PA-Oxf-241_5.

BCW Design Analysis

+15V limiter

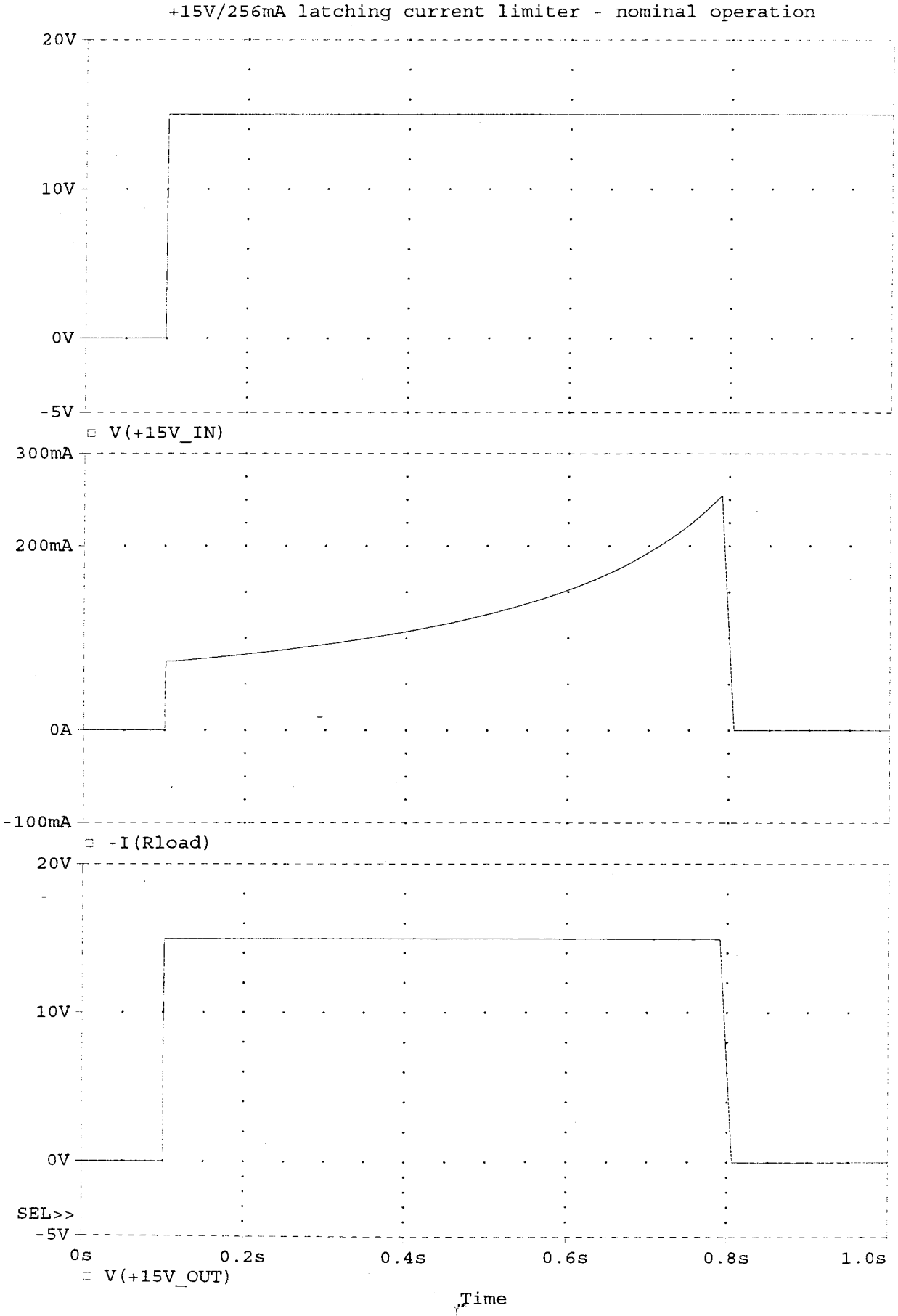
The limit current is set to 256mA. This was arrived at as follows.

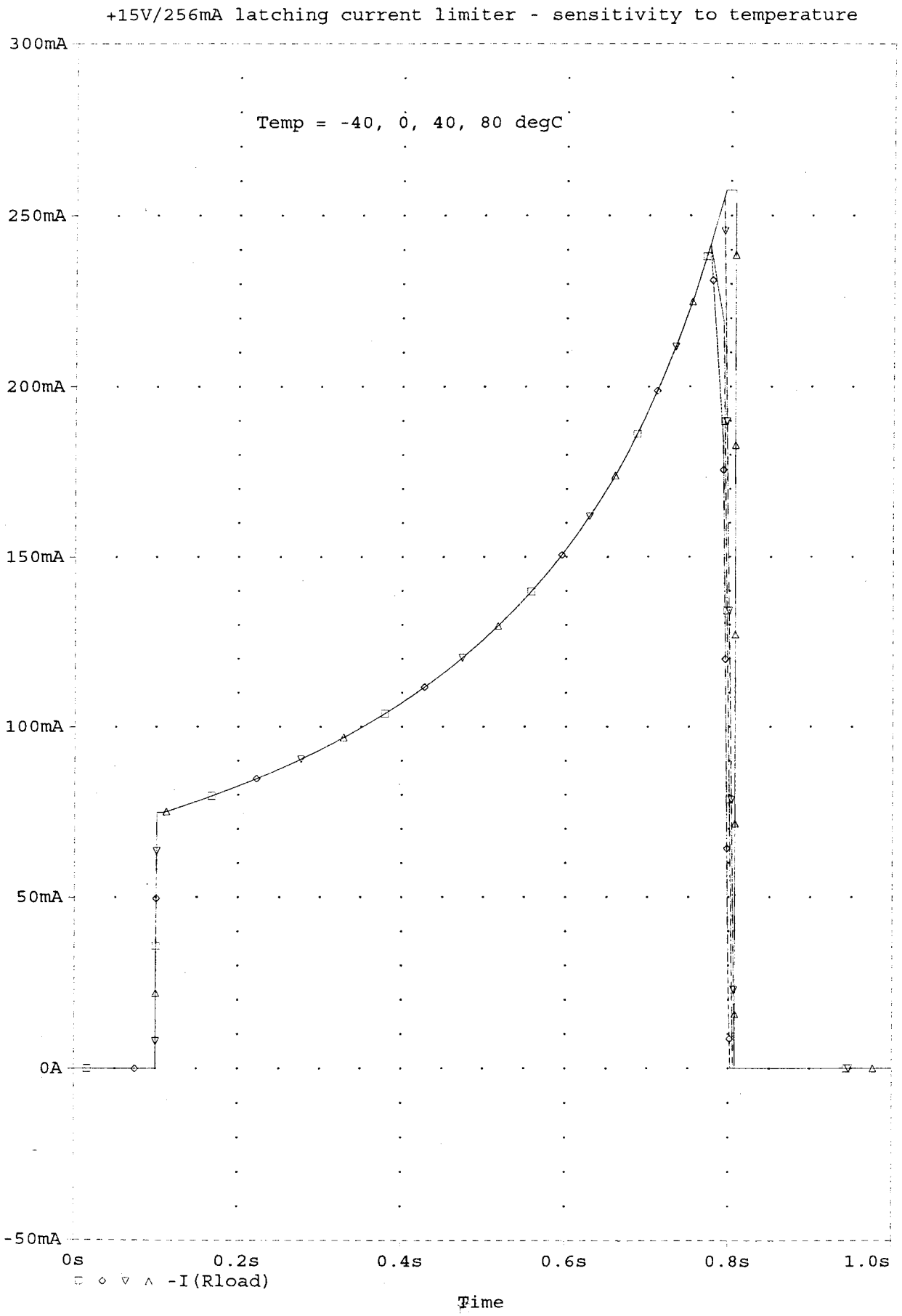
- 80mA (max) due to blackbody heater (from simulation of David Smith's circuit with 220ohm heater element)
- 48mA due to other circuits (as measured on EM without 28V applied)
- An arbitrary 'safety factor' of 2 was applied to total: (80 + 48) x 2 = 256mA

A new design has been produced in an attempt to deal with concerns raised about a previous version. Some of the changes/improvements which have been incorporated are listed below.

- The current sense circuit (U1, Q1, etc.) has been optimized for linearity and insensitivity to supply voltage variations, component tolerances and temperature. (It produces ~10V/A at the unloaded collector of Q1.)
- The limit current is now easily set/adjusted by the ratio of R8, R9.
- The HEXFET switch drive circuit has been redesigned to eliminate the diode circuit which was present to limit the V_{be} applied to a bipolar transistor which has been replaced by J1. In addition, it has been configured to allow additional 'pull down' transistors to be added to switch off the HEXFET (e.g. for power sequencing purposes).
- Several power saving changes have been incorporated: the circuit takes ~2.5mA at 15V.
- The parts count has been reduced.

Note that a 5.1V zener diode is used to provide the reference input to the limit current comparator (U2A, etc.). Clearly, if the supply voltage drops to such a low level that the zener cannot function, then the limit current cannot be guaranteed. However, the limit current decreases as the supply voltage drops below that at which that zener voltage can be maintained.


+15V/256mA latching current limiter - nominal operation
20V
10V
0V
-5V
V(+15V_IN)
300mA
200mA
0A
-100mA
-I(Rload)
20V
10V
0V
SEL>>
-5V
0s
0.2s
0.4s
0.6s
0.8s
1.0s
V(+15V_OUT)
Time


+15V/256mA latching current limiter - sensitivity to temperature
300mA
250mA
200mA
150mA
100mA
50mA
0A
-50mA
Temp = -40, 0, 40, 80 degC
0s
0.2s
0.4s
0.6s
0.8s
1.0s
-I(Rload)
Time

-15V limiter

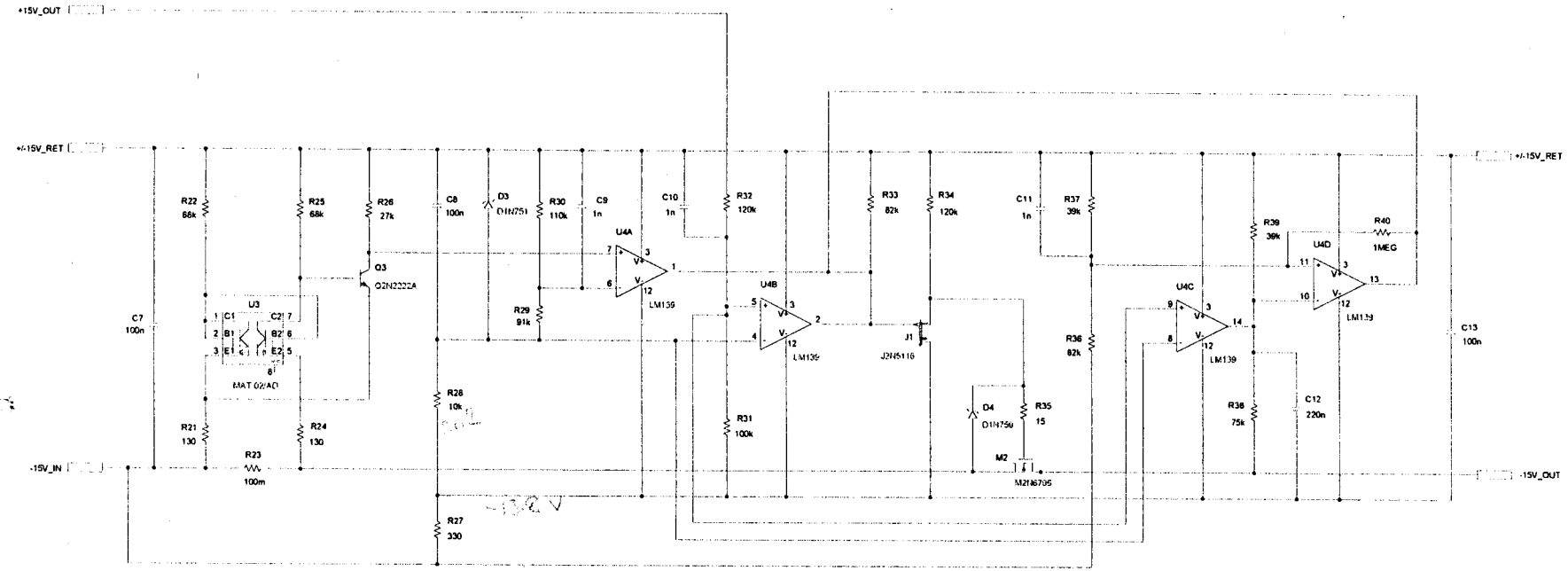
The limit current is set to 132mA. This was arrived at as follows.

- 20mA (max) estimated for blackbody heater. *(This is probably a bit too high but no change is proposed at this late stage.)*
- 46mA due to other circuits (as measured on EM without 28V applied)
- A 'safety factor' of 2 was applied to total: (20 + 46) x 2 = 132mA

As for the +15V limiter, a new design has been produced. Some of the changes/improvements which have been incorporated are listed below.

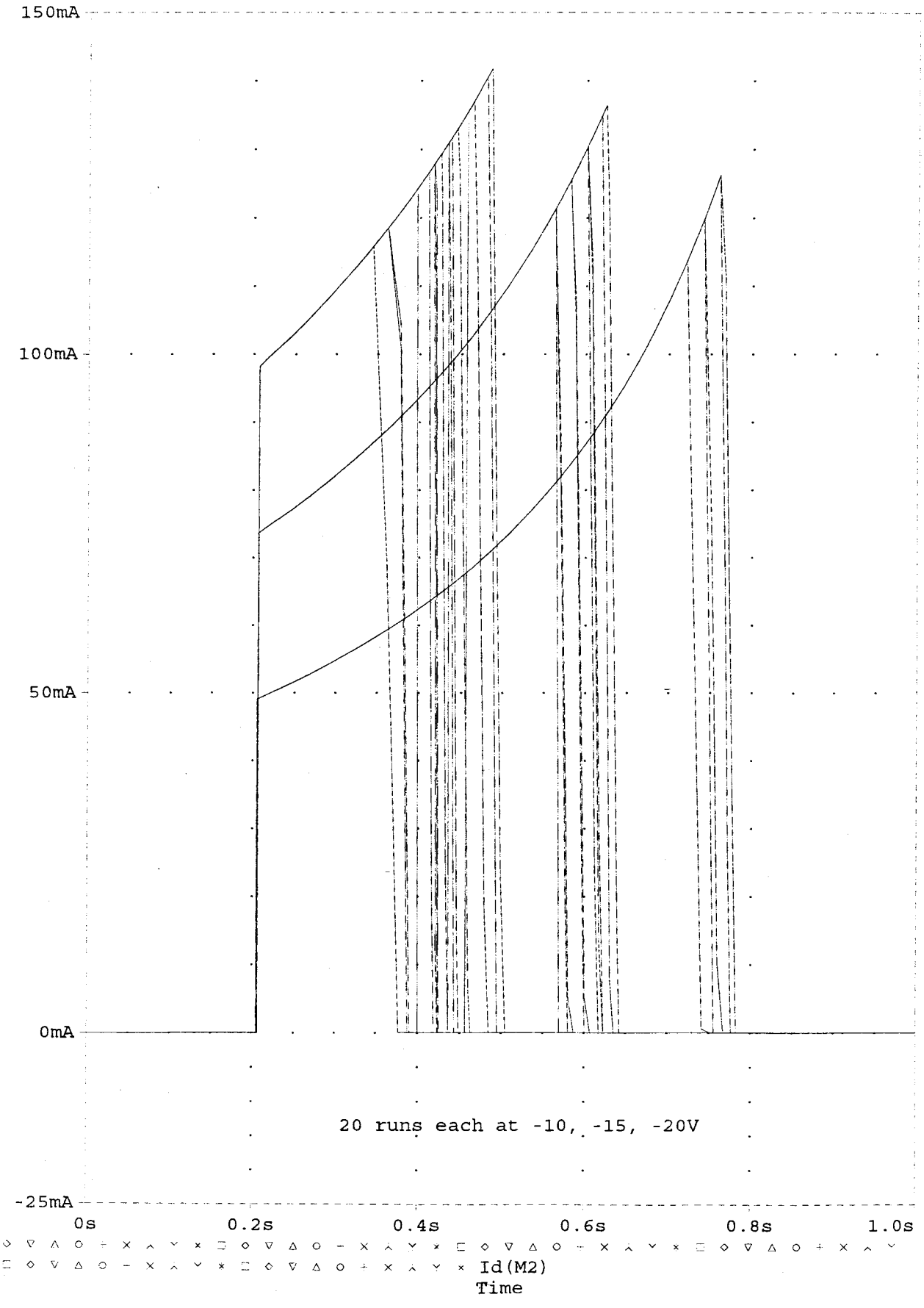
- The current sense circuit (U3, Q3, etc.) has been optimized for linearity and insensitivity to supply voltage variations, component tolerances and temperature. (It produces ~20V/A at the unloaded collector of Q3.)
- The limit current is now easily set/adjusted by the ratio of R29, R30.
- The HEXFET switch drive circuit has been redesigned to eliminate the diode circuit which was present to limit the V_{be} applied to a bipolar transistor which has been replaced by J1. In addition, it has been configured to allow additional 'pull to negative rail' circuits to be added to switch off the HEXFET (e.g. for power sequencing purposes and control by other rails).
- A new on/off control scheme has been implemented. This ensures the -15V rail remains off until the +15V rail exceeds about +6V. Note that the -15V rail will switch off *but not latch off* if the +15V rail drops below that level.
- Several power saving changes have been incorporated: the circuit takes ~3.5mA at -15V.

As in the +15V limiter, a 5.1V zener diode is used to provide the reference input to the limit current comparator (U4A, etc.). Clearly, if the supply voltage drops to such a low level that the zener cannot function, then the limit current cannot be guaranteed. However, the limit current decreases as



HIRDLS BEU: -15V LATCHING CURRENT LIMITER (132mA)

-15V/132mA latching current limiter - sensitivity to component tolerances



+5V limiter

The limit current is set to 170mA. This was arrived at as follows.

- 85mA due to other circuits (as measured on EM without 28V applied)
- An arbitrary 'safety factor' of 2 was applied to total: 85 x 2 = 170mA

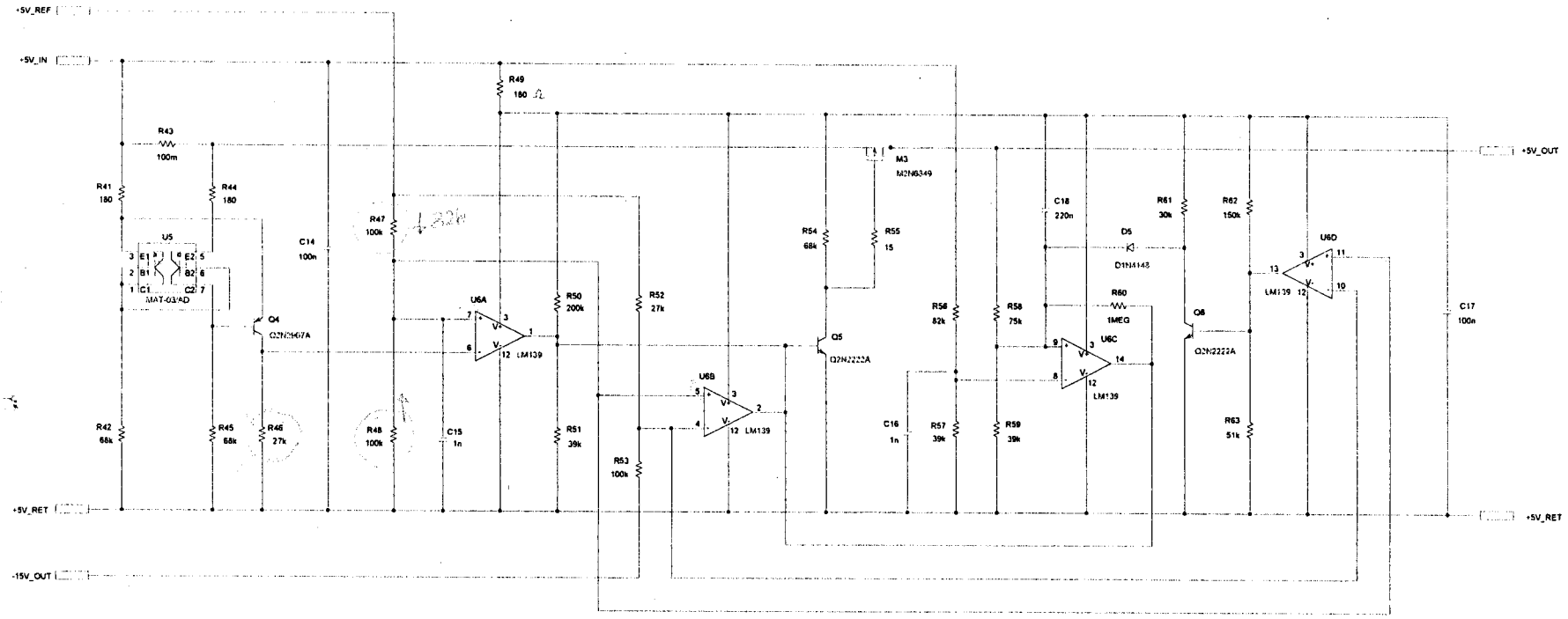
Operation of the LM139 from a single +5V rail is acceptable. (The Texas data sheets specifies 2V minimum provided that Vcc is at least 1.5V more positive than the input common mode voltage.)

The use of the +15v limiter's +5V reference voltage is justified by the fact that the +5V supply is not allowed to be on if the +15V supply is off.

As for the +15V and -15V limiters, a new design has been produced in an attempt to deal with concerns raised about a previous version. Some of the changes/improvements which have been incorporated are listed below.

- The current sense circuit (U5, Q4, etc.) has been optimized for linearity and insensitivity to supply voltage variations, component tolerances and temperature. (It produces ~15V/A at the unloaded collector of Q4.)
- The limit current is now easily set/adjusted by the ratio of R47, R48.
- The HEXFET switch drive circuit has been simplified. In addition, it has been configured to allow additional 'pull down' transistors to be added to switch off the HEXFET (e.g. for power sequencing purposes).
- Several power saving changes have been incorporated: the circuit takes ~1.4mA at 5V.
- The parts count has been reduced.

An undervoltage detection circuit (U6C, etc.) provides the latching function. When +5V_OUT drops below ~90% of +5V_IN, the output of U6C pulls the base of Q5 low and thus latches +5V_OUT off. At switch on, this process is inhibited for a few x ms (set by C18) to allow for inrush current. However, the inrush current will limited to 170mA during this period.



HIRDLS BEU: +5V LATCHING CURRENT LIMITER (170mA)

+5V/170mA latching current limiter - sensitivity to component tolerances