HP 10544A — operation of oven control circuit

To make sense of the following discussion, the reader must refer to my *corrected* HP 10544A schematic, which can be found (among other places) at <http://leapsecond.com/museum/10544/>. A copy of the oven control portion of the corrected schematic also appears on the next page of this document. If you are looking at the HP schematic, you will wonder how the hell it works (and it wouldn't, if HP actually built them as they drew it).

The 10544 oven control circuit uses pulse-width modulation to control the heater in a "bang-bang" manner rather than a smooth proportional manner (as the later HP 10811 does). A3Q3, a 2N2646 UJT, forms a relaxation oscillator (along with A3C1 and A3R10). This oscillator produces a rising ramp with a period of 200-250uS (frequency ~4-5kHz) and a voltage span from ~1v to ~8v.

The positive-going ramp at the emitter of A3Q3 is applied to the base of Darlington transistor A3Q2 (MPSA12), which is 1/2 of a differential pair current switch along with A3Q1 (2N3904).

The thermistor and associated op-amp circuitry set a threshold voltage between ground and about 7v at the base of Q1. After the relaxation oscillator resets to ~1v, current flows through A3Q1 and A3R8, pulling the base of Darlington A3Q4 negative and turning it on to saturation. The collector of A3Q4 therefore applies essentially the full oven heater supply voltage from Pin 14 (nominally 24v) to the high side of the heater.

The oscillator voltage ramps positive toward its ~8v maximum (the trigger point of UJT A3Q3). When the emitter of A3Q2, which is two diode drops below the ramp voltage, exceeds the voltage at the emitter of A3Q1 (which is set by the thermistor and A3U1), A3Q2 steals the current that has been flowing in A3Q1. This turns Darlington switch A3Q4 off, which interrupts the current flowing through the heater. Some time later (about 200-250uS after the previous reset), the oscillator voltage reaches the trigger point of the UJT and it resets the voltage on A3C1 to ~1v and the cycle begins again.

Thus, every 200-250uS the heater is on for a time determined by the thermistor circuitry, and off for the remainder of the ~200-250uS period. This switching action can be seen at the "Oven Monitor", Pin 11 (but note that the instrument may have a capacitor to ground on the mother card side of the oven monitor line, to integrate the switching waveform for use by the instrument's health monitor).

Enjoy,

C. Steinmetz

HP 10544A oven control circuit

A3 10544-60016 OVEN CONTROLLER ASSEMBLY

0854-0213

HEATER 47Ω ±10%

RED — 15 OVEN RETURN

R12 10K — 3 WHT — 11 OVEN MONITOR

2 ORE — 14 OVEN SUPPLY 24v nominal

Q4 3-347 MJE700

~600

~10k

R11 8200

F1 2110-0254 THERMAL FUSE

4 YEL — OVEN CONTROLLER INPUT +11.0 TO 13.5VDC 8

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No charge of any sort may be made
for this schematic

R1 10K

R2 10K

C1 .01UF

LM201AH

R6 51.1K

R5 51.1K

3

8

U1

7

6

2

26-59

CR1 01-40

CR2 01-40

2x 1N4148

Q1 4-23

Q2 4-560

MPSA12

R10 24K

Q3 5-10 2N2646

Pins 8 and 9 must
be connected externally

7

R3* 9090

R7 5.6M

R9 10K

C1 .01

TH1

9.93K 80°C 0837-0122

R4 2K

C2 2UF

Oven temperature

R8 1K

5

6 BLU — 9 NEGATIVE OVEN CONTROLLER