Chapter 10

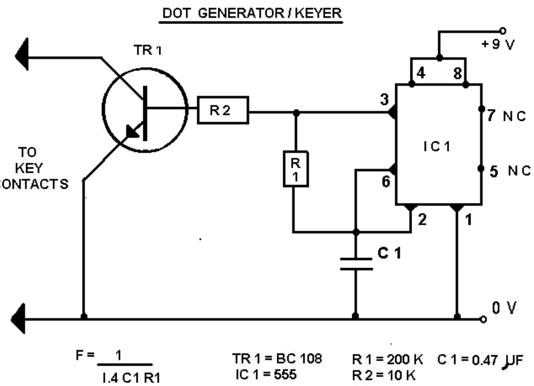
Keyers and Control

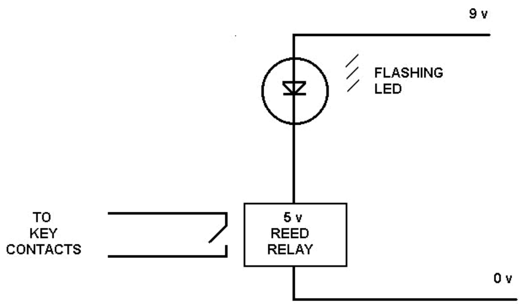
Simple Dot Generator/Keyer

Steve Cooke, G1MPW

Having decided that some sort of keyer was needed to pulse the carrier on 10GHz , I came across the basic astable circuit and added the switching transistor to key the carrier on and off. The switching rate is given by F = 1/1.4 C1 R1. With the values given (200k and 0.47uF) it produces rapid dots.

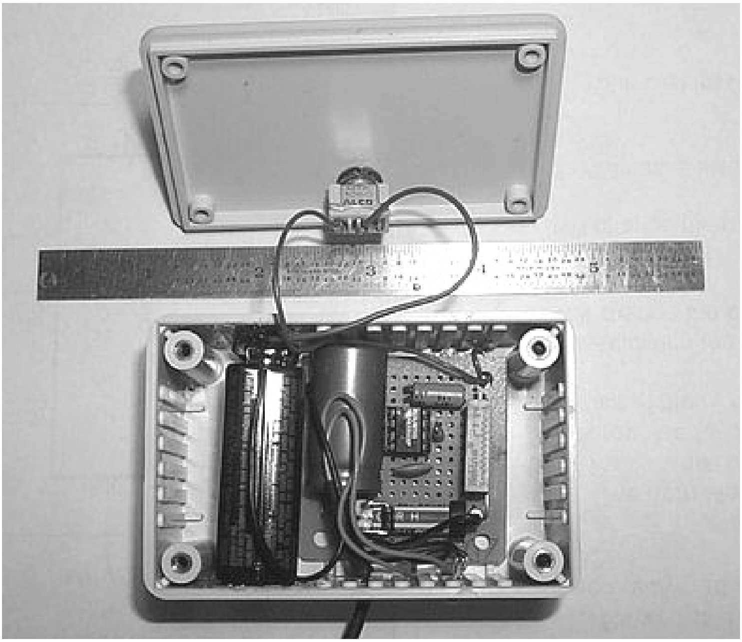
The " simple circuit " was a bit of an after thought but seems to work fine but at a slower rate of about 2Hz. On the FT290 it is necessary to close the PTT switch as well as the key contacts to TX a carrier in the CW mode . I wanted to use a non-locking push button switch but Double Pole varieties don't seem to be available so I used a small reed relay connected across the 555 timer + and - to provide the extra contacts needed for the PTT.





The Dasher …
an automatic CW dash generator

Fred Miller, WO2P

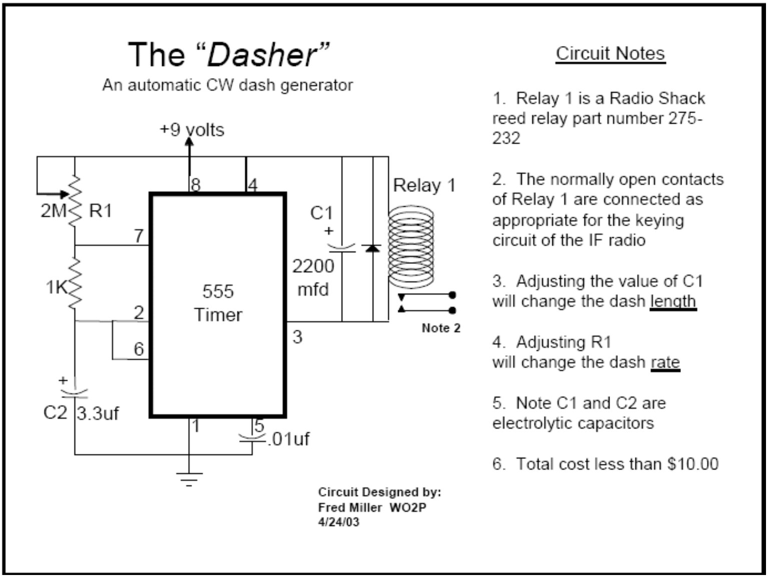


The "Dasher" was designed and built within two week of our recent 24 gigahertz Marathon. It was built purely out of a need for self-preservation. Standing on a cold windy hilltop and sending (not so well formed) dashes for 5 to 10 minutes at a time with a straight key was, to say the least, uncomfortable. I refrained from using my home station keyer because of the added weight and bulk to an already pretty hefty "portable" station. I wanted something small, light and self contained.

Version one was based on a blinking led" from Radio Shack. I demoed it at last month's club meeting. It functioned fairly well and was really inexpensive but the dash rate seemed just too slow. The blink rate was preset by the chip internal to the LED. With no way to adjust it, it was back to the drawing board.

The current version seen here is based on a 555 timer. I experimented with various resistor and capacitor values until I arrived at what I think is a good balance. When operational pin 3 will generate regular low going pulses based on the setting of R1. The low going pulse charges C1 and energies Relay 1 closing the normally open contacts and activating the keyed circuit in the IF radio. When pin 3 goes high C1 discharges through Relay one and delays its release. The length of the Relay 1 release delay is determined by the value of C1. The larger the value of C1 the longer Relay 1 will remain operated. A short period of time later the cycle repeats creating dashes.

Since my IF radio is an ICOM IC-260 that requires hard keying, I connected Relay 1's normally open contacts to a 2 wire cable with an 1/8" plug on the other end. I inserted a 1/8" "Y splitter" into the IF radio CW key jack and then my straight key plug and dasher plug into the splitter. The straight key and the Dasher are in parallel. When I need to send dashes I just flip the toggle switch on the dasher. When my signal is found I switch off the Dasher and finish the QSO with the straight key. The entire circuit including a 9 volt battery fits into a small 3.5" x 2.5" x 1.5" plastic case that is bungie-strapped to the side of my portable microwave system. If you are a "hill-top Microwaver" and looking for a very inexpensive one evening project give this one a try. You will thank yourself the next time you are out on a cold windy day.



On-Off Keying for Microwave Beacons

Andy Talbot, G4JNT

The normal frequency shift keying applied to beacons is no good if the intention of the beacon is to provide a very high stability frequency standard and in this case it becomes necessary to on-off key the RF note 1. Some time ago I built a simple personal beacon based around a DDK004 modified for external source and WDG001. On –off keying was done with the aid of a PNP transistor keying the positive supply to the GaAs FET devices in the WDG001 refer to Fig 1.

Recently, whilst waiting for the new site clearance for GB3SCX to go through, I wanted to install the beacon head unit, with my high stability source, as a personal beacon from the work QTH on Portsdown Hill. GB3SCX is built in two parts. The lower section contains a DDK004 source, modified to apply +12V to the feeder for powering the beacon up the coax. Conventional FSK is used for keying. The head unit contains the final WDG001 X4 stage and 120mW power amplifier. An additional stage at the input contains a MSA02 modamp and DC take off. The modamp is there to permit a high feeder loss for the 2.6 GHz signal, and means the beacon will give full output for a drive as low as –2dBm. This allows a feeder loss of up to 12dB, with overdrive not being a problem as the MSA02 just saturates.

To on-off key this system is not so straightforward, as the WDG001 is now at the head unit and I certainly didn't want to install extra cabling just for the keyer. The solution was to key the 2.6GHz RF feed from the base unit. Initially I just made up another modamp gain stage using a MAR-2, and keyed the supply to this with a PNP transistor.

The circuit is that to the right of the shunt diode shown in Figure 2, the modamp being fed directly with RF. This stage managed a gain of 5dB at 2.6GHz, and saturated at 6dBm output level, enough to drive the head unit with up to around 6dB feeder loss. Keying the supply reduced the saturated output by 16dB, but when driven by the 8dBm available from the DDK004 multiplier still gave an output level of –10dBm.

Remember, the 'SCX beacon would work with a drive level of –2dBm. Applying –10dBm resulted in an output just 10dB down – not ideal for CW keying and this would certainly change over temperature (not tested though). I replaced the MAR-2 device with the higher power MSA04 and achieved a gain of around 4dB, but saturating at a much higher power. Furthermore, the amplitude change by keying the supply was now closer to 20dB., but output when driven by the DDK004 was now 11dBm – far to much for driving the head unit and still giving something like -9dB key up drive level. unless a considerable feeder loss could be added.

Adding a 6dB attenuator pad between the '004 and amplifier stage resulted in levels of 7dBm/ -13dBm which, when connected directly to the head unit, produced an amplitude change of 25dB – a lot more acceptable. By inserting a longer feeder, with around 4dB loss the key up output level could be reduced by well over 30dB – even better.

This hit and miss method of selecting drive levels was adequate for the temporary installation, but for a permanent on-off keyed beacon, some means is needed to reduce the

RF by a lot more than 20dB if sufficient margin is to be allowed for arbitrary feeder losses.

A figure of 40dB would be ideal so that amplifiers can be operated saturated and still give sufficient change in amplitude for at least 30dB final keying levels. Keying of any of the DDK004 multiplier would probably work but was not attempted; since this scheme could be used with the conventional 004 with integral oscillator any attempt to play about here would probably cause chirp. Using two modamps with their supplies switched would allow 40dB level change provided no saturation was occurring, but with a ridiculously high overall gain would need considerable pre-attenuation.

The ideal solution, is to combine modamp supply keying with a shunt diode.

See Figure 2 for the proposed – but not yet tested - circuit of the final keyer.

Note 1

One solution allowing FSK keying while still maintaining a high stability, at least on one of the tones, is to use frequency exchange keying. Here, two completely separate oscillators are used corresponding to mark and space tones, and the outputs switched alternately to the multiplier chain.

One can be made the high stability source, and the other just used for the keying. Frequency, and more importantly phase, information is preserved allowing ultra narrow band DSP based monitoring.

Something not possible if phase coherence is lost between each mark-space transition.

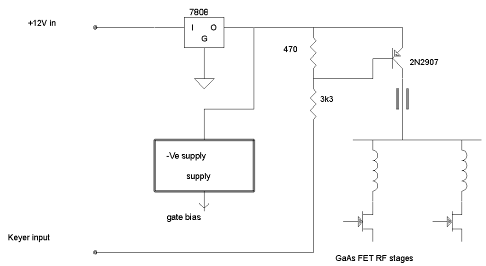


Figure 1
Amplitude keying
the WDG001 multiplier

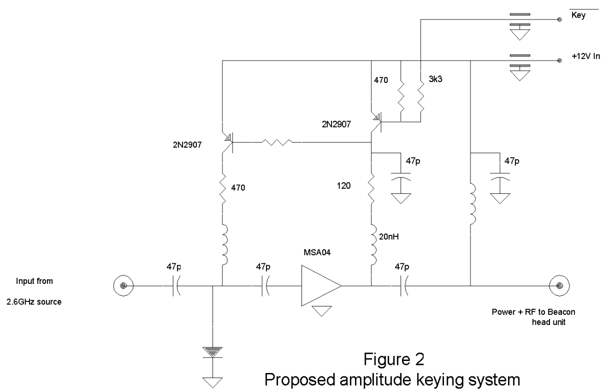


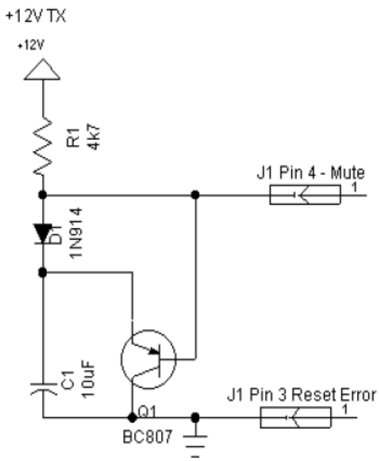
Figure 2
Proposed amplitude keying system

Mute sequencer circuit for the Ionica PA

John Quarmby G3XDY

The sequencer circuit is connected to a low impedance source of +12V on transmit which also operates the antenna changeover relay. This 12V source can be either open circuit or resistively tied to ground when on receive. When going from receive to transmit Tantalum capacitor C1 charges via R1 and D1 with a time constant of a few tens of ms, and the PA mute circuit goes to transmit when the voltage on pin 4 of the connector passes +2.5V. There is a 3k3 resistor to ground in the PA mute circuit which limits the voltage on pin 4 to +5V when the capacitor is fully charged. This allows the antenna relay to fully operate before any RF is applied. When going from transmit to receive, the 12V disappears from R1 and the internal 3k3 resistor pulls down pin 4 towards ground.   This switches on Q1 which rapidly discharges C1 so that the PA is muted within a few hundred microseconds, well before the antenna relay starts to release. Flashing" the PTT will not cause problems as Q1 discharges C1 fast enough to maintain correct operation under all circumstances. The Reset Error output from the PA is grounded to stop it feeding 12V into the Mute circuit through a diode on the PA board. The device driving the Reset Error output is an open collector comparator so there are no ill effects from connecting this to ground.

The original was laid out on a tiny piece of PCB using surface mounted components, but almost any high gain PNP switching transistor should do the job if leaded components are preferred.



Quiet Fan Controller
Speed Varies with Temperature

Paul Wade, W1GHZ © 2005

Many modern radios and other electronic devices rely on muffin fans for cooling. These can be loud and annoying. Some run continuously, while others cycle on and off, either when needed or just on transmit. In some radios, the fan cycling results in a small frequency shift as the oscillator is heated and cooled. Wouldn't it be preferable to have a fan with a variable speed, responding to cooling needs?

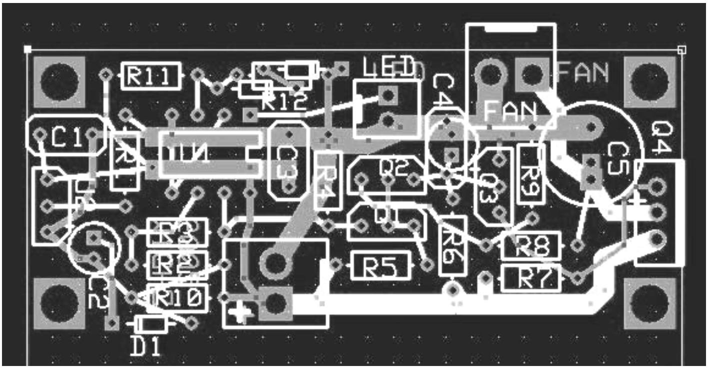
I've thought so for a long time, but never got around to doing something about it. Recently, I decided it was time. I figured this was an obviously useful thing, so there would be lots of circuits available on the web. The only things I could find were microprocessor circuits, many of them relying on fancy fans with internal tachometers – none of those in my junk box. Also, the microprocessor controls the speed by turning the fan on and off rapidly; some of the notes suggested that the results are audible. Most muffin fans use DC brushless motors, so the speed is easily controlled by varying the motor voltage. 12-volt fans are convenient and readily available. Also, there are a number of inexpensive temperature-sensing ICs available. What we need is a simple circuit to vary the fan voltage in proportion to temperature – basically, an amplifier. A couple of op amps should do the job. I sketched out some circuits and simulated them with the free witcherCAD III software from www.linear.com.

None of them worked satisfactorily, so I called the op amp guru, Byron, N1EKV. He agreed that it sounded simple and would look into it. He soon called back to say it wasn't as simple as it sounded because of some choices I had made: to keep one end of the temperature sensor and one end of the fan grounded, and to drive it with a power FET for minimum voltage drop at full speed. The result is that the sensor is referenced to ground, but the FET is referenced to the positive voltage. The final complication is that there is a huge gain in the circuit due to the transconductance of the FET, about 2.5 Siemens (in tube terms, this is 2,500,000 μmhos – a typical tube is 5000) or more. To make things worse, the FET is operating in a non-linear region, and having non-linear elements inside a feedback loop is never a good idea.

I went back to engineering basics: find a circuit to steal. One of the microprocessor fan controls used an interesting circuit to drive a FET and shift the reference from ground to high side. The circuit, in the area of Q1 and Q2 in the schematic, looks like the Widlar current mirror used in many integrated circuits. I added this circuit plus the PNP emitter follower, Q3, and fiddled with the resistances to get it going. Then I consulted Byron again and added capacitors C4 and C5 to stabilize things.

Computer simulations are only as good as the models, and don't always fully model reality, so I built up a breadboard on a piece of perforated board. It actually works – and it definitely oscillates without C4!

Now it felt safe to make a printed-circuit board, to make it reproducible and robust enough for portable equipment – perforated board wonders seem to fall apart bouncing around in

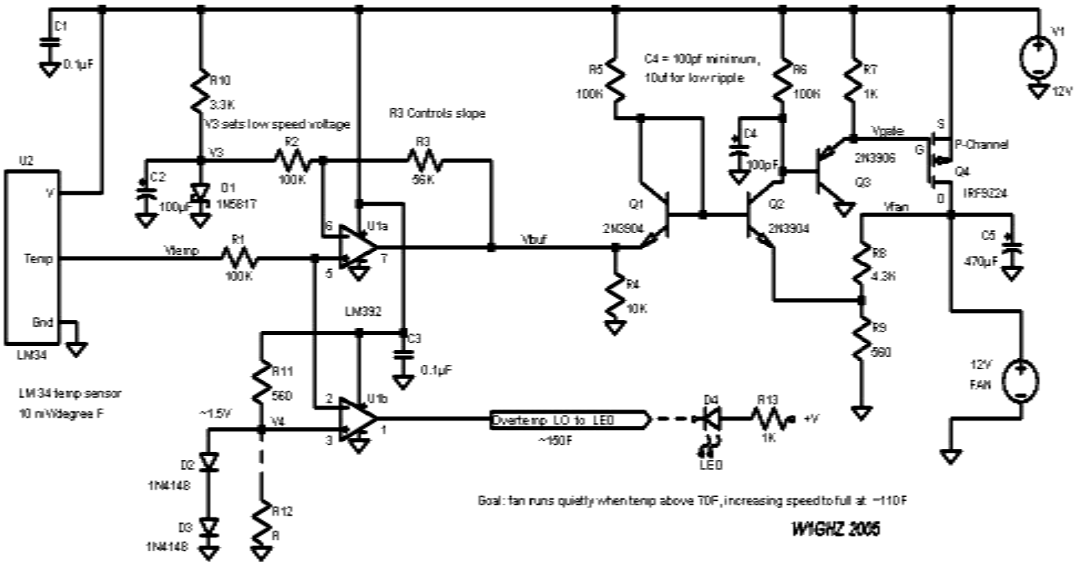


the back of the truck. Since op amps come in pairs and quads, I tried to think of something to do with the other half. The best use I could come up with is an over-temperature alert, but that really requires a comparator rather than an op amp. But there is one IC available with one of each, the LM392. The comparator uses the output of the same temperature sensor to provide an alert at some higher temperature. The output goes low at the desired temperature to turn on whatever: an LED, a sound, a relay to shut down the amplifier, or a jolt to the operator's chair. The noisemaker from a defunct smoke alarm might be interesting, but a blinking LED seems adequate to remind me not to talk so much. I used the free software from ExpressPCB (http://www.expresspcb.com) to layout the board shown in Figure 2 and placed a Miniboard order: three boards in four days for $59. Four days later, the boards arrived, I put one together and sparked it up. After I added one resistor that somehow was left out of the layout (Figure 2 includes the correction), it works fine. The fan purrs away at room temperature and speeds up as the temperature sensor is heated up.

Figure 3 is a photo of the completed controller, with the LM34 temperature sensor at the left edge of the board, not yet attached to a heat source. It could also be soldered to the other side of the board, if the intent were to mount this board on the heat sink. With the resistor values in the schematic, the fan gets about 9.5 volts at room temperature and gets up to full speed with full voltage at about 105°F. We will use Fahrenheit since the LM34 temperature sensor output is in Fahrenheit: 10mV per degree F, so the output at 70°F is 700 mV and at 105°F is 1.05 Volts. The slow speed is set by voltage V3, controlled by resistor R10; decreasing R10 increases the current through Schottky diode D1, which increases the voltage drop of the diode and increases V3. The temperature at which the fan reaches full speed is controlled by resistor R3; increasing R3 makes the fan reach full speed at a lower temperature. Note that we can monitor the temperature directly by measuring voltage Vtemp at the LM34 output, as 10mV per degree F.

The over-temperature setting for the comparator is similarly set by voltage V4, the voltage drop through silicon diodes D2 and D3. Decreasing resistor R11 increases the current through the diodes, increasing the voltage drop and thus raising the temperature setting. With the value shown for R11, V4 is about 1.50 volts, so the over-temperature alarm is at about 150°F. If a much different temperature setting is desired, R12 could

Temperature-proportional Fan Speed Controller



be used instead of the diodes, but the temperature setting would vary with the supply voltage.

The temperature sensor U2, the LM34, should be in contact with the heat sink or surface being cooled by the fan. Either attach the flat side of U2 directly to the heat sink with Super Glue, or use a dab of heat sink compound and clamp it on. A heat sink takes some time to heat and cool, so the fan will not change speed instantaneously, but will speed up as the heat sink heats. More important, it will continue running at higher speed until it brings the heat sink temperature down, gracefully slowing down as things cool. U2 need not be mounted on the printed circuit board, but may be mounted remotely, on the heat sink; twist the wires together, and consider adding ferrite beads if there is a lot of RF floating around. Of course, controlling fan speed won't do much good if there isn't adequate cooling with the fan running at full speed. If you are adding a fan, size, placement, and airflow are important. For cooling a heat sink, impingement cooling, with the air blasting directly into the fins (like a Pentium cooling fan), is much more effective than ordinary convection cooling, where the airflow is just passing through the fins. If you are just cooling a cabinet or enclosure, sucking may be more effective than blowing. But any airflow is better than none at all.