

3A, Three Terminal Adjustable Positive Voltage Regulators

FEATURES

- Output voltage adjustable from 1.2V to 33V
- Guaranteed 3A output current
- Line regulation typically 0.005%/V
- Load regulation typically 0.1%
- Guaranteed thermal regulation
- Current limit constant with temperature
- Standard 3-lead transistor package
- Available in TO-257 military package

DESCRIPTION

The UC150/UC250/UC350 are adjustable 3-terminal positive voltage regulators capable of supplying in excess of 3A over a 1.2V to 33V output range. They require only 2 external resistors to set the output voltage. Further, both line and load regulation are comparable to discrete designs.

In addition to higher performance than fixed regulators, the UC150 series offers full overload protection. Included on the chip are current limit, thermal overload protection and safe area protection. All overload protection circuitry remains fully functional even if the adjustment terminal is accidentally disconnected.

Since the regulator is "floating" and sees only the input-to-output differential voltage, supplies of several hundred volts can be regulated as long as the maximum input to output differential is not exceeded.

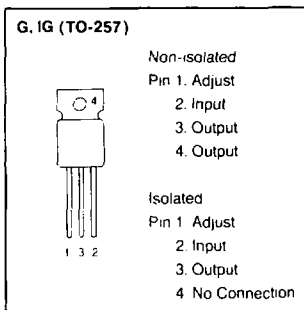
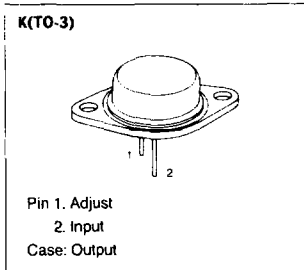
Supplies requiring electronic shutdown can be achieved by clamping the adjustment terminal to ground which programs the output to 1.2V where most loads draw little current.

The UC150/UC250/UC350 are packaged in standard TO-3 transistor package. Along with the new TO-257 Hermetic (TO-220 style) package. The UC150 is rated for operation from -55°C to +150°C, the UC250 from -25°C to +150°C and the UC350 from 0°C to +125°C.

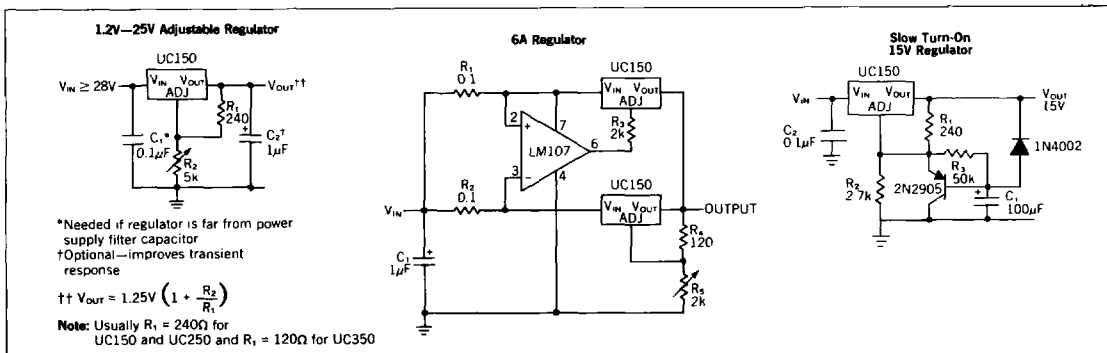
ABSOLUTE MAXIMUM RATINGS

Power Dissipation	Internally limited
Input-Output Voltage Differential	35V
Operating Junction Temperature Range	
UC150	-55°C to +150°C
UC250	-25°C to +150°C
UC350	0°C to +125°C
Storage Temperature	-65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

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TYPICAL APPLICATIONS



Note: When ordering, add suffix 'K' (for TO-3 package), 'G' (for non-isolated TO-257), 'IG' (for isolated TO-257) and 'H' (for TO-5 package) to the part number

ELECTRICAL CHARACTERISTICS (Note 1) $T_A = T_J$

PARAMETER	TEST CONDITIONS	UC150/UC250			UC350			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Line Regulation	$T_A = 25^\circ\text{C}$, $3\text{V} \leq (V_{\text{IN}} - V_{\text{OUT}}) \leq 35\text{V}$, (Note 2)		0.005	0.01		0.005	0.03	%/V
Load Regulation	$T_A = 25^\circ\text{C}$, $10\text{mA} \leq I_{\text{OUT}} \leq 3\text{A}$ $V_{\text{OUT}} \leq 5\text{V}$, (Note 2) $V_{\text{OUT}} \geq 5\text{V}$, (Note 2)		5 0.1	15 0.3		5 0.1	25 0.5	mV %
Thermal Regulation	Pulse = 20 ms, $T_A = 25^\circ\text{C}$		0.002	0.01		0.002	0.03	%/W
Adjustment Pin Current			50	100		50	100	μA
Adjustment Pin Current Change	$10\text{mA} \leq I_L \leq 3\text{A}$ $3\text{V} \leq (V_{\text{IN}} - V_{\text{OUT}}) \leq 35\text{V}$		0.2	5		0.2	5	μA
Reference Voltage	$3 \leq (V_{\text{IN}} - V_{\text{OUT}}) \leq 35\text{V}$, $10\text{mA} \leq I_{\text{OUT}} \leq 3\text{A}$, $P \leq 30\text{W}$	1.20	1.25	1.30	1.20	1.25	1.30	V
Line Regulation	$3 \leq (V_{\text{IN}} - V_{\text{OUT}}) \leq 35\text{V}$, (Note 2)		0.02	0.05		0.02	0.07	%/V
Load Regulation	$V_{\text{OUT}} \leq 5\text{V}$ $10\text{mA} \leq I_{\text{OUT}} \leq 3\text{A}$, (Note 2) $V_{\text{OUT}} \geq 5\text{V}$		20 0.3	50 1		20 0.3	70 1.5	mV %
Temperature Stability	$T_{\text{MIN}} \leq T_J \leq T_{\text{MAX}}$		1			1		%
Minimum Load Current	$(V_{\text{IN}} - V_{\text{OUT}}) = 35\text{V}$		3.5	5		3.5	10	mA
Current Limit	$(V_{\text{IN}} - V_{\text{OUT}}) \leq 10\text{V}$ $(V_{\text{IN}} - V_{\text{OUT}}) = 30\text{V}$	3.0	4.5 1		3.0	4.5 1		A A
RMS Output Noise	$T_A = 25^\circ\text{C}$, $10\text{Hz} \leq f \leq 10\text{kHz}$		0.003			0.003		%
Ripple Rejection Ratio	$V_{\text{OUT}} = 10\text{V}$, $f = 120\text{Hz}$ $C_{\text{ADJ}} = 10\mu\text{F}$	66	65 86		66	65 86		dB dB
Long Term Stability	$T_A = 125^\circ\text{C}$, 1000 Hrs.		0.3	1		0.3	1	%
Thermal Resistance, Junction to Case				1.5			1.5	$^\circ\text{C}/\text{W}$

Notes: 1. Unless otherwise noted, the above specifications apply over the following conditions:

UC150: $-55^\circ\text{C} \leq T_J \leq 125^\circ\text{C}$

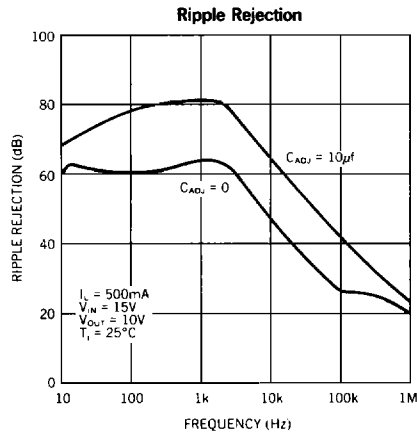
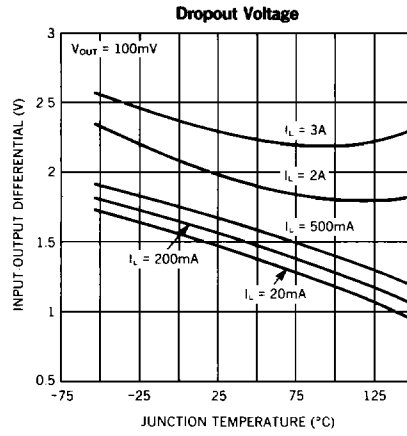
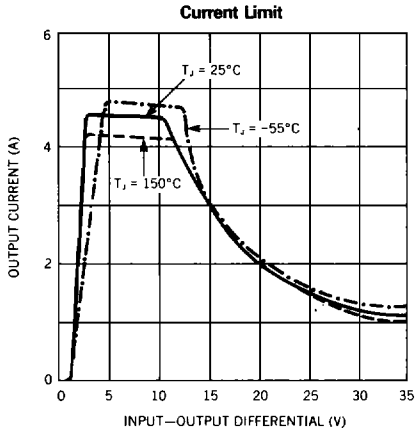
UC250: $-25^\circ\text{C} \leq T_J \leq 125^\circ\text{C}$

UC350: $0^\circ\text{C} \leq T_J \leq 125^\circ\text{C}$

$(V_{\text{IN}} - V_{\text{OUT}}) = 5\text{V}$, $I_{\text{OUT}} = 1.5\text{A}$

2. All regulation specifications are measured at constant junction temperatures using low duty-cycle pulse testing.

TYPICAL PERFORMANCE CHARACTERISTICS



APPLICATION HINTS

In operation, the UC150 develops a nominal 1.25V reference voltage, V_{REF} , between the output and adjustment terminal. The reference voltage is impressed across program resistor R_1 and, since the voltage is constant, a constant current I_1 then flows through the output set resistor R_2 , giving an output voltage of

$$V_{OUT} = V_{REF} \left(1 + \frac{R_2}{R_1} \right) + I_{ADJ}R_2$$

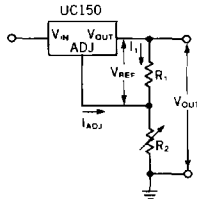


Figure 1

Since the 50 μ A current from the adjustment terminal represents an error term, the UC150 was designed to minimize I_{ADJ} and make it very constant with line and load changes. To do this, all quiescent operating current is returned to the output establishing a minimum load current requirement. If there is insufficient load on the output, the output will rise.

External Capacitors

An input bypass capacitor is recommended. A 0.1 μ F disc or 1 μ F solid tantalum on the input is suitable input bypassing for almost all applications. The device is more sensitive to the absence of input bypassing when adjustment or output capacitors are used but the above values will eliminate the possibility of problems.

The adjustment terminal can be bypassed to ground on the UC150 to improve ripple rejection. This bypass capacitor prevents ripple from being amplified as the output voltage is increased. With a 10 μ F bypass capacitor 86 dB ripple rejection is obtainable at any output level.

In general, the best type of capacitors to use are solid tantalum. Solid tantalum capacitors have low impedance even at high frequencies. Depending upon capacitor construction, it takes about 25 μ F in aluminum electrolytic to equal 1 μ F solid tantalum at high frequencies.

Although the UC150 is stable with no output capacitors, like any feedback circuit, certain values of external capacitance can cause excessive ringing. This occurs with values between 500pF and 5000pF. A 1 μ F solid tantalum (or 25 μ F aluminum electrolytic) on the output swamps this effect and insures stability.

Load Regulation

The UC150 is capable of providing extremely good load regulation but a few precautions are needed to obtain maximum performance. The current set resistor connected between the adjustment terminal and the output terminal (usually 240 Ω) should be tied directly to the output of the regulator rather than near the load. This eliminates line drops from appearing effectively in series with the reference and degrading regulation.

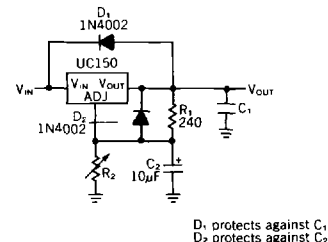
With the TO-3 package, it is easy to minimize the resistance from the case to the set resistor by using 2 separate leads to the case. The ground of R_2 can be returned near the ground of the load to provide remote ground sensing and improve load regulation.

Protection Diodes

When external capacitors are used with any IC regulator it is sometimes necessary to add protection diodes to prevent the capacitors from discharging through low current points into the regulator. Most 10 μ F capacitors have low enough internal series resistance to deliver 20A spikes when shorted. Although the surge is short there is enough energy to damage parts of the IC.

When an output capacitor is connected to a regulator and the input is shorted, the output capacitor will discharge into the output of the regulator. The discharged current depends on the value of the capacitor, the output voltage of the regulator, and the rate of decrease of V_{IN} . In the UC150, this discharge path is through a large junction that is able to sustain 25A surge with no problem. This is not true of other types of positive regulators. For output capacitors of 25 μ F or less, there is no need to use diodes.

The bypass capacitor on the adjustment terminal can discharge through a low current junction. Discharge occurs when *either* the input or output is shorted. Internal to the UC150 is a 50 Ω resistor which limits the peak discharge current. No protection is needed for output voltages of 25V or less and 10 μ F capacitance. Figure 2 shows a UC150 with protection diodes included for use with outputs greater than 25V and high values of output capacitance.



D₁ protects against C₁
D₂ protects against C₂

$$V_{OUT} = 1.25V \left(1 + \frac{R_2}{R_1} \right) + R_2 I_{ADJ}$$

Figure 2. Regulator with Protection Diodes