TITLE: Tick, Tick, Tick (ve haf vays of making you Tock)

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Necessity, it is said, is a Mother. Or something like that. In this case, the damfool clock stem broke off during the annual, and I wasn't about to light out for Oshkosh with something on the panel broken. Generally we wind up coming back HOME with enough broke stuff without starting out that way. So, two weeks before departure, I'm scrambling around trying to find a cheap 12 volt clock. Believe me when I tell you, there aren't any such things ready-made. Cheapest I could find was a $50 used wind-me-up in the local surplus store and prices just went up from there. Sigh. Then inspiration struck.

I remembered looking through the Shack catalog last year and noticing that they were carrying a few of the Trumeter(1) electronic modules, most notably a clock module (and, as we shall see next month, a digital voltmeter module). Wonder…wonder…would these modules fit in a standard 2¼" instrument hole? Well, hallelujah, they just *barely* fit onto a regular old aluminum instrument hole plate with enough room left over for the time-set and alarm-set switches plus an alarm light.

The mechanical drawing shows the instrument hole plate cutout dimensions. The only thing that is slightly different from the way we normally do things is the rectangular cutout for the module itself and the use of "PEM®" nuts (self-clinching nuts) on the corners. These hammer-set nuts make installation a lot easier than regular old nuts and bolts. I made the rectangular cutout with a "nibbling tool" that you can get from any of the popular aviation tool houses or an exceptionally well stocked automobile parts store. The PEM nuts can be had from most anybody in the sheet metal business for a dime apiece or so. The PEM catalog says not to use a hammer to install the nuts, although this has been a "field service" technique I've used for thirty years without a failure. If you want to be "by the book" find somebody with a hydraulic press or extremely large vise. I've also used vise-grip pliers with good results.

Mechanically, this project is fairly simple, but electrically we've got a bit of work to do. Here's the situation…the clock itself typically draws about 1 ìA (one microampere) but has to have a voltage between 1.2 to 1.8 volts (1.5 volts nominal) to run properly. The backlight requires 5 volts at 80 mA for proper operation. Somehow we've got to get the aircraft 12 volt battery down to these voltage levels. Not only that, but we've got to do it so that in the "Master Switch Off" mode the clock doesn't run the battery down. Typically, we say that anything short of 1 mA (one milliampere) will be insignificant in the aircraft battery's state of charge. (The math shows that the clock would have to be connected to the battery for about three *years* to discharge the battery. If you don't fly your aircraft in three years, the battery and clock are going to be the least of your problems. Since we are dealing with such minute currents, we might just as well draw ten times less current than the limit, or a power supply that draws about 100 ìA (a hundred microamps, or 0.1 milliamperes) from the battery in both standby as well as operate mode.

Hmmm…how to regulate down to 1.5 volts…several ways, but the way I prefer is using the constant voltage drop of a silicon diode. At a current of 100 ìA, a garden variety 1N4148 silicon diode has a drop of 0.5 volts. With the base-emitter drop of 0.5 volts at low current, four silicon diodes will give a regulated emitter voltage on the 2N2222a transistor of 1.5 volts at a maximum current of a milliampere or so. Problem 1 solved.

Problem 2 is pretty simple also. For a 5 volt backlight at 80 mA, I'll simply put a resistor in series between the lamp dimmer supply and the backlight pin. The resistor calculates out to 120 ohms at 1 watt, so I can either use a 1 watt resistor or two 240 ohm half-watts in parallel or two 62 ohm half-watts in series. Your choice.

Problem 3 wasn't apparent until I put the clock in the airplane and flew it. No problems until I switched the master off, and the clock reset to zero. Hmmm. Reset the clock. Turn the master on and off…reset to zero again. That huge inductive kick when the master switch relay turns off must be getting into the clock innards…another silicon diode (this time one that will withstand a little reverse voltage, a 1N4001) and a 100 ìf capacitor cleared that little problem up quite nicely.

Of course, I'm never satisfied with just *some* functions of a device working. This little rascal has an alarm output. Could we use that feature? Sure, lots of times I'd like to set an alarm for an hour, or two hours, or an hour and a half into the flight to switch tanks. Or look for a checkpoint. Or anything else having to do with reaching an expected time. And, since I'm using a switch to set the time anyway, why not just use a double-throw center-off switch to set either time or alarm? The little "hours" and "minutes" pushbutton switches don't have a clue as to whether they are setting time or alarm, so the only thing necessary to program the alarm is another throw on the switch, not fifty cents extra.

The "alarm out" pin (14) has a "beep-beep" audio output at 1.5 volts peak-to-peak that will drive another silicon transistor quite well. A red LED connected to that transistor will flash in time to the beep for a full minute when the alarm is triggered. Could I have an audio alarm as well? Certainly. You can pick it off at two places. If you capacitively couple (say, a 0.1 ìf capacitor) the audio from pin 14 of the module, you ought to be able to drive up to a 10 kohm load. If you couple the same capacitor into the junction of the 470 ohm resistor and the LED, you ought to be able to drive a 1 kohm load without a lot of difficulty. And, for those of you who understand how to make a transistor emitter follower, another transistor coupled to that same resistor-LED junction will let you drive loads much lower in impedance.

Author's Notes:

(1) These modules are made by the Trumeter company and sold by The Shack. Believe it or not, the Shack sells them 30% cheaper than I can buy them from Trumeter in quantity.

(2) The guaranteed accuracy of the clock is +/- a minute a month. Since I've had the unit in for less than a month, and since the resolution is a minute, I can't vouch for the accuracy. I can say that the unit has varied less than a minute, but how much less I haven't been able to measure.

(3) I tried doing some clever tricks with the "snooze" feature, but couldn't come up with anything useful. If anybody comes up with a neat trick for an 8 minute snooze delay, please let me know and I'll publish it as a NOTAM in a future article.

(4) 24 volt operation is possible. The 120 ohm backlight resistor needs to go to 270 ohms at 2 watts. The 100 ìf capacitor needs to have it's working voltage increased to 35 volts or more. The 470 ohm resistor in series with the LED needs to 1000 ohms, 1 watt.

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.

Photo / Drawing Legend

Drawings:

999-0621.pdf --	Instrument Hole Plate Manufacturing Drawing
KPsch.pdf –	Schematic Drawing

Photos (all in format DCP00xxx.jpg):

899 –	Using the nibbler to cut a rectangular hole in the instrument hole mounting plate
900 –	The completed plate before painting, before labeling
901 –	Somebody ratted on me to the local fire department that I was doing electrical work today
917 –	Installed into the instrument panel. Note the "Kitchen Timer" for instrument minute:second timing to the left of the installed clock. Also note the newly installed Microair 760 radio to the lower left (a feature article in an upcoming Kitplanes issue).