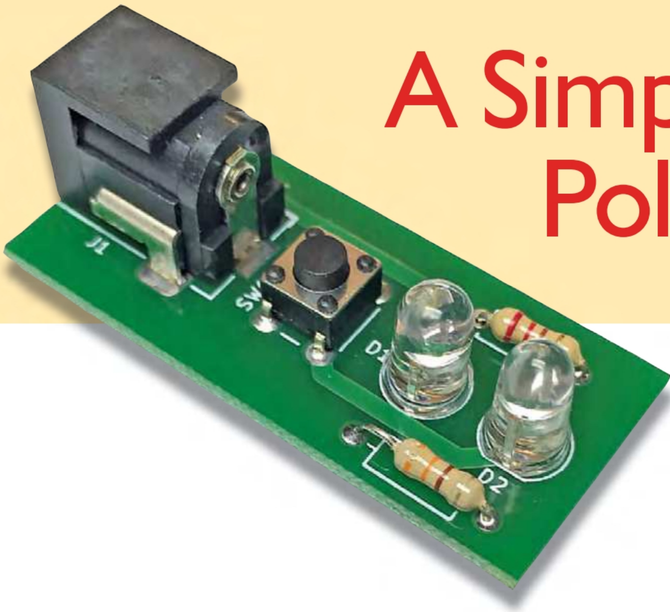

A Simple DC Power Polarity Checker

Save your equipment from reverse polarity disasters.

John Burnley, NUØV

One of the most common mistakes I make while building simple radios is incorrectly hooking up my power supplies. Adapter supplies sometimes have the polarity reversed. Some are even ac and not dc. I try to check the polarity with a volt ohm meter (VOM), but if I forget, there can be chaos.

My operating over the past 2 decades has been with homebrew QRP radio kits from clubs or vendors. These use the common barrel connectors that have powered amateur radios and accessories for decades. There are technologies like Anderson Powerpole connectors that would alleviate polarity issues, but the cost of the connectors and cables were more than the radios themselves. I needed an easy, inexpensive, and consistent solution.

A Simple Polarity Checker

The DC Power Polarity Checker is a simple circuit (see Figure 1), utilizing two light-emitting diodes (LEDs), two resistors, a momentary switch, and a barrel connector that fits your devices. Barrel connectors come in several different sizes, so you must make sure you are using the correct one. The most common ones seem to be 2.1 and 2.5 millimeters. This refers to the diameter of the center pin. The outer sleeve in both cases is 5.5 millimeters.

The device uses two colored LEDs to indicate proper polarity — green is correct, red is reversed. When a power source is connected to the checker, the momentary switch must be pushed to engage the circuit. If the polarity is correct, D1 (green) will be forward biased and conduct. R1 limits the current flowing through D1. D2 (red) is reverse biased and does not conduct. If the polarity is reversed, D2 is forward biased and conducts. R2 limits the current flowing through D2. D1 is reverse biased and does not conduct.

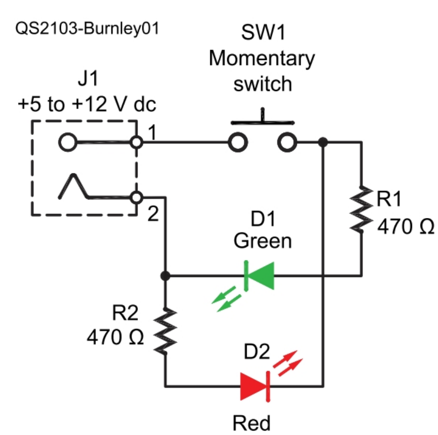

Figure 1 — The schematic diagram, showing the LEDs and current limiting resistors are parallel in the circuit. The polarity of D2 is reversed from D1, ensuring that one is always forward biased.

Table 1 — LED Voltages, Current Ratings, and Calculated Resistance

Source Voltage	Component	Forward Current	Forward Voltage	Calculated Resistor	Chosen Resistor	Adjusted LED Current
+12 V dc	D1	30 mA	2.6 V	313 Ω	470 Ω	20 mA
+12 V dc	D2	40 mA	2.4 V	240 Ω	470 Ω	20.4 mA

Note that the circuit uses the next higher standard 20% resistor value. Both resistors were set to the same value to make sourcing of parts easier. The reduced current will dim the LED slightly from the nominal maximum current.

Table 2 — Parts List

Component	Description	Vendor	Part Number
D1	Green LED	Jameco	333551
D2	Red LED	Jameco	152864
R1, R2	470 Ω, ¼ W carbon film resistor	Jameco	690785
SW1	Momentary switch	Jameco	153252
J1	2½ × 5½ millimeter barrel connector	Jameco	297570
Alternate J1	2.1 × 5½ millimeter barrel connector	Jameco	101178

The resistance calculation is based on the Ohm's Law formula $R = E/I$, where R is the resistance in ohms, and E is the voltage to be dropped across the resistor and is calculated by subtracting the LED's maximum forward voltage, E_f, from the source voltage, E_s. I_f is the maximum forward current in amperes. The modified formula is $R = (E_s - Ef)/I_f$.

The nominal values for R1 and R2 depend on the LEDs you have chosen. Characteristics of LEDs vary by color and manufacturer. Each LED has two important specifications. Forward voltage is the voltage drop required to turn on the LED. The remaining source voltage will appear across the current-limiting resistor, because the sum of the voltages across two devices in series must equal the applied voltage.

Forward current is the current that flows through the LED to produce normal illumination. This must be limited, as too much current through an LED will cause catastrophic damage to the component. Running an LED at less than its rated current is okay; it just dims the light a bit.

Resistor Values

When choosing resistor values, first check the datasheet (if available) and look for maximum forward voltage and maximum forward current. You'll use these values to calculate the resistance with Ohm's Law. If you use old LEDs, you can safely assume similar values for red and green LEDs. Table 1 lists the values for LEDs I had in my junk box and the calculated resistance values.

In all probability, your calculated value will not be one of the standard resistor values. In this case, simply choose a resistor that is the next standard value above your calculated value. If you chose a lower value, you could allow too much current to flow through the LED and damage the component when operating the checker. An LED failure can be quite spectacular, and very dangerous. If you want to check your calculations, you can use the online calculator at **https://www.pcboard.ca/led-dropping-resistor-calculator**.

It is good practice to check the power dissipated in any resistors in your circuits. Volts times amps gives the power in watts. For our design, the resistors will be dissipating less than 10 V × 0.0204 A (or 0.204 W), so a ¼ W or ½ W resistor is fine, especially because the duty cycle is very low.

Building the Checker

Construction is simple. First, install the barrel connector followed by the momentary switch. Next, install the LEDs, making sure to observe the correct polarity. The longer lead is the anode (positive) and the shorter one is the cathode (negative). Finally, solder the resistors in place. The longer lead is the anode (positive) and the shorter one is the cathode (negative). For further building instructions and additional calculations, visit the *QST* in Depth web page at **www.arrl.org/qst-in-depth**.

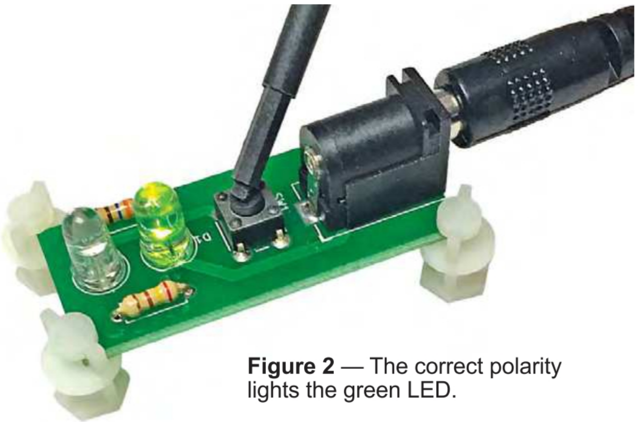

Figure 2 — The correct polarity lights the green LED.

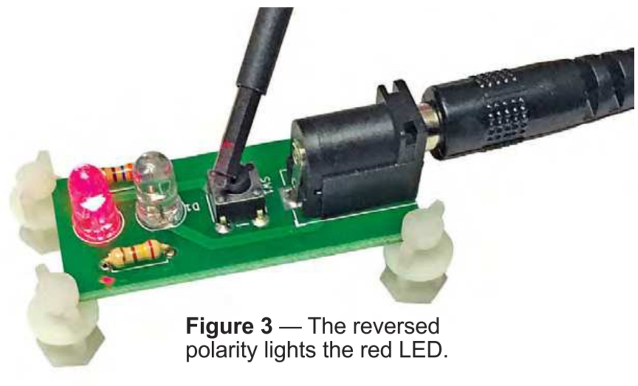

Figure 3 — The reversed polarity lights the red LED.

Operation is equally simple. Plug the power cable under test into the barrel connector. Turn on the power source. Press the momentary switch. If the polarity is correct, the green LED will illuminate. Figure 2 shows a cable with the correct polarity. If the polarity is reversed, the red LED will illuminate as illustrated in Figure 3.

This was a fun project to put together and it has saved me countless headaches. A PCB is available from the author for those who would like to build the DC Power Polarity Checker.

John Burnley, NUØV, has been a licensed amateur for 50 years. He earned a BA degree from the University of Kentucky, and an MBA from the University of Iowa. He worked in information technology for over 30 years in technical, managerial, and executive leadership roles. He is a faculty member at Iowa State University and Des Moines University, teaching information technology courses at the undergraduate and graduate levels. He is a QRP enthusiast, operating low-power equipment. He can be reached at **nu0v@arrl.net**.

For updates to this article, see the *QST* Feedback page at www.arrl.org/feedback.

Feedback

■Anthony Le Cren, F4GOH/KB1GOH, has added GPS capabilities to his WSPR beacon project, featured in his August 2020 *QST* article, "Program an Arduino to Transmit WSPR." The update is available on his website, at **www.hamprojects.wordpress.com/2019/06/02/wspr-beacon**.

■The November 2020 "How's DX?" column stated that the power limit for amateurs is 100 W effective isotropically radiated power (EIRP). The limit is actually 100 W to a half-wave dipole, described by the FCC as follows: "For the purpose of computing ERP, the transmitter PEP (peak envelope power) will be multiplied by the antenna gain relative to a dipole or the equivalent calculation in decibels. A half-wave dipole antenna will be presumed to have a gain of 0 dBd." This is explained in more detail on the ARRL Frequently Asked Questions page about operation on 60 meters, available at **www.arrl.org/60-meter-faq**.

■In "The ARRL February School Club Roundup" announcement, which appeared in the January 2021 issue, the caption for the photo should have read, "Winston Matson (left) and Margaret Clifford (right) operated as part of the N4SMS School Club Roundup team from Schofield Middle School in South Carolina. Winston's sister, Anna Matson, KN4IVD, acted as their mentor." *QST* regrets the error.