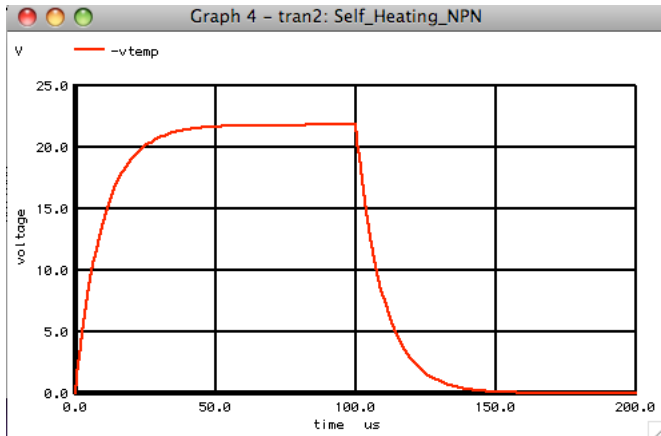
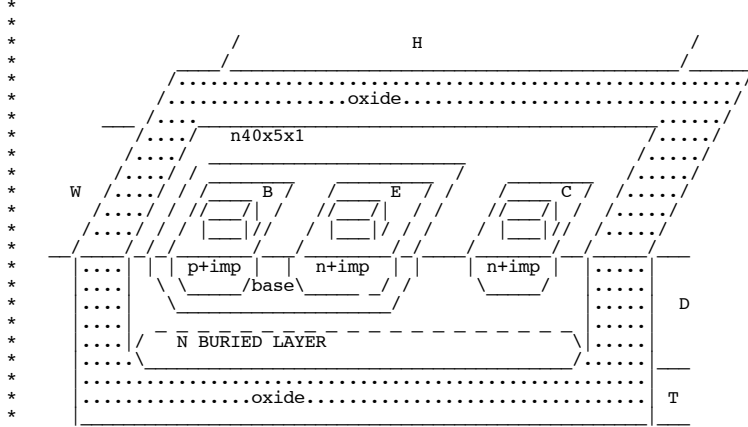


Self_Heating_NPN

TWEAKING THERMAL BEHAVIORAL MODELS TO MATCH THE ACTUAL MEASURED DATA.



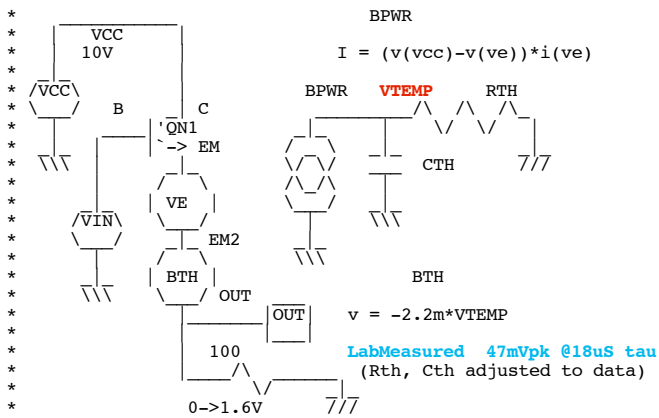
Self_Heating_NPN



H = 81u W = 36u D = 4u T = 1u

Therm Conduct SiO2 1/Rho = 1.4 W/(m*K)
 Spec heat Silicon Cv = 760 J/Kg-K
 Density Silicon = 2.42 gm/cm3

Rth_calc = 170degC/W
 Cth_calc = 21e-9 J/K



```
VCC VCC 0 DC 10
VIN VIN 0 PULSE( 0 2.8 1n 1n 1n 100u 200u )
Q1 VCC VIN EM npv 1
VE EM EM2 DC 0
BTH EM2 OUT v = 2.2m*v(VTEMP)
R1 OUT 0 100
BPWR VTEMP 0 i = (v(VCC) - v(OUT)) * i(VE)
RTH VTEMP 0 160
CTH VTEMP 0 60n
.TRAN 1u 200u 0 1u
```

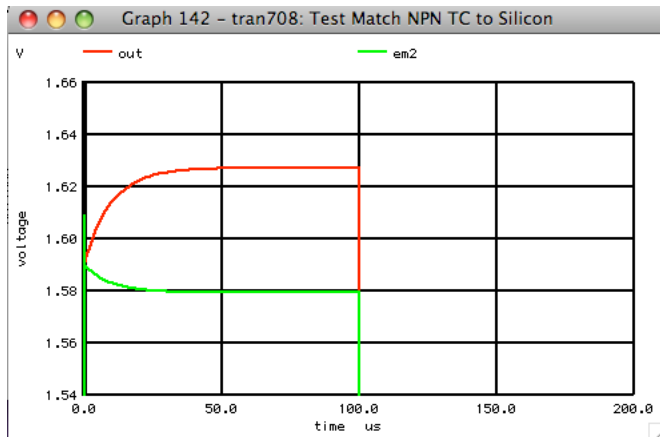
```

.control
set pensize = 2
run
plot out em2 ylimit 1.55 1.65
plot -vtemp
.endc
.model npnv npn (
*=====
+IS=1.1E-16 NF=1.0 BF=120 VAF=30 IKF=6e-03
+ NR=1.0 BR=0.5 VAR=4 IKR=3e-04
+ISE=9E-17 NE=2
+ISC=1E-21 NC=2
+RB=150 RBM=150 IRB=8E-04
+RE=17 RC=110
*=====
+CJE=2E-14 VJE=0.65 MJE=0.3
+CJC=2E-14 VJC=0.65 MJC=0.3
+CJS=3E-14 VJS=0.35 MJS=0.19 XCJC=0.42
+TF=2E-11 XTF=1.25 VTF=1 ITF=0.0035
+TR=6E-09 FC=0.9 PTF=210
*=====
+KF=1.0E-16 AF=1
+XTB=1.4 EG=1.11 XTI=8 TNOM=25
.end
*=====END_OF_SPICE=====

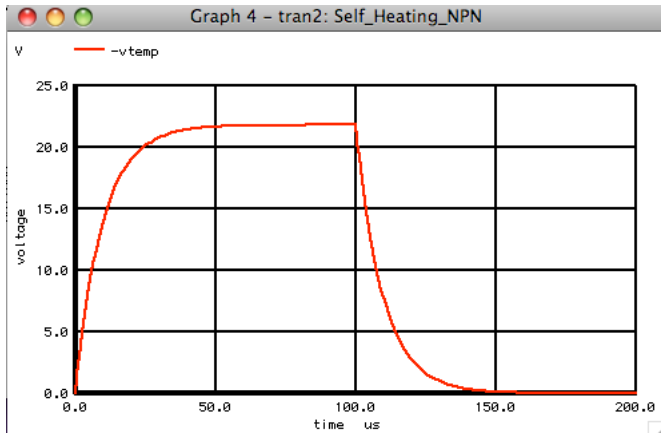
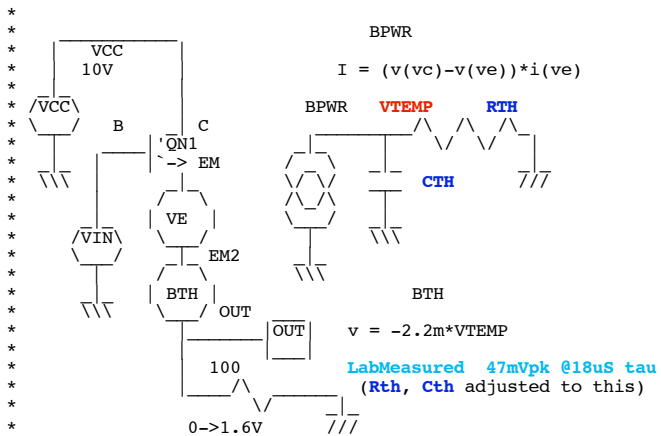
```

To Covert PDF to plain text click below
<http://www.fileformat.info/convert/doc/pdf2txt.htm>

The out waveform below was taken in the lab.
Silicon Oxide has ten times more thermal
insulation compared to silicon

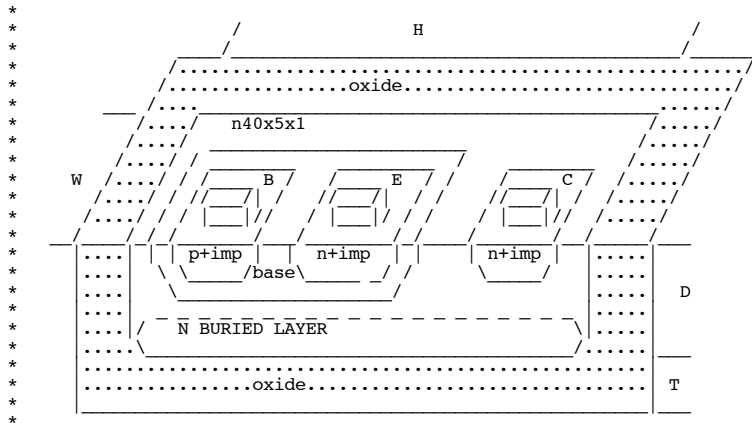


The circuit and output waveforms for the
simulation have been adjusted to match real
silicon data.



The thermal resistance and change in temperature appear to be very close to the calculated value.

The thermal capacitance appears to be about three times larger than expected for just the silicon's volume. The silicon oxide' thermal capacitance is not being included.



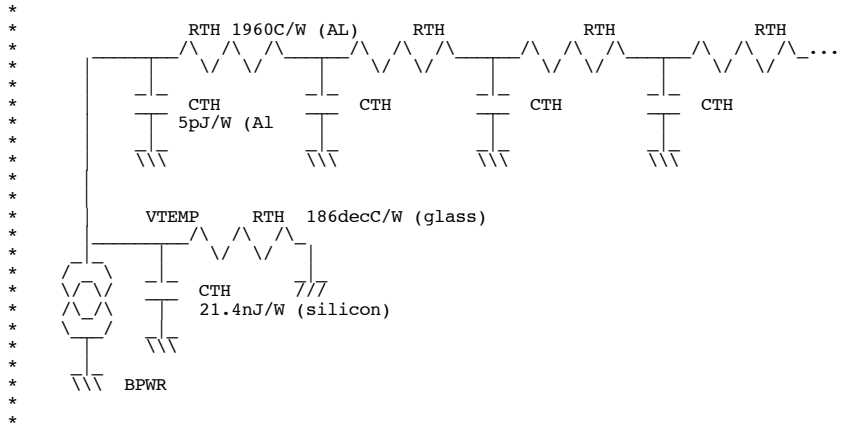
H = 81u W = 36u D = 4u T = 1u

Therm Conduct SiO2	1/Rho	= 1.4 W/(m*K)
Spec heat Silicon	Cv	= 760 J/Kg-K
Density Silicon		= 2.42 gm/cm3

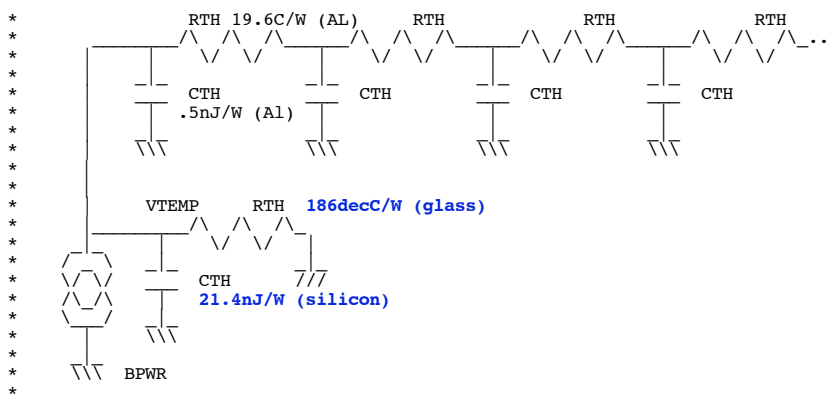
Rth_calc = 170degC/W
 Cth_calc = 21e-9 J/K

The effects of metal were also not included.
 Some pretty thick metal was used to hook up this transistor.

A single min geometry metal trace will add this to the thermal circuit.



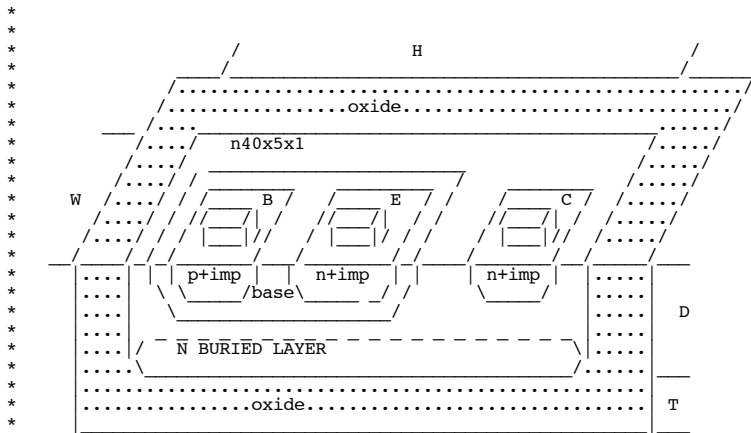
But since there are three thick and long metal traces connecting the transistor to its pads, the thermal situation is perhaps more like this.



The measured overall Rth was 160degC/W and the measured overall Cth appears to be 60nJ/w. This situation suggests that a little more care may have been needed in laying out the metal traces to this thermal self heating geometry.

*#1=====WinSpiceVersion=====

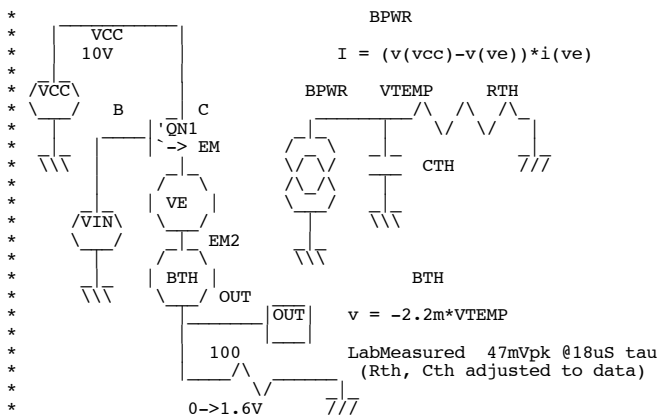
Self_Heating_NPN



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BPWR VTEMP 0 i = (v(VCC) -v(OUT))*i(VE)
RTH VTEMP 0 160
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```

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+ISE=9E-17 NE=2
+ISC=1E-21 NC=2
+RB=150 RBM=150 IRB=8E-04
+RE=17 RC=110
=====
+CJE=2E-14 VJE=0.65 MJE=0.3
+CJC=2E-14 VJC=0.65 MJC=0.3
+CJS=3E-14 VJS=0.35 MJS=0.19 XCJC=0.42
+TF=2E-11 XTF=1.25 VTF=1 ITF=0.0035
+TR=6E-09 FC=0.9 PTF=210
=====
+KF=1.0E-16 AF=1
+XTB=1.4 EG=1.11 XTI=8 TNOM=25
.end
    
```