PWM Signal Generator

FIRST Robotics Team 358, Hauppauge, NY

This is a useful stand-alone device for testing and using motors without a Robot Controller (RC). For those times when you want to run a motor at various speeds from a Victor or Jaguar Speed Controller before adding all the RC, joystick, etc. overhead equipment or programming. Just connect it and control motor speed by turning a knob. This is designed for use with Innovation First Victor speed controllers.

Background:

We can run motors on the test bench or in prototype setups via several methods:

- Driving them with an OI/RC, joystick, circuit breaker, victor/spike
- Connecting them directly to a 12v battery (only full on/off, reversing wires to reverse motor direction)
- Powering them with a Victor and a pwm signal generator
- Using a rheostat w/battery to vary speed (vary speed, reverse wires to reverse direction)

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Victor speed controllers receive their power from a 12v source, but are told what to do with that power via a control cable (see figure 2), generally from the RC, using a coded signal called Pulse Width Modulation (PWM). A PWM generator is a very cheap substitute for a FIRST Robot Controller/Operator Interface/joystick combination and gives you simple hardware speed control without needing a robot controller or any control programming.

Theory:

In FIRST competition the RC software orders up power from a Victor by specifying a value 0-254 and the robot controller hardware turns this request into a PWM signal the Victor hardware can understand.

A typical RC servo or Victor PWM signal is a square wave (see figure 1) of 5 volt pulses where each pulse varies in duration between 1ms, interpreted by the Victor as full reverse, and 2ms (full forward), with a 1.5ms pulse halfway between the two indicating neutral or no power output. The period of the whole PWM signal is around 16-17ms or about 60Hz. Jaguar Speed Controllers use a slightly broader pulse, but can be calibrated to use this Victor-range pulse, or the circuit can be modified slightly to produce a larger range.
This PWM generator circuit creates a regular pwm signal with the timing of the pulses varied by the knob of a potentiometer.
On a side note: when the voltage out of the Victor to a motor is less than full power (12v) the Victor actually switches on/off very fast (120Hz for a Victor 884) to give the motor a lower average voltage. This is also referred to as PWM, but in a different context. For instance, at half power the Victor will be switching on (letting 12v through) half the time and off (0v) the rest of the time so the average power coming out is 6 volts and the motor turns at half speed. Because the power is pulsed a normal multi-meter cannot be used to take accurate readings from a Victor.

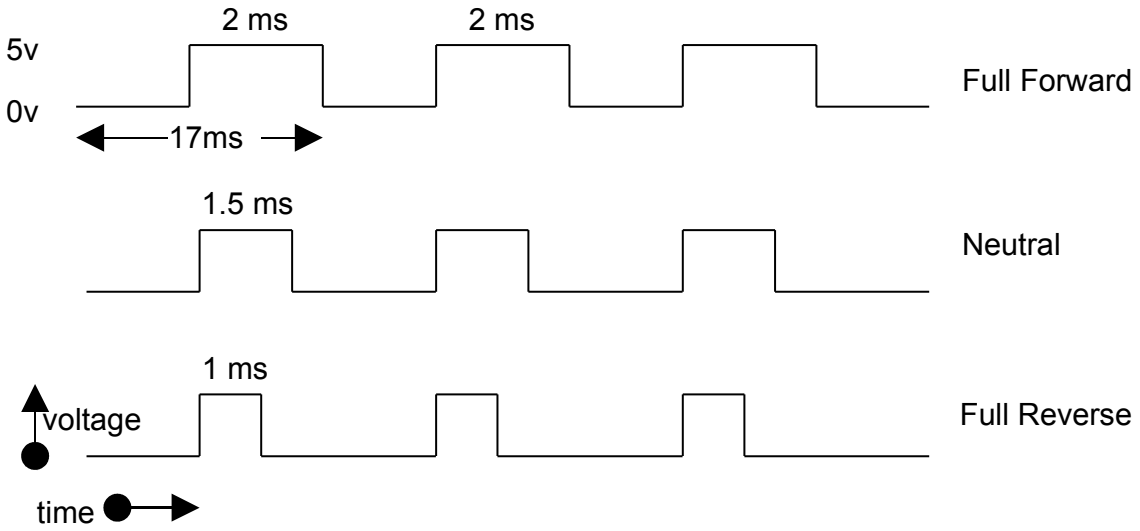


Figure 1: PWM Control Signals
(time between pulses is not to scale)

Construction:

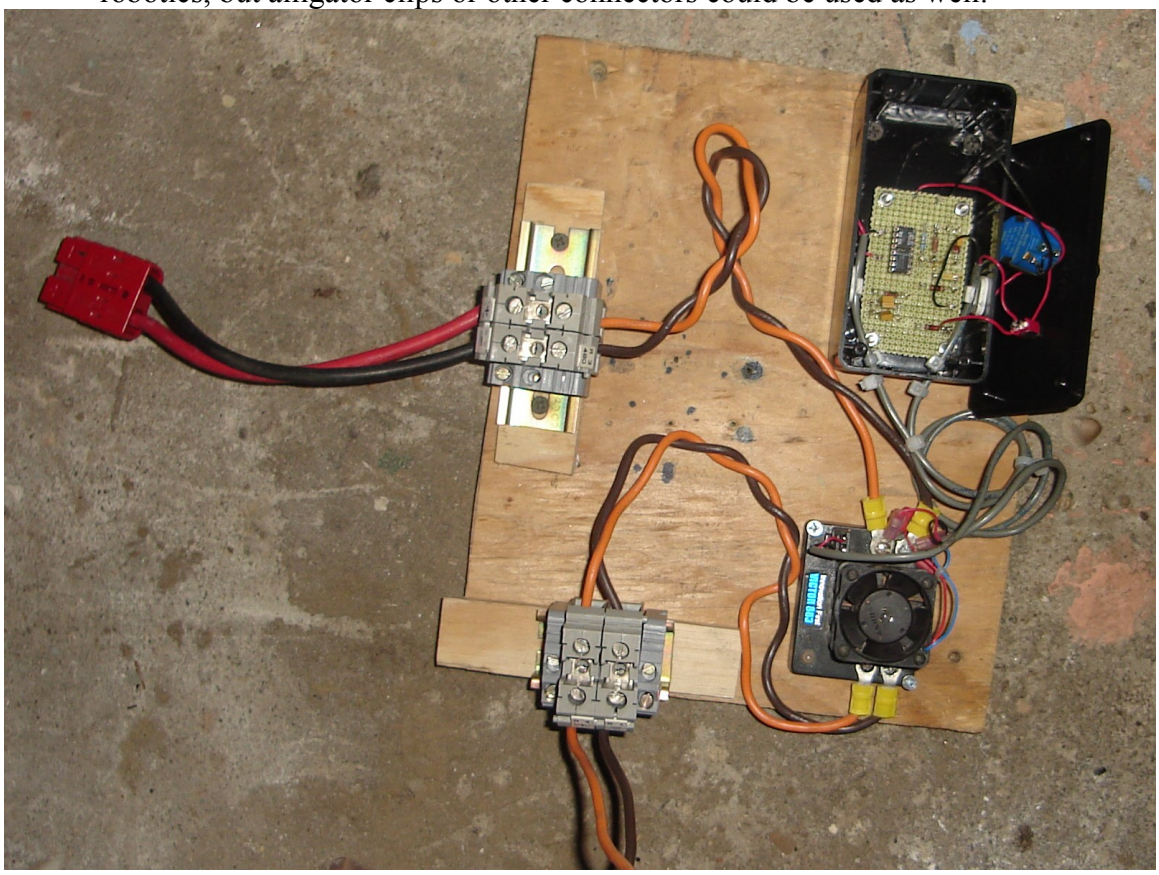
We'll describe the materials and circuits used in ours and you can see how ours is put together from the photographs, but outside the circuit the rest of what you assemble is up to you, so this doesn't describe a step-by-step build of the layout or circuit. Ours drives motors for quick tests of mechanical assemblies and mechanisms before they're mounted on the robot, so it's important to us to be able to quickly connect/disconnect the bare wires of an motor. We chose to use alligator clips large enough to handle the 12v/40+amps a motor could draw and take care they are insulated so they cannot touch and spark. We also use simple wire nuts on occasion when the connections need to be more secure on moving parts.

Some considerations are:

- How to connect the motor to the Victor? Possibilities include hardwiring the motor, using wire nuts, using alligator clips, or power connectors. It depends upon your need. Will you be swapping motors frequently so you'd need a quick disconnect or will it be semi-permanent? In the final configuration will the motors

be wired to a power connector or will they be wired directly to connectors suitable for a victor?

- How to connect the 12v battery? Anderson connectors are common in FIRST robotics, but alligator clips or other connectors could be used as well.



Materials:

- (1) Anderson connector if a standard FRC 12v battery source is to be used, or an appropriate connector to a transformer or other source.
- (2) Large alligator clips for connecting to motors or plan to use an alternate such as wire nuts
- (1) Victor speed controller
- (1) Project box w/PCB board for mounting the electronics
- (1) Potentiometer w/knob (dial the speed)
- (1) Toggle switch (as a kill/run control)
- #6 gauge wire for main power
- #18 gauge or better wire for power to electronics
- PWM cable #22 gauge w/male connector
- Appropriate labels for the controls
- Mounting base (to put it all on)

Tools:

- Multi-meter
- Low-wattage soldering iron w/solder
- Screwdriver(s)
- Drill

Wiring:

Main Power:

The basic layout is straight forward with the main power leading from the battery - to the Victor - to the motor just as you would normally wire your robot (see figure 2). We mounted this whole thing on a wooden base (shown above) and used a pair of power distribution blocks, but there are many ways to connect the battery and motor to the circuit.

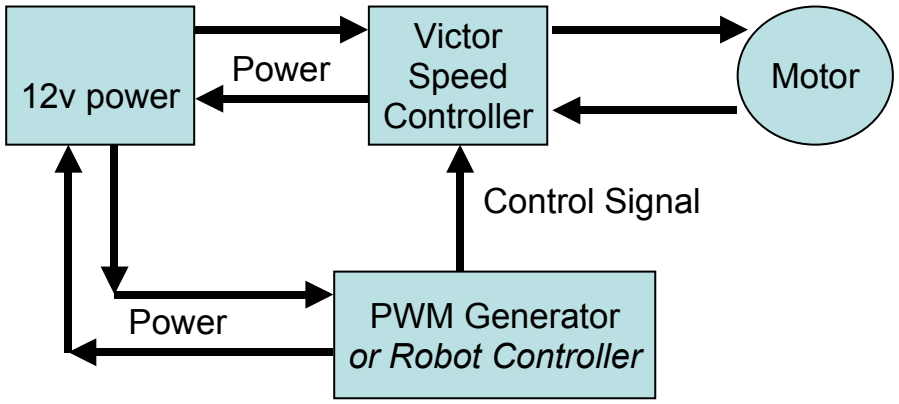


Figure 2: Operation Overview

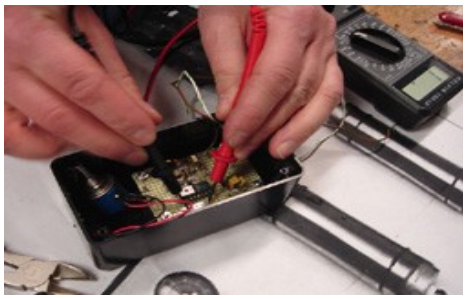
PWM Generator Circuit:

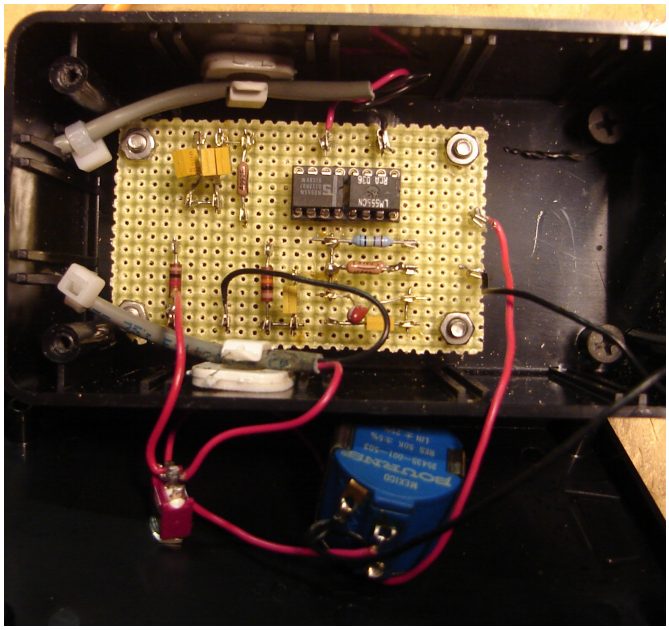
The PWM Generator circuit draws minimal power and we took what power it needs off the Victor input terminals just like the Victor cooling fan does. The PWM output from the circuit connects to the Victor's PWM port.

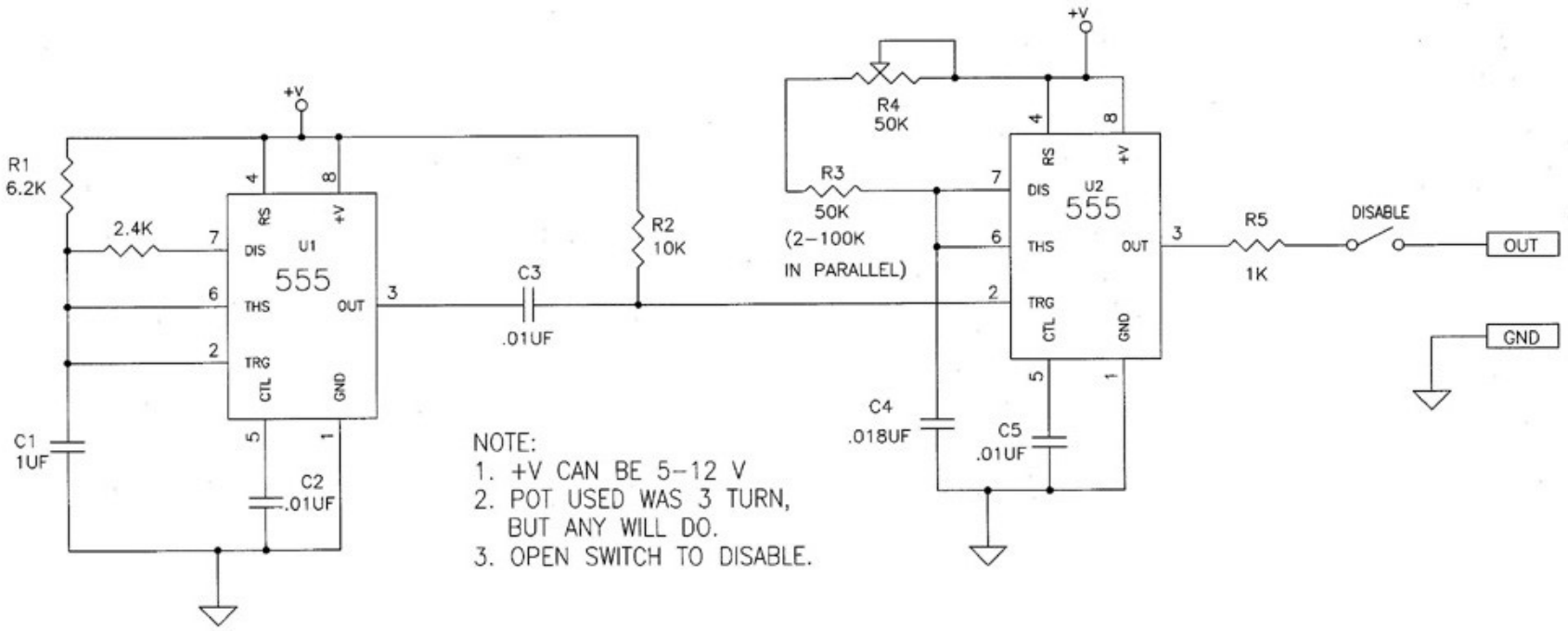
The control circuit itself and the parts required are shown in the following circuit diagram. We recommend wiring this and any new circuit on a temporary breadboard first for testing to make sure you understand how it works and prove you got the circuit right before soldering anything permanently.

Two 555 timing chips and some capacitors and resistors are all that are needed along with the potentiometer to adjust the variable motor speed and a kill switch. One timer chip is setup to trigger the next, so one does the fixed pwm 17ms duration and the other the variable pulse (1-2ms). The electronic parts are pretty standard and can be purchased at outlets such as Radio Shack or online.

Soldering should be done carefully with a low-wattage iron and thin solder so it melts easily. Circuit components typically should not be subjected to extensive, prolonged heat.






+V
R1
6.2K
2.4K
U1
555
DIS
THS
TRG
OUT
RS
CTL
GND
C1
1UF
C2
.01UF
C3
.01UF
R2
10K
R4
50K
R3
50K
(2-100K
IN PARALLEL)
U2
555
C4
.018UF
C5
.01UF
R5
1K
DISABLE
OUT
GND
NOTE:
1. +V CAN BE 5-12 V
2. POT USED WAS 3 TURN,
BUT ANY WILL DO.
3. OPEN SWITCH TO DISABLE.