TESTING AND REVISION

MIE 346 - ASSIGNMENT 4
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NAME	STUDENT NUMBER
KARAN RAIKUNDALIA	1004742727
KEVON SEECHAN	1004941708

University of Toronto

Section A

1.0 Choice and Justification of Selected Power Supply Technique

When designing the power supply circuitry, the following order was used to prioritize various design parameters:

- Efficiency
- Switching Frequency - Complexity of PCB layout
- Peak-to-Peak Ripple Voltage
- Cost / Number of Parts
- Size

The circuitry design selected initially uses a boost circuit to generate a +18 DC Voltage. This is the voltage connected to the positive power supply rail but is also inputted to an inverting converter to produce the -18 DC Voltage which is connected to the negative power supply rail.

Justification for the selected method (relative to using adaptor voltage as the input to two separate circuits):

- Higher Efficiency Ratings Obtainable (Top Priority)
    - Wide range of circuitry options with efficiencies greater than 90%
    - When using a 9V-18V DC input to generate a -18V DC output, the majority of efficiencies obtainable were below 90%. The small range of circuits with efficiencies greater than 90% were significantly more expensive.
- Lower Switching Frequencies
    - Switching frequencies less than 100kHz ensures minimal complexity in the PCB layout.
    - Lower switching frequencies did not compromise the cost or efficiency greatly.
- Lower Peak-to-Peak Ripple Voltages
    - Circuitry converting +18V DC to -18V DC had ripple voltages on the scale of 1mV

1.2 Choice and Justification of Selected Circuits

9V - 18V DC Input, +18V DC Output:

The selected circuit utilized a wide-input range boost controller to generate the desired output voltage. The justification for its selection, presented below, is based off the order of priority for various design elements (see section 1.1):

- 93.2% Steady-State Efficiency
    - The high efficiency ensures a minimal amount of input power is wasted as dissipated heat
    - Although high efficiencies often result in design complexity and added cost, this circuit was less expensive than other circuits with similar efficiency levels. The total BOM was $1.51 USD
- 49.67kHz switching frequency
    - Low switching frequency results in less complexity in the PCB layout
    - Minimal compromise in Efficiency (93.2%) and BOM cost ($1.51 USD)
- 119.16mV peak-to-peak ripple voltage
    - Lowest peak-to-peak ripple voltage for given circuit efficiency.

- BOM cost of $1.51 USD
    - A relatively low BOM cost for a circuit with 21 BOM components. Thus, a high efficiency was achievable without significant rise in expense.

18V - 18V DC Input, -18V DC Output:
This selected design is an inverting buck boost circuit that utilizes a step-down voltage converter. The justification for its selection, presented below, is based off the order of priority for various design elements (see section 1.1):

- 93.3% Steady-State Efficiency
    - The high efficiency ensures a minimal amount of input power is wasted as dissipated heat
- 500kHz switching frequency
    - The switching frequency, slightly higher relative to other circuits, was a necessary compromise to achieve the high level of steady-state efficiency (93.3%). Lower switching frequencies resulted in an approximate 9% drop in steady-state efficiency. This was deemed unacceptable as the top-priority was to maximize this attribute.
- 1.73mV peak-to-peak ripple voltage
    - Low ripple voltage ensures narrow range of DC output and less wasted power
- BOM Count of 16 / BOM Cost of $2.77
    - Relative to other circuits with a similar function, the selected design utilized a lower number of components to achieve a far greater efficiency (93.3%).
    - The low BOM count reduced design complexity without limiting the performance of the circuit against the top-priority goals above.
    - A slightly more expensive BOM was accommodated for to ensure strong performances in the top-priority design goals. Less expensive circuits exhibited efficiencies of approximately 84% - a weak performance against the first design goal.

1.3 Total Bill of Materials (BOM)

INPUT STAGE (A)

Manufacturer/ Supplier Part Number	Quantity	Unit Cost	Website Link	Part Description	Schematic Reference
CFR-25JB-52-9M1 (0.094"" Dia x 0.248"" L (2.40mm x 6.30mm)	1	$0.15	https://www.digikey.ca/en/products/detail/yageo/CFR-25JB-52-9M1/131201	9.1 MOhms ±5% 0.25W, 1/4W Through Hole Resistor Axial Carbon Film	R1X
CF14JT1M00 (0.091"" Dia x 0.236"" L (2.30mm x 6.00mm)	1	$0.15	https://www.digikey.ca/en/products/detail/stackpole-electronics-inc/CF	1 MOhms ±5% 0.25W, 1/4W Through Hole Resistor Axial	R10X

			14JT1M00/1741316	Flame Retardant Coating, Safety Carbon Film	
CF14JT1K00 (0.091"" Dia x 0.236"" L (2.30mm x 6.00mm)	1	$0.15	https://www.digikey.ca/en/products/detail/stackpole-electronics-inc/CF14JT1K00/1741314	1 kOhms ±5% 0.25W, 1/4W Through Hole Resistor Axial Flame Retardant Coating, Safety Carbon Film	R7

Manufacturer/ Supplier Part Number	**Quantity**	**Unit Cost**	**Website Link**	**Part Description**	**Schematic Reference**
CF14JT47K0 (0.091"" Dia x 0.236"" L (2.30mm x 6.00mm))	1	$0.15	https://www.digikey.ca/en/products/detail/stackpole-electronics-inc/CF14JT47K0/1741444	47 kOhms ±5% 0.25W, 1/4W Through Hole Resistor Axial Flame Retardant Coating, Safety Carbon Film	R4
CFR-25JB-52-18K (0.094"" Dia x 0.248"" L (2.40mm x 6.30mm))	2	$0.15	https://www.digikey.ca/en/products/detail/yageo/CFR-25JB-52-18K/590	18 kOhms ±5% 0.25W, 1/4W Through Hole Resistor Axial Carbon Film	R1, R5
CF14JT6K20 (0.091"" Dia x 0.236"" L (2.30mm x 6.00mm))	1	$0.15	https://www.digikey.ca/en/products/detail/stackpole-electronics-inc/CF14JT6K20/1741472	6.2 kOhms ±5% 0.25W, 1/4W Through Hole Resistor Axial Flame Retardant Coating,	R2

				Safety Carbon Film	
CF14JT9K10 (0.091"" Dia x 0.236"" L (2.30mm x 6.00mm))	1	$0.15	https://www.digikey.ca/en/products/detail/stackpole-electronics-inc/CF14JT9K10/1741522	9.1 kOhms±5% 0.25W, 1/4W Through Hole Resistor Axial Flame Retardant Coating, Safety Carbon Film	R3
S200K25SL0N63L6R (Size - 0.256"" Dia (6.50mm)) (Lead Spacing - 0.252""(6.40mm))	1	$0.50	https://www.digikey.ca/en/products/detail/vishay-beyschlag-draloric-bc-components/S200K25SL0N63L6R/2356801	20pF ±10% 1000V (1kV) Ceramic Capacitor SL Radial, Disc	CIN

Manufacturer/ Supplier Part Number	**Quantity**	**Unit Cost**	**Website Link**	**Part Description**	**Schematic Reference**
TL084IN	1	$1.56	https://www.digikey.ca/en/products/detail/texas-instruments/TL084IN/378408	J-FET Amplifier 4 Circuit 14-PDIP	LM324
227161-6	1	$4.79	https://www.digikey.ca/en/products/detail/te-connectivity-amp-connectors/227161-6/287915	CONN BNC JACK R/A 50 OHM PCB	Input Connector
GF-123-0054	2	$1.73	https://www.digikey.ca/en/products/detail/cw-industries/GF-123-0054/4089770	SWITCH SLIDE SPST 8.5A 125V - Through Hole	1X/10X SPST AC/DC-Coupling SPST

PARTS FOR LOW PASS FILTER (B):

Manufacturer/ Supplier Part Number	Quantity	Unit Cost	Website Link	Part Description	Schematic Reference
CF14JT13K0	1	$0.14	https://www.digikey.ca/en/products/detail/stackpole-electronics-inc/CF14JT13K0/1741289	±5% 0.25W, 1/4W Through Hole Resistor Axial Flame Retardant Coating, Safety Carbon Film	R10
CF14JT330K	1	$0.14	https://www.digikey.ca/en/products/detail/stackpole-electronics-inc/CF14JT330K/1741401	±5% 0.25W, 1/4W Through Hole Resistor Axial Flame Retardant Coating, Safety Carbon Film	R11
CF14JT100K	2	$0.14	https://www.digikey.ca/en/products/detail/stackpole-electronics-inc/CF14JT100K/1741263	±5% 0.25W, 1/4W Through Hole Resistor Axial Flame Retardant Coating, Safety Carbon Film	R12 R13
C410C560K3G5TA7200 0.095" Dia x 0.170" L (2.41mm x 4.32mm)	1	$0.13540	https://www.digikey.ca/en/products/detail/kemet/C410C560K3G5TA7200/6688767	CAP CER 56PF 25V C0G/NP0 AXIAL	C3
C410C561K3G5TA7200 0.095" Dia x 0.170" L (2.41mm x 4.32mm)	1	$0.13540	https://www.digikey.ca/en/products/detail/kemet/C410C561K3G5TA7200/6688791	CAP CER 560PF 25V C0G/NP0 AXIAL	C2
C410C180K3G5TA7200	1	$0.13540	https://www.digikey.ca/en/products/detail/	CAP CER 18PF 25V C0G/NP0	C4

0.095" Dia x 0.170" L (2.41mm x 4.32mm)			kemet/C410C180K3G5TA7200/6688755	AXIAL	
C410C331K3G5TA7200 0.095" Dia x 0.170" L (2.41mm x 4.32mm)	1	$0.13540	https://www.digikey.ca/en/products/detail/kemet/C410C331K3G5TA7200/6688785	±10% 25V Ceramic Capacitor C0G, NP0 Axial	C5
ADA4062-2BRZ	1	$5.48	https://www.digikey.ca/en/products/detail/analog-devices-inc/ADA4062-2BRZ/1979394	J-FET Amplifier Circuit - 8-SOIC	U1

PARTS FOR INPUT PROTECTION (C):

Manufacturer/ Supplier Part Number	**Quantity**	**Unit Cost**	**Website Link**	**Part Description**	**Schematic Reference**
1N5817G	2	$0.52	https://www.digikey.ca/en/products/detail/on-semiconductor/1N5817G/1474208	Diode Schottky 1A Through Hole Axial	D1 D2
CF1/4C822J	1	$0.14	https://www.digikey.ca/en/products/detail/koa-speer-electronics-inc/CF1-4C822J/13537354	±5% 0.25W, 1/4W Through Hole Resistor Axial Flame Retardant Coating, Moisture Resistant, Safety Carbon Film	R6
CF1/4CT52R150J	2	$0.14	https://www.digikey.ca/en/products/detail/koa-speer-electronics-inc/CF1-4CT52R150J/13537520	±5% 0.25W, 1/4W Through Hole Resistor Axial Flame Retardant Coating,	R8 R9

				Moisture Resistant, Safety Carbon Film	

PARTS FOR OUTPUT PROTECTION (D):

Manufacturer/ Supplier Part Number	Quantity	Unit Cost	Website Link	Part Description	Schematic Reference
SB140E-G	2	$1.28	https://www.digikey.ca/en/products/detail/diodes-incorporated/SBR12A45SD1-T/3451505	Diode Super Barrier 12A Through Hole DO-201AD	D3 D4
CF14JT2K00	1	$0.14	https://www.digikey.ca/en/products/detail/stackpole-electronics-inc/CF14JT2K00/1741368	±5% 0.25W, 1/4W Through Hole Resistor Axial Flame Retardant Coating, Safety Carbon Film	R14

PARTS FOR POWER SUPPLY (E):

9V - 18V DC Input, +18V DC Output

Manufacturer/ Supplier Part Number	Quantity	Unit Cost	Website Link	Part Description	Schematic Reference
TMK212BJ474KD-T 0.079" L x 0.049" W (2.00mm x 1.25mm)	1	$0.20	https://www.digikey.ca/en/products/detail/taiyo-yuden/TMK212BJ474KD-T/930642?s=N4IgTCBcDaICoFkDSYCMYBCApALAdhyQBEBaOEAXQF8g	CAP CER 0.47UF 25V X5R 0805	C13
CL21C331JBANNNC 0.079" L x 0.049" W (2.00mm x 1.25mm)	1	$0.14	https://www.digikey.ca/en/products/detail/samsung-electro-mechanics/	CAP CER 330PF 50V C0G/NP0 0805	C14

			CL21C331JBANNNC/3886847?s=N4IgTCBcDaIMIBkwEY4GY3IFICECCAckXCALoC%2BQA		
CL21C122JBFNNNE 0.079" L x 0.049" W (2.00mm x 1.25mm)	1	$0.13	https://www.digikey.ca/en/products/detail/samsung-electro-mechanics/CL21C122JBFNNNE/3888644?s=N4IgTCBcDaIMIBkwEY7LGAUgIQGIDlCBREAXQF8g	CAP CER 1200PF 50V C0G/NP0 0805	C20
UUD1V101MNL1GS 0.327" L x 0.327" W (8.30mm x 8.30mm)	1	$0.40	https://www.digikey.ca/en/products/detail/nichicon/UUD1V101MNL1GS/590031?s=N4IgTCBcDaIKpwCIEYBqyAMyCyA5AMsgOIDKIAugL5A	CAP ALUM 100UF 20% 35V SMD	C21
GRM155R71A823KA01D 0.039" L x 0.020" W (1.00mm x 0.50mm)	1	$0.016	https://www.digikey.ca/en/products/detail/murata-electronics/GRM155R71A823KA01D/2610888?s=N4IgTCBcDaIOICUCyBGArGhB2FBBAHGAMwDSuADCgCIgC6AvkA	CAP CER 0.082UF 10V X7R 0402	C15
NPI105C151MTRF 10.4 x 9.4 x 5.8	1	$0.24	https://www.avnet.com/shop/us/products/nic-components/npi105c151mtrf-3074457	Ind Power Unshielded Wirewound 150uH 20% 1KHz 780mA T/R	IND1

			345626589772 /		
RC0201FR-7D68K1L Height: 0.23 mm Length: 0.6 mm Width: 0.3 mm	1	$0.17	https://eu.mouser.com/ProductDetail/Yageo/RC0201FR-7D68K1L/?qs=MLItCLRbWszLUZGL%2FmzFeg%3D%3D	Thick Film Resistors - SMD 68.1kOhms 1/20W 0201 1%	R25
CRCW04021K00FKED 0.039" L x 0.020" W (1.00mm x 0.50mm)	1	$0.06	https://www.digikey.ca/en/products/detail/vishay-dale/CRCW04021K00FKED/1178007	RES SMD 1K OHM 1% 1/16W 0402	R19
ERJ-L03UF75MV 0.063" L x 0.031" W (1.60mm x 0.80mm)	1	$0.13	https://www.digikey.ca/en/products/detail/panasonic-electronic-components/ERJ-L03UF75MV/966108?s=N4IgTCBcDaIKICUBSBaAMgBgMwFUBiA7AKwCyAaiALoC%2BQA	RES 0.075 OHM 1% 1/5W 0603	R20
C0805C105K4RACTU 0.079" L x 0.049" W (2.00mm x 1.25mm)	1	$0.03	https://www.digikey.ca/en/products/detail/kemet/C0805C105K4RACTU/416047?s=N4IgTCBcDaIMIAYAcCCscCMaDSAWASgIJwAqAqiALoC%2BQA	CAP CER 1UF 16V X7R 0805	C16
C2012C0G1H272J060AA 0.079" L x 0.049" W (2.00mm x 1.25mm)	1	$0.12	https://www.digikey.ca/en/products/detail/tdk-corporation/C2012C0G1H272J060AA/	CAP CER 2700PF 50V C0G 0805	C17

			2732943?s=N4IgTCBcDaIMJgAwEYx0QcWQCTAdjAClEA2RAQXJAF0BfIA		
EEE-FK1E330P 0.260" L x 0.260" W (6.60mm x 6.60mm)	1	$0.17	https://www.digikey.ca/en/products/detail/panasonic-electronic-components/EEE-FK1E330P/765970?s=N4IgTCBcDaIKIILQDEDSBGOBmLAGACiALoC%2BQA	CAP ALUM 33UF 20% 25V SMD	C22
GRM1555C1H511GA01D 0.039" L x 0.020" W (1.00mm x 0.50mm)	1	$0.17	https://www.digikey.ca/en/products/detail/murata-electronics/GRM1555C1H511GA01D/2544096?s=N4IgTCBcDaIOICUCyBGArBgwigEmlKcAggAwoAiIAugL5A	CAP CER 510PF 50V C0G/NP0 0402	C18
SS14FL-TP Case: DO-221AC-2	1	$0.35	https://www.mouser.ca/ProductDetail/Micro-Commercial-Components-MCC/SS14FL-TP?qs=7UaJ5Mrpeu0EqKpAEo5Wsw%3D%3D	DIODE SCHOTTKY 40V 1A SOD123F	D5
CSD17571Q2 6-WDFN Exposed Pad	1	$0.56	https://www.digikey.ca/en/products/detail/texas-instruments/CSD17571Q2/4494685	MOSFET N-CH 30V 22A 6SON	M1
CRCW040244R2FKED 0.039" L x 0.020" W	1	$0.06	https://www.digikey.ca/en/products/detail/	RES SMD 44.2 OHM 1% 1/16W	R21

(1.00mm x 0.50mm)			vishay-dale/CRCW040244R2FKED/1177852	0402	
RC0201FR-07866KL 0.024" L x 0.012" W (0.60mm x 0.30mm)	1	$0.06	https://www.digikey.ca/en/products/detail/yageo/RC0201FR-07866KL/5280683?s=N4IgTCBcDaIEoGEAMYkEYBicC0SDsAHAGxEDSAMiALoC%2BQA	RES SMD 866K OHM 1% 1/20W 0201	R22
TPS40211DGQR 10-TFSOP, 10-MSOP (0.118", 3.00mm Width) Exposed Pad	1	$2.41	https://www.digikey.ca/en/products/detail/texas-instruments/TPS40211DGQR/1907867?s=N4IgTCBcDaICoAUDKAWADGAjJgIgcQEUAlEAXQF8g	IC REG CTRLR MULT TOP 10MSOP	U3
RC0603FR-07680RL 0.063" L x 0.031" W (1.60mm x 0.80mm)	1	$0.04	https://www.digikey.ca/en/products/detail/yageo/RC0603FR-07680RL/727355?s=N4IgTCBcDaIEoGEAMA2JBmAYnAtEg7CgBxJwAyIAugL5A	RES SMD 680 OHM 1% 1/10W 0603	R24
CRCW040246K4FKED 0.039" L x 0.020" W (1.00mm x 0.50mm)	1	$0.06	https://www.digikey.ca/en/products/detail/vishay-dale/CRCW040246K4FKED/1178196	RES SMD 46.4K OHM 1% 1/16W 0402	R23
GRM21BR61E106MA73L 0.079" L x 0.049" W (2.00mm x 1.25mm)	1	$0.36	https://www.digikey.ca/en/products/detail/murata-electro	CAP CER 10UF 25V X5R 0805	C19

			nics/GRM21BR61E106MA73L/4905533?s=N4IgTCBcDaIOICUCyYCMAhBA2VBRVADFkgIIDsAzADIgC6AvkA		

18V - 18V DC Input, -18V DC Output

Manufacturer/ Supplier Part Number	Quantity	Unit Cost	Website Link	Part Description	Schematic Reference
SDR0403-680KL 0.177" L x 0.157" W (4.50mm x 4.00mm)	1	$0.67	https://www.digikey.ca/en/products/detail/bourns-inc/SDR0403-680KL/1970307?s=N4IgTCBcDaIMoBEBKAGALCgzAWgGwA4UBpAGRAF0BfIA	FIXED IND 68UH 460MA 1.12OHM SMD	L1
GRM155R60J474KE19D 0.039" L x 0.020" W (1.00mm x 0.50mm)	1	$0.08	https://www.digikey.ca/en/products/detail/murata-electronics/GRM155R60J474KE19D/702530?s=N4IgTCBcDaIOICUCyBGArGhA2ADAKQBYB2AgaQFEUBOAERAF0BfIA	CAP CER 0.47UF 6.3V X5R 0402	C6
CRCW040260K4FKED 0.039" L x 0.020" W (1.00mm x 0.50mm)	1	$0.06	https://www.digikey.ca/en/products/detail/vishay-dale/CRCW040260K4FKED/1178210	RES SMD 60.4K OHM 1% 1/16W 0402	R15
LM43601PWPR	1	$3.42	https://www.digikey.ca/en/products/detail/texas-instruments/LM43601	IC REG BUCK ADJ 1A 16HTSSOP	IC2

			PWPR/4965739?s=N4IgTCBcDaIDIFkAsBmAbABgIwAUDqOASiALoC%2BQA		
EEE-FK1E330UR 0.209" L x 0.209" W (5.30mm x 5.30mm)	1	$0.15	https://www.digikey.ca/en/products/detail/panasonic-electronic-components/EEE-FK1E330UR/765971?s=N4IgTCBcDaIKIILQDEDSBGOBmLAGAqgEogC6AvkA	CAP ALUM 33UF 20% 25V SMD	C7
CL32B106KBJNNWE 0.126" L x 0.098" W (3.20mm x 2.50mm)	1	$0.48	https://www.digikey.ca/en/products/detail/samsung-electro-mechanics/CL32B106KBJNNWE/3889046?s=N4IgTCBcDaIMIBkDMYBCBGADANgNKoCkA5IgdQFEQBdAXyA	CAP CER 10UF 50V X7R 1210	C8
CRCW04021M00FKED 0.039" L x 0.020" W (1.00mm x 0.50mm)	1	$0.06	https://www.digikey.ca/en/products/detail/vishay-dale/CRCW04021M00FKED/1178349	RES SMD 1M OHM 1% 1/16W 0402	R16
C2012X6S1H475K125AC 0.079" L x 0.049" W (2.00mm x 1.25mm)	1	$0.34	https://www.digikey.ca/en/products/detail/tdk-corporation/C2012X6S1H475K125AC/2733034?s=N4IgTCBcDaIMJgAwEYwA0BsBlZAJALAOwCsA0qsQIJwgC6Avk	CAP CER 4.7UF 50V X6S 0805	C9

			A		
EMK212BJ225KG-T 0.079" L x 0.049" W (2.00mm x 1.25mm)	1	$0.10	https://www.digikey.ca/en/products/detail/taiyo-yuden/EMK212BJ225KG-T/930645?s=N4IgTCBcDaIKIFkDSYCMYBCApMYCsSA4gLQAqIAugL5A	CAP CER 2.2UF 16V X5R 0805	C10
C0805C151J5GACTU 0.079" L x 0.049" W (2.00mm x 1.25mm)	1	$0.10	https://www.digikey.ca/en/products/detail/kemet/C0805C151J5GACTU/411124?s=N4IgTCBcDaIMIAYAcCCscCMqMClUHEBBOAFQFUQBdAXyA	CAP CER 150PF 50V C0G/NP0 0805	C11
C1608X5R1V475K080AC 0.063" L x 0.031" W (1.60mm x 0.80mm)	1	$0.32	https://www.digikey.ca/en/products/detail/tdk-corporation/C1608X5R1V475K080AC/3648577?s=N4IgTCBcDaIMIEYBsAGAHADQKwCUEDUAWAdiwGl0UBBOEAXQF8g	CAP CER 4.7UF 35V X5R 0603	C12

LED AND INPUT COMPONENTS

Manufacturer/ Supplier Part Number	Quantity	Unit Cost	Website Link	Part Description	Schematic Reference
XLVG12D	1	$0.49	https://www.digikey.ca/en/products/detail/sunled/XLVG12D/13559302	5MM GREEN LED	LED1
CF14JT1K00 (0.091"" Dia x 0.236"" L	1	$0.15	https://www.digikey.ca/en/products/detail/s	1 kOhms ±5% 0.25W, 1/4W	R26

(2.30mm x 6.00mm)			tackpole-electronics-inc/CF14JT1K00/1741314	Through Hole Resistor Axial Flame Retardant Coating, Safety Carbon Film	
1812L050PR	1	$0.67	https://www.digikey.ca/en/products/detail/littelfuse-inc/1812L050PR/267849	PTC RESET FUSE 15V 500MA 1812	F1, Fuse
GF-123-0054	1	$1.73	https://www.digikey.ca/en/products/detail/cw-industries/GF-123-0054/4089770	SWITCH SLIDE SPST 8.5A 125V - Through Hole	On/Off_Switch
PJ-202B	1	$0.82	https://www.digikey.ca/en/products/detail/cui-devices/PJ-202B/252008	CONN PWR JACK 2.5X5.5MM SOLDER	J4

JUMPER

Manufacturer/ Supplier Part Number	Quantity	Unit Cost	Website Link	Part Description	Schematic Reference
JL-100-25-T	3	$0.15	https://www.digikey.ca/en/products/detail/samtec-inc/JL-100-25-T/2685201	SHUNT JUMPER	J1 J2 J3

1.3.1 Unit Cost

The unit cost for all components required to build an oscilloscope is $13.64.
This value accounts for the input protection, oscilloscope front end, low-pass filter, output protection, power supply and microcontroller. The cost was generated using parts available from common suppliers such as Digikey.

1.4 Simulations:

Unfortunately, the circuits we selected did not provide us the option to run the required simulations. This was brought to the attention of Prof Mackay, who informed us to simply state this in the report.

Section B

2.0 - Block Diagram:

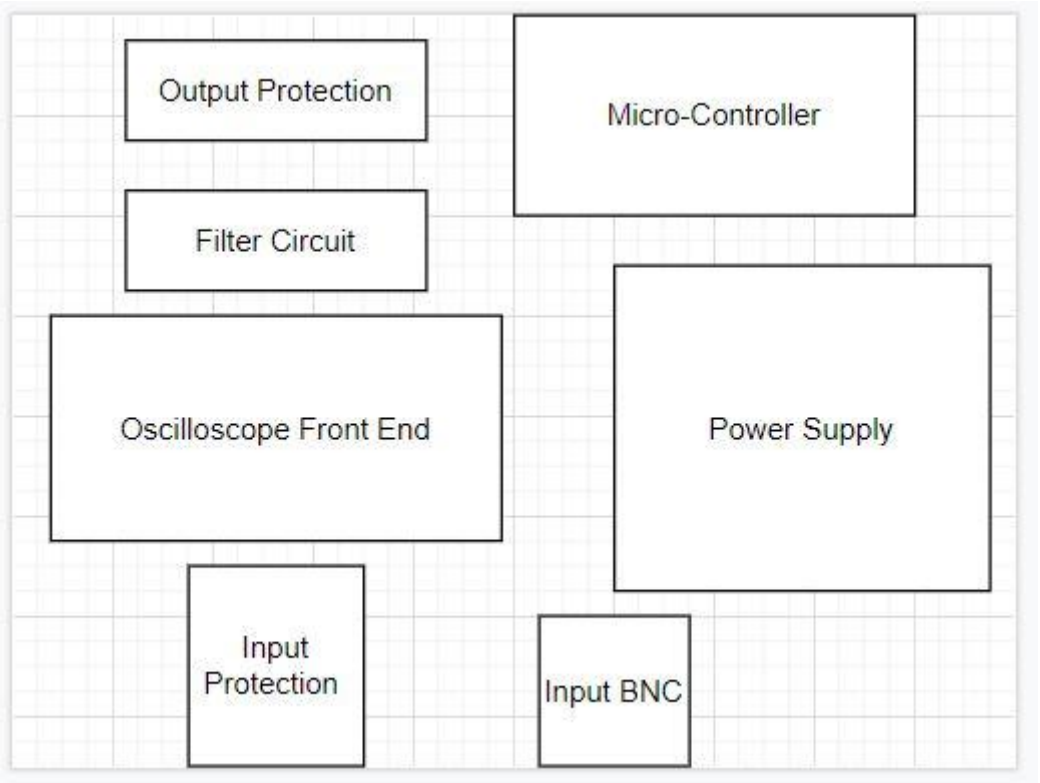
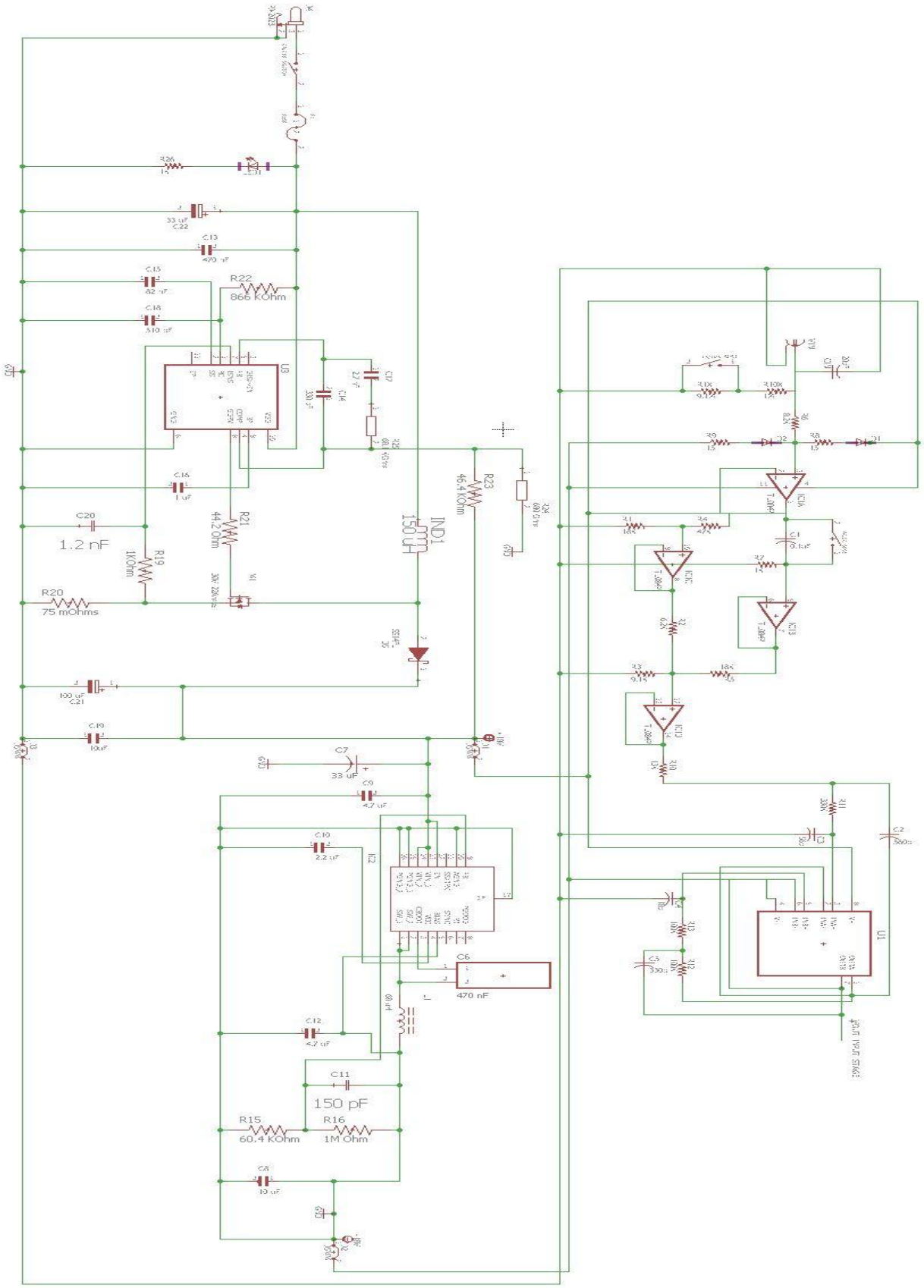


Figure 1: Basic PCB Layout

2.1 Schematic Diagram:


R22
866 KOhm
C20
1.2 nF
R19
1KOhm
R21
44.2Ohm
R20
75 mOhms
IND1
150 uH
R23
464 KOhm
C7
33 uF
C9
4.7 uF
C10
2.2 uF
C6
470 nF
C12
4.7 uF
C11
150 pF
R15
60.4 KOhm
R16
1M Ohm
C8
10 uF

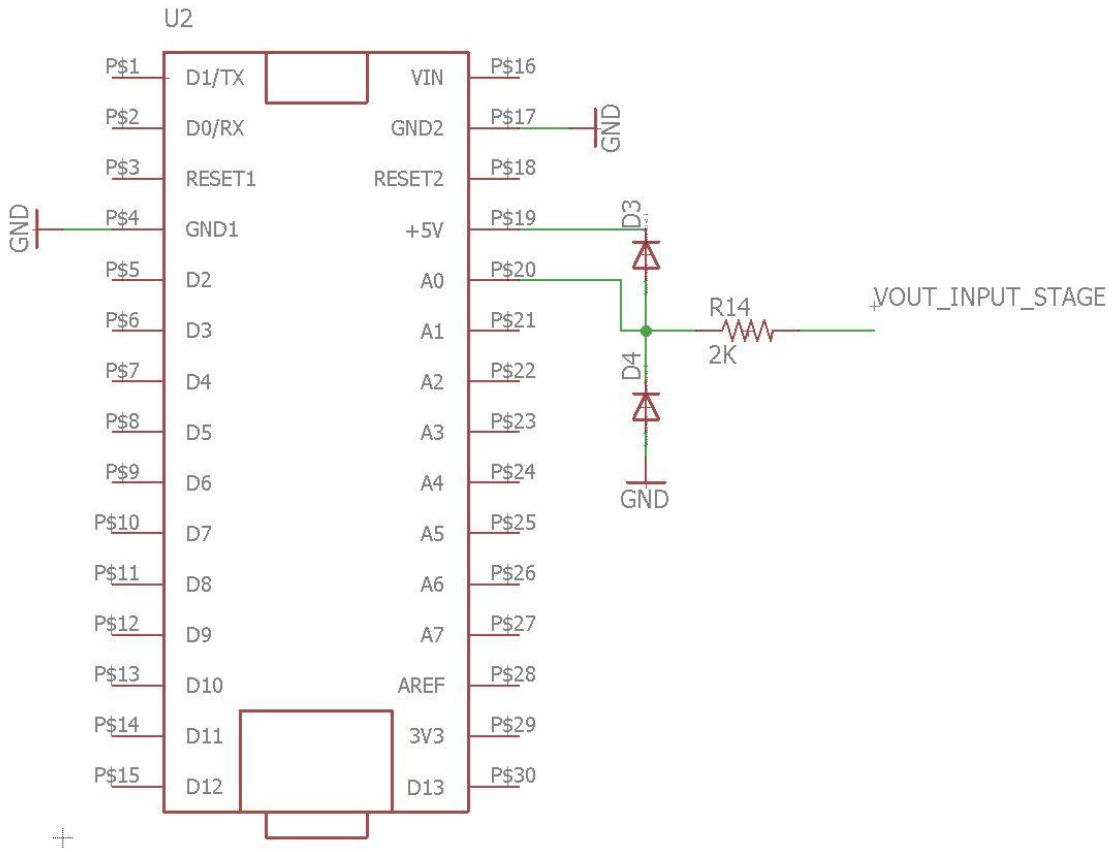
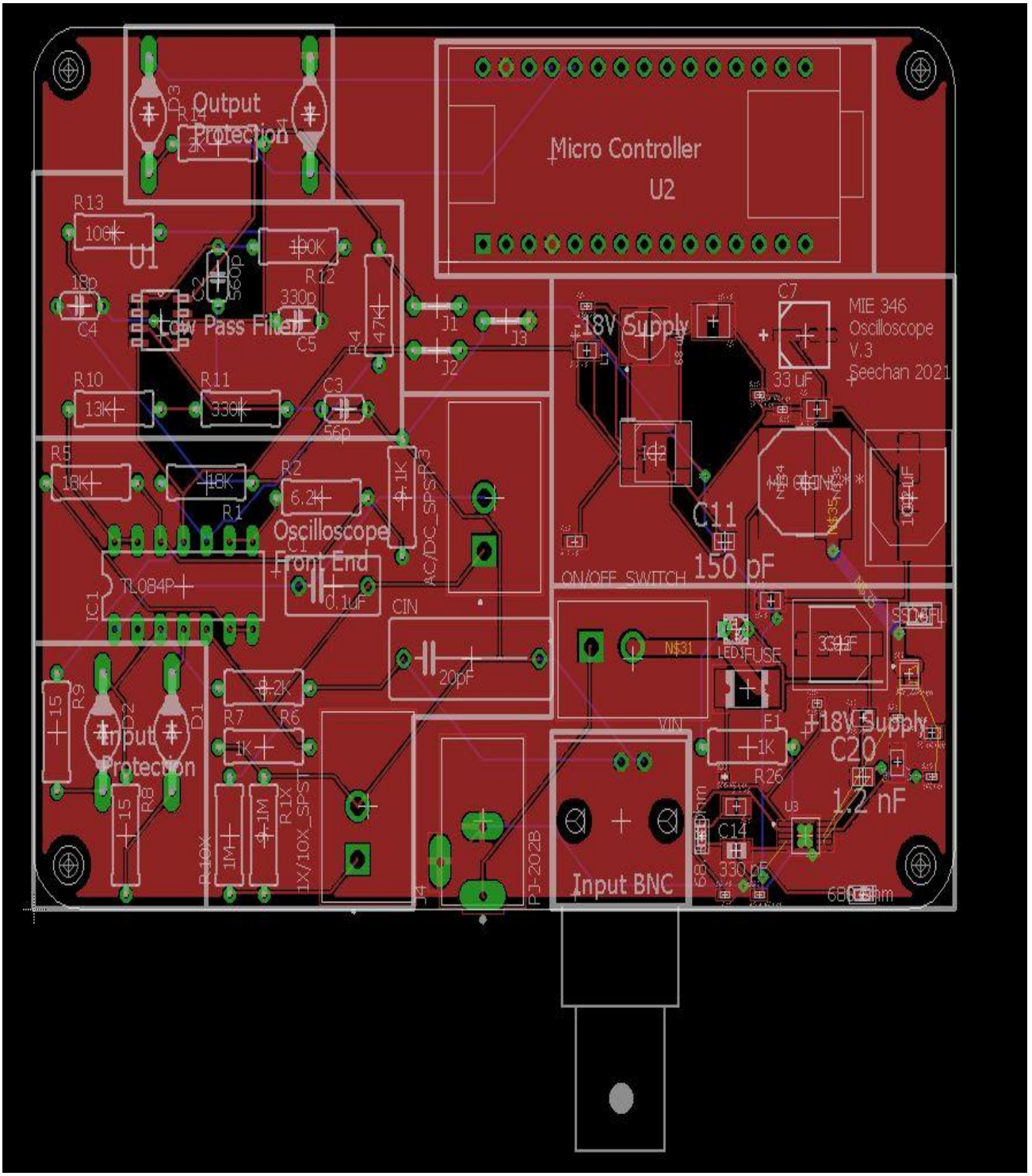
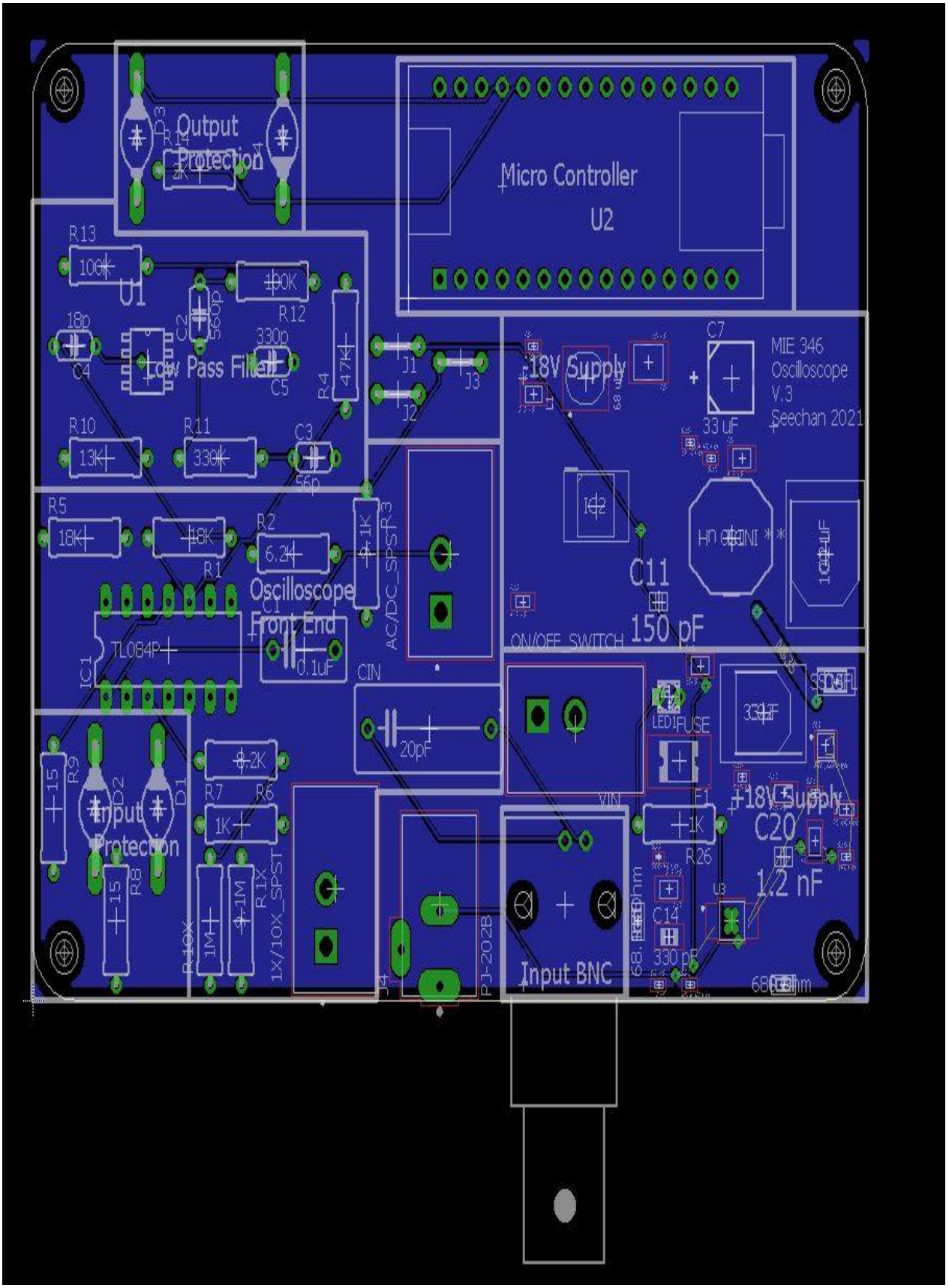


Figure 2 and 3 - Full Circuit Schematic

2.2 Top Copper Layer:



2.3 Bottom Copper Layer



2.4 Both Copper Layers