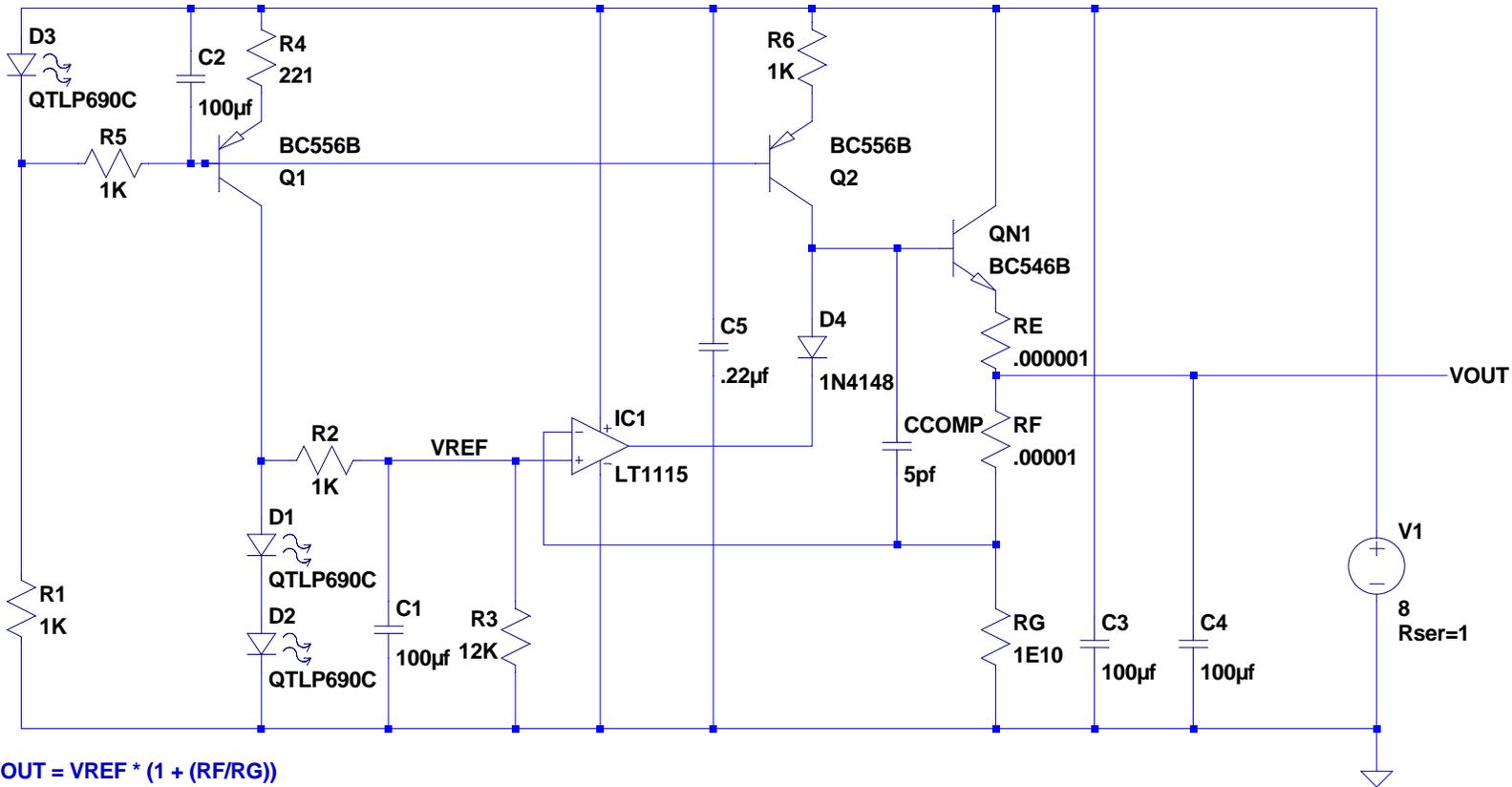


```
.tran 0 1 0 1E-6  
.options plotwinsize=0  
;ac oct 100 1 20meg
```



$$V_{OUT} = V_{REF} * (1 + (R_F/R_G))$$

CCOMP is optional. If required 5-22pf should be enough to stabilize the circuit. Do not use it if you don't need it, as it limits the performance at high frequencies.

RE is either a very low value resistor (say 1 ohm) or a jumper. In most cases a jumper is fine especially if using CCOMP.

If you require an output voltage greater than the VREF then you use RF and RG (or VRG if you use a potentiometer) to set the gain. RF should be < 1K for optimal performance. RF can be a jumper if you are not using RG. When used this way the output will follow VREF.

R1 should be chosen to get 4-10ma through D3. You could use a suitable Source/Gate connected JFET CCS or a CLD. You have many options and no hard and fast rules.

R6 should be chosen to get 1ma or so through D4 and the base of QN1. Its purpose is to limit short circuit current at the output by limiting the current that is available at the base of QN1. There is a trade off between safety and output impedance. The more current through R6 the lower the output impedance, but also the more short circuit current is possible. The value chosen is related to the beta of the pass device (QN1/2). Keep in mind that the opamp has to source that current, so do not make it too high.

If you don't care to limit output current you can omit R6 and Q2 and jumper D4. You could also make QN1 a Darlington or a CFP in that case if you like.

R3 is used to adjust the VREF to your target voltage, say 3.3V. You need to keep the reference voltage high enough for the opamp. The value of R3 will be dependant on the type of LEDs used and the current through R4. I try to keep the current through R4 > 4ma.

IC1 should be a unity gain stable type opamp with low voltage noise. LME49710, OPA227, or LT1115 would all be good choices as would others. The performance of the circuit will largely be determined by the performance of the opamp so choose a good one with low noise.