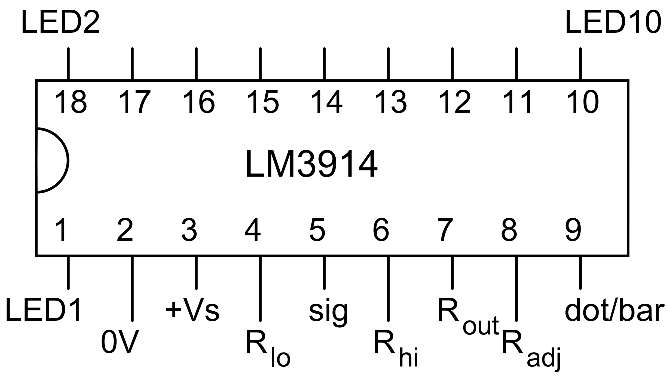
12V Battery Tester.

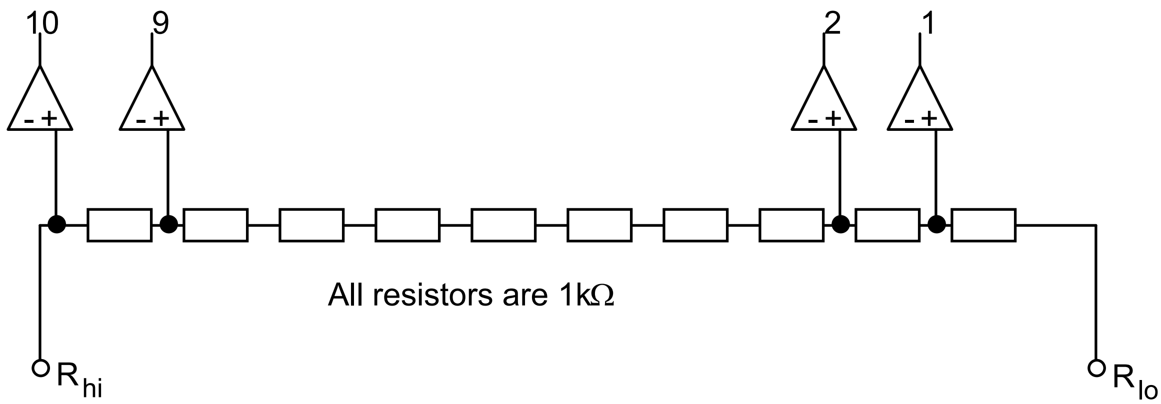
Specification

Takes power from the circuit under test (approximately 15mA).
Based on LM3914 IC.
Displays voltages from 10V - 14.5+V using LEDs.
10 LED dot display showing every half volt.
Colour indication to show state of battery.

Using the LM3914



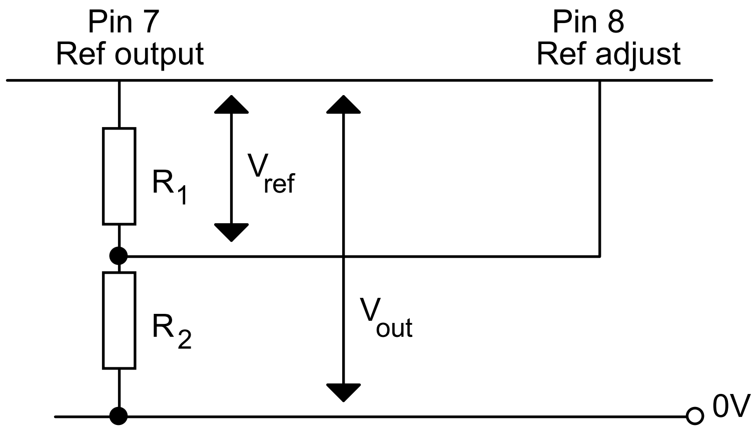
R_{hi} is the connection to the top of the internal resistor divider chain
R_{lo} is the connection to the bottom of the internal resistor divider chain.
The internal resistor divider chain is arranged as below.



The signal input to the LM3914 is derived from a voltage divider across the power supply terminals made up of two 10kΩ 1% resistors. This means that R_{hi} must be at a voltage of 7.25V for LED10 to light at 14.5V. For LED1 to light at 10V, R_{lo} must be at a voltage of 4.75V, owing to the 1kΩ resistor before the comparator for LED1. This will give 5V at the non-inverting input of the LED1 comparator.

This results in a voltage of (7.25 - 4.75) 2.5V across the LM3914 internal resistor chain.
With 2.5V across the 10kΩ internal resistor chain, a 19kΩ needs to be connected from R_{lo} to 0V to achieve the required voltages. The 19kΩ resistor was made from selected a 18kΩ and 1kΩ resistor.

The LM3914 contains an internal voltage reference which produces a constant voltage of 1.25V between pin 7 and pin 8 (pin 7 is positive with respect to pin 8). The voltage at pin 7 with respect to 0V is controlled using the circuit below.



V_{out} is given by the formula

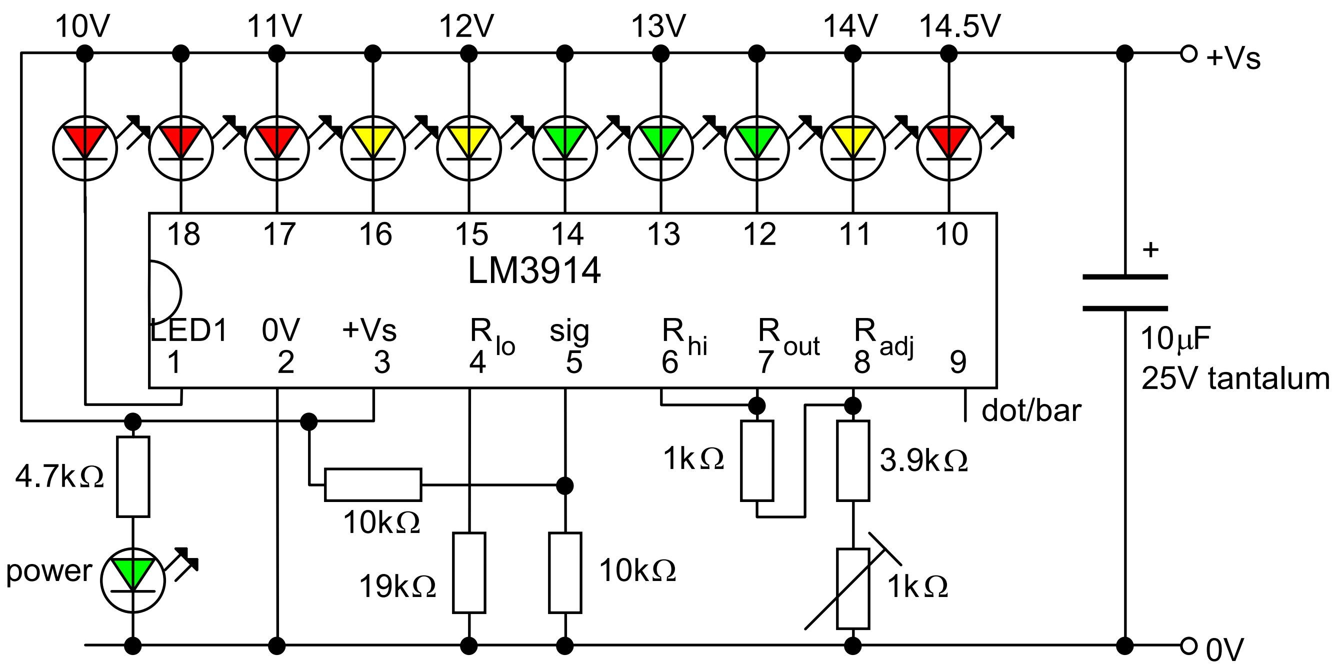
$$V_{out} = V_{ref}\left(1 + \frac{R_2}{R_1}\right) + I_{adj}R_2$$

where Vref = 1.25V and Iadj ≈ 120μA (maximum).
The current passing out of Pin 7, also determines the current which will pass through each LED. The LED current will be approximately 10 times larger than this current, so

$$I_{LED} \approx \frac{12.5}{R_1}\ \text{Amps}$$

A 1kΩ resistor was used for R_1, which gave an LED current of approximately 12.5mA. The equation for V_{out} was then rearranged and solved for a value of R_2 giving a value for R2 of 4380Ω, which was made from a 3.9kΩ resistor in series with a 1kΩ variable resistor.

The complete circuit diagram is shown below.



The prototype was built on stripboard. A layout is not included as this will depend on the size of LEDs used.

A power on LED is included in case the battery voltage is below 10V.

A 12V lead acid battery can be considered to be fully discharged at a terminal voltage of 11V.

A 12V lead acid battery can be considered to be fully charged at a terminal voltage of 12.9V
A battery should be allowed around 20 minutes for its terminal voltage to settle following being charged or discharged.

Aim to keep 12V lead acid batteries at a terminal voltage of >12.3V.

To float charge a battery, a supply of 13.5 - 13.8V should be used.

Charging with a terminal voltage of 14 - 14.5V, will charge the battery much faster but runs the risk of doing permanent damage to the battery if it is allowed to overcharge.

Lead acid batteries should always be stored fully charged.

Heat is detrimental to the life of batteries.

ALL lead acid batteries (including SLA) need to be checked for electrolyte level and topped up with distilled water when necessary. The top of the plates should just be covered.