

# Oscilloscope Input Stage and PCB

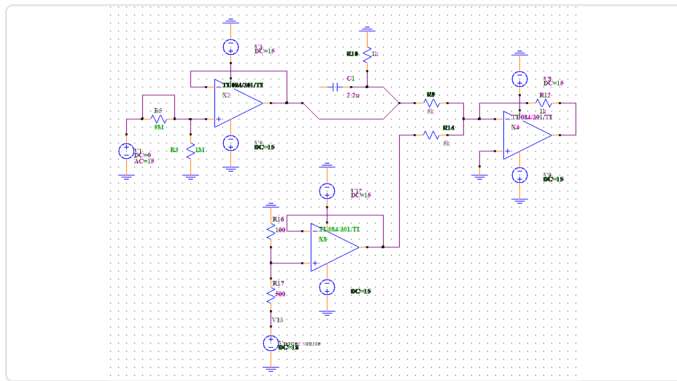
University of Toronto, MIE346 (Analog and Digital Electronics for Mechatronics) · Two-person team, Feb to Mar 2023

Analog design

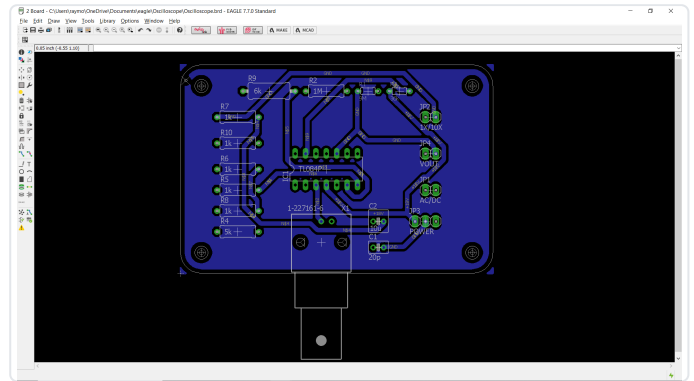
PCB layout

Designed and laid out the analog front-end of an entry-level oscilloscope probe.

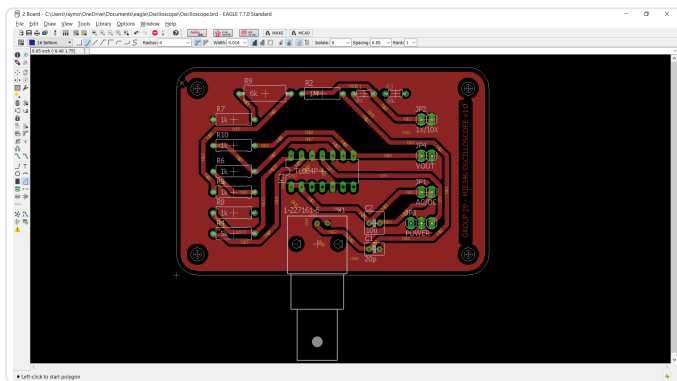
This two-part assignment designed the analog input stage of an oscilloscope: it takes a probe input swinging from -15V to +15V and shifts and amplifies it to a 0 to 5V output, with selectable 1X/10X attenuation and AC/DC coupling. The first part compared three op-amp architectures and verified the chosen design by simulation; the second turned it into a manufacturable printed circuit board.



Final TL084 op-amp input-stage schematic.



EAGLE PCB top component layer.



PCB bottom routing layer.

Component	Manufacturer	Supply Part #	Quantity	Unit Cost	Website Link	Part Description	Part Reference
20pF Capacitor	KEMET	C315C2003G05TA	1	0.58	<a href="https://www.digikey.ca/m/products/detail/10.150/Lx0.1007/W(3.81mmx2.54mm)">https://www.digikey.ca/m/products/detail/10.150/Lx0.1007/W(3.81mmx2.54mm)</a>		C1
10u Capacitor	TDK Corporation	FK25N7R1E100K	1	0.92	<a href="https://www.digikey.ca/m/products/detail/10.4F+10%+24V+Ceramic+Capacitor+N7R+Radial">https://www.digikey.ca/m/products/detail/10.4F+10%+24V+Ceramic+Capacitor+N7R+Radial</a>		C2
90k Resistor	YAGEO	CFR-2120-C-90M1	1	0.15	<a href="https://www.digikey.ca/m/products/detail/0.075/Diax0.114-L(1.90mmx3.80mm)">https://www.digikey.ca/m/products/detail/0.075/Diax0.114-L(1.90mmx3.80mm)</a>		R1
1M Resistor	TE Connectivity Passive Product	YR1B1M0CC	1	0.94	<a href="https://www.digikey.ca/m/products/detail/1.0MOhms+1%+0.25W,+1.4W+Through+Hole+Resist">https://www.digikey.ca/m/products/detail/1.0MOhms+1%+0.25W,+1.4W+Through+Hole+Resist</a>		R2
30k Resistor	Panasonic Electronic Components	ERO-S2PHF3002	1	0.14	<a href="https://www.digikey.ca/m/products/detail/30.kOhms+1%+0.25W,+1.4W+Through+Hole+Resist">https://www.digikey.ca/m/products/detail/30.kOhms+1%+0.25W,+1.4W+Through+Hole+Resist</a>		R3
5k Resistor	Vishay Dale	RN55D5001FB14	1	0.99	<a href="https://www.digikey.ca/m/products/detail/5.kOhms+1%+0.125W,+1.8W+Through+Hole+Resist">https://www.digikey.ca/m/products/detail/5.kOhms+1%+0.125W,+1.8W+Through+Hole+Resist</a>		R4
1k Resistor	YAGEO	MFR-250FB5-1K	5	0.14	<a href="https://www.digikey.ca/m/products/detail/1.kOhms+1%+0.25W,+1.4W+Through+Hole+Resist">https://www.digikey.ca/m/products/detail/1.kOhms+1%+0.25W,+1.4W+Through+Hole+Resist</a>		R5, R6, R7, R8, R10
6k Resistor	Vishay Dale	RN60D6001FB14	1	1.01	<a href="https://www.digikey.ca/m/products/detail/6.kOhms+1%+0.25W,+1.4W+Through+Hole+Resist">https://www.digikey.ca/m/products/detail/6.kOhms+1%+0.25W,+1.4W+Through+Hole+Resist</a>		R9
TL084 Op-amp	Texas Instruments	296-1784-5-ND	1	0.95	<a href="https://www.digikey.ca/m/products/detail/JFET+Amplifier+4+Circuit+14-PDIP">https://www.digikey.ca/m/products/detail/JFET+Amplifier+4+Circuit+14-PDIP</a>		IC1
BNC Connector	TE Connectivity AMP Connectors	A24494-ND	1	17.71	<a href="https://www.digikey.ca/m/products/detail/BNC+Connector+Inck,+Female+Socket+500tan+Panel+FP3">https://www.digikey.ca/m/products/detail/BNC+Connector+Inck,+Female+Socket+500tan+Panel+FP3</a>		JP3
Rocker Switch	C&K	CKN10927-ND	2	16.15	<a href="https://www.digikey.ca/m/products/detail/Rocker+Switch+SPST+0.4VA+(AC/DC)+20+V+Thruout+JP1,+JP2,+JP4">https://www.digikey.ca/m/products/detail/Rocker+Switch+SPST+0.4VA+(AC/DC)+20+V+Thruout+JP1,+JP2,+JP4</a>		SW1, SW2

Component bill of materials.

## Analog design

Three candidate block architectures were compared (a resistive divider with follower, and summing versus differential amplifiers). The final design used a TL084 quad op-amp topology with an input noise filter and a DC-blocking capacitor, verified by transient simulation across the 1X/10X and AC/DC modes.

## From schematic to board

The chosen schematic was captured in EAGLE and laid out as a through-hole PCB with top and bottom copper, a full bill of materials, and exported Gerber files ready for fabrication.

## SELECTED REFERENCES

- D. Alciatore, Introduction to Mechatronics and Measurement Systems (course text).
- Pico Technology, "Oscilloscope AC Coupling" knowledge base.
- Texas Instruments, TL084 quad operational amplifier datasheet.

Engineering portfolio brief. Course and team project; contribution as noted above.