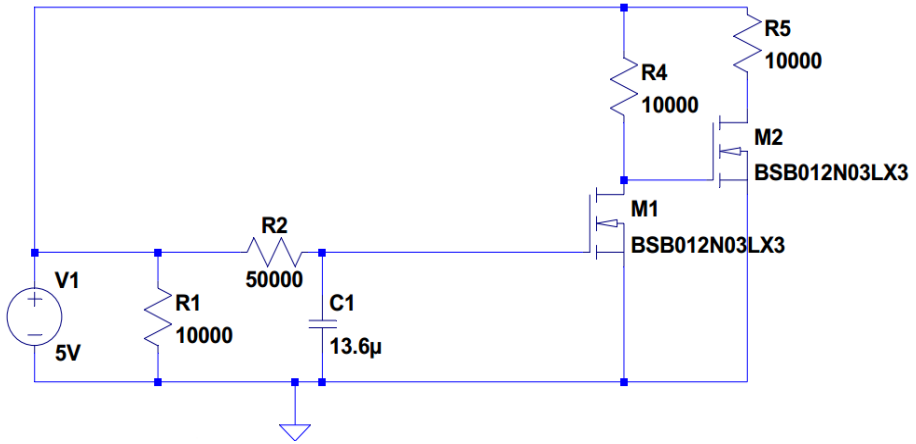
Serial Interface:

Pin No.	Symbol	External Connection	Function Description
1	GND	Power Supply	Ground
2	VDD	Power Supply	Supply Voltage for OLED and logic.
3	NC	-	No Connect
4	D/C	MPU	Register select signal. D/C=0: Command, D/C=1: Data Tie LOW for 3-wire Serial Interface.
5-6	VSS	Power Supply	Ground
7-12	GND	Power Supply	Ground
13	SDI	MPU	Serial Data Input signal.
14	SCL	MPU	Serial Clock signal.
15	GND	Power Supply	Ground
16	/RES	MPU	Active LOW Reset signal.
17	/CS	MPU	Active LOW Chip Select signal.
18	GND	Power Supply	Ground
19	PS	MPU	Parallel/Serial select. HIGH: Parallel. LOW: Serial
20	CPU	MPU	Interface select. HIGH: 6800 interface. LOW: 8080 interface

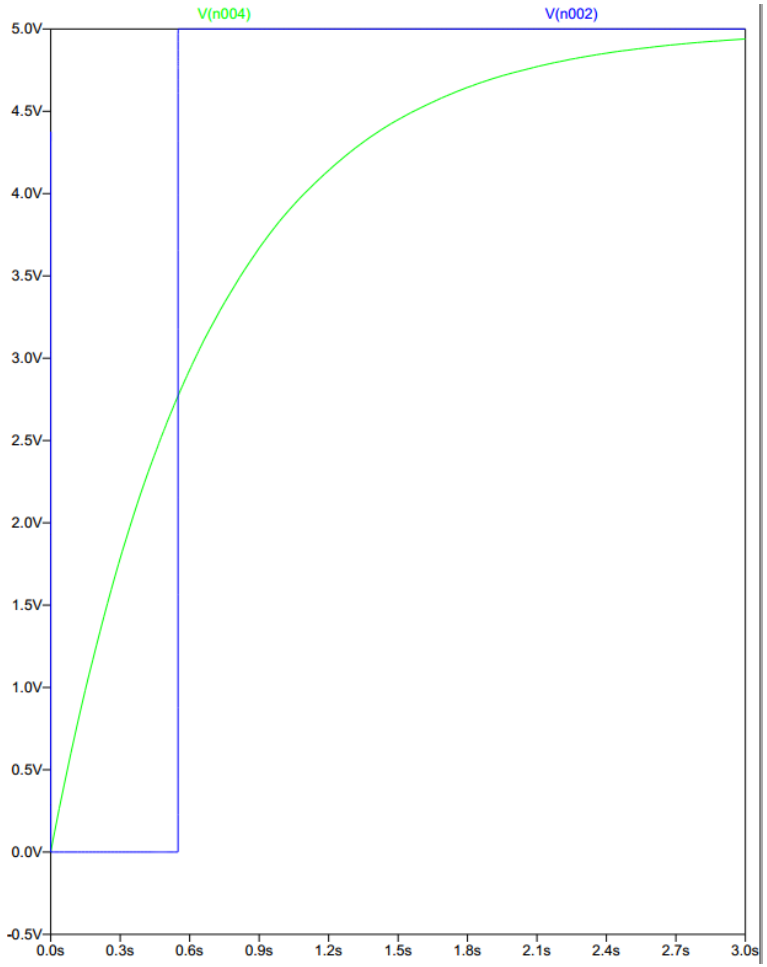
Delay circuit for HV EN/DIS pin

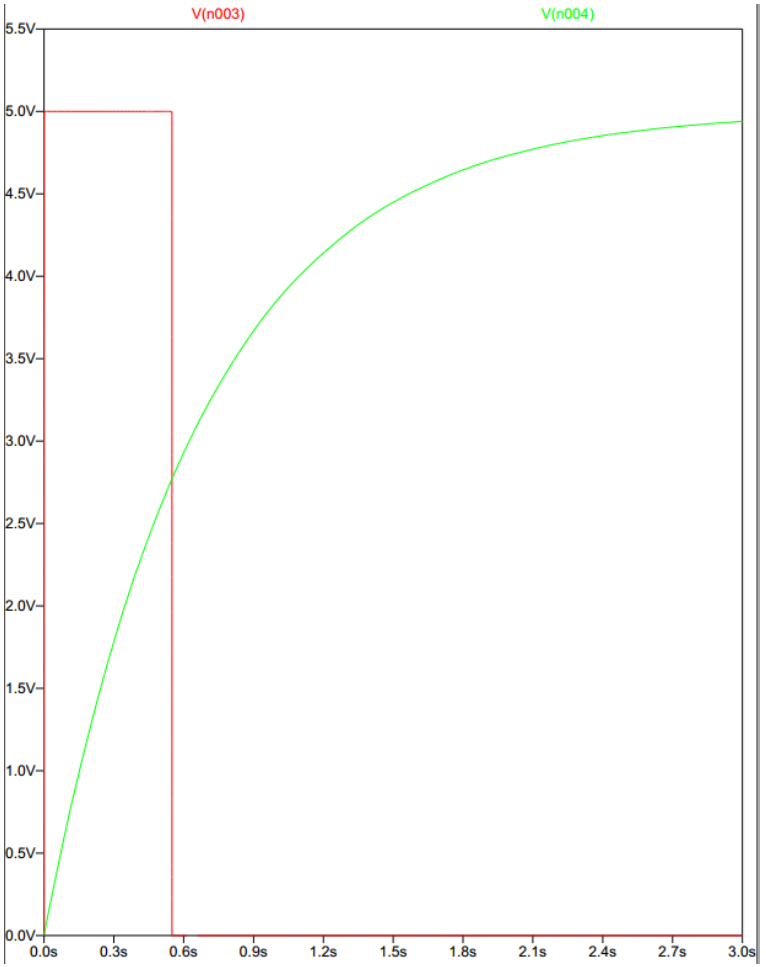
- 500ms delay circuit to make sure that the HV modules wakes up at the disabled state
- Simulations are done with the FET with different threshold voltage and thus is slightly incorrect





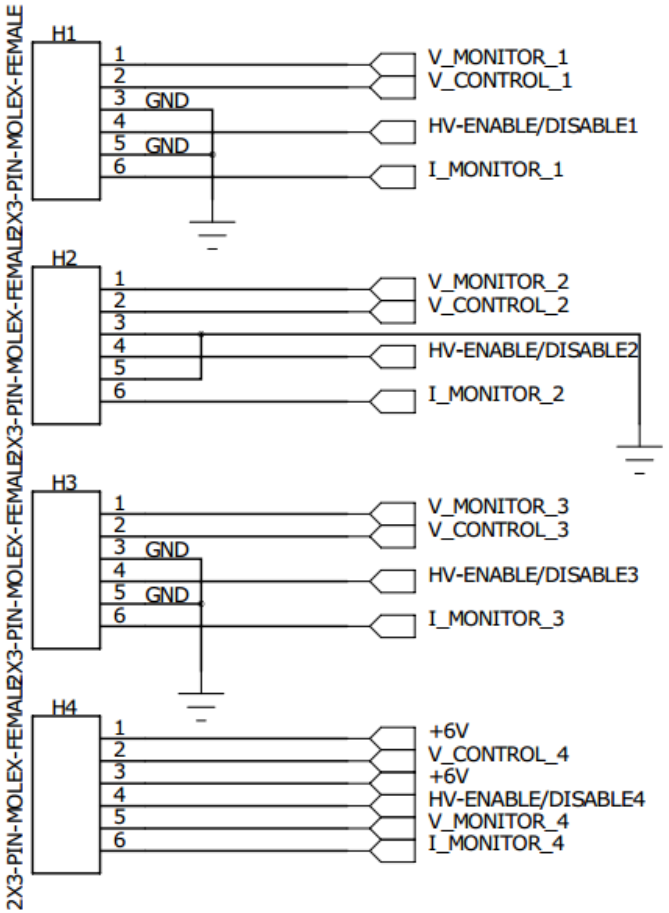
Simulation result



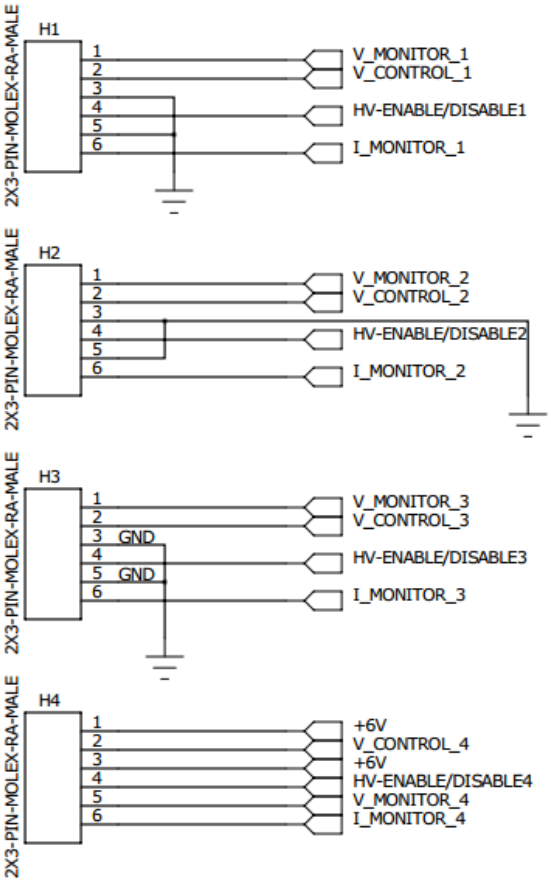


Connector comparison

- Display Board



- HV Board



Display Board – Bill of Materials

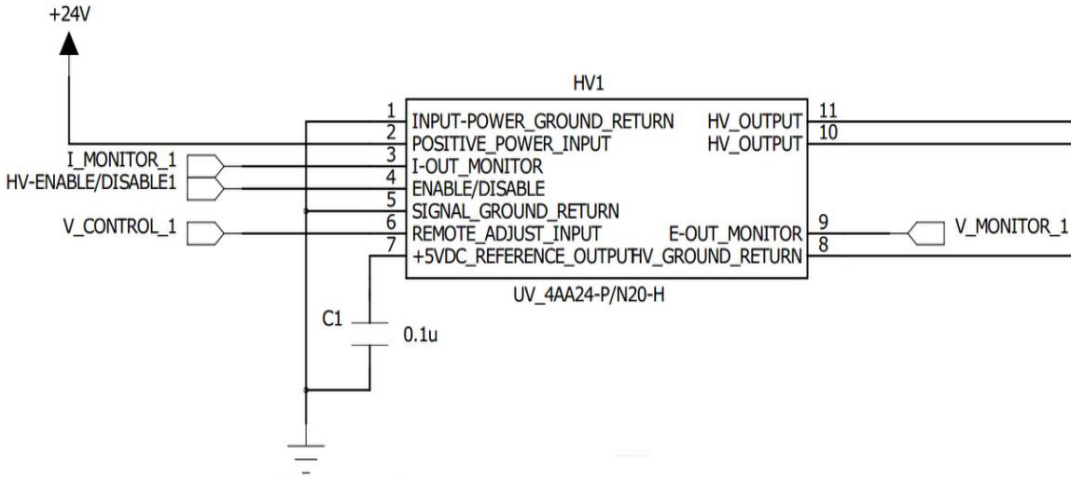
Part	Part Number	Quantity	Datasheet	Price
Display	NHD-1.69-160128UGC3-ND (Digikey)	1	http://www.newhavendisplay.com/specs/NHD-1.69-160128UGC3.pdf	$28,5
ADC	AD7998	1	http://www.analog.com/static/imported-files/data_sheets/AD7997_7998.pdf	$8,62
DAC	AD5696R	2	http://www.analog.com/en/digital-to-analog-converters/da-converters/ad5696r/products/product.html	$17,24
FET	CSD8853/296-37303-1-ND (digikey)	2	http://www.ti.com/lit/ds/symlink/csd88537nd.pdf	$1,72
Polyswitch	MINISMDC075FCT	1		$0,31
Regulator	LT1529CQ-5#PBF	1	http://cds.linear.com/docs/en/datasheet/1529fb.pdf	$7,41
Toggle Switch	7201SYWQE	5	http://datasheet.octopart.com/7201SYWQE-C%26K-Components-datasheet-11046592.pdf	$7,77
Rotary encoder	Bourns EM14	1	http://www.bourns.com/pdfs/em14.pdf	$30,56
Board Connector	WM17736-ND (Digikey)	4	http://www.molex.com/pdm_docs/sd/015247043_sd.pdf	$1,67

High Voltage Board

- High Voltage Board has the High Voltage components

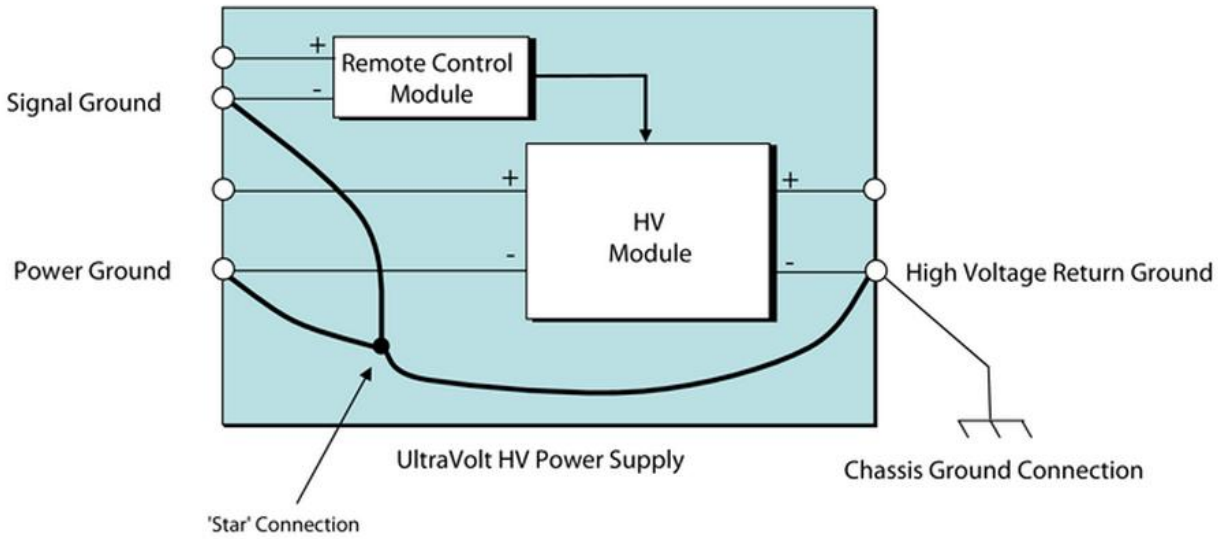
Pin Routing / Configuration

CONNECTIONS	
PIN	FUNCTION
1	Input-Power Ground Return
2	Positive Power Input
3	Iout Monitor
4	Enable/Disable
5	Signal Ground Return
6	Remote Adjust Input
7	+5VDC Reference Output
8	HV Ground Return
9	Eout Monitor
10 & 11	HV Output



Grounding

- Module has 3 different grounds:
  - Signal Ground
  - Power Ground
  - High Voltage Return Ground
- All Grounds are tied together inside the module



Power Problems

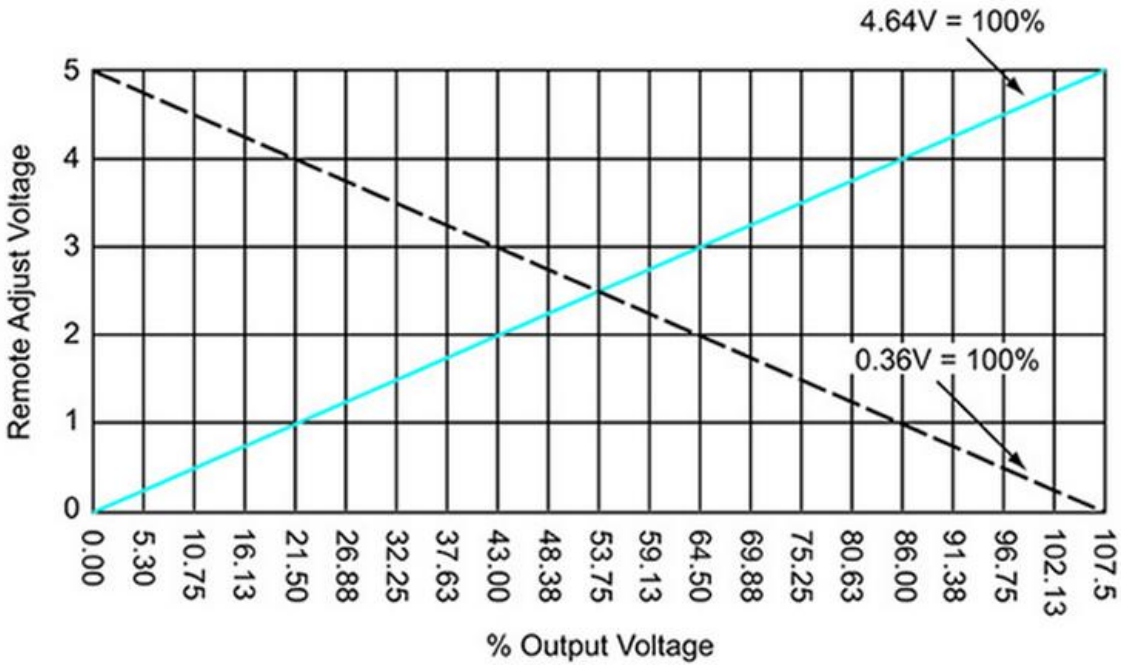
- The power supply for power supply can provide 1,5 A for 24V line
- If all 4 channels are in use together with full load and max Eout, the total current draw is 5.4 A

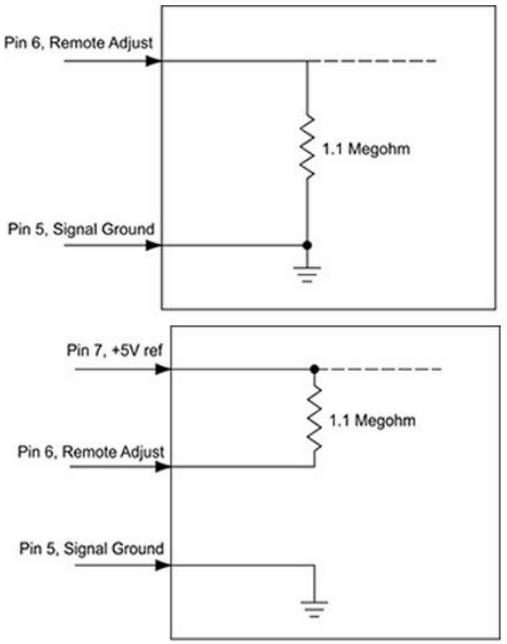
Solution

- The PMT's needs only 2000V (max) to work
- Therefore the total current draw will be 2,7A
- Not still enough
  - Only 2 Channels will be used with this main power supply

Voltage controlling

- Voltage can be controlled from 0% to 107.5%
  - Positive supplies are scaled so that 4.64V = 100%
  - Negative supplies are scaled so that 5V = 0%
- A 1.1MΩ resistor pull up provides zero output voltage if the control pin is left open



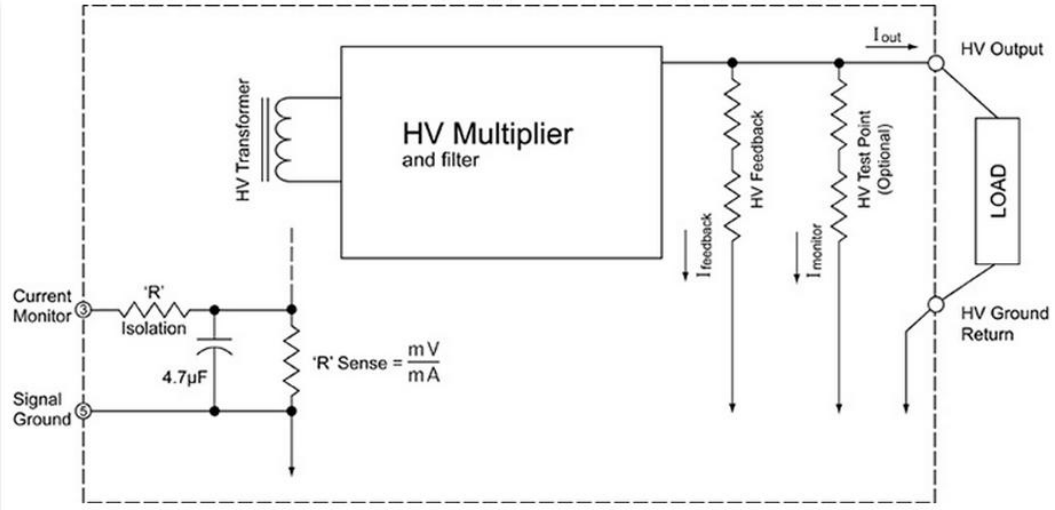


Voltage monitoring

- Is accomplished with a high-voltage divider resistor set
- The divider resistor set is designed to be properly scaled with a 10MΩ input-impedance meter connected to the circuit

Current monitoring

- The HV Multiplier in each high-voltage power supply is grounded through the R_{Sense} resistor
- Current scale factor is 0,752 mA/V
- Positive supplies has negative current-monitor voltage and vise versa with negative supplies
- Low output Impedance: 1-22Ω
  - Buffer?



HV Board Bill of Materials

Part	Part Number	Quantity	Datasheet	Price
Ultravolt Positive HV-Module	4AA24-P20-H	2	http://www.ultravolt.com/uv_docs/AASeriesDS.pdf	$514
Ultravolt Negative HV-Module	4AA24-N20-H	2	http://www.ultravolt.com/application_notes/TN-2.pdf	$514
Board Connector	WM17723-ND (Digikey)	4	http://www.molex.com/pdm_docs/sd/015246180_sd.pdf	$1,78
Power connector	WM18446-ND (Digikey)	1	http://www.molex.com/pdm_docs/sd/039303035_sd.pdf	$0,89

What still has to be done

- Can get rid of one DAC
  - The HV Enable/ Disable pins should be connected directly to the GPIO pins
- Pull up resistors has to be moved closer to the receiving pins.
  - Also more pull up resistors
- Buffers for the low impedance current-monitor path
- Current compensation in code

What is learnt during this Project

- HTML and CSS Web designing
  - The project page was the first one I used HTML
- AutoCAD 2D mechanical designing tool
- Autodesk Inventor 3D mechanical designing tool
- Circuit designing
- What not to do in next design ☺