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Failure Detection and Annunciation

Revision -A- 3 July 2007

at 0842 AM 6/29/2007 -0400, you wrote

I'm wondering if there is a device I can install on my landing lights that will sense when the high beam filament has failed and automatically switch the current to the low beam filament.

I'm using the single source/single switch wig-wag system, as per http//www.aeroelectric.com/PPS/Lighting/WigWag.pdf pg 3.0 and have only one wire to each light.

My landing lights are a Bob Olds design and utilize dual filament automotive H4 halogen bulbs, one per side. I would like to have something (preferably home brewed - read low $$$) at each headlamp that will fall over to the low beam so I can double bulb life, reduce maintenance and save a little money.

I've often recommended that builders consider dual filament lamps for landing/taxi/recognition applications. Modern automotive halogen lamps are exceedingly robust, available in lots of sizes and shapes. Until something better comes along, they're also readily available, cheap and perform well.

A system set up for optimized illumination in high-beam operation will probably not be acceptable for extended operations in the low-beam mode. However, some light is better than no light, hence the low-beam filament offers a useful backup until the lamp can be replace to restore original performance.

I'd counsel against any form of automatic changeover. It adds complexity that becomes another questionable variable during pre-flight. How do you KNOW that system is working? How is failure tested or annunciated from the cockpit. If a failure of a lamp occurs and changeover is automatic, what assures that you become aware of it before the second filament fails also? The complexity of detection, automatic remedial action and annunciation adds cost of ownership issues with a poor return on investment. Loss of a light bulb is a very low-risk failure. Modern halogen lamps are very long lived in cars . . . failure rates on airplanes is low too.

Aside from system design philosophies that drive operating features and architectures, is there a low way to detect a lamp failure? If it's easy to do, why not include this feature in other applications? How about nav lights? Bilge pumps in float planes? Pitot heater? Avionics cooling blowers? There are a number of systems wherein future inconvenience, expense and/or misery can be avoided with incorporation of a stone simple failure warning system.

A good example is overvoltage detection and shutdown for alternators. No matter how rare the event, the risks are never zero and the expense and perhaps hazards associated with an unmitigated failure event can be spectacular. Toward the stone simple, low design goal, I'll refer the reader to the circuits described on pages 3 and 4 document.

These illustrations suggest techniques for assembling a "reed switch" as a current sensing relay, a resistor, and an LED in such a way as to detect and annunciate when a device is expected to operate but in fact has failed to draw the expected amount of current. The circuits on

page 3 configure an LED that illuminates when the load is ON. Alternatively, you can wire the sensor to provide a dark LED that illuminates when the appliance ceases to draw expected current as shown on page 4.

You can read up on reed switches at . . .

http://en.wikipedia.org/wiki/Reed_switch

Bare reed switch capsules are cheap and readily available.

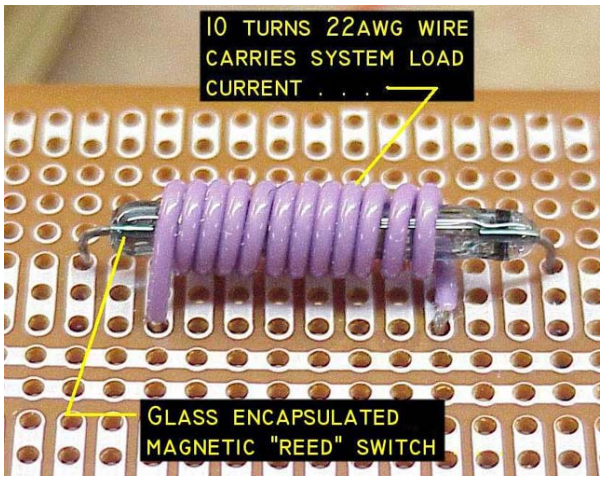
Check with suppliers like

http://jameco.com and

http://mpja.com

Radio Shack at http://radioshack.com sells a reed relay that can be de-wound of its many turns of voltage driven relay and re-wound with fewer turns for a current driven device.

You'll need to fiddle with the surrounding coil. Fairly robust loads (landing light, pitot heaters) will be wound with a few turns of relatively heavy wire suited for the

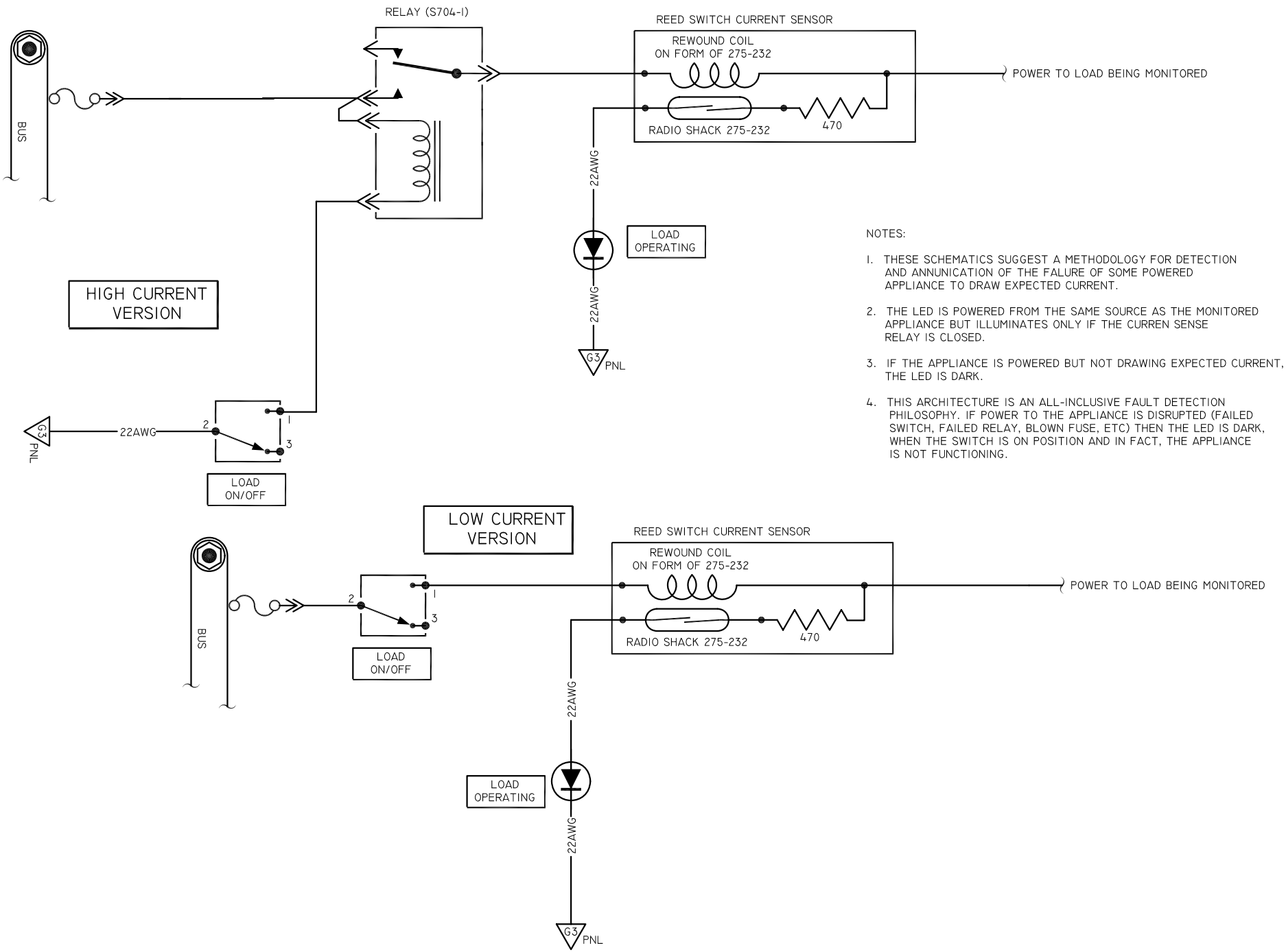


loads. Light loads like a cooling fan might take dozens of turns of smaller wire.

The configuration illustrated in the picture above works nicely for a 3A load with the reed switch I had on hand. You need just enough turns of wire so that the reed switch stays closed at about 70% of rated load for the appliance being monitored.

Page 3: When power switch is ON, voltage will appear at the power lead to the load and unless the reed switch closes the LED stays dark. If the load draws the expected level of current, the reed switch closes and the LED is illuminated. Should the system become disconnected or the load fail to function at it's expected load current, the reed relay does not pull in and the lamp stays dark. This detection and annunciation philosophy is used on TC aircraft for Pitot Heat ON annunciation.

Page 4: There's a variation on the theme for annunciation. Suppose you want the light to come ON only when the system is not drawing expected current. Note that the ***illuminate-on-failure*** architecture is not all-inclusive. There are a few failure modes that are not detected. For example, if the fuse blows and you turn the switch on, the LED will stay dark thus offering a false “system okay” annunciation.



NOTES:

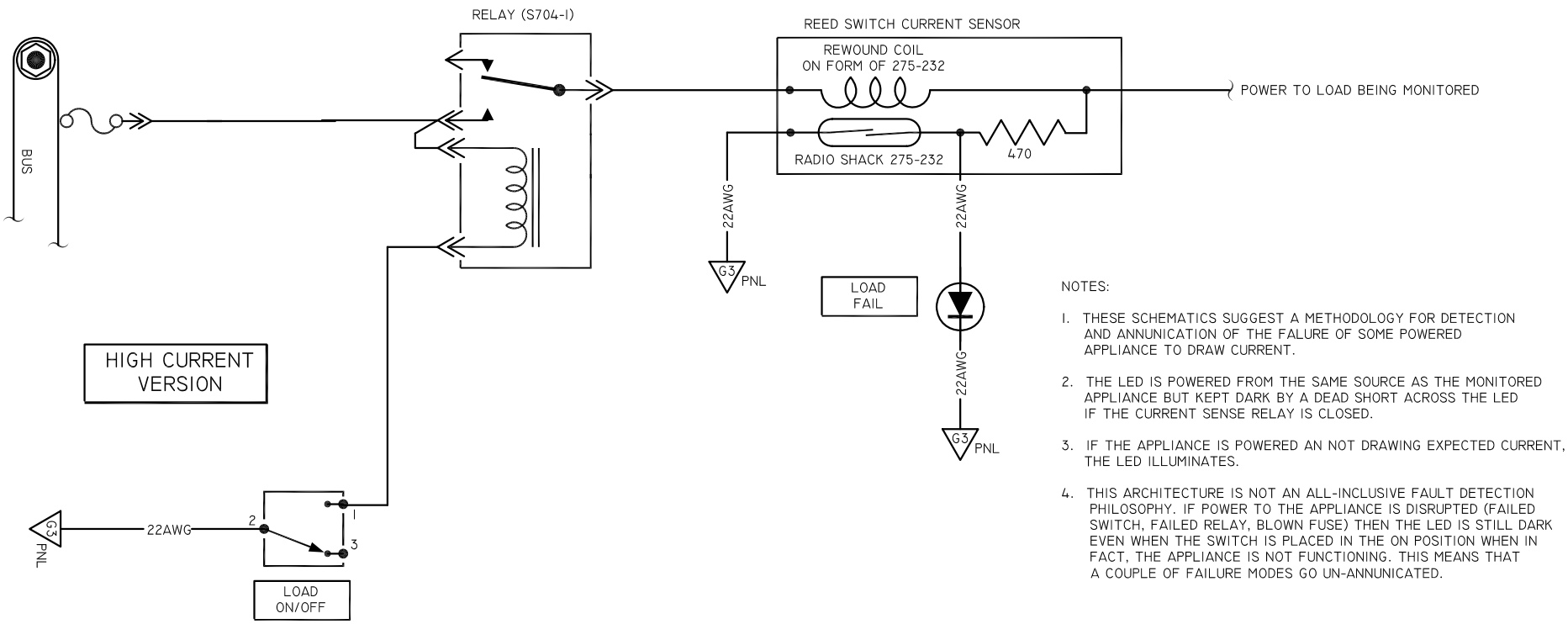
1. THESE SCHEMATICS SUGGEST A METHODOLOGY FOR DETECTION AND ANNUNICATION OF THE FALURE OF SOME POWERED APPLIANCE TO DRAW EXPECTED CURRENT.
2. THE LED IS POWERED FROM THE SAME SOURCE AS THE MONITORED APPLIANCE BUT ILLUMINATES ONLY IF THE CURREN SENSE RELAY IS CLOSED.
3. IF THE APPLIANCE IS POWERED BUT NOT DRAWING EXPECTED CURRENT, THE LED IS DARK.
4. THIS ARCHITECTURE IS AN ALL-INCLUSIVE FAULT DETECTION PHILOSOPHY. IF POWER TO THE APPLIANCE IS DISRUPTED (FAILED SWITCH, FAILED RELAY, BLOWN FUSE, ETC) THEN THE LED IS DARK, WHEN THE SWITCH IS ON POSITION AND IN FACT, THE APPLIANCE IS NOT FUNCTIONING.

TITLE

FAILURE WARNING W/ON ANNUNCIATION

PAGE

3



NOTES:

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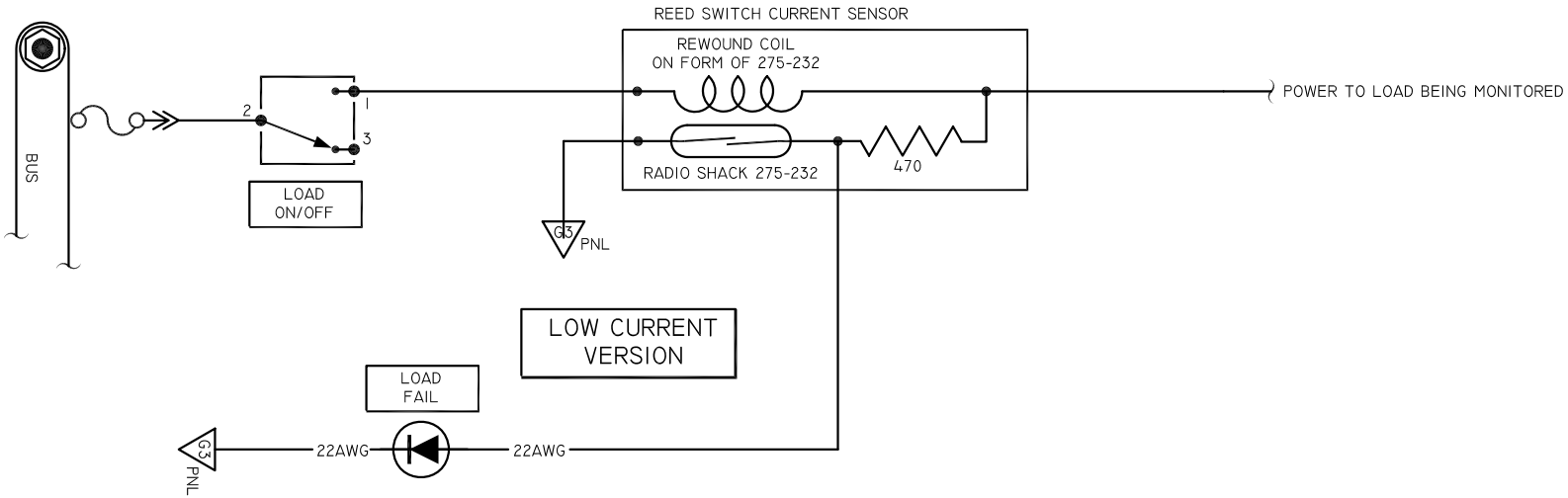
2. THE LED IS POWERED FROM THE SAME SOURCE AS THE MONITORED APPLIANCE BUT KEPT DARK BY A DEAD SHORT ACROSS THE LED IF THE CURRENT SENSE RELAY IS CLOSED.
3. IF THE APPLIANCE IS POWERED AN NOT DRAWING EXPECTED CURRENT, THE LED ILLUMINATES.
4. THIS ARCHITECTURE IS NOT AN ALL-INCLUSIVE FAULT DETECTION PHILOSOPHY. IF POWER TO THE APPLIANCE IS DISRUPTED (FAILED SWITCH, FAILED RELAY, BLOWN FUSE) THEN THE LED IS STILL DARK EVEN WHEN THE SWITCH IS PLACED IN THE ON POSITION WHEN IN FACT, THE APPLIANCE IS NOT FUNCTIONING. THIS MEANS THAT A COUPLE OF FAILURE MODES GO UN-ANNUNICATED.



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V2

TITLE

GENERIC FAILURE WARNING

PAGE

4