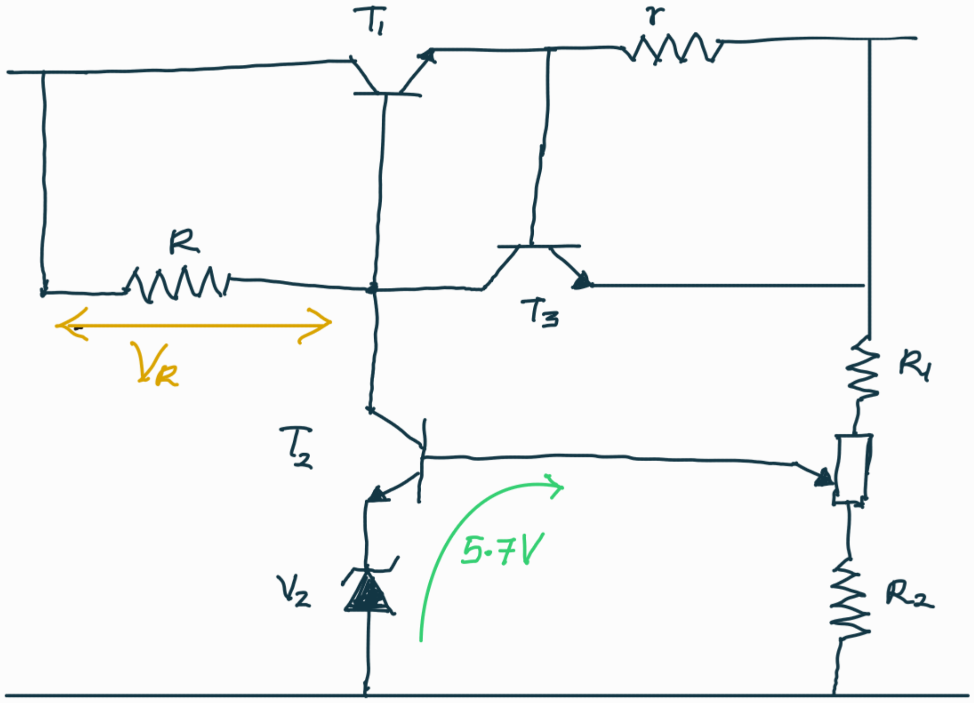
Input Voltage 14V – 18V
Output Voltage 6V – 12V
Maximum Current 1.5A



T_1 = TIP31C (40W)
T_2 = BD139 (12W)
T_3 = BC109
Zener 1N4732A (500mW)

For maximum voltage

$$\frac{R_2}{R_1+R_2+10k} \times 12 = 5.7V$$

$$12R_2 = 5.7(R_1+R_2+1000)$$

$$6.3R_2 = 5.7R_1 + 5700$$

For minimum voltage

$$\frac{R_2+1000}{R_1+R_2+1000} \times 6 = 5.7V$$

$$6R_2 + 6000 = 5.7(R_1+R_2+1000)$$

$$0.3R_2 + 300 = 5.7R_1$$

$$R_1 = 105.26\Omega$$

$$R_2 = 1k\Omega$$

Current limiting

max V_{BE} of $T_3 = 0.77V$

max current $= 1.5A$

$r = 0.513\,\Omega$

Power $= 0.77V \times 1.5A = 1.155\,W$

Due to lack of components we have selected 0.5Ω resistor (1Ω 5W resistors in Parallel)

new maximum current $= \dfrac{0.77V}{0.5\Omega} = 1.54A$

Power $= 1.54^2 \times 0.5$
$= 1.1858\,W$

R/ $V_{R\,min} = V_{i(min)} - (V_{o(max)} + 0.7)$

$= 14V - (12V + 0.7V)$

$= 1.3V$

Required $I_{R\,max}$

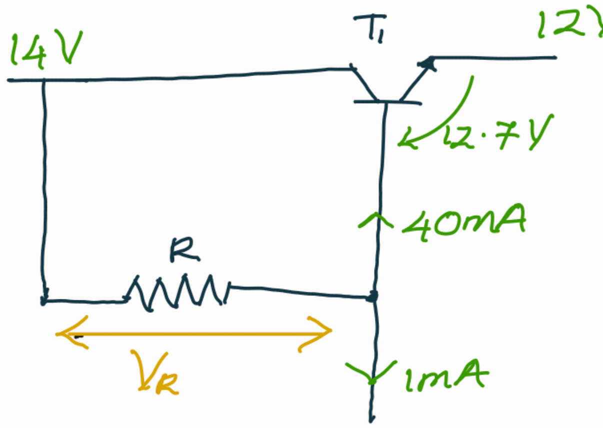
$I_{R\,max} \geq I_{Z\,min} + I_{B\,max}$

$\geq 1mA + \dfrac{1A}{40}$

$I_{R\,max} \geq 26mA$

$R < \dfrac{1.3V}{26mA}$

$R < 50\Omega$



considering Tolerances,

$1.05R < 50\Omega$

$R < 47.62\Omega$

For maximum voltage

$$\frac{R_2}{R_1+R_2+10k} \times 12 = 5.7V \qquad \frac{12}{5.7} - 1 = \frac{R_1+10k}{R_2}$$

For minimum voltage

$$\frac{R_2+10000}{R_1+R_2+10000} \times 6 = 5.7V \qquad \frac{6}{5.7} - 1 = \frac{R_1}{R_2+10k}$$

considering tolerances

$$\frac{1.05 \times R_2}{0.95(R_1+R_2+10k)} \times 12 \geqslant 5.7V$$

$$\frac{0.95(R_2+10000)}{1.05(R_1+R_2+10000)} \times 6 \leqslant 5.7V$$

consider the cases when equal & solve

$$7.185 R_2 = 5.415 R_1 + 54150$$

$$0 = 0.285 R_2 + 5.985 R_1 + 2850$$

consider tolerances for registers & solve

$$1.1 \leqslant \frac{(R_1+1k)0.95}{R_2 \times 1.05} \Rightarrow 1.55 R_2 = 0.95 R_1 + 0.95k$$

$$0.05 \geqslant \frac{R_1 \times 1.05}{(R_2+1k)0.95} \Rightarrow 0.0475 R_2 + 0.0475k = 1.05 R_1$$

$$R_1 = 75\Omega$$

$$R_2 = 658.9\Omega$$

$i_{z,max} \rightarrow V_o \min, V_{in} \max, i_b \min$

$$i_{z,max} = \frac{18V - (6V + 0.7V)}{47\Omega} - i_b \min$$

$$= \frac{11.3V}{47\Omega} - 1mA = 239.42 mA$$

<u>At No loading condition</u>

T_1/ $P_{max} \rightarrow i_c \max, V_i \max, V_o \min$

$$P_{max} = i_c \max [V_i \max - (V_o \min)]$$
$$= 1A (18V - 6V)$$
$$= 12W$$

<u>At 1Ω loading condition</u>

T_1/ $P_{max} = 1A [18V - (1V + 1V)]$
$$= 16W$$

T_2/ maximum possible voltage $= 12.7V - 4.7V$
$= 8V$

maximum possible current $= 239.42 mA$

maximum possible Power dissipation $= 8V \times 0.23942 mA$
$= 1.915W$

for zener maximum possible,

$$P_{max} = 4.7V \times 239.42mA$$

$$= 1.125W$$

Hence we use two zeners in parallel to withstand power dissipation