TITLE: Somewhere Over The Voltage Skies Are Blue…Somewhere Over The Voltage Dreams That You Dream Come True

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Last month in Kitplanes® Aero'lectrics column we saw a brute-force crowbar circuit that popped the fuse when the circuit voltage got too high. This month, we'll take a more surgical approach to the problem.

The problem, as stated last month, is that when generators gen or alternators alt, sometimes they get a little overenthusiastic about it and French-fry some rather expensive silicon parts in our radios and instruments. Not a good thing. One way of preventing this is by installing last month's crowbar circuit that will pop the fuse and keep the radio from being a crispy critter.

The other way of doing this same operation is by installing a set of relay contacts between the battery bus and the radio that will open up if the voltage should go out of the normal range. If you compare this month's circuit to last month's circuit, you will see some striking similarities. (Hooray for Windoze cut-and-paste routines {;-)) As a matter of fact, the U101A circuitry is absolutely identical. Since an LM358 has two op-amps per package, all we have to do is configure the second op-amp as a flip-flop, add a relay and driver transistor, and we are home free.

Under normal conditions, the output pin of U101A is held low (zero volts) by the voltage on D101. However, when the voltage rises above normal, the voltage at the (+) input will exceed the D101 voltage and the output pin will immediately go high (supply volts).

On U101B, under normal conditions, the voltage set by the divider R106 and R107 sets the (-) input to about 20% of supply volts and the (+) input has no voltage on it because U101A output is low. With the output of U101B low, Q101 has no base current and the relay K101 does not pull in. With the relay in the unenergized (not pulled in) mode, the normally-closed contacts of K101 provide a path for the bus voltage to the radio load.

However, when the voltage rises above the limit set by R102, the output of U101A rises to supply volts and overcomes the voltage set by the R106-R107 divider by forcing the (+) input higher than the (-) input, which in turn sets the output of U101B high and turns Q101 on. Turning Q101 on pulls relay K101 in and breaks the circuit for the radio load. A second feedback path to the (+) input through R109 keeps the output of U101B high no matter what the output of U101A does after U101B is "triggered". If U101B is triggered and K101 is pulled in, U101B can be untriggered by reducing the voltage at the (+) input by means of R110 and S101. However, if the circuit is still over-voltaged, as soon as S101 is released, U101B will instantly trigger again. If S101 is held on, it provides an emergency override to the circuit and allows operation of the load with the known overvoltage of the battery bus.

Calibration of the circuit is marvelously similar to last month's calibration. All I did was move a few parts around, but they are the identical parts to last month's crowbar article. The same comment holds true for the in-aircraft test circuit.

Some other comments might be in order here…

1. With the crowbar circuit, the voltage to the op-amp is turned off when the SCR fires. That is NOT the case with this circuit. If the battery bus voltage rises to more than 32 volts it may damage the op-amp, but then again, if this sort of overvoltage exists, you've got more troubles than a destroyed op-amp. In a

12 volt system, this sort of overvoltage is well nigh impossible, but with a 24 volt system it is very possible in a runaway electrical system failure. If I was running this circuit on a 24 volt system, I'd think very seriously about supplying the op-amp (the power supply terminal only) from a 12 volt regulator that could take 40 or 50 volts without blowing up. Run the WHOLE circuit from the regulator with the exception of the R103 connection to the unregulated bus.

2. 12 volt relays are cheap. 24 volt relays are a bit more expensive. If you want to use a Rat Shack 12 volt relay on 24 volts, just put a resistor in series with the coil OR use the 12 volt regulator (see (1) above) to run the relay, too. The resistor should be of the same resistance as the coil winding with a wattage of at least 144/R where R is the resistance value in ohms.

3. R111 and D103 are optional. They only tell you when the OVR has fired.

4. The relay was purposely designed to run fail-safe. That is, if the OVR circuitry fails, the predominant failure mode will return the relay to the "on" or unenergized condition. Even if the OVR circuitry fails in the unusual mode, S101 provides an override to allow the load to operate normally.

That's about it for voltage protection schemes. Next month we take the Radio Shack little digital clock module and turn it into an aircraft clock, complete with timing alarm. After that, we take the Radio Shack digital voltmeter and turn it into an aircraft voltmeter/ammeter. Then we take the same voltmeter module and turn it into a complete digital engine instrument system – oil pressure, oil temperature, fuel quantity…the whole nine yards. Stay tuned.

Author's Note: Jim Weir is the chief avioniker at RST Engineering. He will be glad to answer avionics questions for this article or on any avionics subject in the Internet newsgroup rec.aviation.homebuilt. If you are having trouble with newsgroups, go to www.rst-engr.com and click on the "How To Use The Net" link.