Solid-State Those Pilot Lamps
By Phil Salas – AD5X

Introduction

As I'm sure you know, many old and even new brands of ham gear use the popular #44, #47, and #51 pilot lamps. My latest restoration project, a Johnson Ranger, has five 6.3VAC pilot lamps, each drawing 250 milliamps, for a total of 8-watts dissipated power. And three of the pilot lamps are enclosed in impossible to replace items on the Ranger – namely the dial (two lamps) and the meter (one lamp). Long-term exposure to the approximately 1.5 watts per lamp of heat in these enclosed places was a concern to me.

All Electronics (www.allelectronics.com) sells 5 mm 3000 mcd white LEDs for $2 each (LED-75). These are three times brighter than the original Ranger pilot lamps. However, LEDs do have a narrow viewing range so they can normally only be used when the lamp is mounted such that the LED faces forward. In the three enclosed pilot lamps of the Ranger, the pilot lamps do face forward so these would be perfect for LED replacements.

Making the LED Pilot Lamps

First of all, most of the ultra-bright LEDs have normal operating currents of about 20 milliamps. In order to properly set this current, I put a 500-ohm pot in series with a 6.3VAC source and measured the current on a multi-meter. Remember that LEDs are diodes, so they rectify the AC voltage and therefore LED polarity doesn't matter (obviously polarity does matter if the LED is driven from a DC voltage source). Using this methodology, I determined the series resistors necessary to provide 20 milliamps from a 6.3VAC source for most ultra-bright LEDs is as shown in Table 1 below:

Table 1

LED	Fwd Voltage	Series Resistor
White	4V	82 ohms
Green	3V	100 ohms
Amber	3V	100 ohms
Blue	3V	100 ohms
Red	2V	120 ohms

Depending on your particular LEDs, LED current, and voltage sources, you should probably make this same measurement to ensure that you pick the correct dropping resistor for your application. Incidentally, when using AC sources, it is best to either put a second LED reversed across the first LED, or connect a diode across the LED as shown in the schematics. The reason is that the maximum reverse voltage is only around 5-6 volts, and most AC sources can exceed this. So a second LED (which will double the output) or a diode will restrict the reverse voltage applied to the LED to a safe value. I didn't worry about this for my 6.3VAC source and haven't had any problems, but I would certainly do it for higher AC voltages.

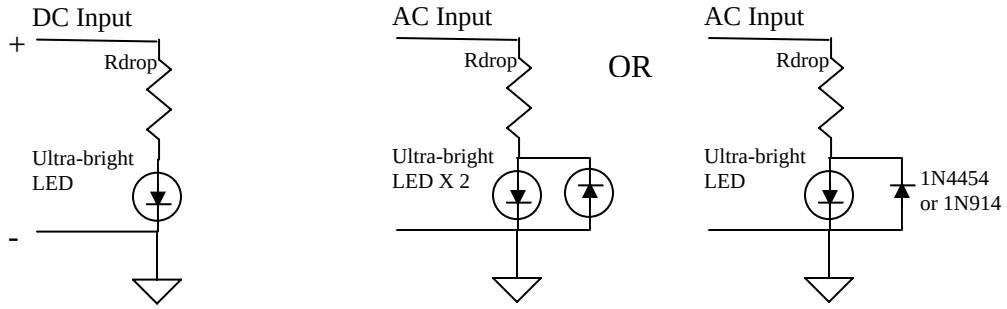
Building a pilot lamp substitute is easily done if you can build the ultra-bright LED and dropping resistor directly into the associated pilot lamp socket. In my case, the pilot

lamps all used bayonet bases. I chose to purchase some #47 bulbs (All Electronics #LP-47 @ 2/$1.00) and sacrifice them for this purpose.

To prepare the LED-lamp base, do the following:

1) Put on safety glasses!
2) Wrap the pilot lamp in a small plastic sandwich bag and gently crush the glass part with pliers.
3) Using the pliers, gently squeeze and rotate the base. This should break up the remainder of the glass in the base. When through, ensure that the base is as round as possible.
4) Shake out the glass, and then use a solder-sucker to remove the solder from the tip of the base.
5) Using needle nose pliers, pull the remaining pieces of bulb and wiring out of the base. If necessary, re-use the solder-sucker to clear out any remaining solder.

The schematic circuits are pretty simple.



Gather up the necessary parts. In my case, I used the 3000 mcd ultra-bright white LEDs discussed earlier with a ¼-watt 82-ohm series resistor. Refer to the first photo.

Now, cut one lead of the resistor, and one lead of the LED to 1/8-inch. Overlap these short leads and solder them together. The use of one of those desk-top "helping hands" is great for holding these parts together while soldering. Now bend the remaining LED lead over and up as seen in the second photo.

Insert the long resistor lead though the hole in the base until the body of the resistor bottoms out in the base. Solder the resistor lead in place. Now solder the bent-up LED lead to the side of the lamp base. If you'd like, you can fill the base with epoxy or hot-glue to give it some stability. I didn't find this necessary. Clip off excess lead lengths and you're done. Refer to the last photo. Now you can just insert these LED Pilot Lamps into the original pilot lamp sockets. You've decreased the current drain by at least a factor of 10, and significantly increased the reliability of the lamp. In most cases, the intensity will be noticeably brighter.

<u>The Other Two Ranger Lamps</u>

The remaining two lamps ("ON" and "TRANSMIT") used in the Johnson Ranger mount vertically behind the front panel, and the light is actually picked up from the side of the lamps and transmitted through two jewel assemblies to the front. These jewel assemblies

have an inside diameter of 5 mm, therefore the 5 mm ultra-bright LEDs wound up fitting tightly into these assemblies. Since the jewels have red lenses, I went ahead and used lower cost ultra-bright red LEDs for these two locations (All Electronics LED-94 @ $0.75 ea). As it turned out, these LEDs were too bright at the full 20 milliamps of current! To get the brightness to that of the original pilot lamps, I soldered a 1K-ohm series resistor from the applicable 6.3VAC source to one lead of each LED, and a ground wire to the other lead of each LED.

Conclusion

Building LED replacement lamps for normal incandescent pilot lamps is not difficult, and no longer expensive due to the improved prices on ultra-bright LEDs. You'll probably never have to replace a pilot lamp again after making this conversion.