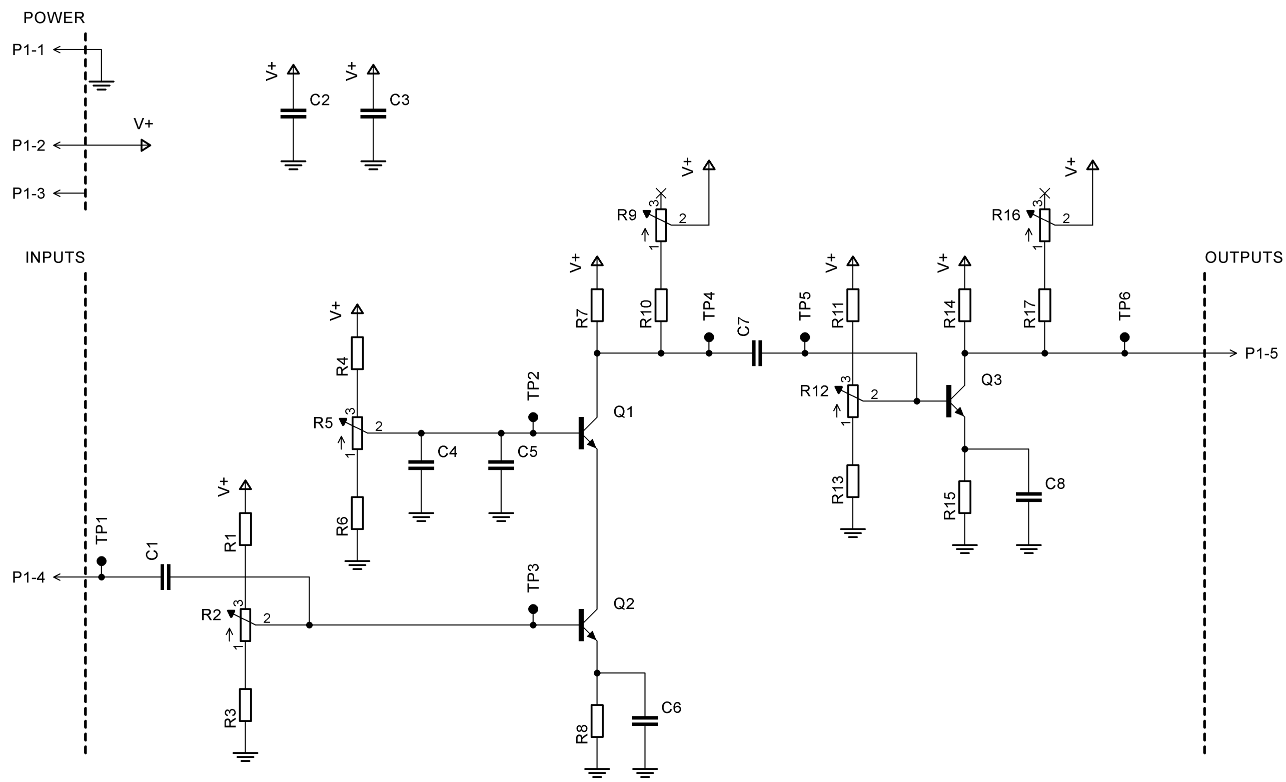
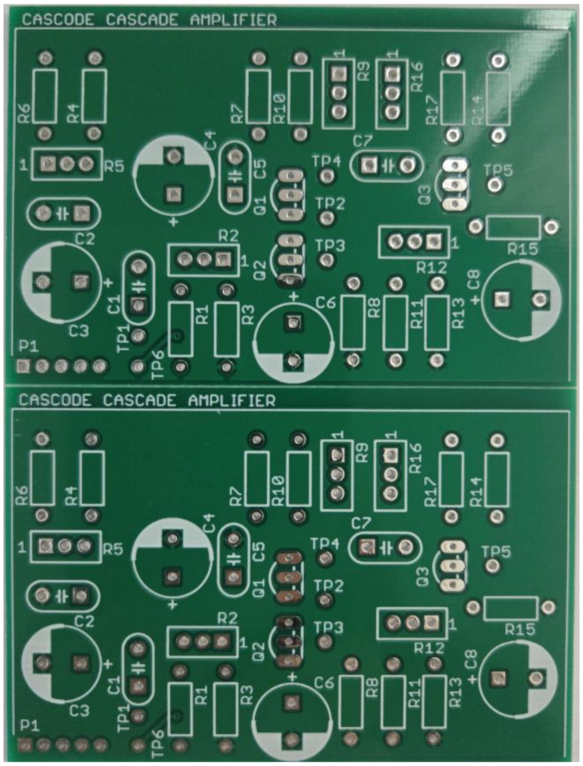
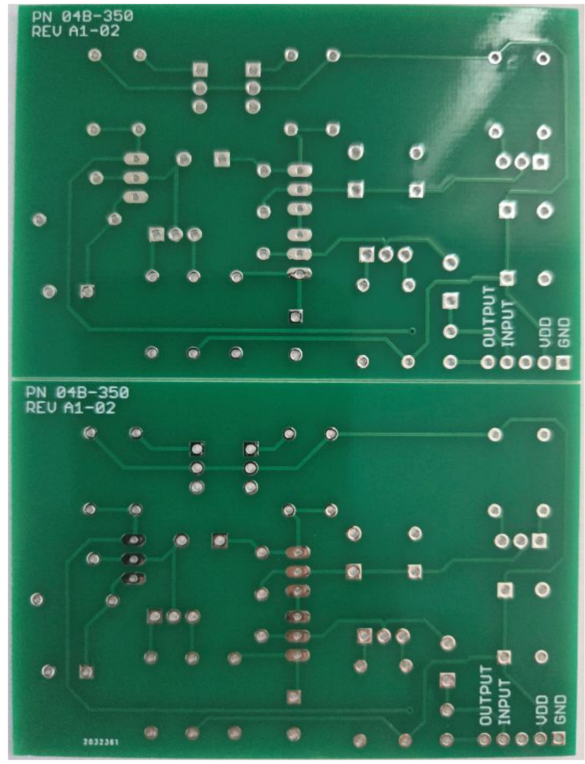
Cascode Cascade Amplifier





Front Side



Back Side

PART NO	TITLE	PIECES PER PANEL
04B-350	Cascode Cascade Amplifier	2

Ordering Information

Email me, nolan@minipcb.com, a list of the boards you'd like to buy, how many you want, when you want them delivered by, and a shipping address. We'll figure out what payment option and price works for you.

Circuit Description

This miniPCB implements a three-transistor cascode-cascade amplifier designed to combine the high-frequency advantages of a cascode stage with the voltage gain stacking of a cascaded configuration. Built around discrete NPN bipolar junction transistors (Q1, Q2, and Q3), the circuit enables hands-on exploration of advanced analog amplifier techniques including stage isolation, Miller effect suppression, and gain distribution.

Power Supply Conditioning

Capacitors C2 and C3 act as power rail filter capacitors, suppressing high-frequency noise and stabilizing the DC supply voltage. Test point TP4 allows measurement of the collector of Q1, providing insight into the voltage swing of the cascode stage output.

Input Coupling and Signal Entry

The input signal is AC-coupled via C1, which decouples the DC component of the input source and ensures proper biasing of the first active stage. Test point TP1 enables measurement of the input voltage directly at the signal entry.

Cascode Input Stage (Q2)

Q2 serves as the lower transistor in the cascode configuration. Its base is biased using a resistor network composed of R1, R2 (a multiturn trimmer), and R3, which set the operating point and collector current. Test point TP3 provides access to the base of Q2 for bias voltage monitoring.

The emitter of Q2 is connected to ground through R8 and capacitor C6, forming an AC ground while providing emitter degeneration and thermal stability.

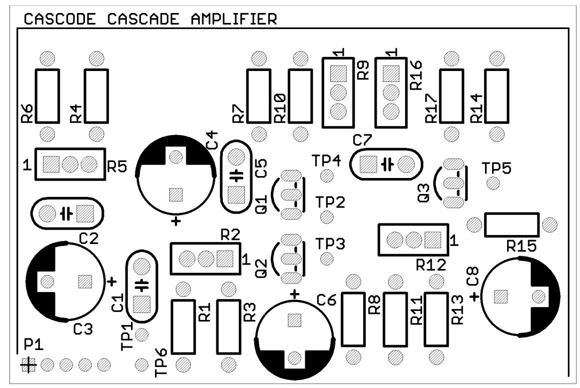


Figure 1 - Single Board, Component Outlines

Cascode Driver Stage (Q1)

Q1 operates as the upper transistor in the cascode pair, with its emitter directly connected to the collector of Q2. Its base is biased by a network of R4, R5 (trimmer), and R6, while capacitors C4 and C5 stabilize this bias voltage by bypassing transient variations. Test point TP2 enables voltage measurements at the base of Q1.

The collector of Q1 connects to the V+ rail through R7, R9 (trimmer), and R10, which set the collector load and influence the gain. TP4, as previously mentioned, monitors this node.

Cascaded Amplifier Stage (Q3)

The output from the cascode stage is AC-coupled to the next gain stage via C7, which connects the collector of Q1 to the base of Q3. This decoupling capacitor allows signal transfer while maintaining DC bias separation between stages. Test point TP5 enables direct measurement of the Q3 base.

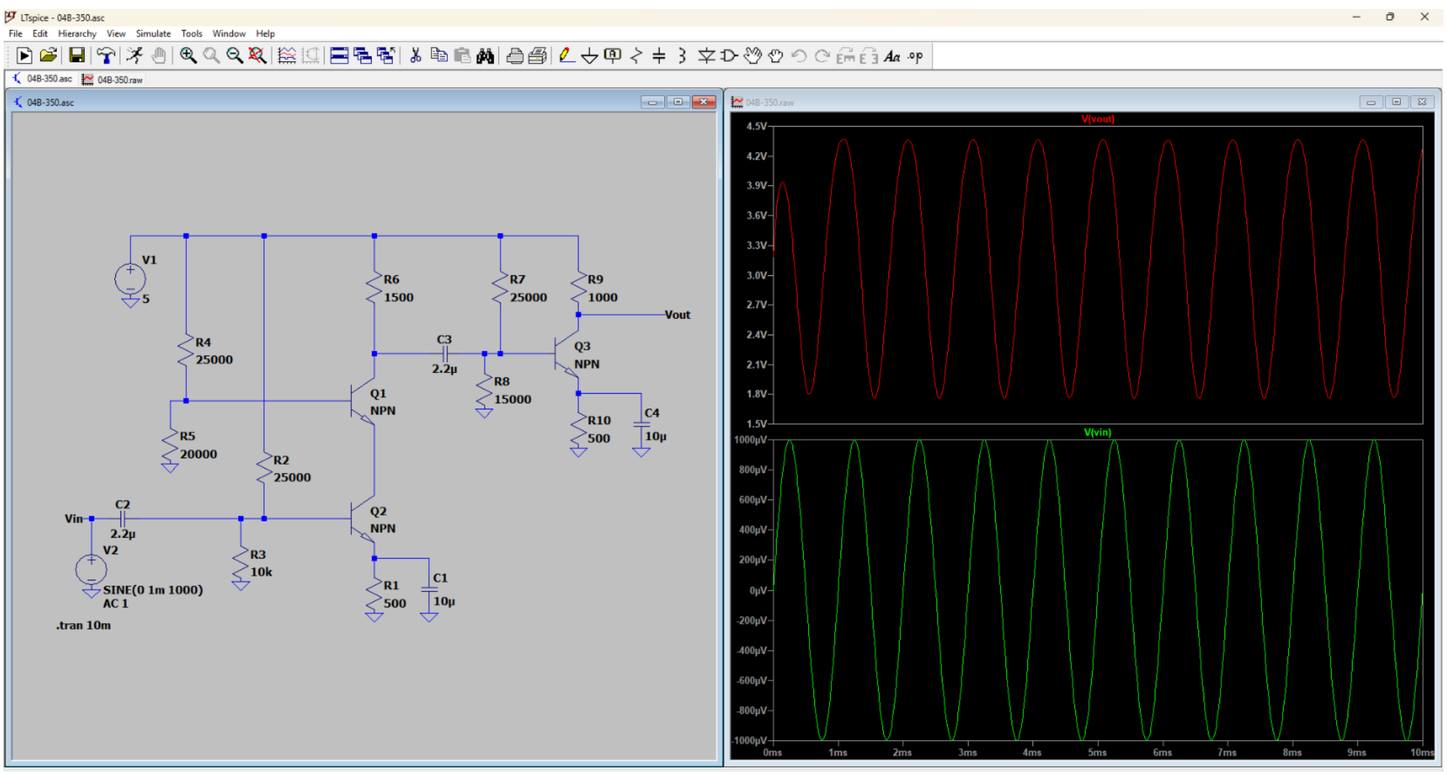
The base of Q3 is biased by a resistor divider made up of R11, R12 (trimmer), and R13. The emitter is grounded through R15 and bypassed by C8 to reduce AC degeneration and improve gain. The collector load is formed by R14, R16 (trimmer), and R17, connected between the collector and V+. Test point TP6 enables probing of the Q3 collector and serves as a convenient output node for scope or load connection.

Transistor Configuration and Application

Q1 and Q2 form a cascode stage, where Q2 handles the input signal and Q1 buffers the output, enhancing bandwidth and reducing distortion. Q3 then cascades the amplified signal, offering additional gain. This layout is ideal for demonstrating stage-to-stage interaction, frequency response shaping, and biasing strategies in high-performance amplifier design.

Simulation in LTspice

LTspice was used to verify that selected component values produced reasonable amplifier behavior before assembling physical boards. The simulation helped confirm that the circuit was biased correctly, the signal was amplified, and the overall configuration functioned as expected with a voltage gain slightly greater than 1200. While the analysis wasn't exhaustive, the simulation served as a practical check to ensure the design was sound and worth building.



Parts List

REF DES	PART TYPE	VALUE / DESCRIPTION
C1	CAPACITOR	2.2uF
C2	CAPACITOR	0.1uF
C3	CAPACITOR	10uF
C4	CAPACITOR	10uF
C5	CAPACITOR	0.1uF
C6	CAPACITOR	10uF
C7	CAPACITOR	2.2uF
C8	CAPACITOR	10uF
R1	RESISTOR	10kΩ
R2	RESISTOR (TRIMMER)	25kΩ
R3	RESISTOR	10kΩ
R4	RESISTOR	10kΩ
R5	RESISTOR (TRIMMER)	25kΩ
R6	RESISTOR	10kΩ
R7	RESISTOR	3.3kΩ
R8	RESISTOR	500Ω
R9	RESISTOR (TRIMMER)	2kΩ
R10	RESISTOR	1kΩ
R11	RESISTOR	10kΩ
R12	RESISTOR	25kΩ
R13	RESISTOR	10kΩ
R14	RESISTOR	3.3kΩ
R15	RESISTOR	500Ω
R16	RESISTOR	2kΩ
R17	RESISTOR	1kΩ
Q1	TRANSISTOR	2N3904
Q2	TRANSISTOR	2N3904
Q2	TRANSISTOR	2N3904
TP1-TP11	TEST POINT	KEYSTONE ELECTRONICS SERIES 5000
P1	HEADER PINS	5POS, 2.54mm PITCH, RA

Pictures of the Build

Testing Videos

Parts List (Form)

REF DES	PART TYPE	VALUE / DESCRIPTION
C1	CAPACITOR	
C2	CAPACITOR	
C3	CAPACITOR	
C4	CAPACITOR	
C5	CAPACITOR	
C6	CAPACITOR	
C7	CAPACITOR	
C8	CAPACITOR	
R1	RESISTOR	
R2	RESISTOR (TRIMMER)	
R3	RESISTOR	
R4	RESISTOR	
R5	RESISTOR (TRIMMER)	
R6	RESISTOR	
R7	RESISTOR	
R8	RESISTOR	
R9	RESISTOR (TRIMMER)	
R10	RESISTOR	
R11	RESISTOR	
R12	RESISTOR	
R13	RESISTOR	
R14	RESISTOR	
R15	RESISTOR	
R16	RESISTOR	
R17	RESISTOR	
Q1	TRANSISTOR	
Q2	TRANSISTOR	
Q2	TRANSISTOR	
TP1-TP11	TEST POINT	KEYSTONE ELECTRONICS SERIES 5000
P1	HEADER PINS	5POS, 2.54mm PITCH, RA

Revision History

REV	DESCRIPTION	ECO	DATE
A	Initial Release		