Volt Tattler

Example Circuits - Revision C

Here are some example circuits that may be used with the output signals of the Volt Tattler version 1.01 Rev B. I am sure that there can be many others as well.

Disclaimer

These are example circuits for public use. Progress Direct Systems LLC is not responsible for changes to Volt Tattler (VT) or for damage directly or indirectly caused by using the Volt Tattler.

The Signals

The Volt Tattler has 6 signal lines, 5 of which provide various signals and the sixth provides a ground reference for those signals. The signals are direct outputs from the microcontroller and as such may need considerable adaptation to serve a particular purpose.

	V Between Thresholds	**V Above High Threshold**	**V Below Low Threshold**
L (LE)	Low	Low	High
GE (HE)	Low	High	Low
O (OOR)	Low	High	High
M (Morse)	Low	Keying Morse 'H' (….)	Keying Morse 'L' *(.-..)
T (Tone)	Low	Sounding Morse 'H' (….)	Sounding Morse 'L' (.-..)
G (Ground)	Reference for the other signals.	Reference for the other signals.	Reference for the other signals.

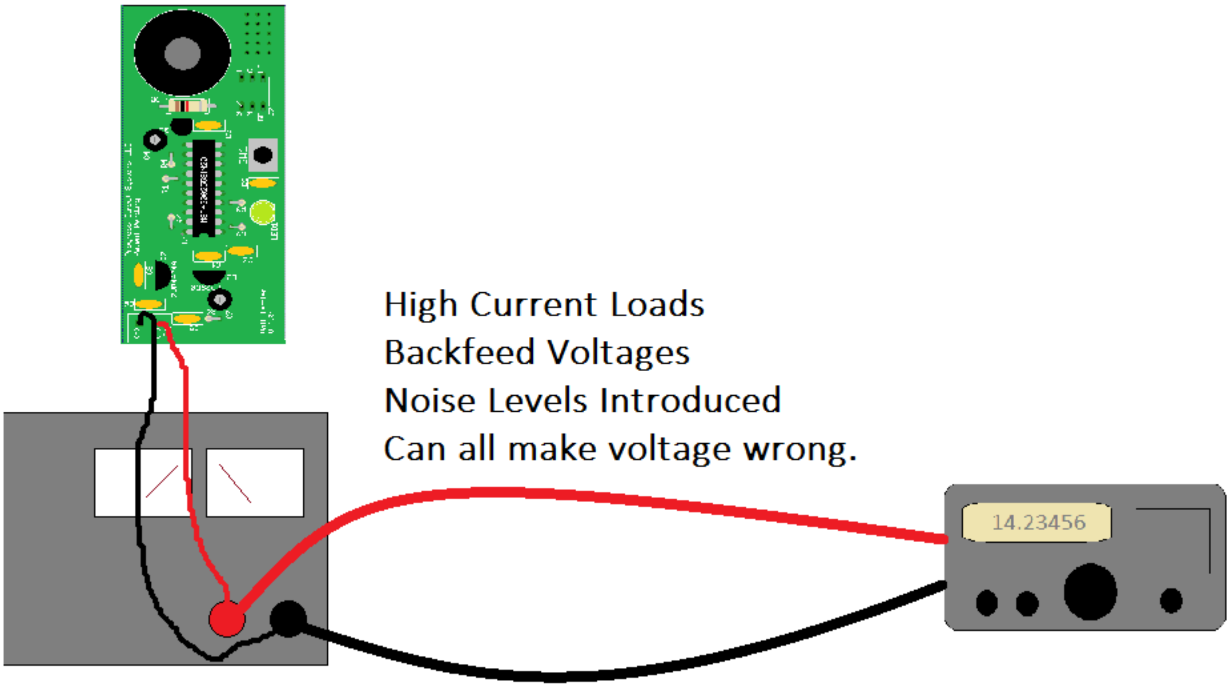
G - Ground for the other signals.
L - High (3V) when voltage is at or below the low threshold. This signal can source or sink 6 mA.
GE - Low when voltage is at or above the high threshold. Again this signal can source or sink 6 mA.
M - Morse keying of VT status. This provides keying for an external tone generator. This signal can key an external oscillator. 3V = key down, 0V = key up. This signal can source or sink 6 mA.
T - Morse tone at about 4 kHz that mimics directly the tone from the piezoelectric speaker. This is a 0V to 3V 4 kHz signal that can be coupled to external amplification to provide a larger signal. This signal should be capacitively coupled. This signal can source or snkabut3 mA.

Connecting VT Into the System

Before we can use the signals from VT we must first connect it into our system. We can simply find two points that represent system voltage and ground and connect VT with the proper polarity. But there may be some considerations to getting what you want from your Volt Tattler.

At the Source

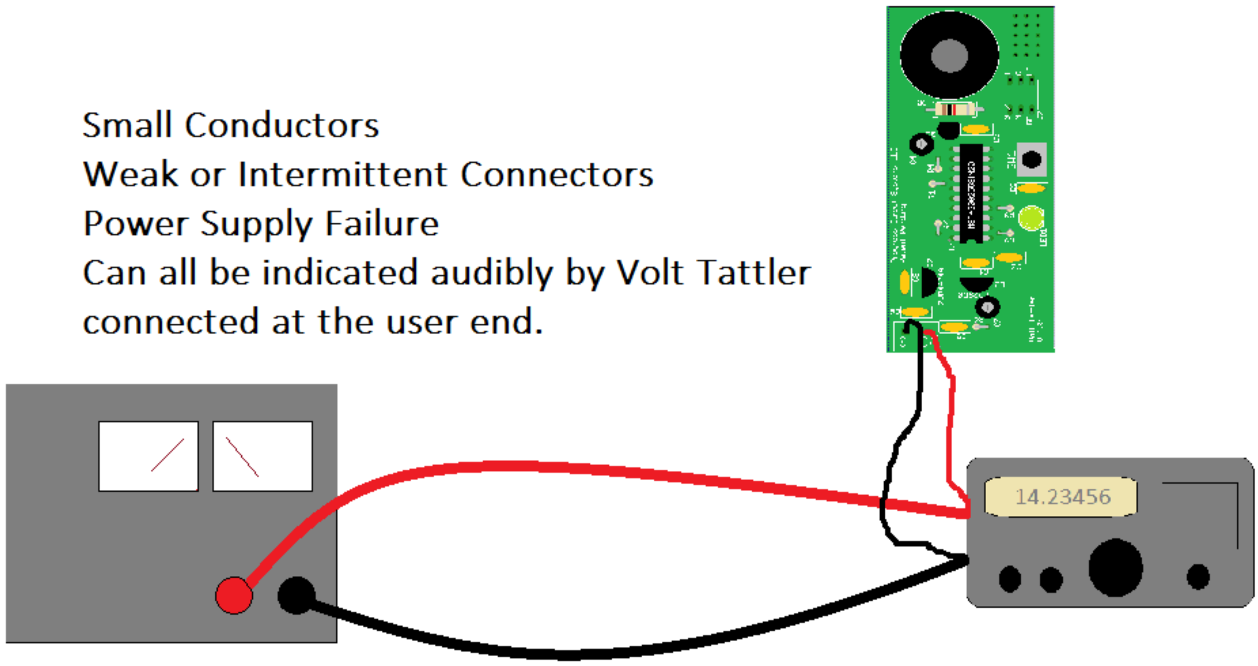
We can connect VT near the power source. This is especially useful if you are responsible for the power supplied for multiple users. As people connect and disconnect their equipment the voltage can be monitored and VT will squawk if there is a problem caused by, for example, too many users being connected, or somebody decided to connect his brand new 600 watt solid state linear amplifier. If anything causes the voltage to droop VT will not like that and the tattling will commence.



At the User's End

A lot of things can happen between a power source and the piece of equipment using that power. The power source itself can fail causing the voltage to go up or down inappropriately. Wires between the supply and your equipment may be too small to carry the current for your nice new 600 watt solid state linear amplifier. Connectors can be high resistance. Even intermittent connections can be detected. All of these can cause your rig to operate incorrectly and perhaps even be damaged. Having VT at the user's end of the power connections can help you see and troubleshoot problems.

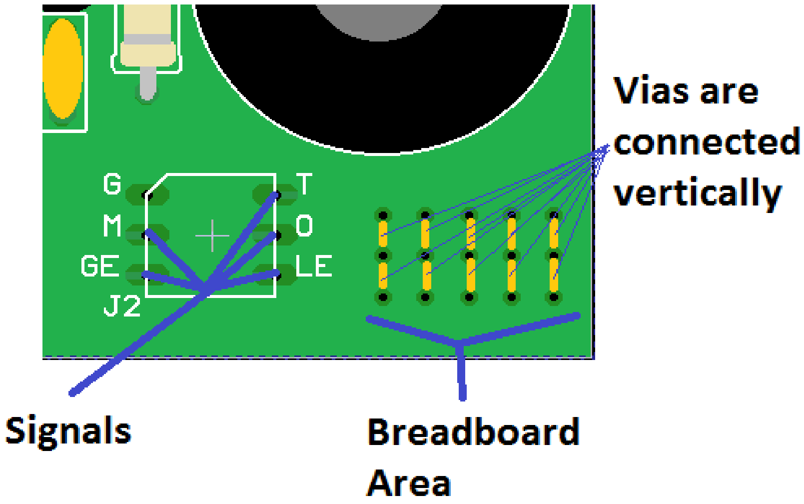
Every time VT powers up it announces power-up with the roger 'R' .-. letting you know it is on the job. Hearing the roger signal when the power was supposed to be "on" can tell you of a voltage dropout and perhaps intermittent connections.



Noisy DC

Although VT has some bypass protection for RF and even audio frequency noise, sometimes VT may be too “sensitive” even though the measured voltages do not seem to be wandering outside the limits. This may be lessened by further bypassing the input voltage to the Volt Tattler. <u>Care must be taken, however, as too much bypass capacitance can cause VT to miss power supply excursions of short duration.</u>

Signals and Breadboard Area



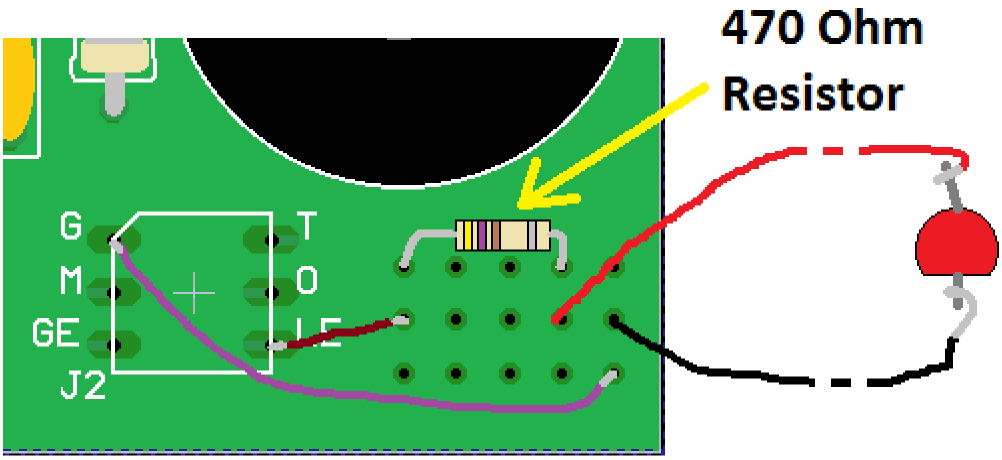
The Volt Tattler V1.01 has the signals next to a small breadboard area. It is hoped that this small area will assist in getting signals from the board for use by equipment downstream. The breadboard area is a set of vias vertically connected. Parts may be inserted here for experimentation and implementation purposes.

Circuit Suggestions

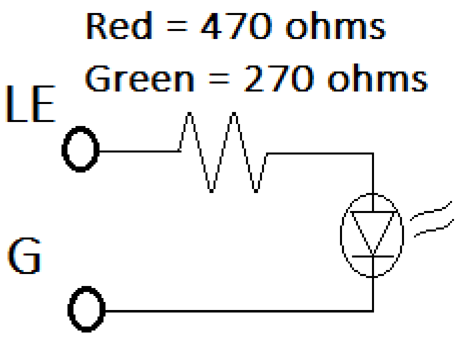
Driving an LED

Driving an LED can be simple or a bit more involved depending on the LED and the brightness expected. The Heartbeat LED is driven directly by a pin not unlike the signals provided. If you plan to drive a small red or green LED as an indicator in a not highly lit environment then a simple current limiting resistor may be all that is needed. It turns out that some LEDs may need a bit more voltage. It is still possible to use these but it will take a bit more circuitry.

Suppose we wanted a signal to indicate remotely (in the same room) that the battery voltage has dropped low. The LED is to be RED. Current should be limited to a few milliamps. The microcontroller datasheet indicates that 6 mA is a maximum that should be expected. Working circuits from the controller manufacturer indicate that a 470 ohm resistor may be good for a red LED while a 270 ohm resistor would work well for a green LED.



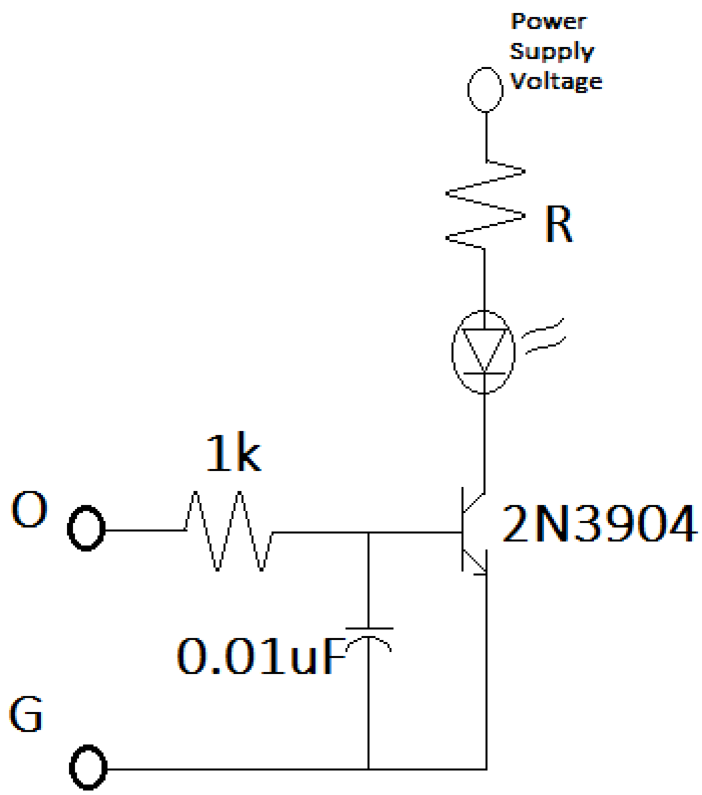
We see that a simple series resistor of 470 ohms is enough to allow the red LED to shine. A 270 Ohm resistor would be used to drive a green LED. But remember that whenever Volt Tattler is driving the LED, that current must be added to the total draw for the system.



Driving a Brighter LED

A brighter LED will require more current and probably a bit more voltage as well. In much the same way as the piezoelectric speaker is driven, we can use the incoming voltage source and a driver transistor like the 2N3904 to provide a brighter LED experience.

Most LEDs can handle a bit more than 5 or 6 mA. Commonly LEDs are specified at 20 mA or more current. If we use dropping resistor to match the expected voltage of the power supply we can use the power supply voltage to provide additional drive.



The value of R depends on the maximum anticipated power supply voltage (including failure modes) to protect the LED and the 2N3904 against over current.

We can calculate R by taking the maximum anticipated voltage. Subtracting the LED voltage drop then use Ohm's Law to calculate the value of the resistor.

V_{FD} = 3.0 = the forward voltage drop of the LED. This can be obtained from the datasheet.
$V_{MaxExpected}$ = 20.0
I_{LEDMAX} = 0.02 A (20 mA)

R = (20.0 – 3.0)/0.02 = 850 ohms.

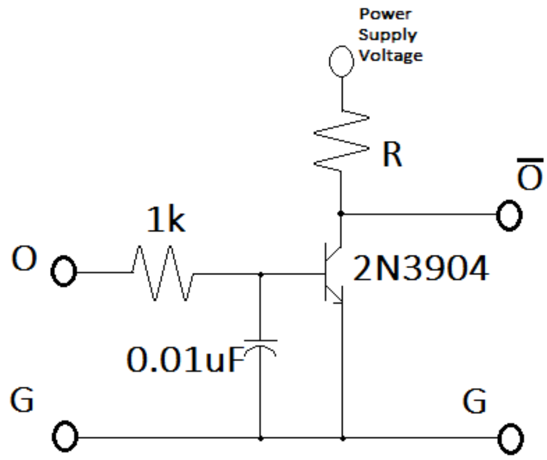
It is better to round up to 1000 ohms just to be safe.
We also need to know the wattage of the resistor.

Power = (20.0 – 3.0) * 0.02 = 0.34W

So a ¼ watt resistor is insufficient for this to keep the system robust. Putting a 1W 1K resistor would allow the system to fail at 20 volts indefinitely keeping the LED lit the entire time without damage to VT, the transistor or the LED.

Note that in this case I used the O output signal that goes active whenever VT voltage goes either high or low. The means that any abnormal voltage will light this LED. But any of the outputs (except G) could be used to drive this circuit.

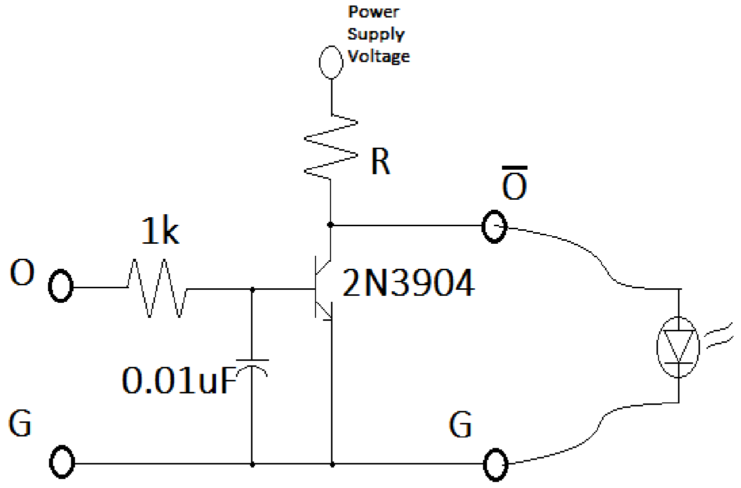
Signal Inversion



Any of the signals can be inverted simply with the circuit above. In this case the output logic level will be the inverse of O. This may be useful if a true logic signal is needed to indicate that the voltage is OK. Resistance and power values for R should be determined for driving downstream logic requirements. If we want to drive an LED, however, R can be determined as shown here.

Suppose you have a green LED that needs to light up when the VT is happy. From the datasheet for our LED we find the forward voltage drop (V_{LED}) = 2.5 and the forward current (I_{LED}) is 20mA (0.02A). R must be able to do 2 things.

- It must be able to limit the current to an LED connected between the ***Not O*** and ***G*** terminals.
- It must manage the power that it dissipates.



Also suppose that your supply (V_{PS}) was 13.8V. We can calculate both the resistance value and the power value for R as follows:

$V_R = V_{PS} - V_{LED}$
$V_R = 13.8 - 2.5 = 11.3V.$

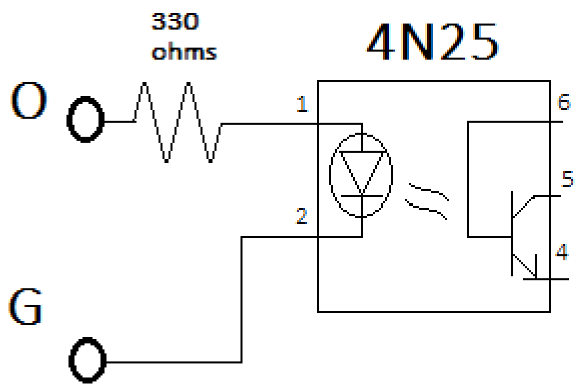
It is important to see that the LED and R are in series. Therefore all of the current passing through the LED will also pass through R. That is to say $I_R = I_{LED}$.

$R = V_R / I_R = 11.3 / 0.02A = 565$ ohms. We can use a 680 ohm resistor and be close enough and still protect against over current. But what wattage rating?

$P_R = V_R * I_R = 11.3 * 0.02A = .226$ Watts. Although technically we could get away with using a quarter watt resistor here, good engineering practices would suggest a half watt just to be sure.

So a good values for R would be 680 ohms and ½ Watt to light the green LED when Volt Tattler is operating within normal limits.

Optical Isolation

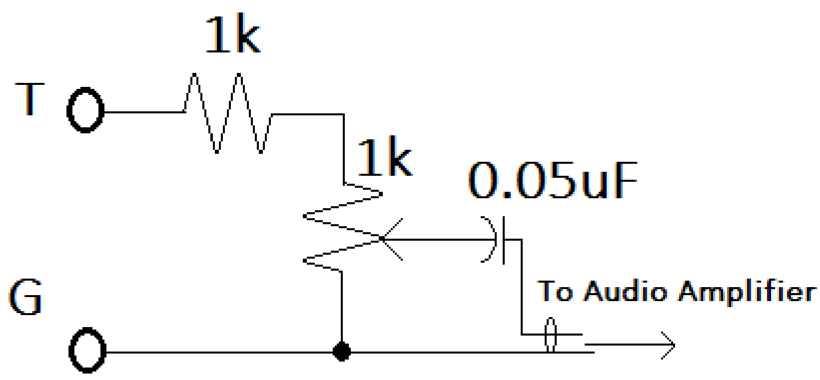


It is possible to optically isolate the output making it more immune to downstream common mode issues. Here the O output has been selected to drive a 4N25 optoisolator. With the 330 ohm resistor the LED should drive at about 5 mA. With the 4N25's 20% current transfer ratio the output transistor will conduct about 1mA. Sometimes a 0.01uF capacitor is placed between the base and emitter of the transistor of optoisolators to suppress environmental EMF noise on the output transistor.

Audio Morse Code

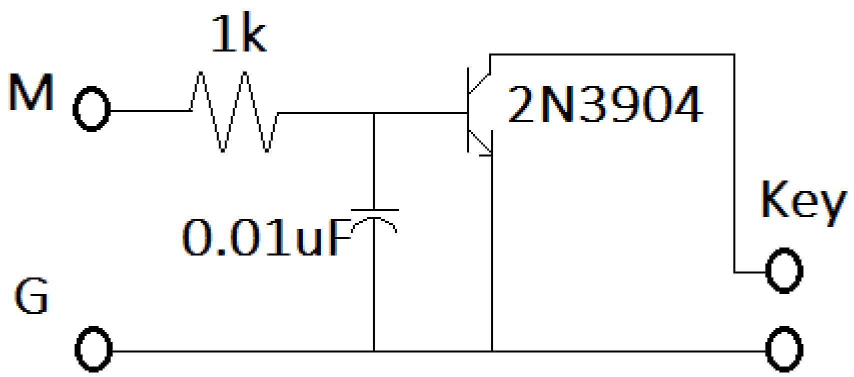
One of the signals Volt Tattler provides is the 1.5kHz Morse Code audio. Although this is a square wave it can be used to drive an amplifier but it needs to be interfaced to do so. The signal is fairly large and may need to be attenuated as well as capacitively coupled. 1.5KHz was chosen so as to make it stand out where CW enthusiasts generally use lower audio frequencies to copy Morse Code during communications while not being too high so as to be difficult for us older hams to notice.

A simple way to attenuate the signal is to use a dropping resistor and an adjustment potentiometer before the decoupling capacitor.



The above circuitry somewhat isolates the audio output from the microcontroller. It also provides a bit of adjustable attenuation for the audio. Be aware that AC hum may be present here in the form of ground loop hum. An isolation transformer can help. In addition amplification locally to VT can cut down on ground loop induced hum.

Keying an Oscillator

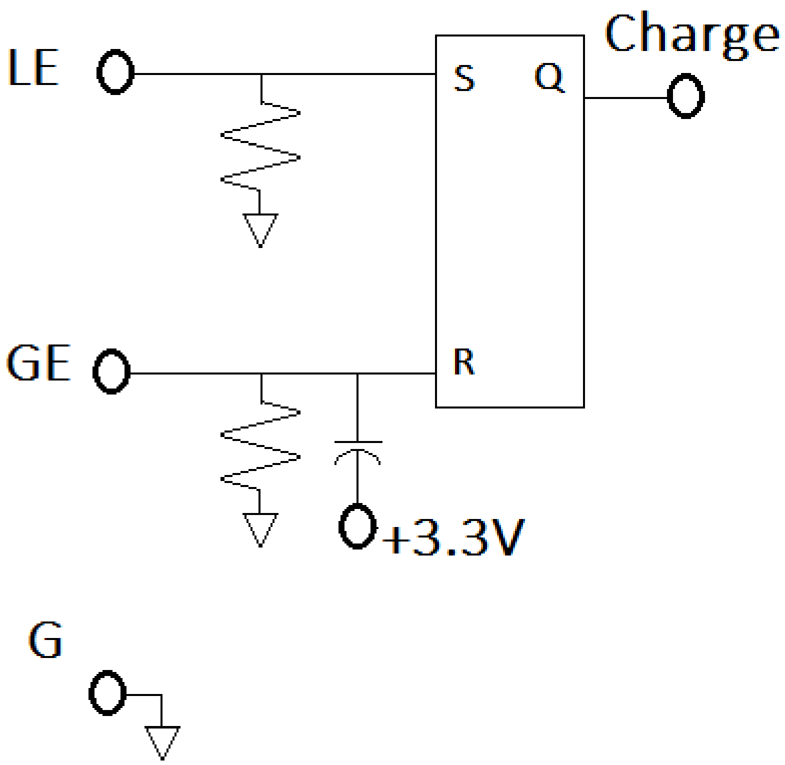


A code oscillator can be generally keyed by a simple straight key. A straight key is a simple switch that shorts two contracts. Here we are using the 2N3904 as an inverter and to provide enough key current to drive many code oscillators. Optical isolation might also be used but output current from the optical isolator may not be enough to directly drive the oscillator.

Charging Batteries

Volt Tattler may be used to provide programmable voltage levels for charging batteries. Not all batteries use simple voltage thresholds for charge control. It is up to the user to know what they are doing here. In addition to the VT you will need to provide circuitry to switch from charge to not charge, limit the charge current and to manage power up and power down state of the system.

Following are some suggestions for a way to start experimenting with battery charging using VT.

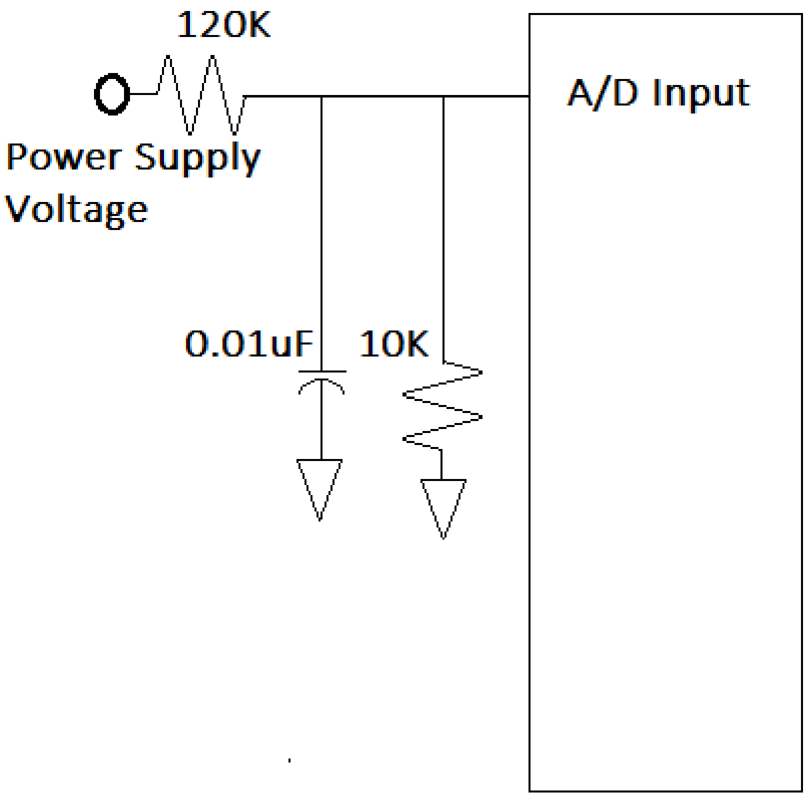


Essentially VT drives a Set/Reset flipflop. The HC logic family interfaces nicely here. The capacitor would force a reset at power up so that the unit will not start charging just because the R/S flip-flop saw power. This is just a suggestion. Considerably more work would be needed to provide a viable voltage controlled battery charging system.

Advanced Concepts

Volt Tattler measures its own power supply voltage. This is to simplify its use and minimize current draw. But it is possible to use VT for other voltages, as long as those voltages are referenced to VT common and maximum voltages at the microcontroller are not exceeded. VT voltage sensing input circuitry is very simple.

It is important to understand that modifications such as these may disable the VT polarity protection. Care must be taken to avoid damage of the unit due to high input voltage or reversed polarity.



It should be possible to disconnect the 120K resistor and then use whatever resistor that you desire. One end of the new resistor would still connect to the A/D but the other end of the resistor might connect to other voltages within the system. As long as the voltages would be measured with respect to the ground of the Volt Tattler this should be entirely possible. You would want to ensure that the Volt Tattler voltages were not exceeded and that the microcontroller was activated before other devices at power up. That way voltages would not be coming into the powered-down controller A/D input that might damage it if powered down.

Of course calibration would be needed relating to the new voltages.

More Precise Thresholds

Perhaps you didn't need coverage to 25 volts. If your system could only possibly go to, for example, 15 volts you could lower the 120K resistance and calibrate the Volt Tattler.

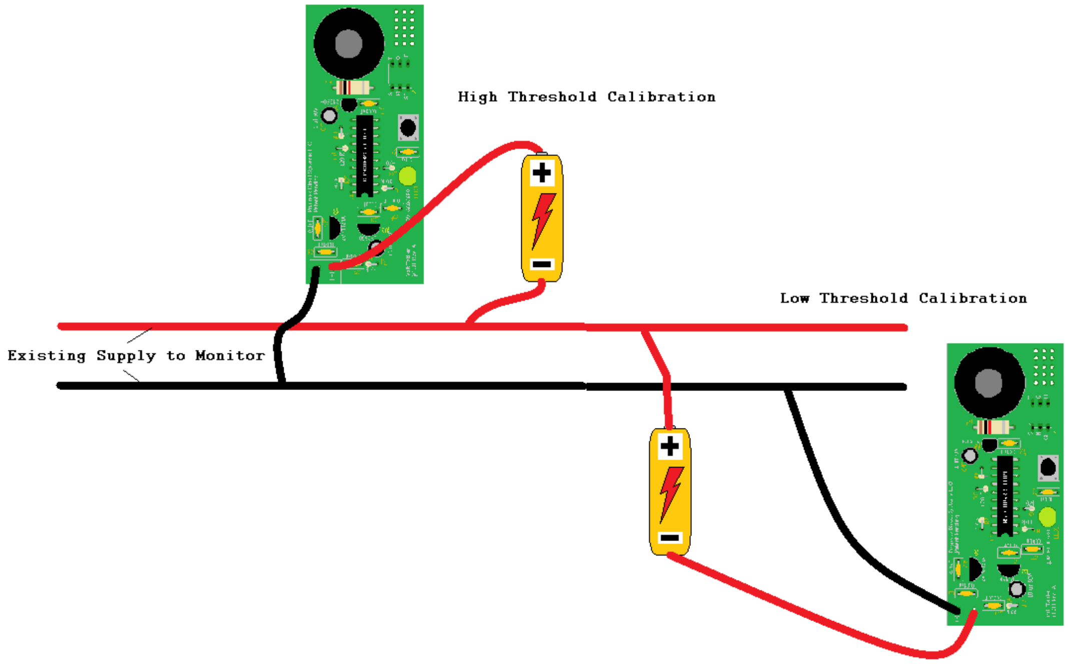
With the 120k resistor the ratio of the power supply voltage to the A/D voltage for the standard Volt Tattler is approximately (120 + 10)/10 = 13.

Resolution for the standard Volt Tattler is about 0.03V. (30V / 1024). You could improve that by simply changing the 120K to say 68K. Now the ratio of power supply voltage to A/D voltage would be (68+10)/10 = 7.8. That means the maximum voltage measured would be approximately 2.5 * 7.8 = 19.5 volts. This means that the resolution would improve from 0.03V to about 0.02V, (19.5/1024).

In this case polarity protection would still remain in place.

Calibration Without an Adjustable Supply

Perhaps you don't have a variable supply. Maybe you only have the normal supply voltage and no way to adjust it to calibrate high and low thresholds. There is still a way to calibrate for a voltage above and below the supply that you have. We can do this using a fresh 1.5V cell and the supply that you intend to monitor.



Looking at the diagram we can see how to use a single 1.5 volt battery to add and subtract 1.5 volts from an existing supply. Calibration of the high and low thresholds in this way gives a small margin around the voltage at the time of calibration.

For example if we have a 13.6 volt power supply. We can use a single cell to give us thresholds of around 15.1 and 12.1 volts. If a supply goes awry these thresholds may be sufficient for your needs.

Wrap Up

These are but a few of the possible circuits and ideas that I am sure are possible with the Volt Tattler. Remember that VT output logic signals are simply 3V logic output from the microcontroller. Also remember that every feature that you add will come with a corresponding increase in current draw. For some systems this may not be an issue.