INTEGRATED CIRCUITS

UNITRODE

1.5A, Three Terminal Adjustable Positive Voltage Regulators

UC117
UC217
UC317

FEATURES

- Output voltage adjustable from 1.2 to 37V
- Guaranteed 1.5A output current
- Line regulation typically 0.01%/V
- Load regulation typically 0.1%
- Temperature-independent current limit
- Standard 3-lead transistor packages (TO-3, TO-220) (TO-3, TO-220, TO-5, TO-257, and isolated TO-257)

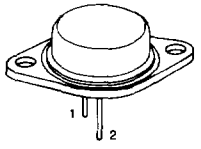
DESCRIPTION

This monolithic integrated circuit is an adjustable 3-terminal positive voltage regulator designed to supply more than 1.5A of load current with an output voltage adjustable over a 1.2 to 37V range. Although ease of setting the output voltage to any desired value with only two external resistors is a major feature of this circuit, exceptional line and load regulation are also offered. In addition, full overload protection consisting of current limiting, thermal shutdown and safe-area control are included in this device which is packaged in TO-3 and TO-220 packages. The UC117 is rated for operation from −55°C to +150°C, the UC217 from −25°C to +150°C and the UC317 from 0°C to +125°C.

ABSOLUTE MAXIMUM RATINGS

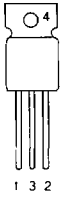
Power Dissipation ..... Internally limited
Input—Output Voltage Differential 40V
Operating Junction Temperature Range
UC117 ..... −55°C to +150°C
UC217 ..... −25°C to +150°C
UC317 ..... 0°C to +125°C
Storage Temperature ..... −65°C to +150°C
Lead Temperature (Soldering, 10 seconds) ..... 300°C

K(TO-3)



Pin 1. Adjust
2. Input
Case: Output

G, IG (TO-257)

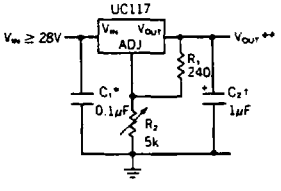


Non-isolated
Pin 1. Adjust
2. Input
3. Output
4. Output

Isolated
Pin 1. Adjust
2. Input
3. Output
4. No Connection

TYPICAL APPLICATIONS

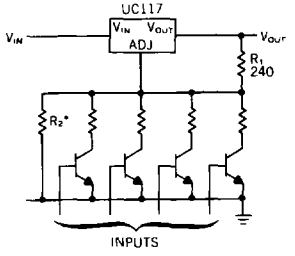
1.2V—25V Adjustable Regulator



*Needed if device is far from filter capacitors
†Optional—improves transient response

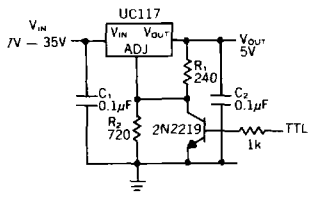
†† $V_{OUT} = 1.25V\left(1 + \frac{R_2}{R_1}\right)$

Digitally Selected Outputs



*Value determines maximum V_{OUT}

5V Logic Regulator with Electronic Shutdown*



*Min output ≈ 1.2V

Note: When ordering, add suffix "K" (for TO-3 package) or "T" (for TO-220 package), "G" (for non-isolated TO-257) and "IG" (for isolated TO-257) to the Part Number.

ELECTRICAL CHARACTERISTICS (Note 1) $T_A=T_J$

PARAMETER	TEST CONDITIONS	UC117/UC217			UC317			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Line Regulation	T_A = 25°C, 3V ≤ (V_{IN} − V_{OUT}) ≤ 40V, (Note 2)		0.01	0.02		0.01	0.04	%/V
Load Regulation	T_A = 25°C, 10mA ≤ I_{OUT} ≤ I_{MAX}							
	V_{OUT}≤5V, (Note 2, 3)		5	15		5	25	mV
	V_{OUT}≥5V, (Note 2, 3)		0.1	0.3		0.1	0.5	%
Thermal Regulation	T_A = 25°C, 20ms Pulse		0.03	0.07		0.04	0.07	%/W
Adjustment Pin Current			50	100		50	100	μA
Adjustment Pin Current Change	10mA ≤ I_L ≤ I_{MAX} 2.5V ≤ (V_{IN} − V_{OUT}) ≤ 40V		0.2	5		0.2	5	μA
Reference Voltage	3 ≤ (V_{IN} − V_{OUT}) ≤ 40V 10mA ≤ I_{OUT} ≤ I_{MAX}, P ≤ P_{MAX}	1.20	1.25	1.30	1.20	1.25	1.30	V
Line Regulation	3 ≤ (V_{IN} − V_{OUT}) ≤ 40V, (Note 2)		0.02	0.05		0.02	0.07	%/V
Load Regulation	10mA≤I_{OUT}≤I_{MAX}, (Note 2, 3)							
	V_{OUT} ≤ 5V		20	50		20	70	mV
	V_{OUT} ≥ 5V		0.3	1		0.3	1.5	%
Temperature Stability	T_{MIN} ≤ T_J ≤ T_{MAX}		1			1		%
Minimum Load Current	V_{IN} − V_{OUT} = 40V		3.5	5		3.5	10	mA
Current Limit	(V_{IN} − V_{OUT}) ≤15V							
	K, T, G, IG Packages	1.5	2.2		1.5	2.2		A
	H Package	1.5	2.2		1.5	2.2		A
	(V_{IN} − V_{OUT}) = 40V							
	K, T, G, IG Packages		0.4			0.4		A
	H Package		0.2			0.2		A
RMS Output Noise	T_A = 25°C, 10Hz ≤ f ≤ 10kHz		0.003			0.003		%
Ripple Rejection Ratio	V_{OUT} = 10V, f = 120Hz		65			65		dB
	C_{ADJ} = 10μF	66	80		66	80		dB
Long Term Stability	T_A = 125°C, 1000 Hrs.		0.3	1		0.3	1	%
Thermal Resistance, Junction to Case	K Package		2.3	3		2.3	3	°C/W
	T Package						5	°C/W
	H Package		12			12		°C/W
	G Package		2.5	3.5		2.5	3.5	°C/W
	IG Package		3.0	4.2		3.0	4.2	°C/W

Notes: 1. Unless otherwise noted, the above specifications apply over the following conditions:
UC117: −55°C ≤ T_J ≤ 125°C
UC217: −25°C ≤ T_J ≤ 125°C
UC317: 0°C ≤ T_J ≤ 125°C
V_{IN} − V_{OUT} = 5V, I_O = 0.5A, I_{MAX} = 1.5A FOR K, T, G, IG Packages
V_{IN} − V_{OUT} = 5V, I_O = 0.1A, I_{MAX} = 0.5A FOR H Package
P_{MAX} = 20W for K Package, 15W for T, G, IG Packages, and 2W for H Package
2. All regulation specifications are measured at constant junction temperatures using low duty-cycle pulse testing.
3. Measurement taken at 0.180 inches from case for G and IG Packages.

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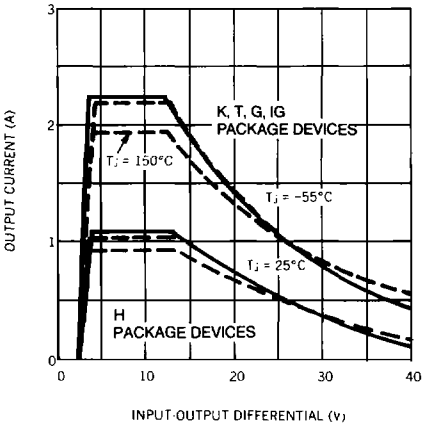
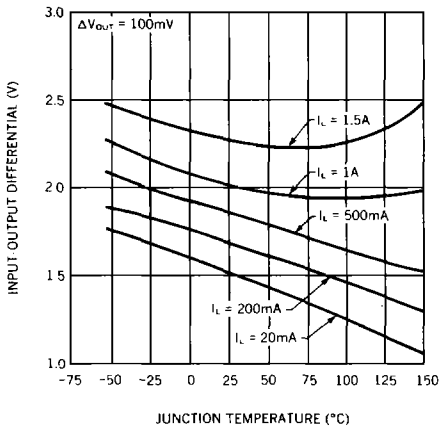
TYPICAL PERFORMANCE CHARACTERISTICS

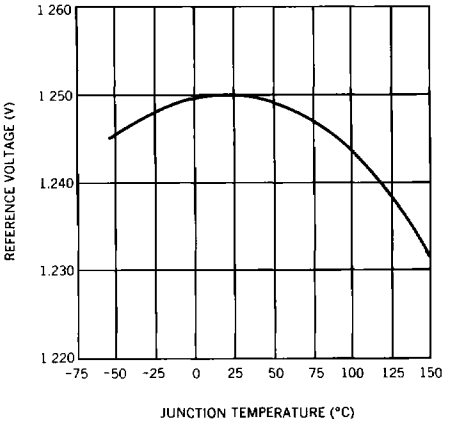
Current Limit



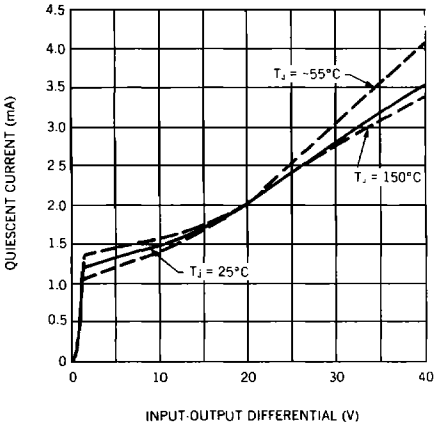
Dropout Voltage



Temperature Stability



Minimum Operating Current



APPLICATION HINTS

In operation, the UC117 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

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

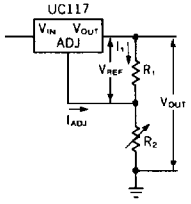


Figure 1

Since the 100μA current from the adjustment terminal represents an error term, the UC117 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 0.1μF disc or 1μF 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 UC117 to improve ripple rejection. This bypass capacitor prevents ripple from being amplified as the output voltage is increased. With a 10μF bypass capacitor 80 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 25μF in aluminum electrolytic to equal 1μF solid tantalum at high frequencies.

Although the UC117 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 1μF solid tantalum (or 25μF aluminum electrolytic) on the output swamps this effect and insures stability.

Load Regulation

The UC117 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 240Ω) 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 10μF 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 discharge current depends on the value of the capacitor, the output voltage of the regulator, and the rate of decrease of V_{IN}. In the UC117, this discharge path is through a large junction that is able to sustain 15A surge with no problem. This is not true of other types of positive regulators. For output capacitors of 25μF 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 UC117 is a 50Ω resistor which limits the peak discharge current. No protection is needed for output voltages of 25V or less and 10μF capacitance. *Figure 2* shows a UC117 with protection diodes included for use with outputs greater than 25V and high values of output capacitance.

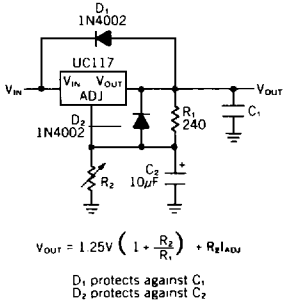


Figure 2. Regulator with Protection Diodes

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