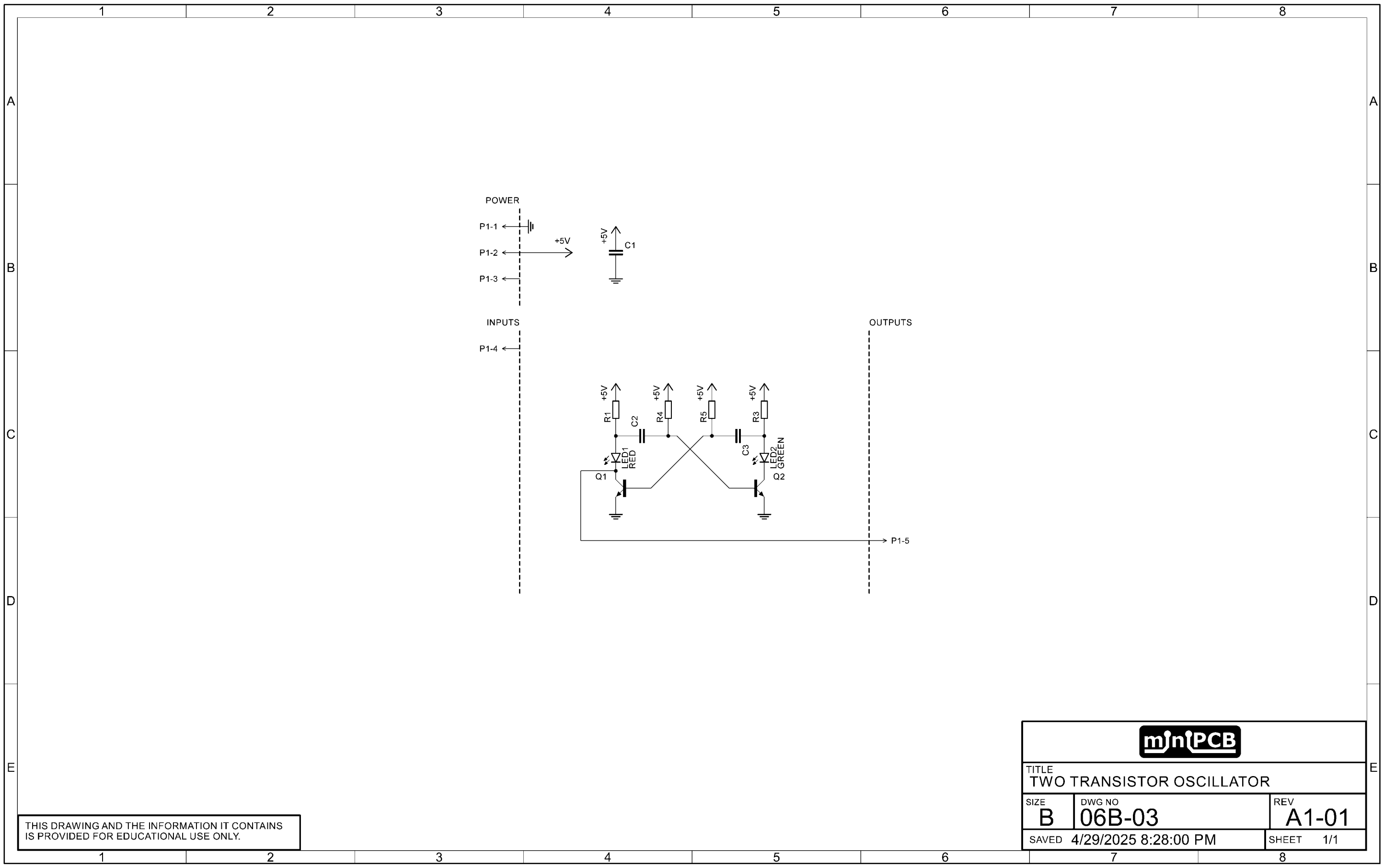
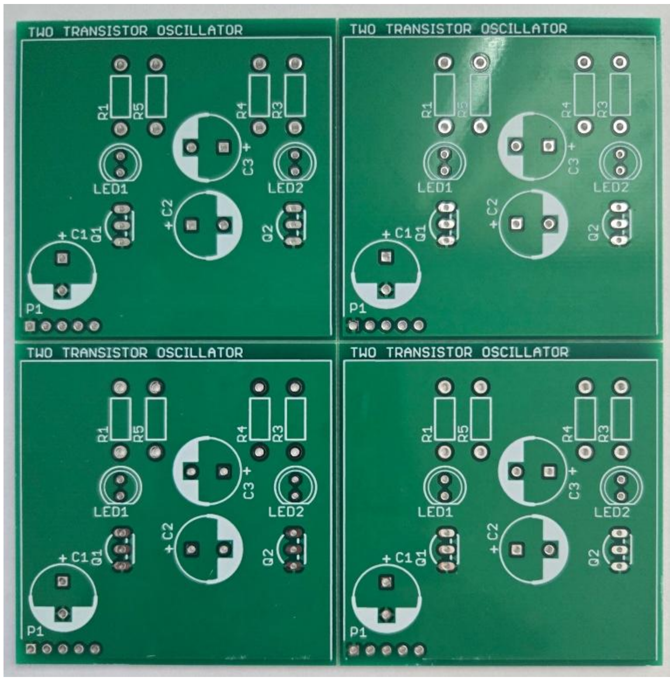
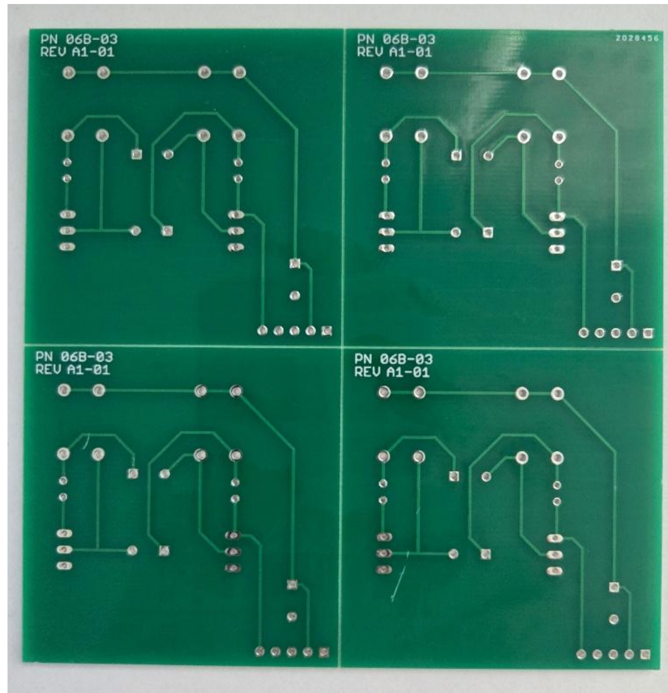
Two Transistor Oscillator





Front Side



Back Side

miniPCB Part Number

PART NO	TITLE	PIECES PER PANEL
06B-03	Two Transistor Oscillator	4

miniPCB Revision History

REV	DESCRIPTION	DATE
A1-01	Initial Release	29APR2025

Circuit Description

This miniPCB implements a **complementary two-transistor astable multivibrator** designed to generate a continuous square-wave output. The circuit alternately switches two transistor stages on and off, creating an oscillating signal that drives LEDs for a visual indication of operation and is available at the **OUTPUT** pin (P1-5).

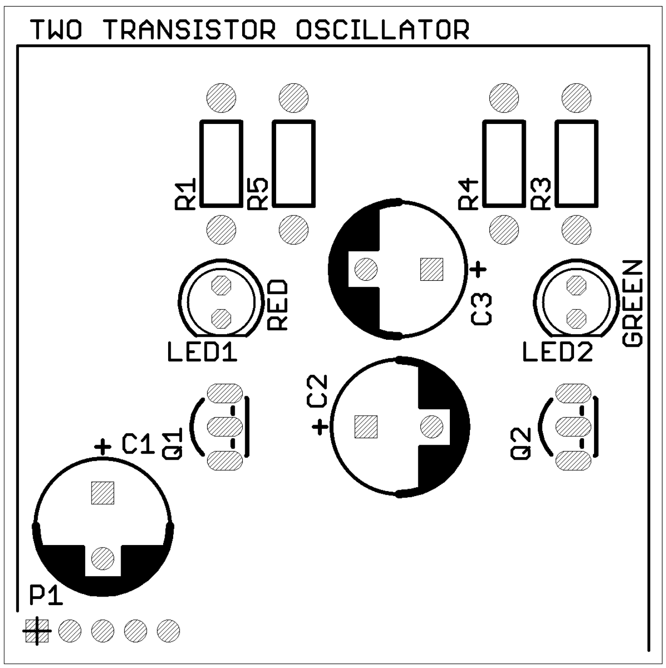


Figure 1 - Components Top Side

Power and Bypass

- **C1** is a supply bypass capacitor that filters noise and stabilizes the DC rail for reliable oscillation.

Oscillator Core

The heart of the circuit is formed by **Q1** and **Q2**, which are cross-coupled through timing capacitors **C2** and **C3**:

- **Q1** and **Q2** operate in a regenerative feedback loop where each transistor's collector is capacitively coupled to the other's base.
- **R2** and **R3** provide base bias currents, ensuring proper turn-on when the opposite transistor turns off.
- **R1** and **R4** serve as collector load resistors, converting the transistor switching into voltage waveforms and supplying current to the LEDs.

LED Indication

- **LED1** (with Q1) and **LED2** (with Q2) alternately blink at the oscillator frequency, providing a clear visual cue of the two-phase operation.

How the Oscillation Works

1. Assume **Q1** is ON and **Q2** is OFF.
    - Current flows through **R1** and LED1 into Q1's collector-emitter path to ground, lighting LED1.
    - Q2's base is pulled low by the discharging path through **C2**, keeping Q2 OFF.
2. As **C2** charges through **R3**, Q2's base voltage rises until it reaches the turn-on threshold.
3. When Q2 turns ON, it pulls its collector low, lighting LED2 and driving Q1's base low through **C3**, turning Q1 OFF.
4. The cycle repeats in the opposite phase.
    1. This cross-coupling ensures continuous oscillation without any external trigger.

Output Signal

- The output at **P1-5** is taken from the collector of Q2, providing a square-wave signal swinging between near-ground and near-+5 V levels.
- The output can be used as a clock source for digital circuits, a blinking LED driver, or as a simple timing signal for experiments.

Frequency Control

- The oscillation frequency is determined primarily by **R2/C2** and **R3/C3** time constants.
- Increasing capacitance or resistance slows the blink rate; decreasing them speeds it up.
- For symmetry, **R2 ≈ R3** and **C2 ≈ C3** yield an approximately 50% duty cycle.

Educational Notes

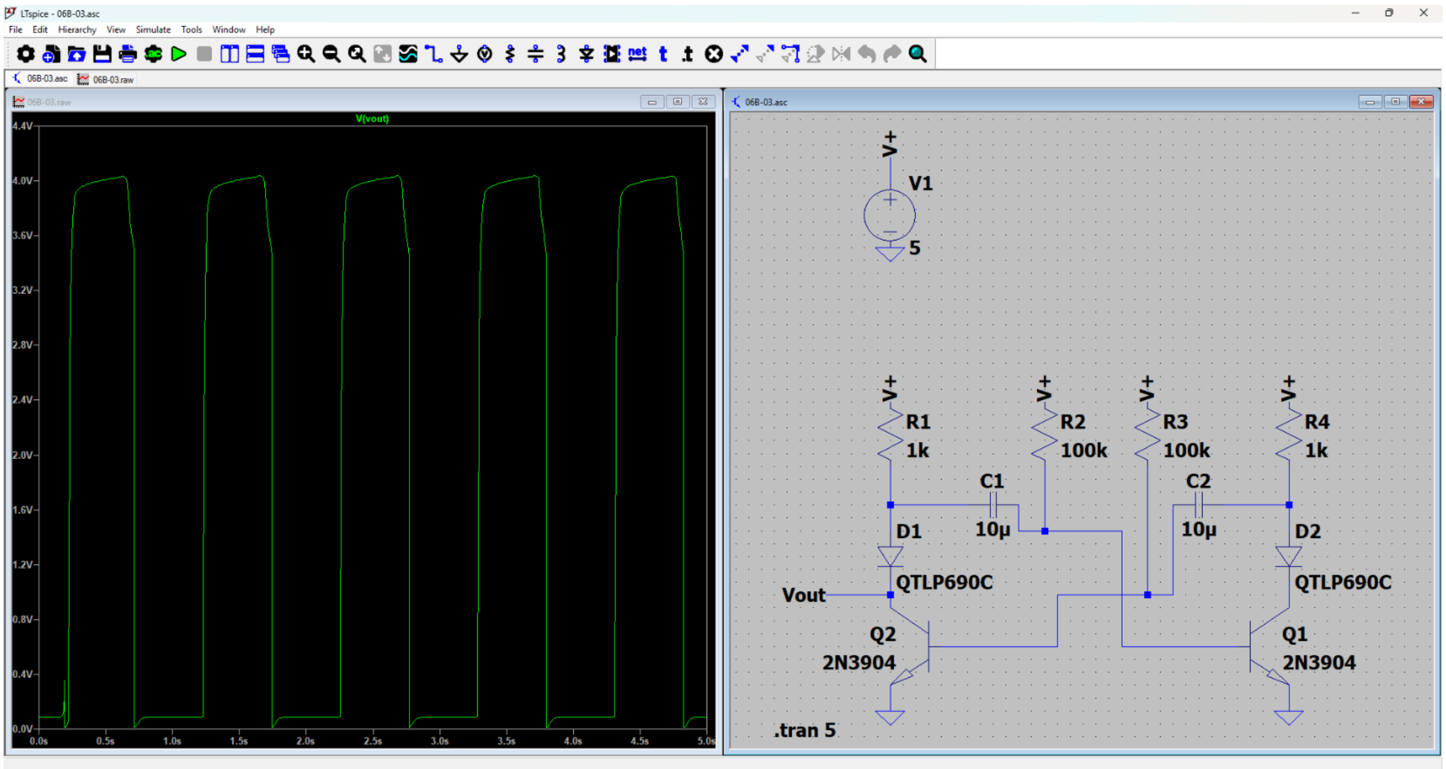
- This design is a classic **astable multivibrator**, ideal for teaching feedback, regenerative switching, and capacitor-controlled timing.
- Swapping LED colors or altering RC values can demonstrate duty cycle and frequency effects in real time.
- The circuit functions at low voltages, making it safe and interactive for classroom use.

An engineer would rarely use a two-transistor astable multivibrator in a modern production design because its frequency stability is poor, it has significant component tolerances, and it produces relatively slow edges with asymmetrical duty cycles unless carefully balanced. Integrated timer ICs (like the 555) or microcontrollers can generate more precise, stable, and adjustable oscillations with fewer external parts.

However, this circuit might still be chosen in a simple, low-cost, or fully discrete design where part count is less critical, the application is tolerant of frequency drift, or when the goal is to teach or demonstrate basic transistor switching and feedback principles. Its visible LED outputs and symmetrical two-phase operation also make it useful for driving alternating loads or for retro-style designs that avoid ICs altogether.

Simulation in LTspice

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



Example Parts List

REF DES	PART TYPE	VALUE / DESCRIPTION
C1	CAPACITOR	100 uF
C2	CAPACITOR	10 uF
C3	CAPACITOR	10 uF
LED1	LIGHT EMITTING DIODE	RED
LED2	LIGHT EMITTING DIODE	GREEN
P1	PINS HEADER	5 PIN, 0.1” PITCH, RIGHT ANGLE
Q1	TRANSISTOR	2N3904
Q2	TRANSISTOR	2N3904
R1	RESISTOR	1 kΩ
R3	RESISTOR	1 kΩ
R4	RESISTOR	100 kΩ
R5	RESISTOR	100 kΩ

Parts List Form

REF DES	PART TYPE	VALUE / DESCRIPTION
C1	CAPACITOR	
C2	CAPACITOR	
C3	CAPACITOR	
LED1	LIGHT EMITTING DIODE	RED
LED2	LIGHT EMITTING DIODE	GREEN
P1	PINS HEADER	5 PIN, 0.1” PITCH, RIGHT ANGLE
Q1	TRANSISTOR	
Q2	TRANSISTOR	
R1	RESISTOR	
R3	RESISTOR	
R4	RESISTOR	
R5	RESISTOR	

Build

NEED TO ADD

Testing

NEED TO ADD

Industry Feedback

Send your feedback to nolan@minipcb.com.

References

- https://www.minipcb.com/06/06B-03.html
- https://www.youtube.com/@minipcb

Revision History

REV	DESCRIPTION	DATE
A	Initial Release	13AUG2025