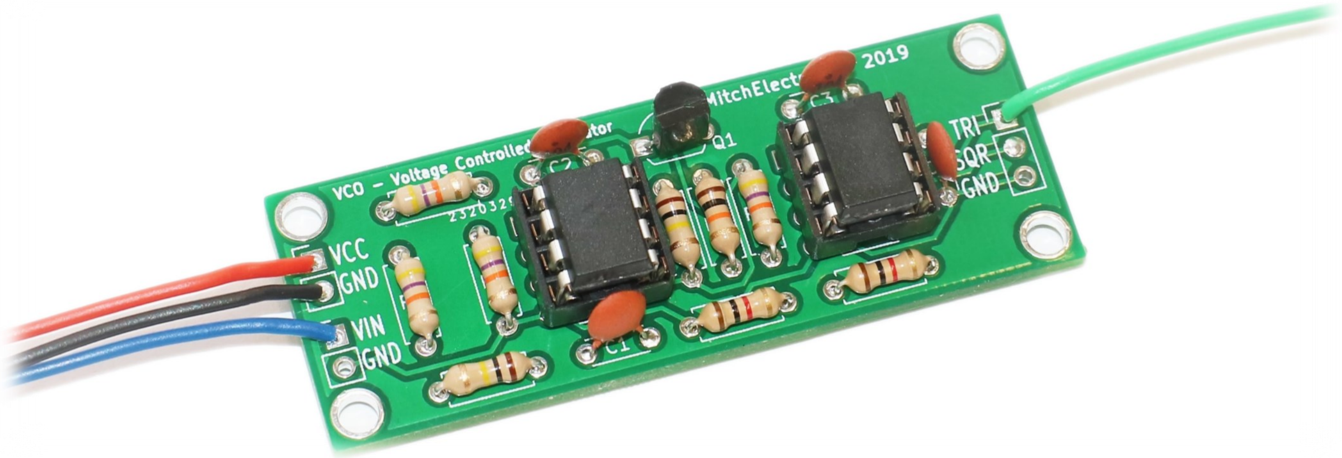
Voltage Controlled Oscillator

MitchElectronics® 2019



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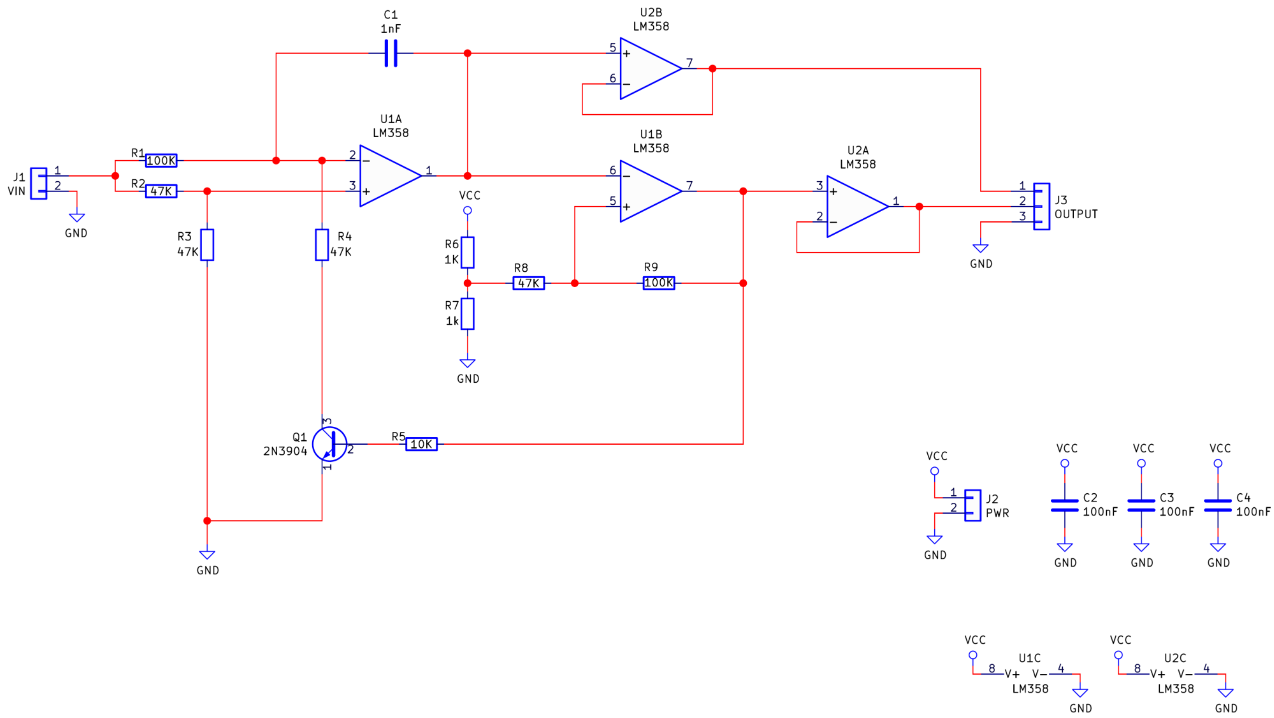
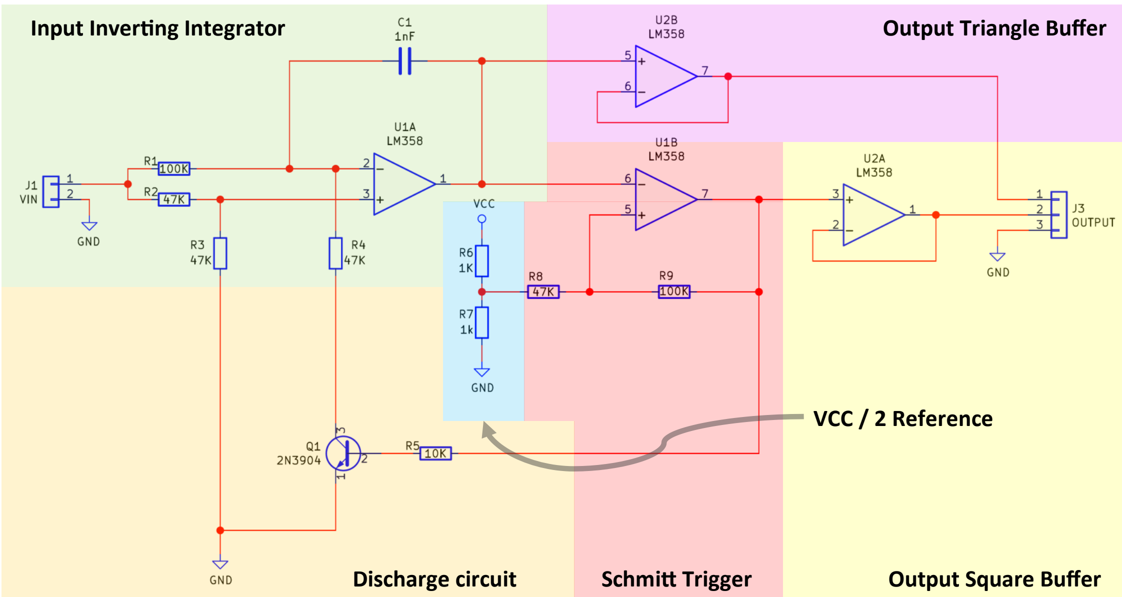


Schematic (Blocktised)



SCHEMATIC EXPLANATION

The Voltage Controlled Oscillator (VCO for short), is a very practical circuit for generating square and sine waves. While these waves can be produced using the Simple Function Generator Kit, the VCO allows for controlling the output frequency with the use of a voltage signal instead of using a potentiometer. This means that the output frequency of the VCO can easily be controlled by microcontrollers and other analogue circuits which can create some pretty interesting results. For example, a 1V octave synthesiser can be built using this module whereby a 1V octave keyboard is connected to an exponential converter which feeds its output into the VCO to produce keyboard tones. This circuit can also be used in retro ways such as sensor data transmission where the voltage output of a sensor is converted into a frequency and the frequency of the output will be proportional to the sensor reading (a similar system was done in early satellites such as Sputnik).

The VCO is a complex circuit and so only an overview of its workings will be presented in this instruction manual. The VCO consists of the following sub-circuits (refer to the blocktised schematic to see these sub-circuits):

- Integrator Circuit
- Schmitt Trigger Circuit
- Voltage Reference
- Discharge Circuit
- Output Buffers

The input to the VCO is fed into the integrator circuit and the purpose of the integrator circuit is to produce each side of the triangular waveform (steadily increasing or steadily decreasing). The larger the input to the integrator the faster the voltage rises / falls and the smaller the input voltage the slower the voltage rises / falls.

The integrator feeds its output into an inverting Schmitt trigger whose hysteresis points are determined by resistors R8 and R9. If the output of the integrator goes beyond the upper hysteresis limit then the output of the inverting Schmitt trigger turns off. If the output of the integrator goes lower than the lower hysteresis limit then the output of the inverting Schmitt trigger turns on.

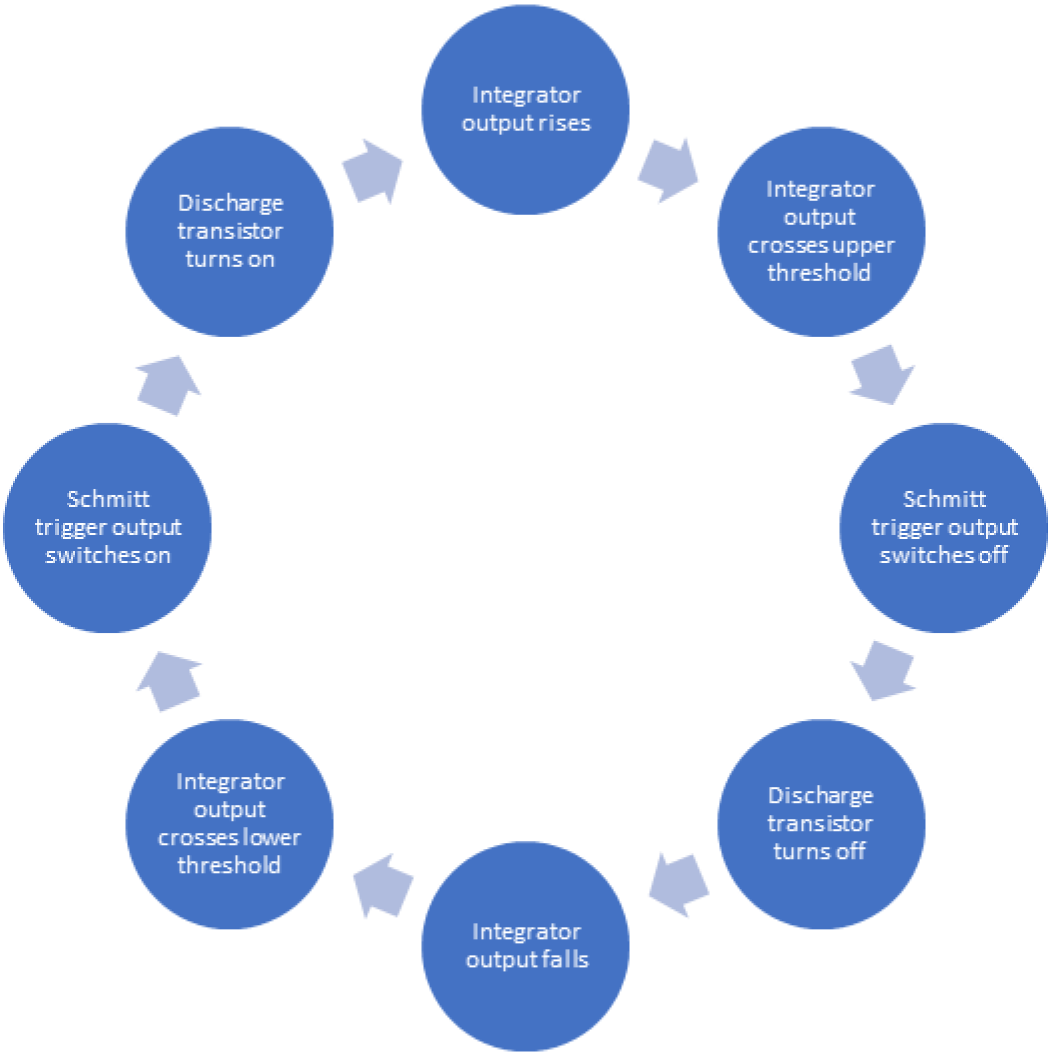
The output of the inverting Schmitt trigger is also connected to a discharge transistor Q1 which controls whether the integrators output should rise or fall. If the output of the inverting Schmitt trigger is high then the discharge transistor is turned on and therefore the output of the integrator begins to rise (as it's an inverting integrator). If the output of the inverting Schmitt trigger is low then the discharge transistor is turned off and therefore the output of the integrator begins to fall.

So to sum up how the system oscillates:

1. Integrator output begins to rise and eventually crosses the upper threshold of the Schmitt trigger
2. The Schmitt triggers output switches off and this turns off the discharge transistor
3. The integrators output begins to fall and eventually crosses the lower threshold of the Schmitt trigger
4. The Schmitt triggers output switches on and this turns on the discharge transistor
5. The discharging transistor causes the output of the integrator to rise and we go back to step 1

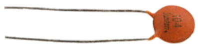
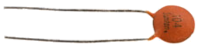
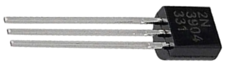
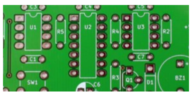
SCHEMATIC EXPLANATION

The two buffers are used to provide signal outputs that do not affect the VCO oscillation. The square wave output is obtained from the Schmitt triggers output as this switches on and off while the triangular waveform is obtained from the integrator output (as this steadily rises and falls). The triangular waveform has a DC offset and this can be removed with the use of a coupling capacitor. The process cycle of the VCO is shown below



MATERIALS

Check that you have the following components

Component	Component Name	Quantity	Looks like
LM358	U1, U2	2	
8 DIP Socket	U1, U2	2	
1KΩ Resistor	R6, R7	2	
10KΩ Resistor	R5	1	
47KΩ Resistor	R2, R3, R4, R8	4	
100KΩ Resistor	R1, R9	2	
1nF Capacitor	C1	1	
100nF Capacitor	C2, C3, C4	3	
2N3904 Transistor	Q1	1	
Red, Blue, Green, and Black Wire	-	1	
PCB	-	1	

Download the electronics construction manual

To learn how to construct circuits on PCBs download the Electronics Construction Manual from Mitch-Electronics using the link below. This document shows you how to install all electronic components used in MitchElectronics kits. The list below shows the sections relevant to this kit so do not worry if you see component sections in the document that don't come with this kit!

www.mitchelectronics.co.uk/electronicsConstructionManual.pdf

Relevant sections in the electronics construction manual

Resistors

Capacitors

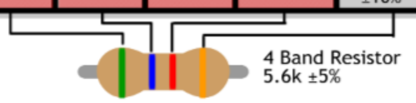
Transistor

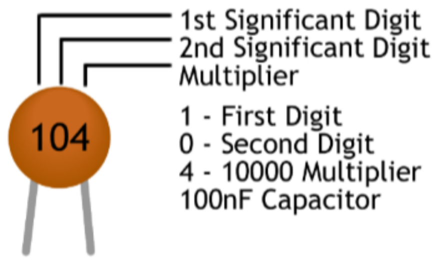
ICs

Wires

RESISTOR AND CAPACITOR IDENTIFICATION

Colour	1ST Band	2ND Band	3RD Band	Multiplier	Tolerance
BLACK	0	0	0	1Ω	
BROWN	1	1	1	10Ω	±1%
RED	2	2	2	100Ω	±2%
ORANGE	3	3	3	1kΩ	
YELLOW	4	4	4	10kΩ	
GREEN	5	5	5	100kΩ	±0.50%
BLUE	6	6	6	1MΩ	±0.25%
VIOLET	7	7	7	10MΩ	±0.10%
GREY	8	8	8		±0.05%
WHITE	7	7	7		
GOLD					±5%
SILVER					±10%





IMPORTANT INFORMATION

RoHS Compliant Kit (Lead free)

Low Voltage Kit

Caution! Soldering Required

TERMS AND CONDITIONS

MitchElectronics Mission

The main goal of MitchElectronics products is to provide safe electronics to makers and professionals alike while keeping the cost affordable. MitchElectronics kits are ideal for classrooms whereby students can learn about electronics using a hands-on approach which is not only highly effective at teaching students but also improves hand-eye co-ordination as well as grow interest in electronics. Since MitchElectronics kits are aimed at novices and those who are new to electronics they are designed to use low voltage power supplies such as 9V batteries which are inherently safe due to their limited voltage and current capabilities.

MitchElectronics Liability

MitchElectronics kits must be inspected and tested by a competent individual before use and must be constructed by those who are competent to do so. MitchElectronics is not liable for kits and products that are constructed incorrectly or to a poor standard whereby poor standard includes (but not limited to) poor solder connections, overheated components, and damaged components. MitchElectronics is not liable for harm, injury, or damage caused by the misuse of kits and/or products if

- Incorrectly constructed
- Powered by sources other than “portable batteries” or the specified power supply
- Kits used outside their operational range (such as voltage supply, temperature etc.)
- Used as a sub-system (i.e. connected to additional circuits and modules)
- Used in a non-educational environment
- Used in a commercial environment
- Used in any dangerous or potentially hazardous environment
- Purchased from an unauthorised third party

Portable batteries refers to low powered alkali batteries. Lithium-based batteries and those with large current capabilities (such as lead-acid batteries) are not considered portable or safe

The use of the kits or products in the above scenarios automatically voids any warrantee or guarantee of that kit or product.

Kits must be

- Inspected for damage before and after construction
- Inspected for missing parts
- Constructed correctly by a qualified individual
- Used in an appropriate manner (i.e. within operational ranges)
- Purchased from an authorised seller

Those who are not competent to construct, inspect, and test kits and products must be accompanied by a competent individual and that competent individual assumes all responsibility for harm or damages and MitchElectronics is not liable for any harm or damage.

Missing Parts

MitchElectronics is only liable for missing parts for kits that have been purchased within 28 days and that have been purchased directly from www.mitchelectronics.co.uk. MitchElectronics is not liable for any product sold by an unauthorised third party.