OV Protection

What is meant by "Over Voltage"?

Nominal bus voltage is 14.2 +/-0.3 volts.

- **Is 14.6 volts an "Over Voltage" condition?**
- **Inductive devices in the system have the potential for generating low energy, short duration "spikes" for tens of micro-Seconds. Potential for damage is nil . . .**
- **An alternator that's working hard is suddenly unloaded, it will "overshoot" in what the automotive industry calls a "load dump". To re-create this event in an airplane, you would have to open a battery contactor with the alternator running at high RPM and charging a badly depleted battery with light system loads. As long as a battery is on line, automotive "load dump" cannot happen.**

What is meant by "Over Voltage"?

An alternator that no longer benefits from a working voltage regulator can produce prolonged and spectacular bus voltages:

- **A well cared for battery* can stand-off the ravages of a runaway alternator for several seconds. For example, a runaway 60A alternator will quickly push an 18 ah battery to about 17 volts followed by slow climb from there . . .**

- **An over-voltage protection system set at 16.3 volts is generally set to shut down a runaway alternator in 200-400 milliseconds after onset of the event.**

A runaway alternator driving a Li-Ion battery with integrated protection electronics MAY go into automatic disconnect. A careful evaluation of system dynamics for the proposed alternator/battery pairing is in order.

What is meant by "Over Voltage"?

- **High-voltage, low-energy events (spikes) are not true "over voltage" events. They are easily handled with a combination of:**
  - **Capacitors across DC inputs to vulnerable devices**
  - **Transient Voltage Suppressor (TVS) built into vulnerable devices (TVS also stands off lightning).**
- **High-energy over-voltage event (runaway) is a potentially harmful condition. Runaways are precipitated by failures of regulators or associated wiring. DO-160 design goals call for standing off a 20v surge for 1 second.**
- **A healthy battery will keep things below 18 volts for much longer than one second. Hence, crafting an OV protection system is pretty much a no-brainer.**

What is meant by "Over Voltage"?

- **Momentary, low level voltage excursions may be a condition generated by a regulator's inability to respond to large, step-changes in system loads.**

- **The excursions are small and non-hazardous.**

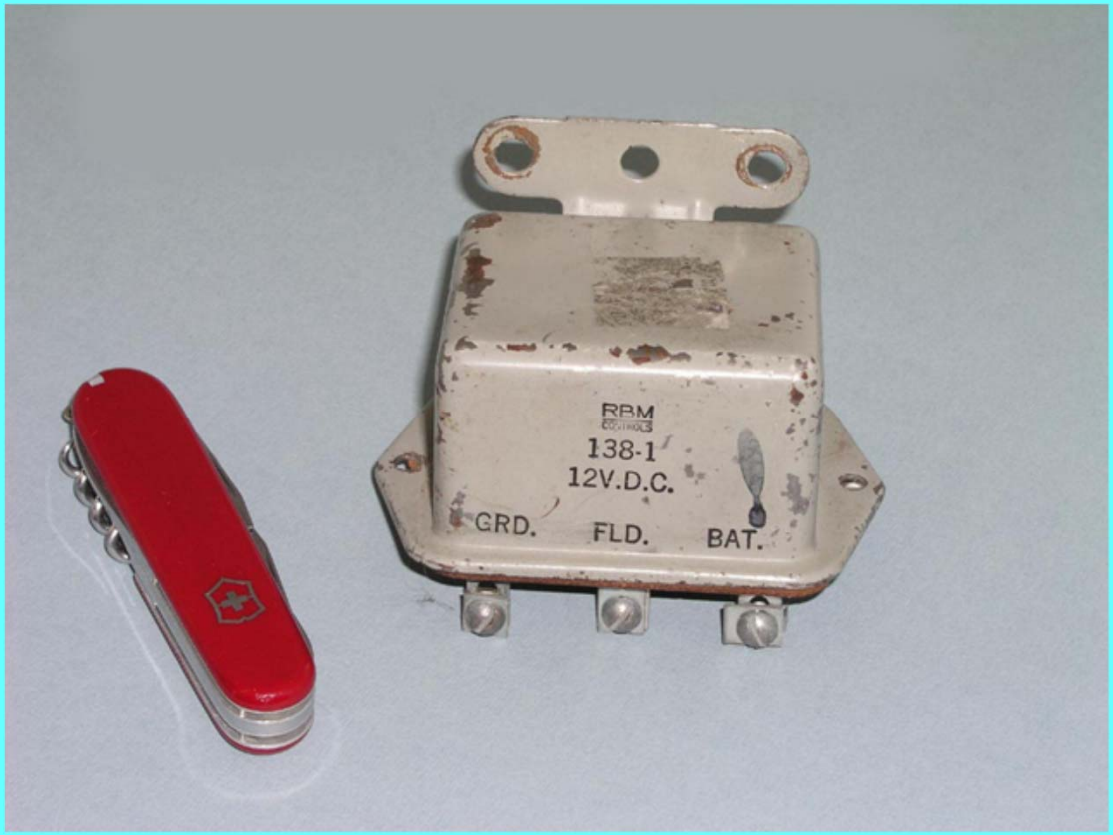
- **Poor regulator dynamics can be a nuisance. For example: the pulsating load current of a strobe supply may cause panel lights to flicker in synchronization with the strobe firings . . .**

- **The ONLY source of potentially hazardous (protracted, high energy) elevated bus voltage is a runaway alternator.**

What is meant by “Over Voltage”?

- **Unless your system of choice offers absolute runaway prevention (1 x 10^{-6} failures per flight hour), a separate OV management system for each engine driven power source is indicated.**

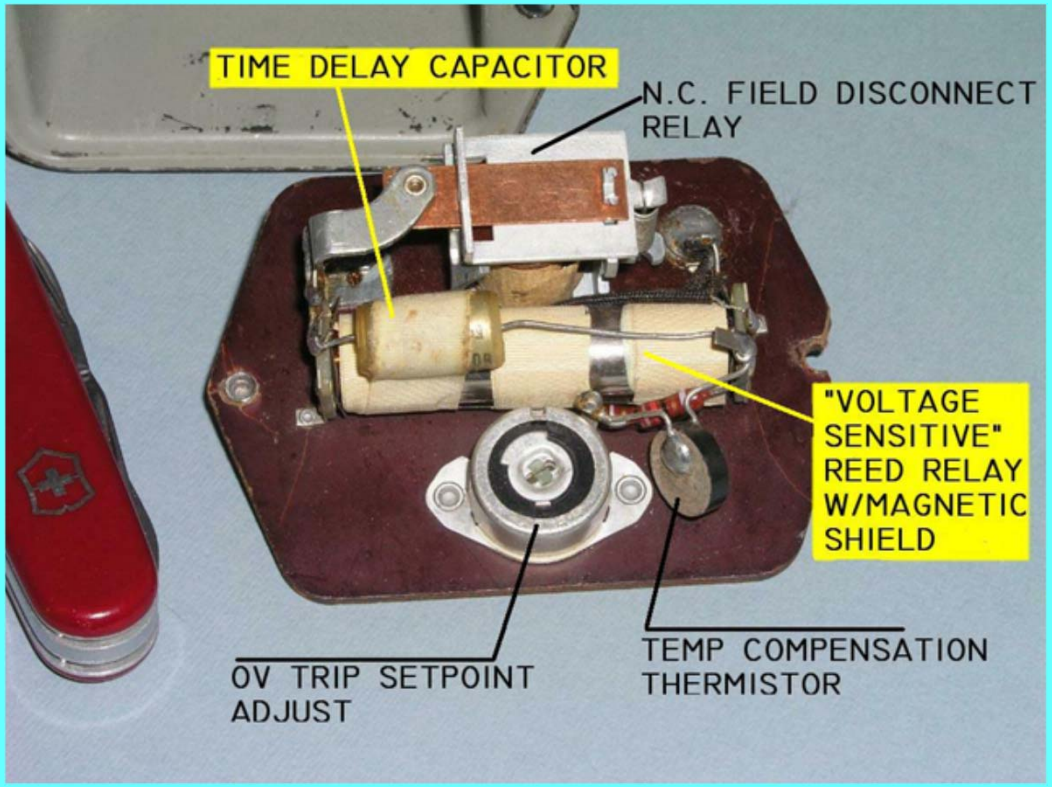
- **The optimal OV protection design requires an understanding of system dynamics but event the best of designs is subject to nuisance trips. A “one-time reset” policy is called for.**



This device by RBM Controls was the best we knew how to do for Over Voltage protection in 1975.

Without knowing exactly what this device was designed to do, it was easily mistaken for a voltage regulator.

Note labels on the screw terminals!



This was probably the last of the Copper-n-Steel era popular OV Relay designs . . .

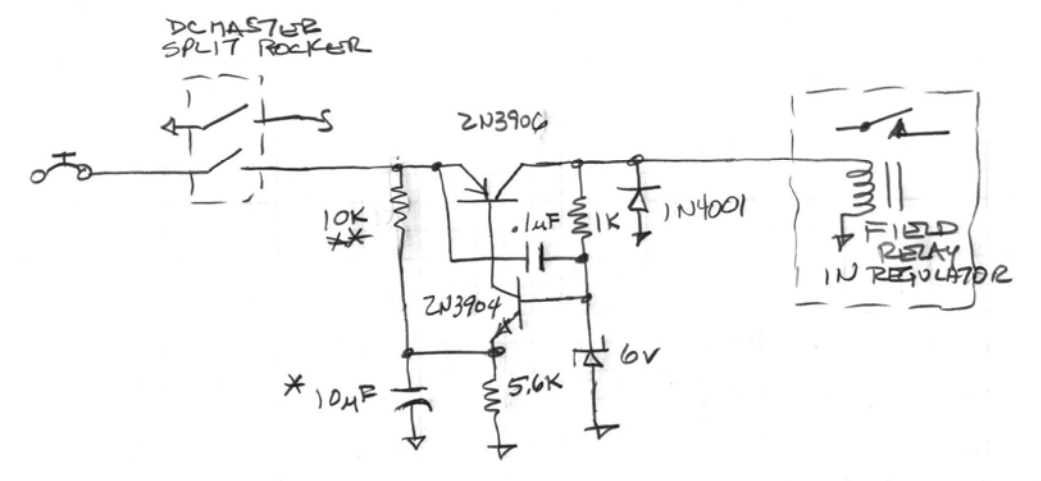
Just how bad can an OV event be?

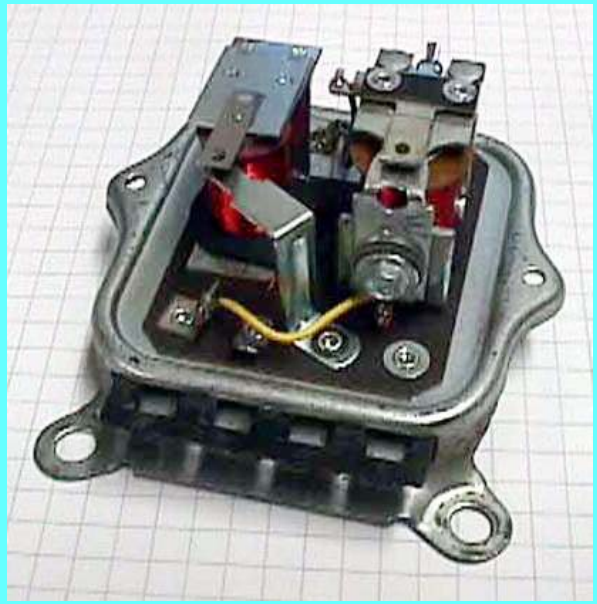
This product was offered for a short time to adapt a 14V automotive alternator for the generation of 90-110 Volts DC at 20 Amps or more . . .

This was a relatively "mild" OV event because field voltage was deliberately set at an limited to 12 volts.

An alternator in runaway due to regulator failure excites its own field with the product of the runaway. A lightly loaded alternator spinning at 10,000+ RPM will produce spectacular voltages at the B-Lead terminal . . . 200V easily . . .

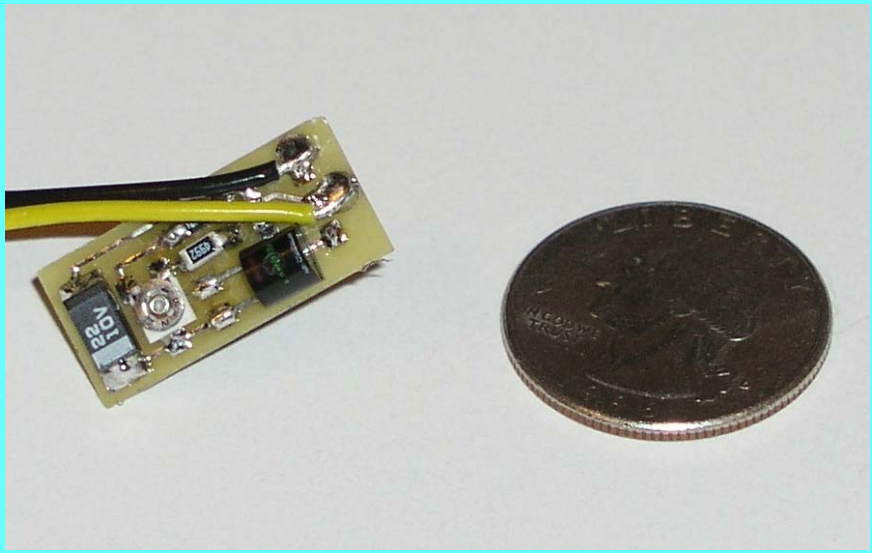
Firewall against failure . . .





- **This simple 2-transistor, one-zener circuit was typical of the OV protection incorporated onto the Cessna single-engine aircraft circa 1970.**

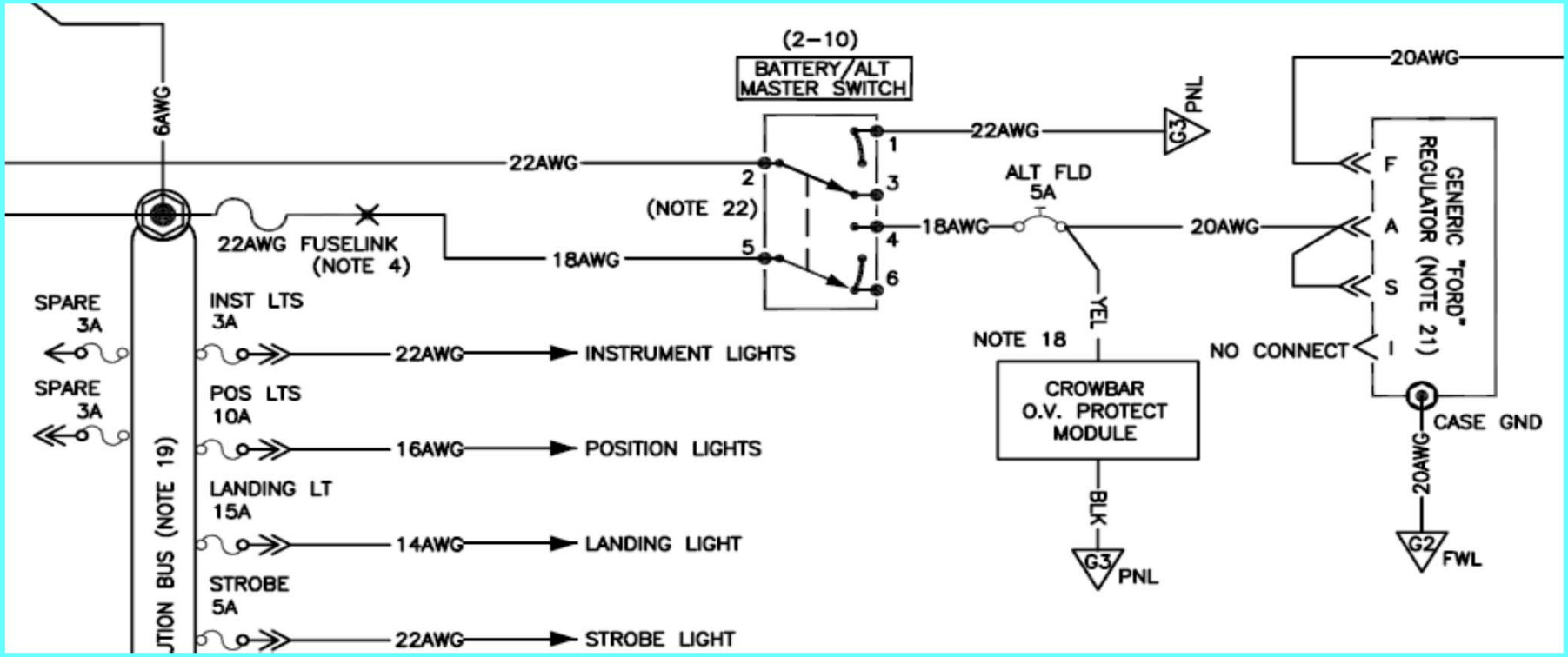
- **The circuit took advantage of a field voltage control relay that was built into the electro-mechanical “Ford” regulators of that era . . .**



This is a “Crowbar” OV Protection module offered by AeroElectric Connection and B&C for over 15 years.

Similar technology is built into alternators by Plane Power and in several PMA/STC’d aftermarket regulators . . .

Note the use of a fusible link for extending a fuse block bus onto the panel to support the breaker upstream of a crowbar OV protection module . . .



Blast from the past. The Beech “Lightning”. An Allison turboshaft powered single engine airplane . . . ‘almost’ the first T/C aircraft to carry crowbar OV protection.