THREE-TERMINAL ADJUSTABLE OUTPUT POSITIVE VOLTAGE REGULATORS

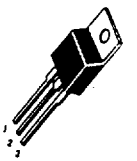
The LM317 is adjustable 3-terminal positive voltage regulator capable of supplying in excess of 1.5 A over an output voltage range of 1.2 V to 37 V. This voltage regulator is exceptionally easy to use and require only two external resistors to set the output voltage. Further, it employs internal current limiting, thermal shutdown and safe area compensation, making it essentially blow-out proof.

FEATURES

- Output Current in Excess of 1.5 Ampere
- Output Adjustable between 1.2 V and 37 V
- Internal Thermal Overload Protection
- Internal Short-Circuit Current Limiting Constant with Temperature
- Output Transistor Safe-Area Compensation
- Floating Operation for High Voltage Applications
- Standard 3-lead Transistor Packages
- Eliminates Stocking Many Fixed Voltages

PIN ARRANGEMENT

Z SUFFIX
PLASTIC PACKAGE
TO-220

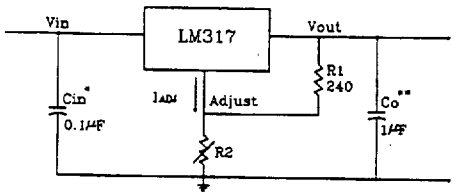


PIN 1.ADJUST
2. V_{out}
3. V_{in}

Heatsink surface connected to Pin2

CIRCUIT SCHEMATIC

STANDARD APPLICATION



* = Cin is required if regulator is located an appreciable distance from power supply filter.

** = Co is not needed for stability, however it does improve transient response.

$V_{out} = 1.25\ V\ (1 + R_2 / R_1) + I_{Adj}\ R_2$

Since I_{Adj} is controlled to less than 100 μA, the error associated with this term is negligible in most applications

ORDERING INFORMATION

Device	Tested Operating Temperature Range	Package
LM317CZ	T_J = 0°C to 125°C	TO-220

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input-Output Voltage Differential	$V_I - V_O$	40	Vdc
Power Dissipation	P_D	Internally Limited	
Operating Junction Temperature Range	T_J	0 to + 150	°C
Storage Temperature Range	Tstg	-65 to +150	°C

LM317 ELECTRICAL CHARACTERISTICS

($V_I - V_O$ = 5.0 V; I_O = 0.5 A for TO-220 packages; $T_J = T_{low}$ to T_{high} [see Note 1]; I_{max} and P_{max} per Note 2; unless otherwise specified.)

Characteristic	Figure	Symbol	Min.	Typ.	Max.	Unit
Line Regulation (Note 3) T_A = 25°C, 3.0 V ≤ I_O ≤ 40 V	1	REGline	--	0.01	0.04	%V
Load Regulation (Note 3) T_A = 25 °C, 10 mA ≤ I_O ≤ I_{max} V_O ≤ 5.0 V_O ≥ 5.0	2	REGload	 -- --	 5.0 0.1	 25 0.5	 mV %V
Thermal Regulation (T_A =+ 25°C) 20 ms Pulse			--	0.03	0.07	%W
Adjustment Pin Current	3	I_{Adj}	--	50	100	μA
Adjustment Pin Current Change 2.5V ≤ $V_I - V_O$ ≤ 40 V 10mA ≤ I_L ≤ I_{max}, P_D ≤ P_{max}	1.2	ΔI_{Adj}	--	0.2	5.0	μA
Reference Voltage (Note 4) 3.0 V ≤ $V_I - V_O$ ≤ 40 V 10mA ≤ I_O ≤ I_{max}, P_D ≤ P_{max}	3	V_{ref}	1.225	1.25	1.275	V
Line Regulation (Note 3) 3.0 V ≤ $V_I - V_O$ ≤ 40 V	1	REGline	--	0.02	0.07	%V
Load Regulation (Note 3) 10mA ≤ I_O ≤ I_{max} V_O ≤ 5.0 V V_O ≥ 5.0 V	2	REGload	 -- --	 20 0.3	 70 1.5	 mV %V

SCHEMATIC DIAGRAM

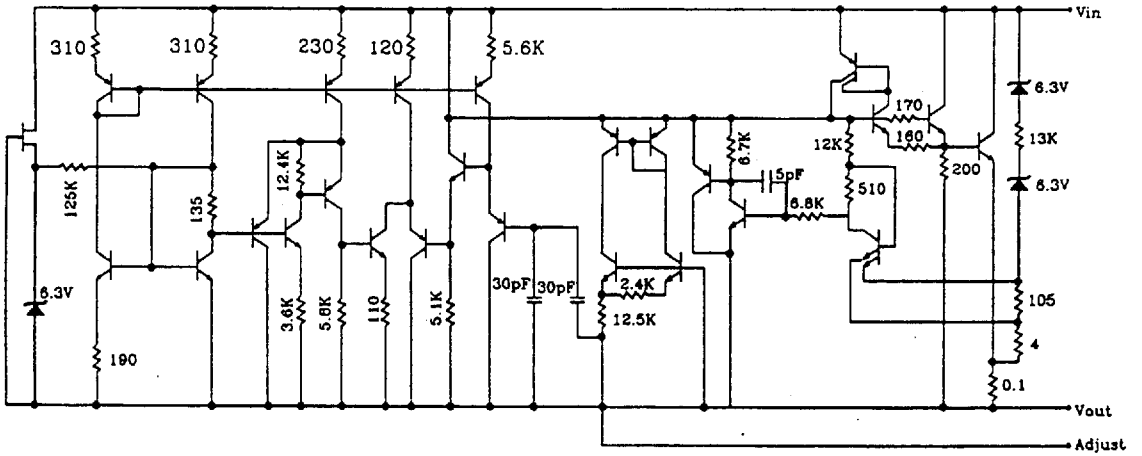
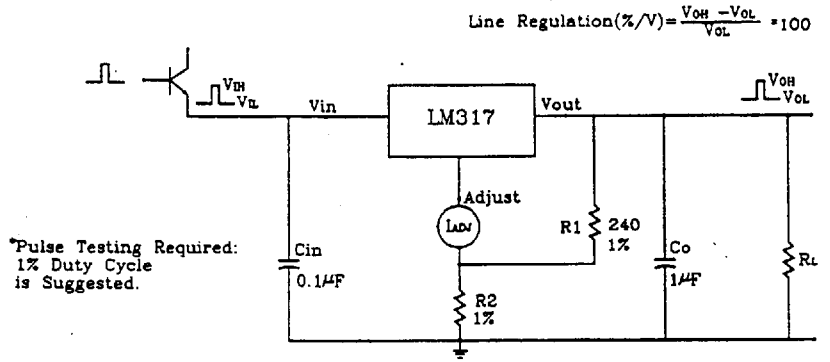


FIGURE 1- LINE REGULATION AND LINE TEST CIRCUIT



ELECTRICAL CHARACTERISTICS

(V_I-V_O = 5.0 V; I_O = 0.5A for TO-220 packages; $T_J = T_{low}$ to T_{high} [see Note 1]; I_{max} and P_{max} per Note 2; unless otherwise specified.)

Characteristic	Figure	Symbol	Min	Typ	Max	Unit
Temperature Stability ($T_{low} \le T_J \le T_{high}$)	3	T_S	--	0.7	--	% V
Minimum Load Current to Maintain Regulation (V_I - V_O = 40 V)	3	I_{Lmin}	--	3.5	10	mA
Maximum Output Current V_I - $V_O \le$ 15V, $P_D \le P_{max}$ V_I - V_O = 40V, $P_D \le P_{max}$, T_A = 25°C	3	I_{max}	 1.5 0.15	 2.2 0.4	 -- --	A
RMS Noise, % of V_O T_A =25°C, 10 Hz $\le$ f $\le$ 10 KHz	--	N	--	0.003		% V
Ripple Rejection, V_O = 10 V, f = 120Hz (Note 5) Without C_{Adj} C_{Adj} = 10 µF	4	RR	 -- 66	 65 80	 -- --	dB
Long-Term Stability, $T_J = T_{high}$ (Note 6) T_A =25°C for Endpoint Measurements	3	S	--	0.3	1.0	%1.0 K Hrs.
Thermal Resistance Junction to Case	--	$R_{\theta JC}$	--	5.0	--	°C/W

NOTES:

(1) T_{low} = 0°C T_{high} = + 125°C

(2) I_{max} = 1.5 A

P_{max} =20 W

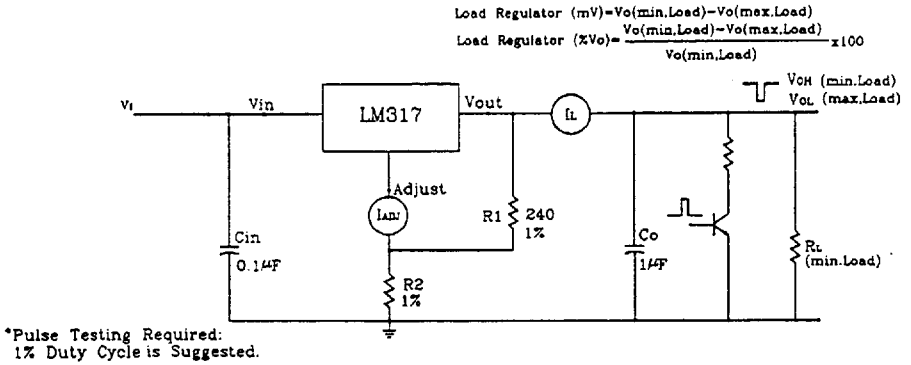
(3) Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.

(4) Selected devices with tightened tolerance reference voltage available.

(5) C_{Adj}, when used, is connected between the adjustment pin and ground.

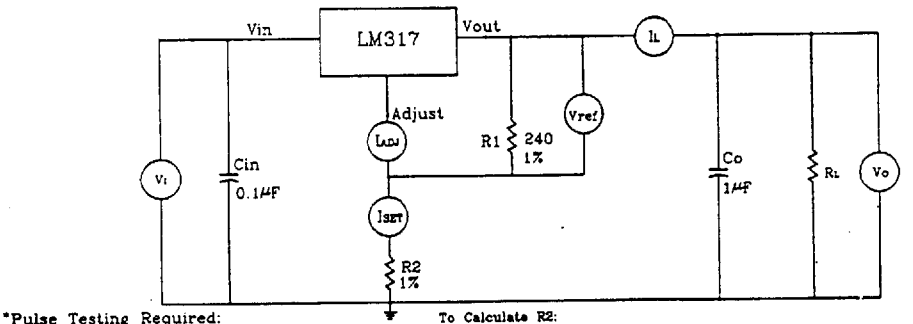
(6) Since Long-Term Stability cannot be measured on each device before shipment, this specification is an engineering estimate of average stability from lot to lot.

FIGURE 2 - LOAD REGULATION AND ΔI_{adj} / LOAD TEST CIRCUIT



*Pulse Testing Required:
1% Duty Cycle is Suggested.

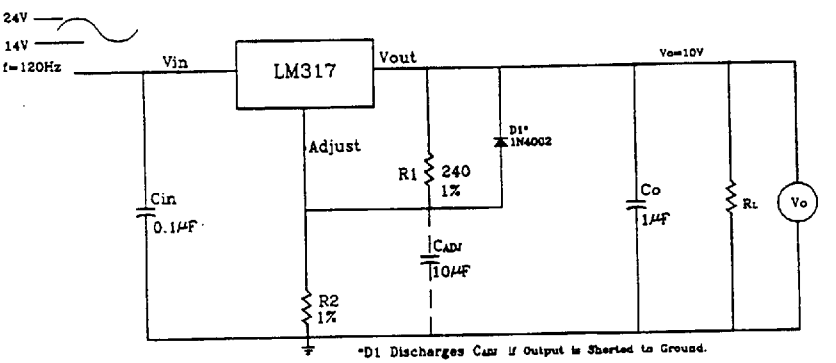
FIGURE 3 - STANDARD TEST CIRCUIT



*Pulse Testing Required:
1% Duty Cycle is Suggested.

To Calculate R2:
Vo=ISET R2+1.250V
Assume ISET=5.25mA

FIGURE 4 - RIPPLE REJECTION TEST CIRCUIT



*D1 Discharges CADJ if Output is Shorted to Ground.

FIGURE 5-LOAD REGULATION

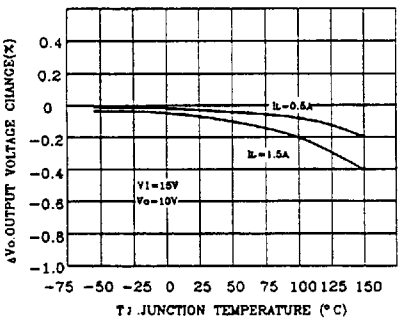


FIGURE 6-CURRENT LIMIT

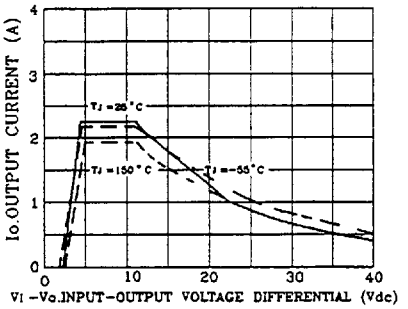


FIGURE 7-ADJUSTMENT PIN CURRENT

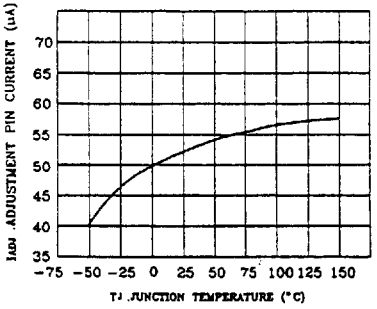


FIGURE 8-DROPOUT VOLTAGE

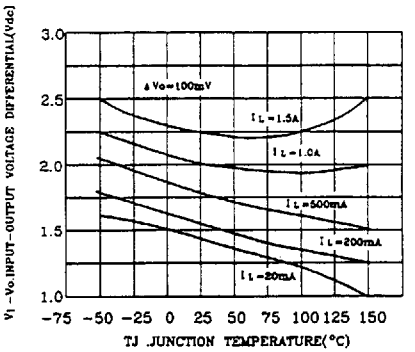


FIGURE 9-TEMPERATURE STABILITY

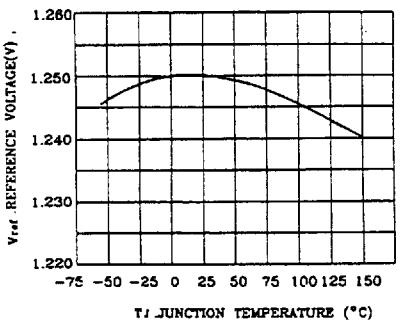


FIGURE 10-MINIMUM OPERATING CURRENT

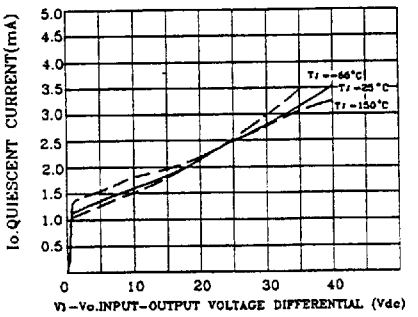


FIGURE 11-RIPPLE REJECTION versus OUTPUT VOLTAGE

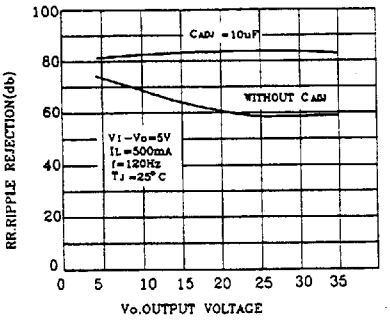


FIGURE 12-RIPPLE REJECTION versus OUTPUT CURRENT

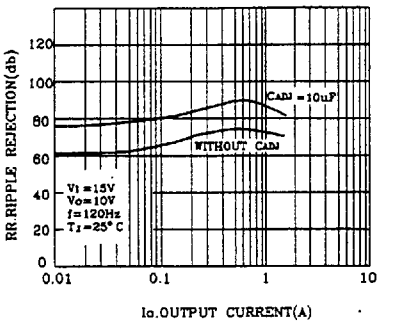


FIGURE 13-RIPPLE REJECTION versus FREQUENCY

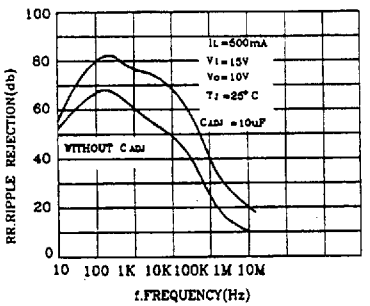


FIGURE 14-OUTPUT IMPEDANCE

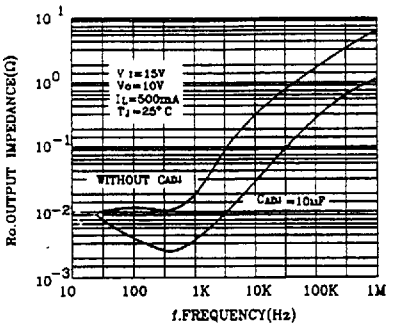


FIGURE 15-TEMPERATURE STABILITY

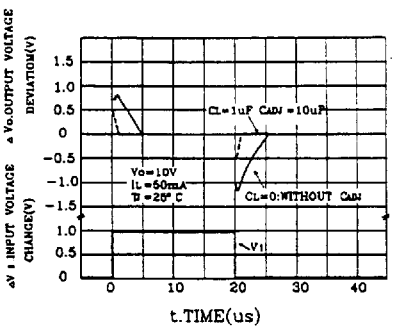
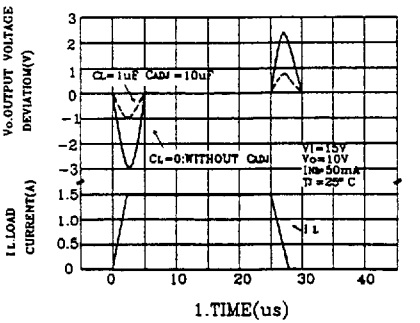


FIGURE 16-LOAD TRANSIENT RESPONSE



APPLICATIONS INFORMATION

BASIC CIRCUIT OPERATION

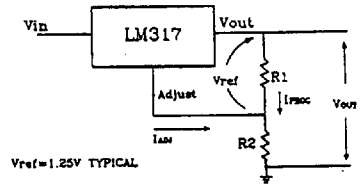
The LM317 is a 3-terminal floating regulator. In operation, the LM317 develops and maintains a nominal 1.25 volt reference (V_{ref}) between its output and adjustment terminals. This reference voltage is converted to a programming current (I_{PROG}) by R_1 (see Figure 17), and this constant current flows through R_2 to ground. The regulated output voltage is given by:

$$V_{out} = Vref\,(1+\frac{R_2}{R_1}) + I_{Adj}\,R_2$$

Since the current from the adjustment terminal (I_{adj}) represents an error term in the equation, the LM317 was designed to control I_{adj} to less than 100 μA and keep it constant. To do this, all quiescent operating current is returned to the output terminal. This imposes the requirement for a minimum load current. If the load current is less than this minimum, the output voltage will rise.

Since the LM317 is a floating regulator, it is only the voltage differential across the circuit which is important to performance, and operation at high voltages with respect to ground is possible.

FIGURE 17 -BASIC CIRCUIT CONFIGURATION



EXTERNAL CAPACITORS

A 0.1μF disc or 1μF tantalum input bypass capacitor (C_{in}) is recommended to reduce the sensitivity to input line impedance.

The adjustment terminal may be bypassed to ground to improve ripple rejection. This capacitor (C_{ADJ}) prevents ripple from being amplified as the output voltage is rejection about 15dB at 120 H_Z in a 10 volt application.

increased. A 10μF capacitor should improve ripple

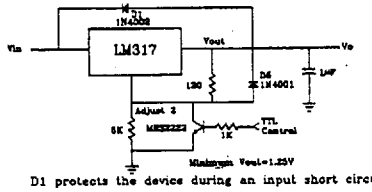
Although the LM317 is stable with no output capacitance, like any feedback circuit , certain values of external capacitance can cause excessive ringing. An output capacitance (C_O) in the form of a 1 μF tantalum or 25 μF aluminum electrolytic capacitor on the output swamps this effect and insures stability.

PROTECTION DIODES

When external capacitors are used with any I.C. regulator it is sometimes necessary to add protection diodes to prevent the capacitors from discharging through low current points into the regulator.

Figure 18 shows the LM317 with the recommended protection diodes for output voltages in excess of 25 V or high capacitance values (C_O > 25 μF, C_{ADJ} > 10μF). Diode D_1 prevents C_O from discharging thru the I.C. during an input short circuit. Diode D_2 protects against capacitor C_{ADJ} discharging through the I.C. during an output short circuit. The combination of diodes D_1 and D_2 prevents C_{ADJ} from discharging through the I.C. during an input short circuit.

FIGURE 18 - VOLTAGE REGULATOR WITH PROTECTION DIODES



D1 protects the device during an input short circuit

The LM317 is capable of providing extremely good load regulation, but a few precautions are needed to obtain maximum performance. For best performance, the programming resistor (R_1) should be connected as close to the regulator as possible to minimize line drops which effectively appear in series with the reference, thereby degrading regulation . The ground end of R_2 can be returned near the load ground to provide remote ground sensing and improve load regulation.

FIGURE 19-"LABORATORY"POWER SUPPLY WITH ADJUSTABLE CURRENT LIMIT AND OUTPUT VOLTAGE

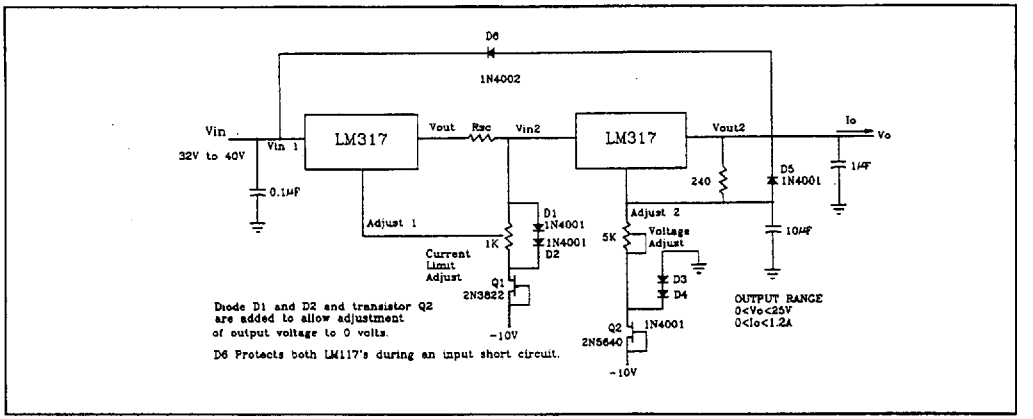


FIGURE 20-ADJUSTABLE CURRENT LIMITER

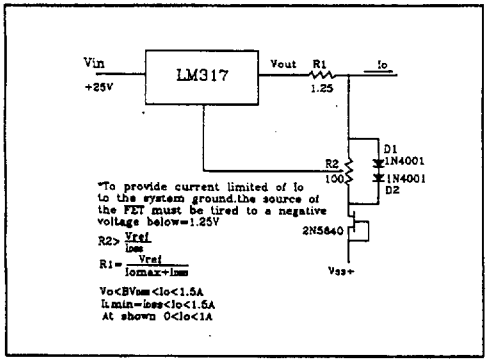


FIGURE 21-5V ELECTRONIC SHUT DOWN REGULATOR

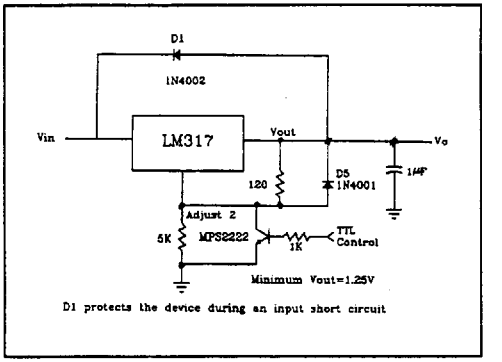


FIGURE 22-SLOW TURN-ON REGULATOR

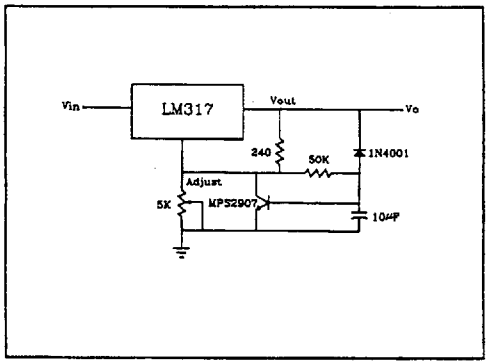


FIGURE 23-CURRENT REGULATOR

