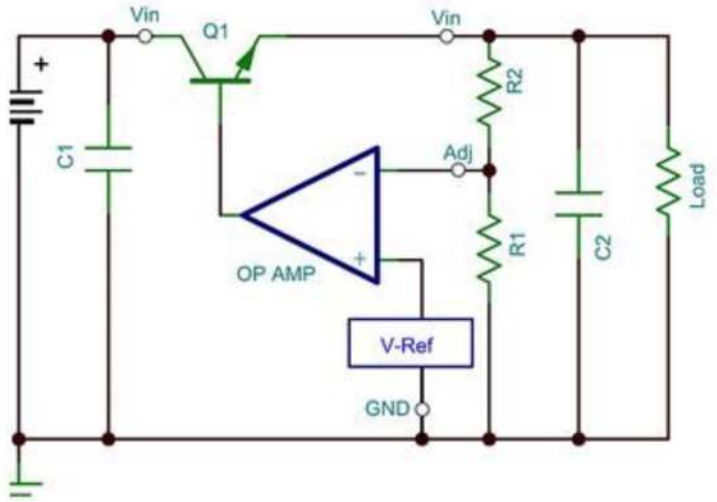
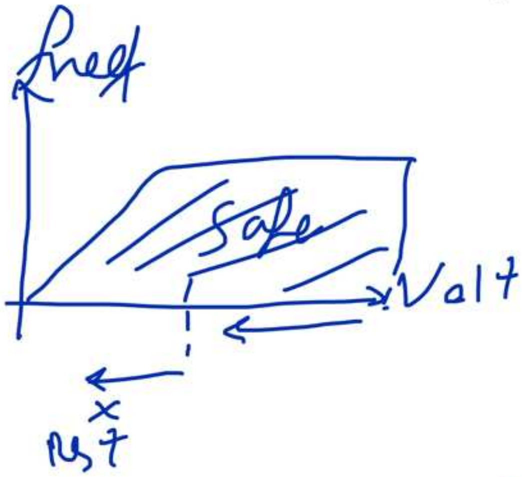
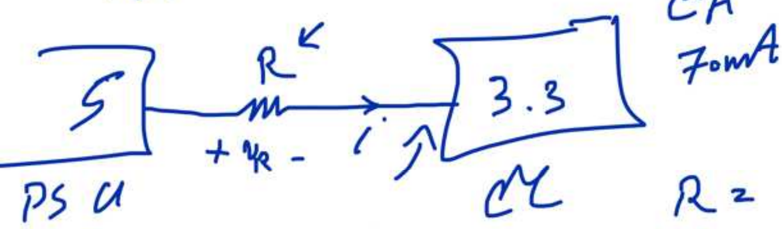
Linear Voltage Regulators



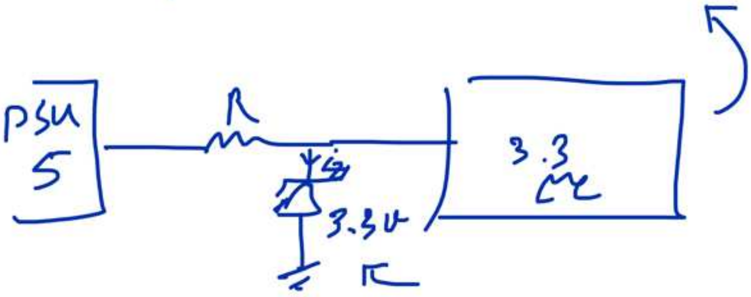


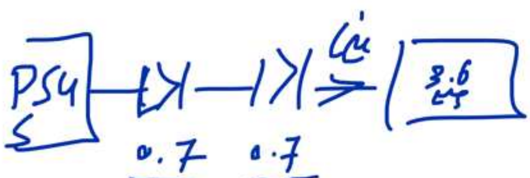
flash
EEprom
fusebit



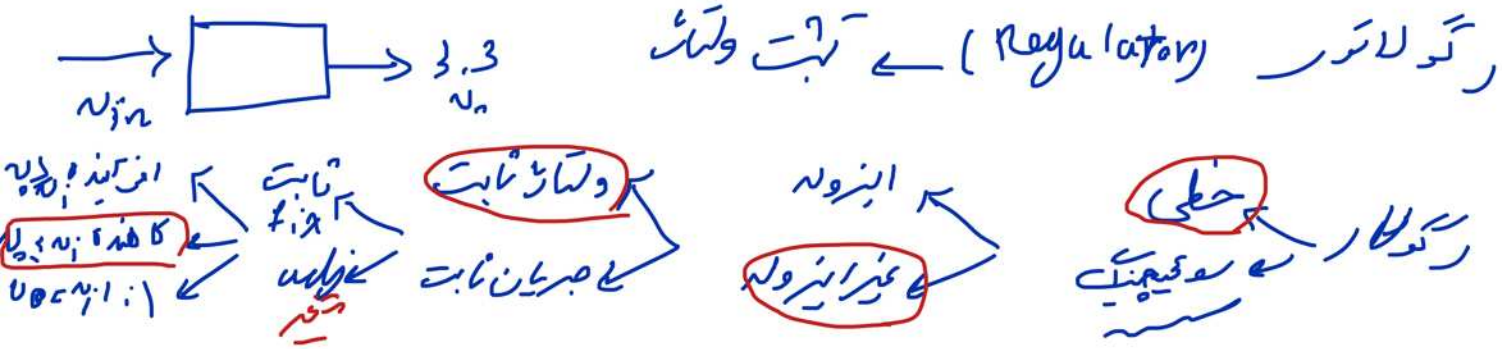
$R = \frac{5-3.3}{10mA} = \_\_\_$

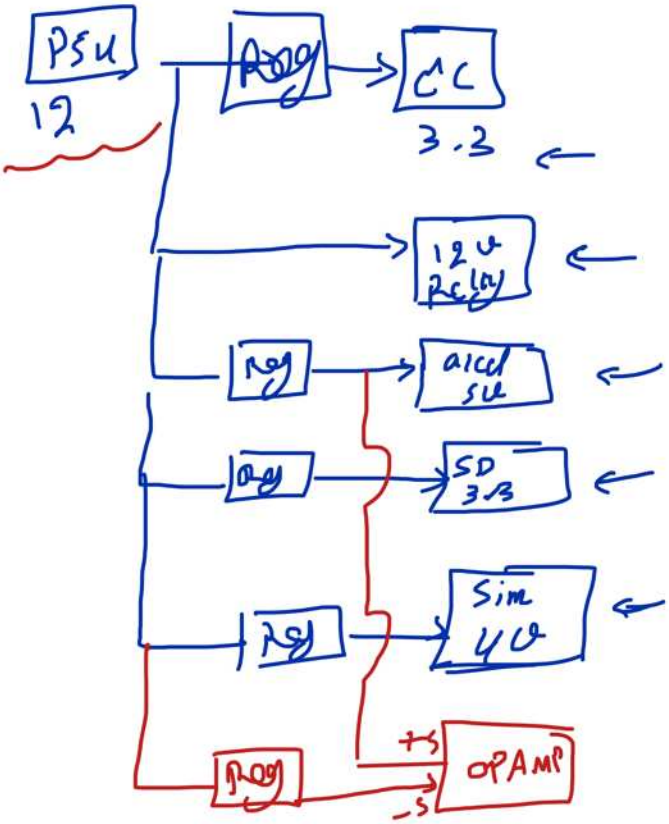
$V_R = Ri$

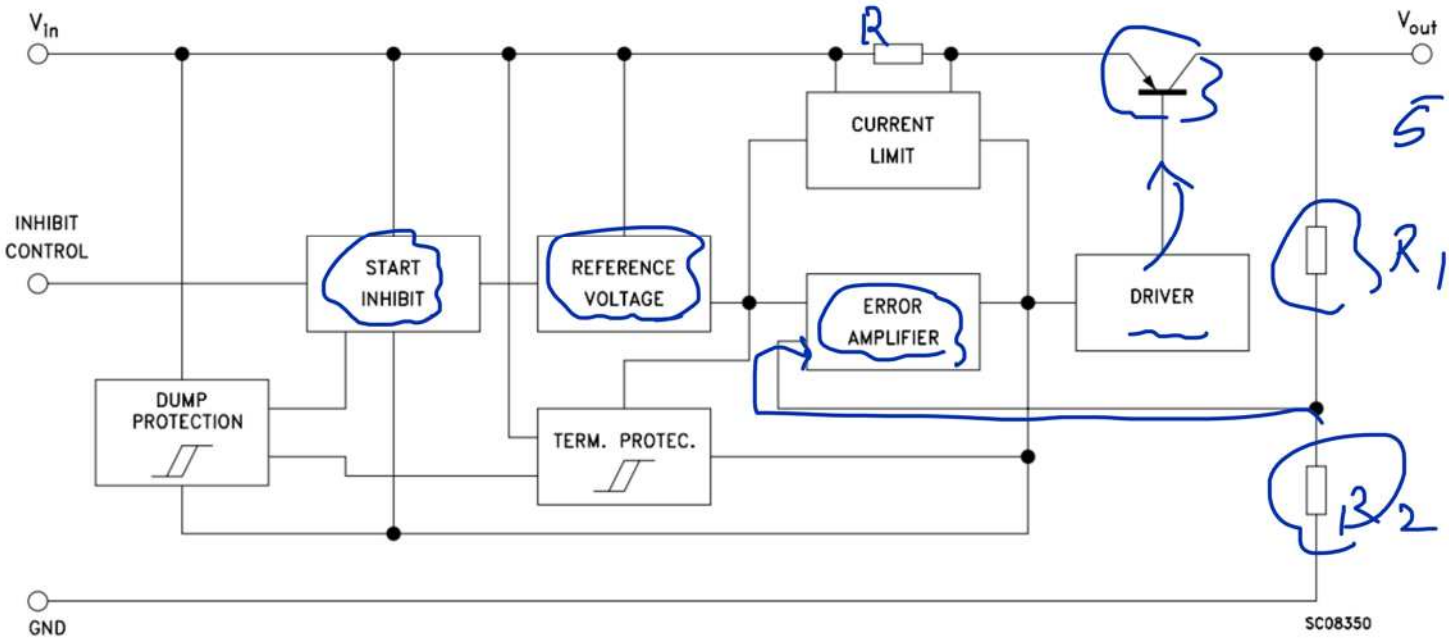




$5 - 0.7 \times 2 = 3.6$

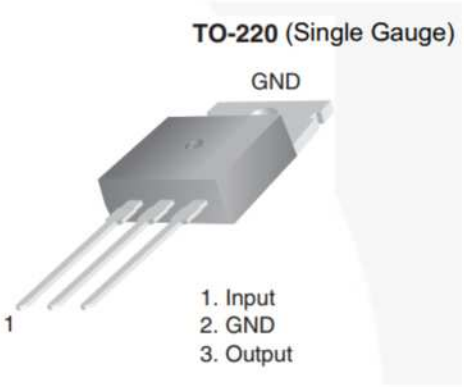

3.3
ولتاژ ثابت
ایزوله
خطی


PSU
12
3.3
12 V
SD
3.3
Sim
µC
OPAMP


Vin
Vout
R
CURRENT LIMIT
INHIBIT CONTROL
START INHIBIT
REFERENCE VOLTAGE
ERROR AMPLIFIER
DRIVER
DUMP PROTECTION
TERM. PROTEC.
GND
SC08350

78XX

79XX



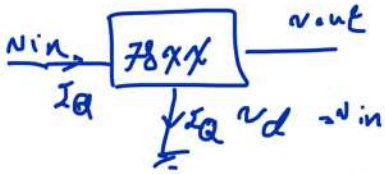
To-220

$I_o^{max} = 1A$

Product Number	Output Voltage Tolerance	Package	Operating Temperature
LM7805CT	±4%	TO-220 (Single Gauge)	-40°C to +125°C
LM7806CT			
LM7808CT			
LM7809CT			
LM7810CT			
LM7812CT			
LM7815CT			
LM7818CT			
LM7824CT			
LM7805ACT	±2%		0°C to +125°C
LM7809ACT			
LM7810ACT			
LM7812ACT			
LM7815ACT			

78XX

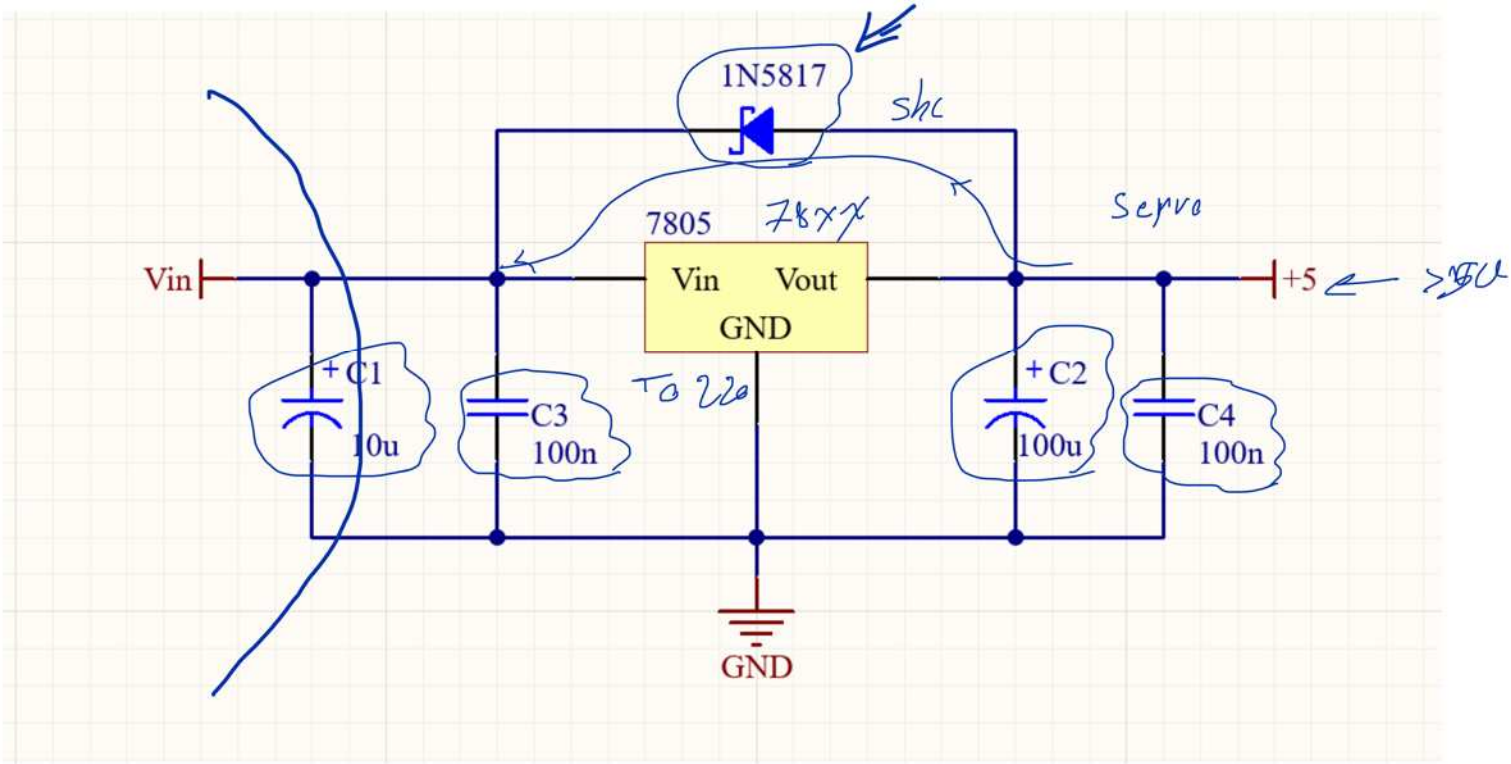
Symbol	Parameter		Value	Unit
V_I	Input Voltage	V_O = 5 V to 18 V	35	V
		V_O = 24 V	40	
$R_{\theta JC}$	Thermal Resistance, Junction-Case (TO-220)		5	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction-Air (TO-220)		65	°C/W
T_{OPR}	Operating Temperature Range	LM78xx	-40 to +125	°C
		LM78xxA	0 to +125	
T_{STG}	Storage Temperature Range		- 65 to +150	°C

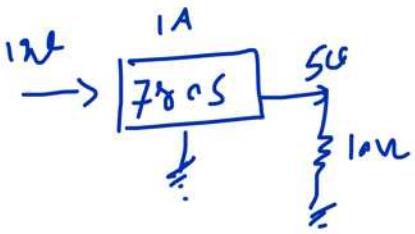


I_{load}

min load

I_Q	Quiescent Current	T_J =+25°C		5.0	8.0	mA
V_{DROP}	Dropout Voltage	T_J = +25°C, I_O = 1 A		2.0		V





$\Delta V = 12 - 5 = 7V$

$P_{loss} = 7 \times 0.5 = 3.5W$

$I_{Load} = \frac{5V}{10\Omega} = 0.5A$

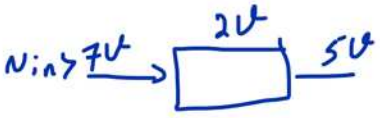
$\Delta\theta = 3.5 \times \frac{65}{1} \Rightarrow \Delta\theta = 227.5°$

$\theta_R = \theta_a + \Delta\theta = 25 + 227.5 = 252.5°$

Vb = libre ✗

min Vin ✗

Iout < ✗



ΔV <

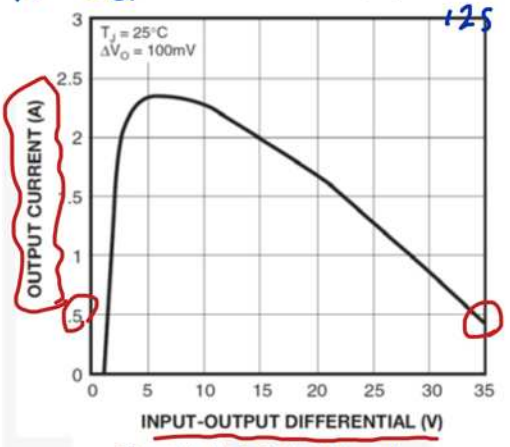


Figure 3. Peak Output Current

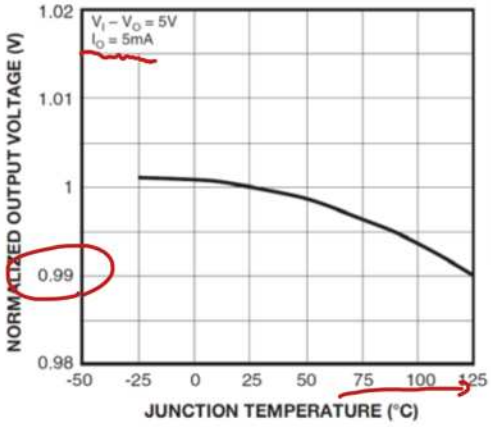


Figure 4. Output Voltage

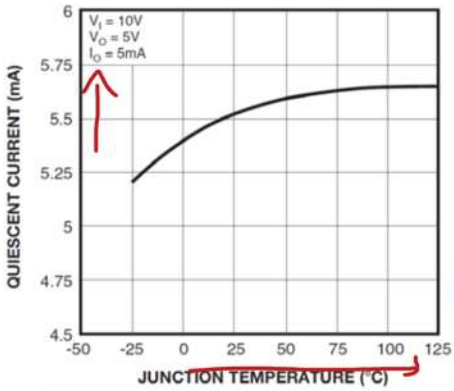


Figure 2. Quiescent Current

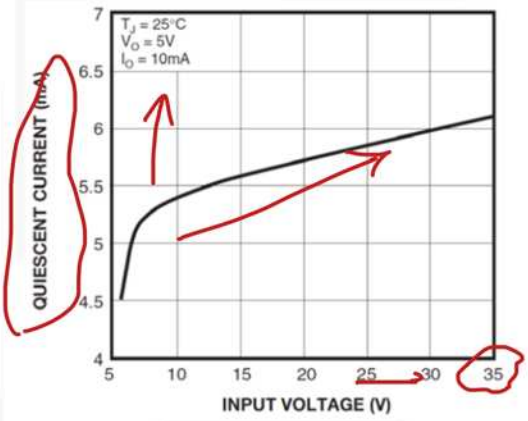
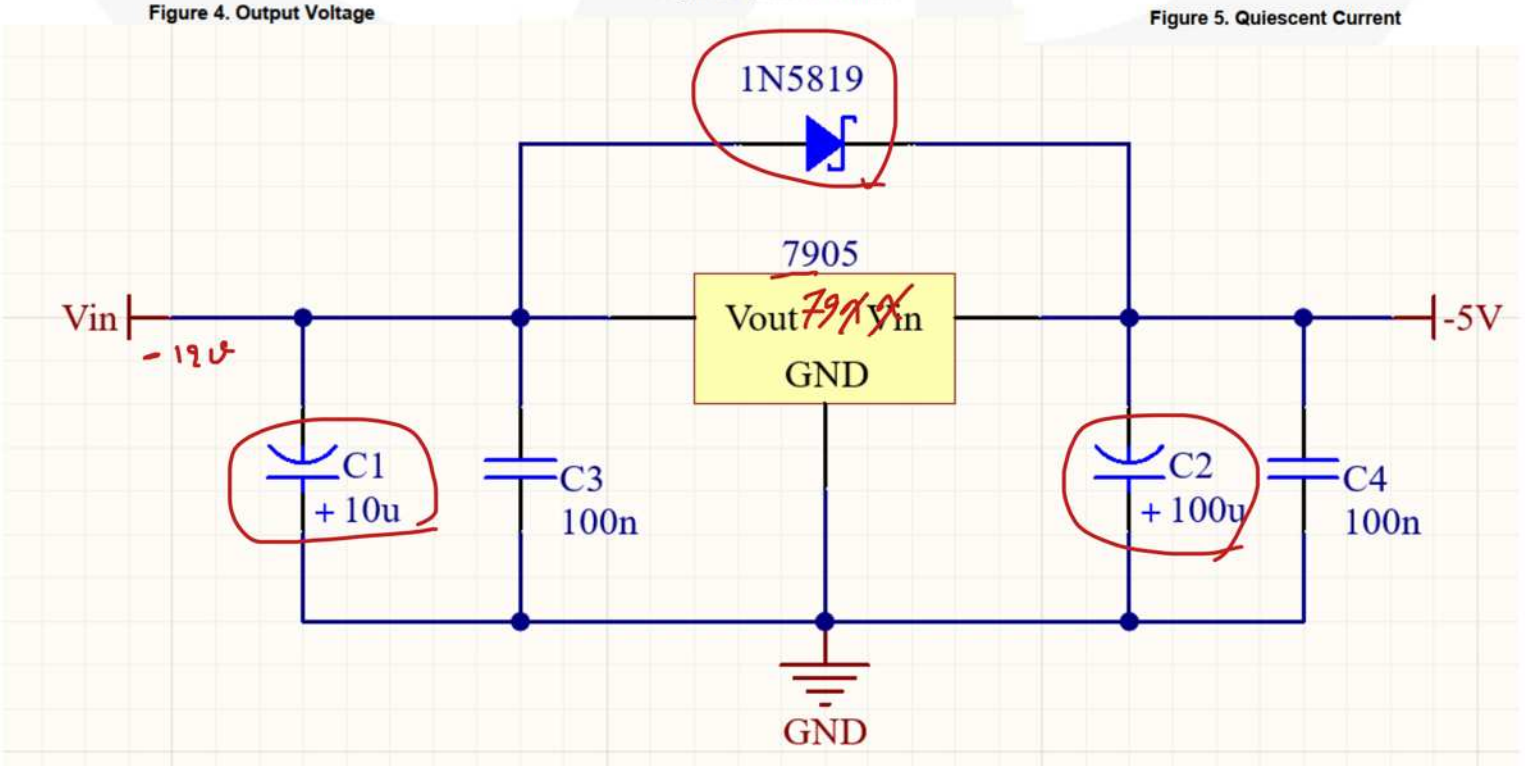
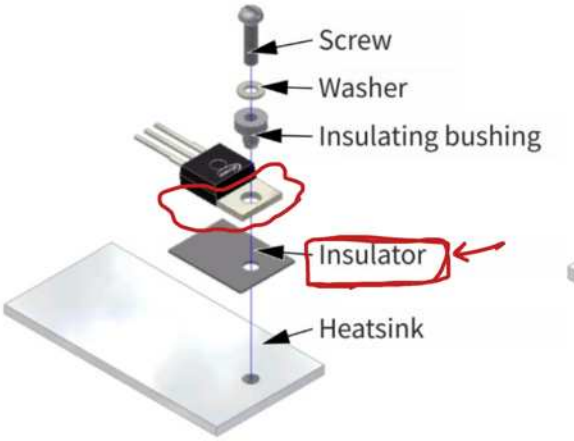
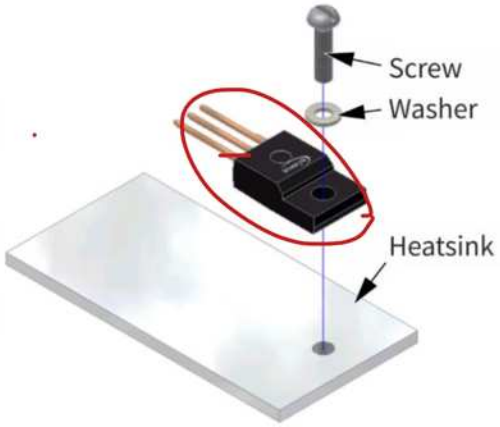


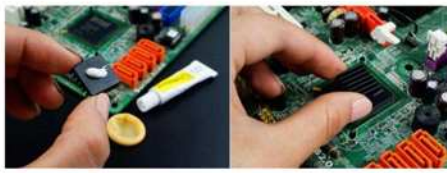
Figure 5. Quiescent Current

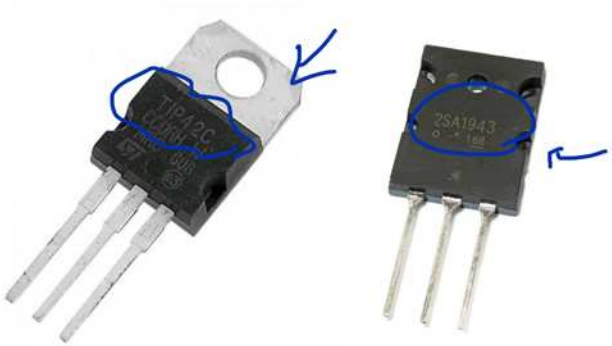


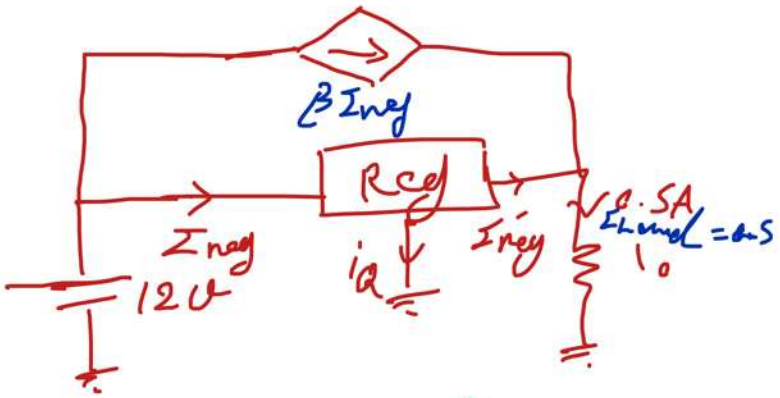

Screw
Washer
Insulating bushing
Insulator
Heatsink


Screw
Washer
Heatsink


HEATSINK PLASTER
STARS-922







$I_{neg} = I_Q + I'_{neg}$

$\downarrow$

$5mA \Rightarrow I_{neg} \simeq I'_{neg}$

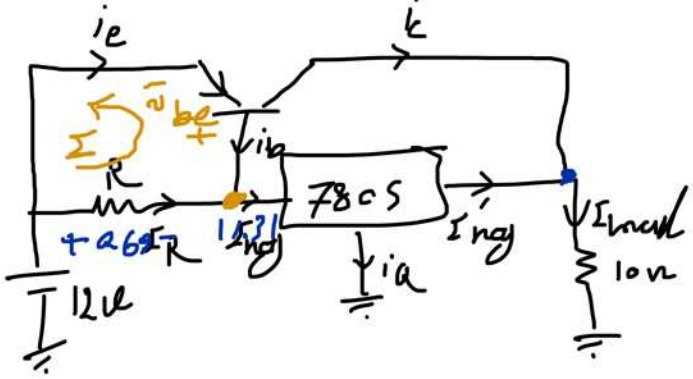
$I_L = I'_{neg} + \beta I_{neg}$

PNP

$i_e = (1+\beta) i_b$

$i_C = \beta i_b$

$\boxed{i_e = i_C}$



$\begin{cases} R I_R + v_{be} = 0 \\ I_R + i_b = I_{neg} \Rightarrow \boxed{I_R = I_{neg} - i_b} \end{cases}$

$\Rightarrow R(I_{neg} - i_b) + v_{be} = 0$

$\Rightarrow R = \dfrac{-v_{be}}{I_{neg} - i_b} \Rightarrow \boxed{R = \dfrac{v_{be}}{i_b - I_{neg}}}$

$I_{load} = I'_{neg} + i_C$

$i_C = \beta i_b$

$I_R = I_{neg} - i_b$

$I_L = i_C + I'_{neg} \Rightarrow \boxed{i_C = I_L - I'_{neg}}$

$i_C = \beta i_b \Rightarrow \boxed{i_b = \dfrac{i_C}{\beta}}$

$$R = \frac{v_{be}}{\frac{i_C}{\beta} - I_{neg}} = \frac{v_{be}}{\frac{I_L - I'_{neg}}{\beta} - I_{neg}} \Rightarrow R = \frac{v_{be}}{\frac{I_L - I'_{neg}}{\beta} - \frac{\beta}{\beta} I_{neg}}$$

$$\Rightarrow R = \frac{\beta v_{be}}{I_L - I'_{neg} - \beta I_{ng}} \Rightarrow \boxed{R = \frac{\beta v_{be}}{I_L - (1+\beta) I_{neg}}}$$

T_{1942C} $\begin{cases} \beta = 30 \\ v_{be} = -0.7 \end{cases}$

$$R = \frac{30(-0.7)}{0.5 - (1+30)(0.05)} \xrightarrow{\text{solve}} \boxed{R = 20\Omega}$$

$I_{neg} = 0.05 = 50mA$

$\xrightarrow{STD}$ $\boxed{R = 18\Omega}$

$$i'_b = \frac{i'_c}{\beta} = \frac{0.5}{30} \xrightarrow{calc} \boxed{i'_b = 16.667mA}$$

$$I_R = I_{neg} - i'_b = 55mA - 16.667mA \Rightarrow \boxed{I_R = 38.33mA}$$

$$I_{neg} = I'_{neg} + i'_Q = 50mA + 5mA = 55mA$$

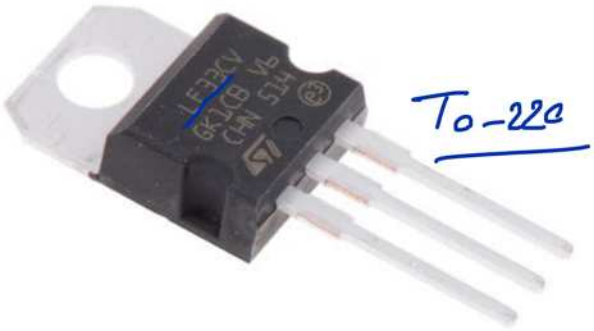
$$P_R = R i_R^2 = 18 \times (38.33 \times 10^{-3})^2 \Rightarrow \boxed{P_R = 26.45mW}$$

$R = 18\Omega \rightarrow$ (25mW) $\frac{1}{4}W$

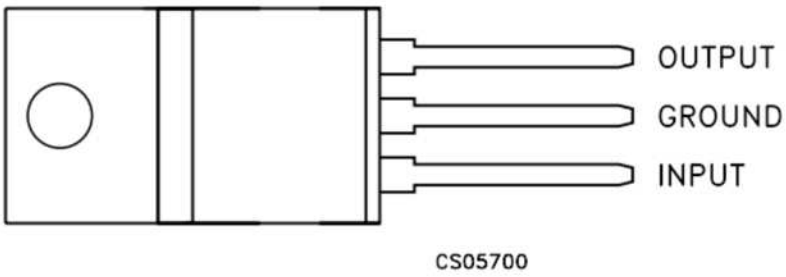
$$v_R = R \cdot i_R = 18 \times 38.33 \times 10^{-3} \Rightarrow \boxed{v_R = 0.69V}$$

$P_{Reg} = (11.31 - 5) \times 0.055 \Rightarrow \boxed{P^{new}_{Reg} = 0.347W} \times \frac{65^\circ}{1W} \Rightarrow T_R = 22.5$

$$T_{Reg} = T_R + T_a = 22.5 + 25 \Rightarrow \boxed{T_{Reg} = 47.55^\circ C}$$



To-220



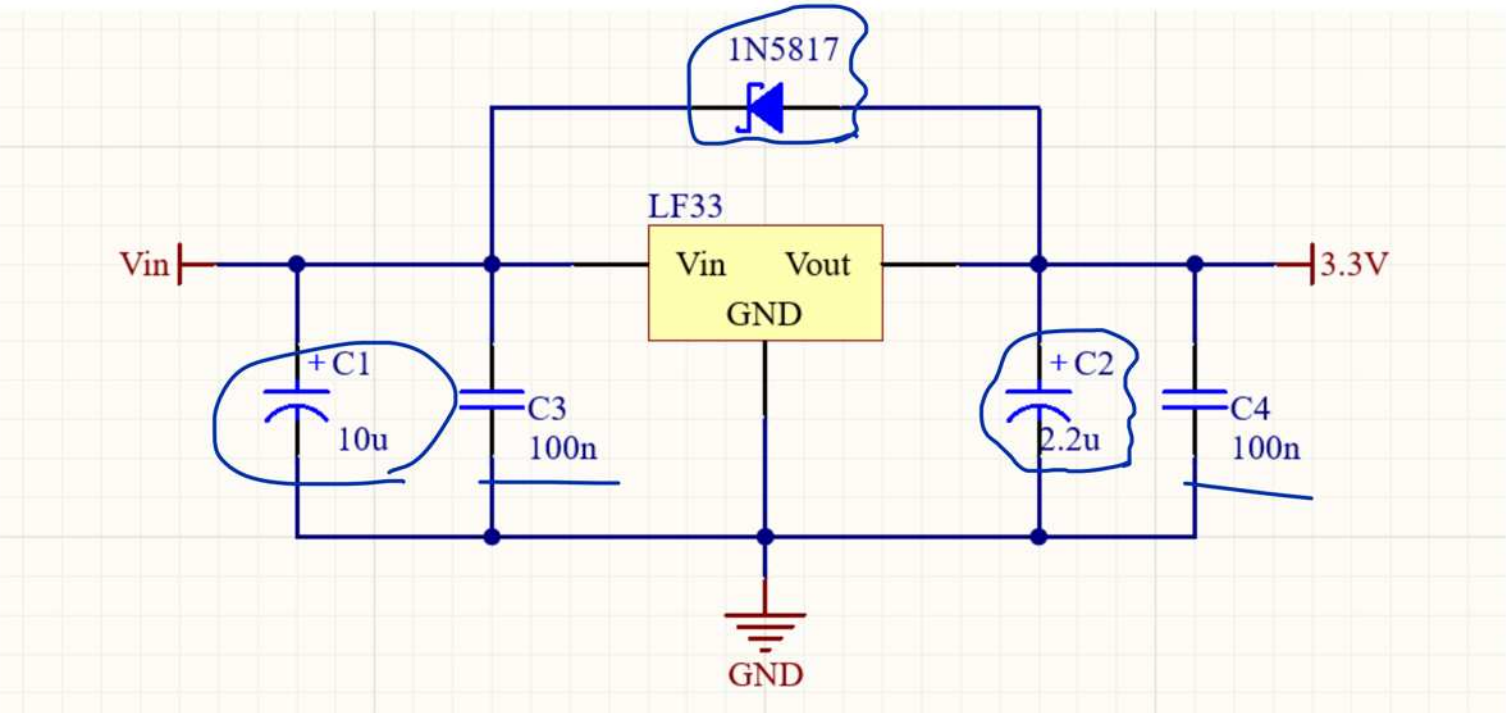
- OUTPUT VOLTAGES OF 1.25; 1.5; 1.8; 2.5; 2.7; 3; 3.3; 3.5; 4; 4.5; 4.7; 5; 5.2; 5.5; 6; 8; 8.5; 9; 12V

78xx 7805, LF50

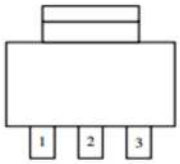
V_I	DC Input Voltage			-0.5 to 40 (*)		V
V_O	Output Voltage	I_O = 50 mA, V_I = 5.3 V	3.267	3.3	3.333	V
		I_O = 50 mA, V_I = 5.3 V, T_a = -25 to 85°C	3.234		3.366	
I_d	Quiescent Current	V_I = 4.3 to 16V, I_O = 0mA, ON MODE		0.5	1	mA
		V_I = 4.6 to 16V, I_O = 500mA			12	
		V_I = 6 V, OFF MODE		50	100	µA
V_d	Dropout Voltage	I_O = 200 mA		0.2	0.35	V
		I_O = 500 mA		0.4	0.7	

5mA – 8mA

2 V



SOT-223 Top View

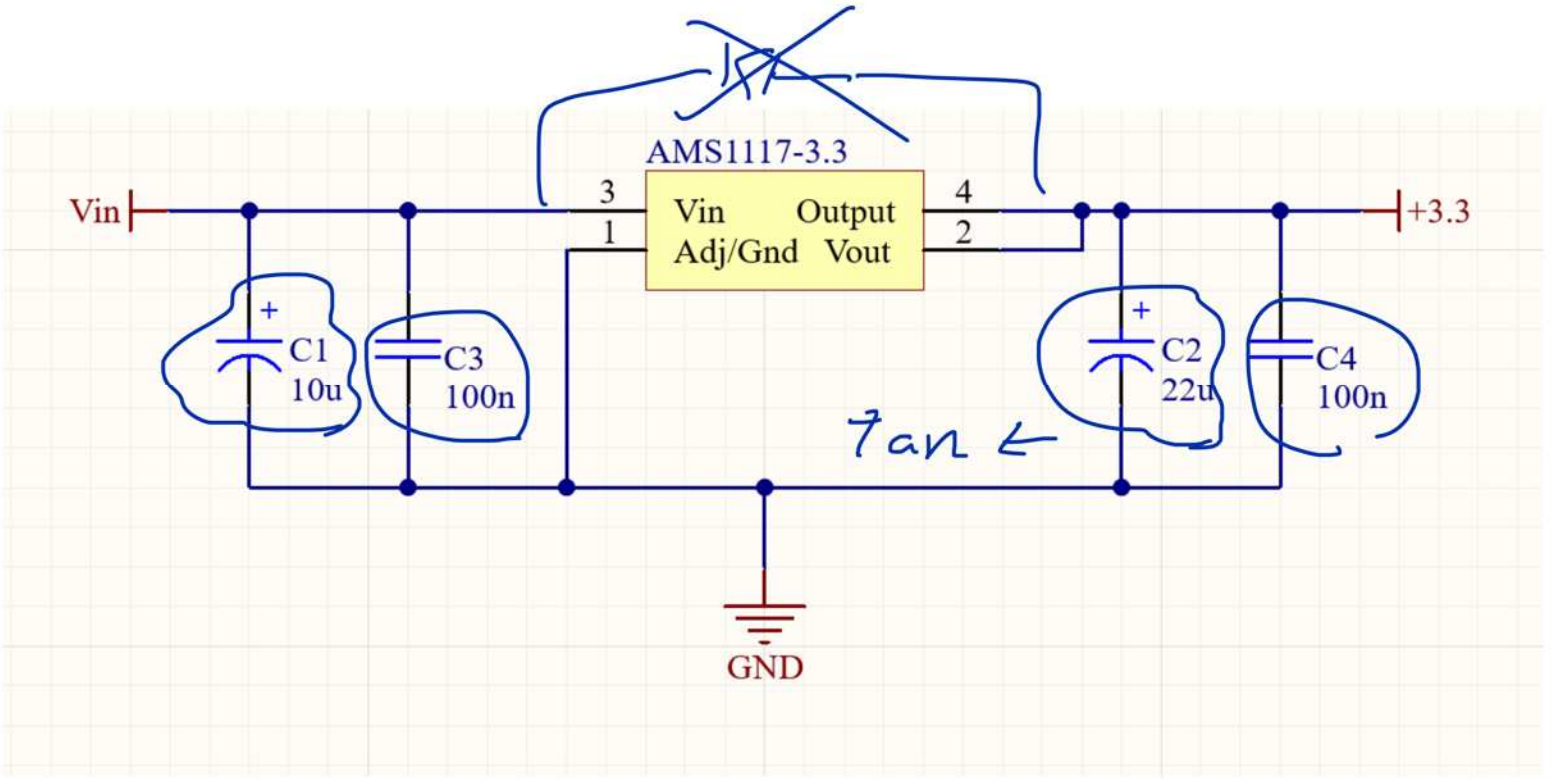


1- Ground/Adjust
2- V_{OUT}
3- V_{IN}

- Three-terminal adjustable or fixed low dropout 1.2V,1.5V,1.8V, 2.5V, 2.85V, 3.3V, 5V. Regulators

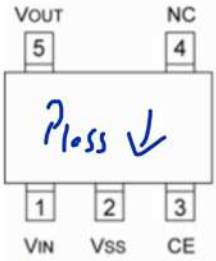
48 → 5
SW

Input Supply Voltage	V_{IN}	18			V
AMS1117-3.3, I_{OUT}=10mA, V_{IN}=5V,T_J=25°C , 0≤I_{OUT}≤1A, 4.75V≤V_{IN}≤10V		3.250 3.235	3.300 3.300	3.349 3.365	V
Dropout Voltage	V_{drop}	I_{OUT}=100mA I_{OUT}=500mA I_{OUT}=1A	--	1.00 1.05 1.20	1.20 1.25 1.30	V
Quiescent Current	I_q	4.25V≤V_{IN}≤ 6.5V	--	5	10	mA



LDO XC6209F33

XC6209



Ploss ↓

2Q ↓

Maximum Output Current	: 150mA (300mA=XC6209 E to H types)
Dropout Voltage	: 60mV @ 30mA : 200mV @ 100mA
Maximum Operating Voltage	: 2.0V ~ 10V
Output Voltage Range	: 0.9V ~ 6.0V(0.05V increments)
Highly Accurate	: ±2% (VOUT>1.5V) ±30mV (VOUT≦1.5V)
Low Power Consumption	: 25μA (TYP.)

XC6209①②③④⑤⑥-⑦

DESIGNATOR	ITEM	SYMBOL	DESCRIPTION
①	Type of Regulator CE Pin Logic	A	150mA, Active High, Pull-down resistor built-in (*2) (Semi-custom)
		B	150mA, Active High, No pull-down resistor (Standard)
		C	150mA, Active Low, Pull-up resistor built-in (*2) (Semi-custom)
		D	150mA, Active Low, No pull-up resistor (Semi-custom)
		E	300mA (*1), Active High, Pull-down resistor built-in (*2) (Semi-custom)
		F	300mA (*1), Active High, No pull-down resistor (Standard)
		G	300mA (*1), Active Low, Pull-up resistor built-in (*2) (Semi-custom)
		H	300mA (*1), Active Low, No pull-up resistor (Semi-custom)
②③	Output Voltage	09~60	Output Voltage Range: 0.9V~6.0V e.g. : 3.0V⇒②=3, ③=0
		30~60	For 1% product, output voltage range is 3.0V~6.0V.
④	Output Voltage Accuracy	2	0.1V increments, Accuracy: ±2% (*3) e.g.: 2.80V⇒②=2, ③=8, ④=2
		1	0.1V increments, Accuracy: ±1% e.g.: 3.00V⇒②=3, ③=0, ④=1
		A	0.05V increments, Accuracy: ±2% (*3) e.g.: 2.85V⇒②=2, ③=8, ④=A
		B	0.05V increments, Accuracy: ±1% e.g.: 3.05V⇒②=3, ③=0, ④=B
⑤⑥-⑦ (*4)	Packages (Order Unit)	MR	SOT-25 (3,000/Reel)
		MR-G	SOT-25 (3,000/Reel)
		PR	SOT-89-5 (1,000/Reel)
		PR-G	SOT-89-5 (1,000/Reel)
		DR	USP-6B (3,000/Reel)
		DR-G	USP-6B (3,000/Reel)

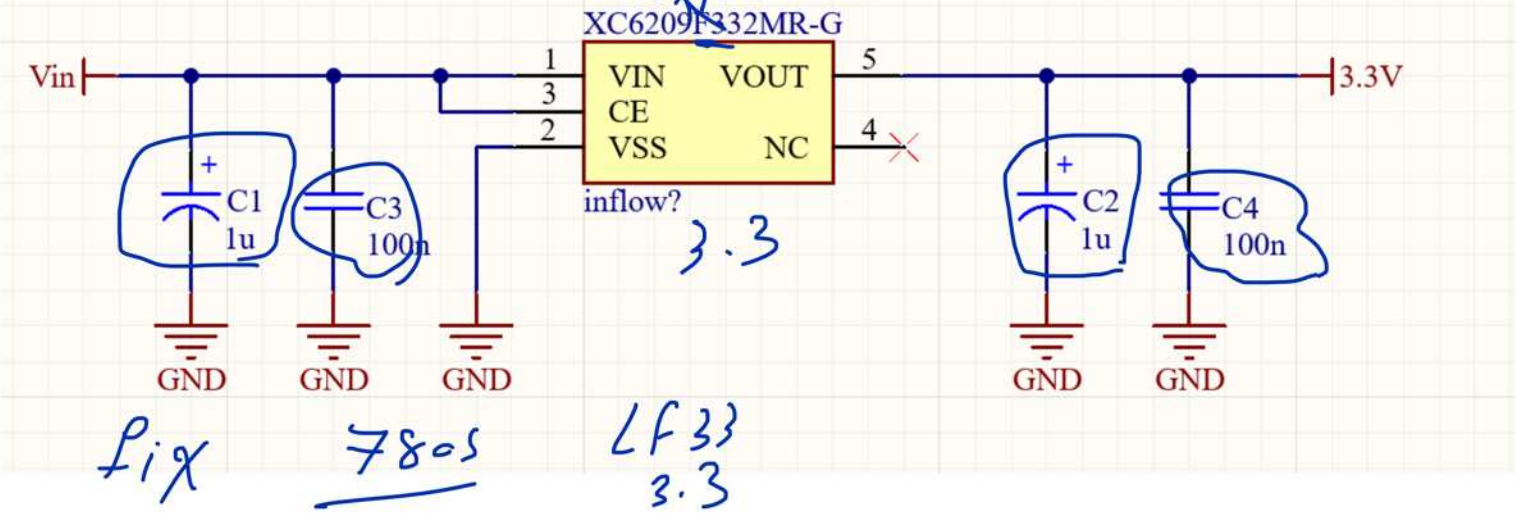
100mA / 5mA = 20h ≈ 8 day

1000mA / 25mA = 1600h

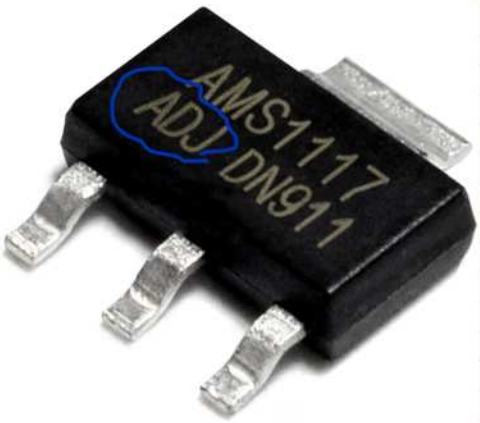
4.4 − 3.3 = 1.1

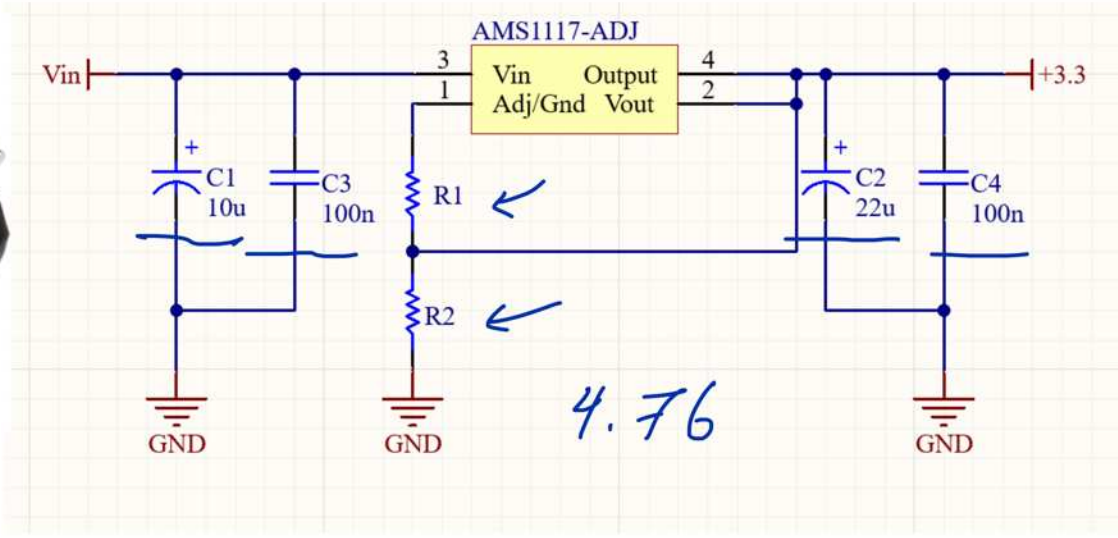
3.7 − 3.3 = 0.4

LDO



Lix 7805 LF33 3.3





$$V_o = V_{ref}\left(1 + \frac{R_2}{R_1}\right) + I_{adj} \cdot R_2$$

$V_{ref} = 1.25\,V$

$I_{adj} = 50\,\mu A$

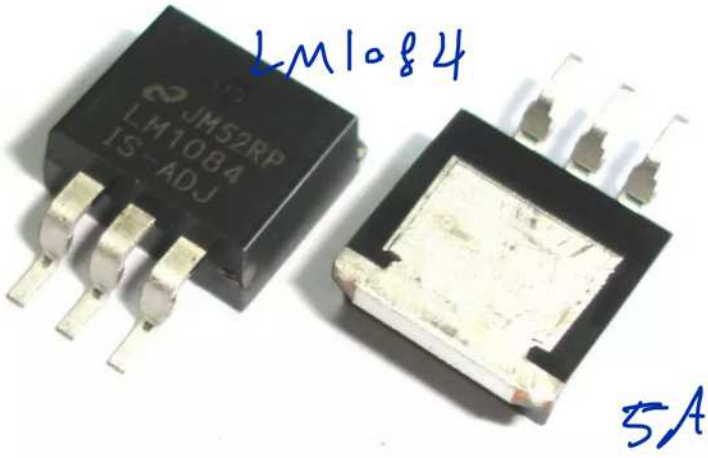
$R_1 \simeq 100\,\Omega$

$$3.3 = 1.25\left(1 + \frac{R_2}{R_1}\right)$$

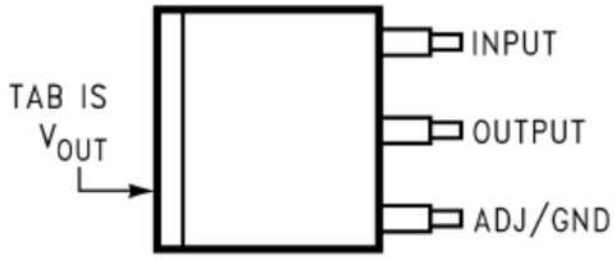
$$3.3 = 1.25\left(1 + \frac{R_2}{100}\right)$$

Solve $\Rightarrow$ $R_2 = 164$

2A



5A



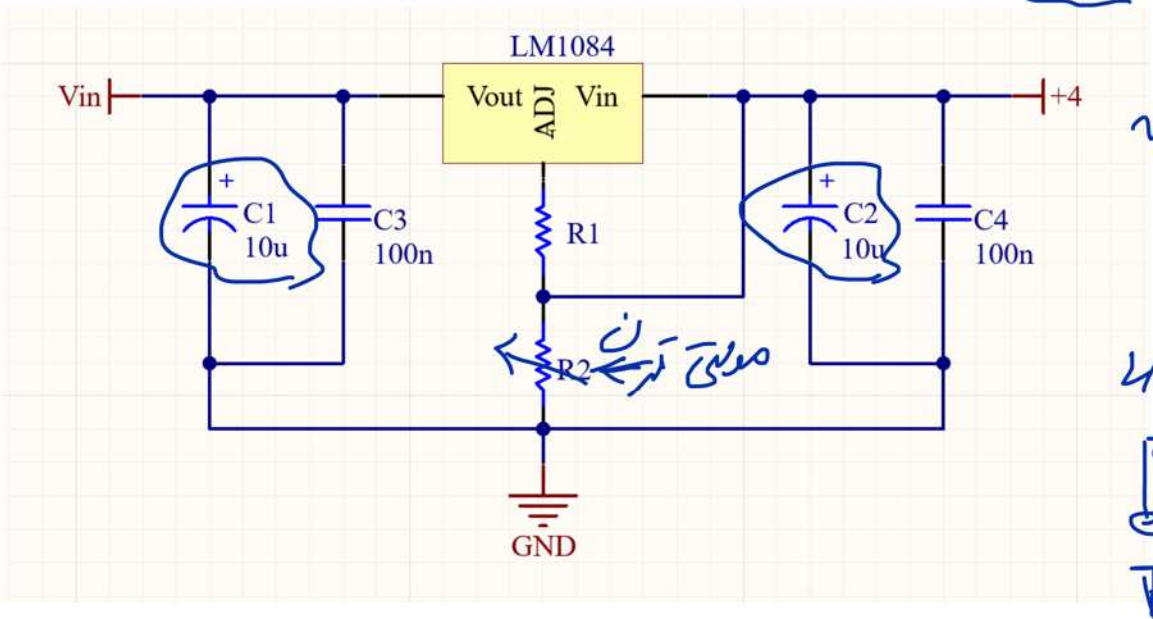
- Available in 3.3-V, 5.0-V, and Adjustable Versions

Maximum Input to Output Voltage Differential			
LM1084-ADJ		29	V
LM1084-3.3		27	V
LM1084-5.0		25	V

Dropout Voltage(5)	LM1084-ADJ, 3.3, 5, 12, ΔV_{REF}, ΔV_{OUT} = 1%, I_{OUT} = 5A, –40°C ≤ T_J ≤ 125°C		1.3	1.5	V

V_{OUT}	Output Voltage(3)	LM1084-3.3, I_{OUT} = 0 mA, V_{IN} = 8 V, 0 ≤ I_{OUT} ≤ $I_{FULL\ LOAD}$, 4.8 V ≤ V_{IN} ≤ 15 V	3.270	3.300	3.330	V
		LM1084-3.3, I_{OUT} = 0 mA, V_{IN} = 8 V, 0 ≤ I_{OUT} ≤ $I_{FULL\ LOAD}$, 4.8 V ≤ V_{IN} ≤ 15 V , –40°C ≤ T_J ≤ 125°C	3.235	3.300	3.365	
		LM1084-5.0, I_{OUT} = 0 mA, V_{IN} = 8 V, 0 ≤ I_{OUT} ≤ $I_{FULL\ LOAD}$, 6.5 V ≤ V_{IN} ≤ 20 V	4.950	5.000	5.050	V
		LM1084-5.0, I_{OUT} = 0 mA, V_{IN} = 8 V, 0 ≤ I_{OUT} ≤ $I_{FULL\ LOAD}$, 6.5 V ≤ V_{IN} ≤ 20 V, –40°C ≤ T_J ≤ 125°C	4.900	5.000	5.100	

Quiescent Current	LM1084-3.3, V_{IN} = 18 V		5.0	10.0	mA
	LM1084-5.0, V_{IN} ≤ 20 V		5.0	10.0	mA



$V_o = V_{ref}\left(1 + \frac{R_2}{R_1}\right)$

$V_{ref} = 1.25$

$4 = 1.25\left(1 + \frac{R_2}{R_1}\right)$

$R_1 = 10\Omega$

$R_2 = 22\Omega$