3A. Negative Adjustable Regulator

FEATURES

- *Guaranteed* 1% Initial Voltage Tolerance
- *Guaranteed* 0.015%/V Line Regulation
- *Guaranteed* 0.02%/W Thermal Regulation
- 100% Burn-in in Thermal Limit

APPLICATIONS

- Adjustable Power Supplies
- System Power Supplies
- Precision Voltage/Current Regulators
- On-Card Regulators

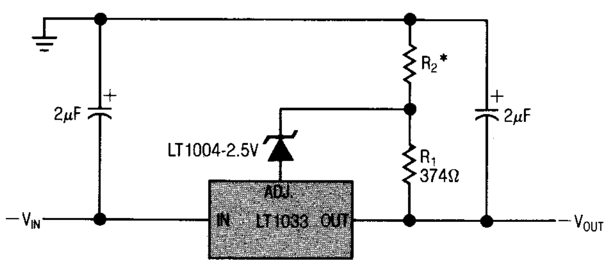
DESCRIPTION

The LT1033 negative adjustable regulator will deliver up to 3 Amps output current over an output voltage range of −1.2V to −32V. Linear Technology has made significant improvements in these regulators compared to previous devices, such as better line and load regulation, and a maximum output voltage error of 1%.

The LT1033 is easy to use and difficult to damage. Internal current and power limiting as well as true thermal limiting prevents device damage due to overloads or shorts, even if the regulator is not fastened to a heat sink.

Maximum reliability is attained with Linear Technology's advanced processing techniques combined with a 100% burn-in in the thermal limit mode. This assures that all device protection circuits are working and eliminates field failures experienced with other regulators that receive only standard electrical testing.

Precision Regulator †



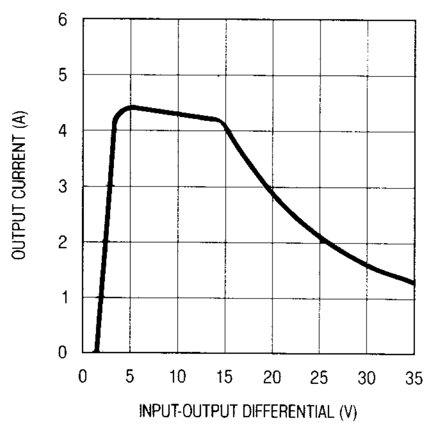
IMPROVED LINE & LOAD REGULATION **

$* R_2 = \frac{R_1}{3.75}(V_{OUT} - 3.75)$

** REGULATION IS IMPROVED BY $\frac{V_{OUT}}{1.25}$

† EXTERNAL LT1004 REFERENCE IMPROVES LINE, LOAD, AND THERMAL REGULATION

Current Limit



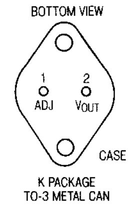
ABSOLUTE MAXIMUM RATINGS

Power Dissipation .... Internally Limited
Input to Output Voltage Differential 35V
Operating Junction Temperature Range
 LT1033M .... −55°C to 150°C
 LT1033C .... 0°C to 125°C
Storage Temperature Range
 LT1033M .... −65°C to 150°C
 LT1033C .... −65°C to 150°C
Lead Temperature (Soldering, 10 sec.)...... 300°C

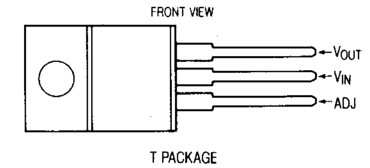
PRECONDITIONING

100% THERMAL LIMIT BURN-IN

PACKAGE/ORDER INFORMATION



LT1033MK
LT1033CK



LT1033CT

ELECTRICAL CHARACTERISTICS (See Note 1)

SYMBOL	PARAMETER	CONDITIONS		LT1033M MIN	LT1033M TYP	LT1033M MAX	LT1033C MIN	LT1033C TYP	LT1033C MAX	UNITS
V_{REF}	Reference Voltage	$\|V_{IN}-V_{OUT}\| = 5V$, $I_{OUT} = 5mA$, $T_j = 25°C$		−1.238	−1.250	−1.262	−1.238	−1.250	−1.262	V
		$3V \le \|V_{IN}-V_{OUT}\| \le 35V$ $5mA \le I_{OUT} \le I_{MAX}$, $P \le P_{MAX}$	●	−1.215	−1.250	−1.285	−1.200	−1.250	−1.300	V
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation	$10mA \le I_{OUT} \le I_{MAX}$, (See Note 2)								
		$T_j = 25°C$, $\|V_{OUT}\| \le 5V$			10	50		10	50	mV
		$T_j = 25°C$, $\|V_{OUT}\| \ge 5V$			0.2	1.0		0.2	1.0	%
		$\|V_{OUT}\| \le 5V$	●		20	75		20	75	mV
		$\|V_{OUT}\| \ge 5V$	●		0.4	1.5		0.4	1.5	%
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation	$3V \le \|V_{IN}-V_{OUT}\| \le 35V$, (See Note 2) $T_j = 25°C$			0.005	0.015		0.01	0.02	%/V
			●		0.01	0.04		0.02	0.05	%/V
	Ripple Rejection	$V_{OUT} = -10V$, $f = 120Hz$ $C_{ADJ} = 0$		56	66			60		dB
		$C_{ADJ} = 10\mu F$		70	80		66	77		dB
	Thermal Regulation	$T_j = 25°C$, 10msec Pulse			0.002	0.02		0.002	0.02	%/W
I_{ADJ}	Adjust Pin Current		●		65	100		65	100	μA
ΔI_{ADJ}	Adjust Pin Current Change	$10mA \le I_{OUT} \le I_{MAX}$	●		0.2	2		0.5	2	μA
		$3V \le \|V_{IN}-V_{OUT}\| \le 35V$	●		1.0	5		2	5	μA
	Minimum Load Current	$\|V_{IN}-V_{OUT}\| \le 35V$			2.5	5.0		2.5	5.0	mA
		$\|V_{IN}-V_{OUT}\| \le 10V$			1.2	3.0		1.2	3.0	mA
I_{SC}	Current Limit	$\|V_{IN}-V_{OUT}\| \le 10V$, (See Note 2)		3	4.3	6	3	4.3	6	A
		$\|V_{IN}-V_{OUT}\| = 35V$, $T_j = 25°C$		0.5	1.3	2.5	.5	1.3	2.5	A
$\frac{\Delta V_{OUT}}{\Delta Temp}$	Temperature Stability of Output Voltage	$T_{MIN} \le T \le T_{MAX}$	●		0.6	1.5		0.6		%
$\frac{\Delta V_{OUT}}{\Delta Time}$	Long Term Stability	$T_A = 125°C$, 1000 Hours			0.3	1.0		0.3	1.0	%
e_n	RMS Output Noise (% of V_{OUT})	$T_A = 25°C$, $10Hz \le f \le 10kHz$			0.003			0.003		%
Θ_{JC}	Thermal Resistance Junction to Case	T Package						4		°C/W
		K Package			1.2	2.0		1.2	2.0	°C/W

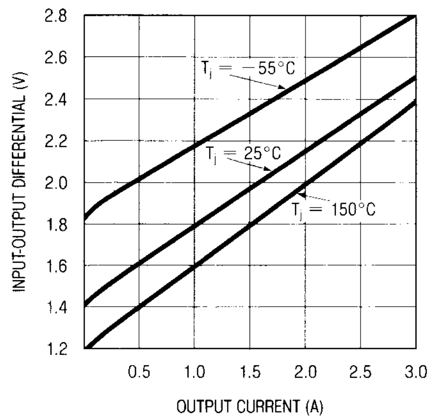
The ● denotes the specifications which apply over the full operating temperature range. Otherwise $T_j = 25°C$.

Note 1: Unless otherwise indicated, these specifications apply: $|V_{IN} - V_{OUT}| = 5V$; and $I_{OUT} = 5mA$. Power dissipation is internally limited. However, these specifications apply for power dissipation up to 30W. See guaranteed minimum output current curve. $I_{MAX} = 3A$.

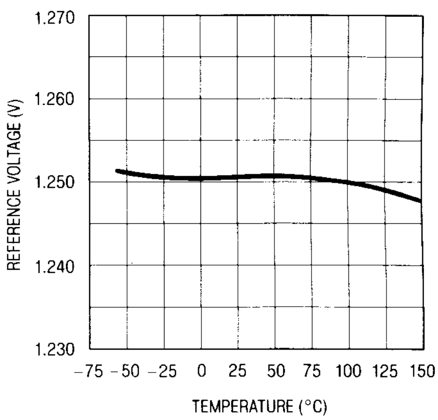
Note 2: Testing is done using a pulsed low duty cycle technique. See thermal regulation specifications for output changes due to heating effects. Load regulation is measured on the output pin at a point 1/8″ below the base of the package.

TYPICAL PERFORMANCE CHARACTERISTICS

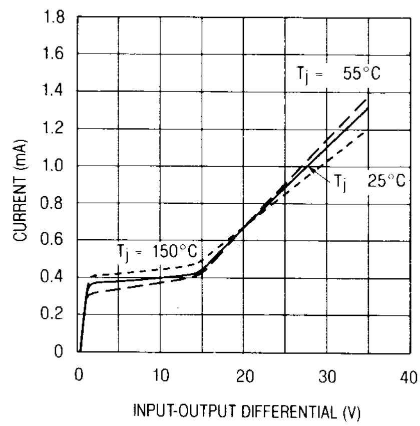
Dropout Voltage



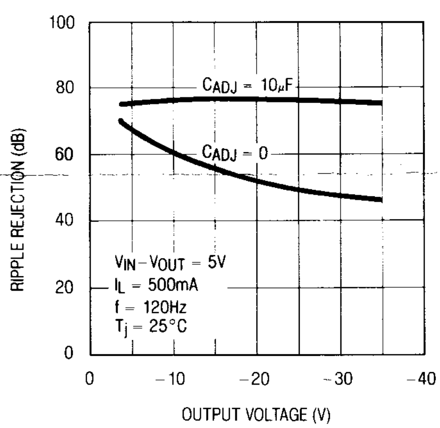
Temperature Stability



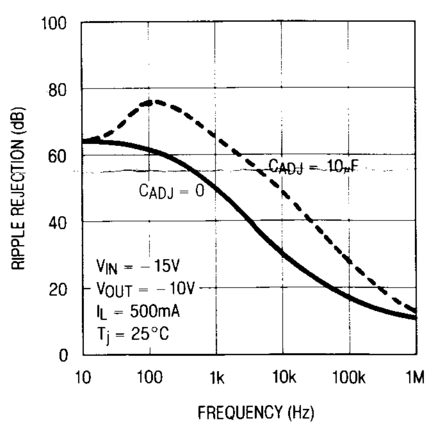
Minimum Load Current



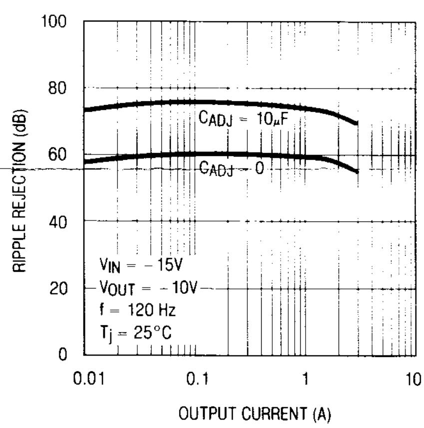
Ripple Rejection



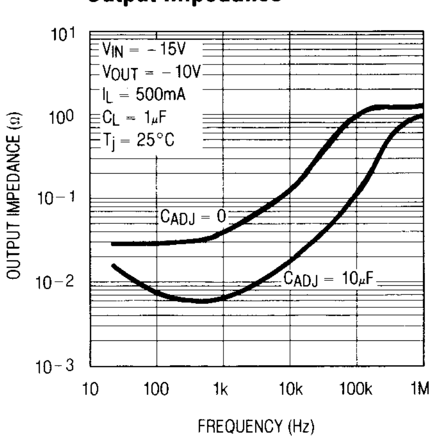
Ripple Rejection



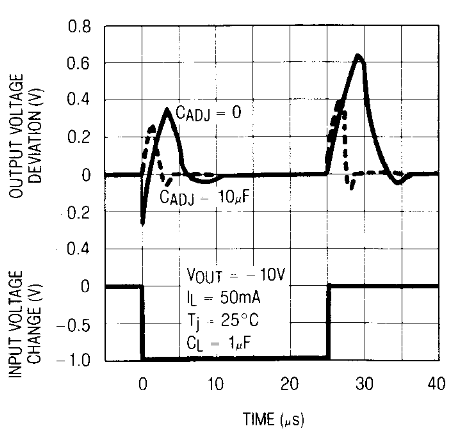
Ripple Rejection



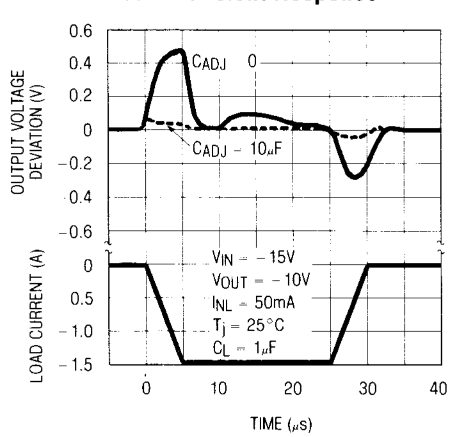
Output Impedance



Line Transient Response

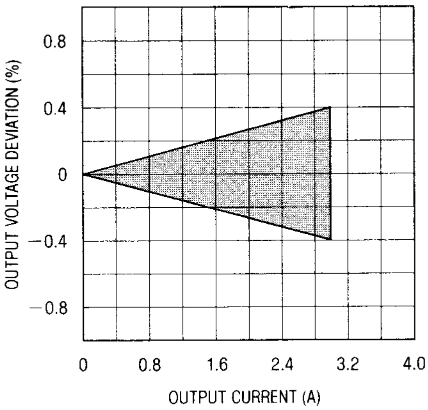


Load Transient Response



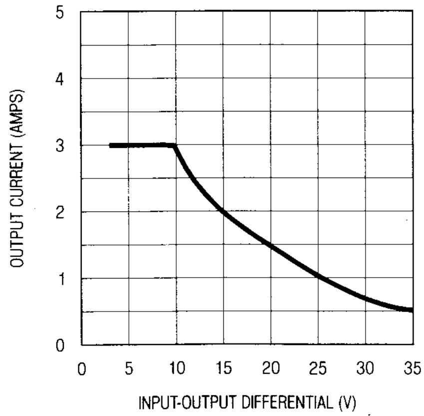
TYPICAL PERFORMANCE CHARACTERISTICS

Load Regulation*

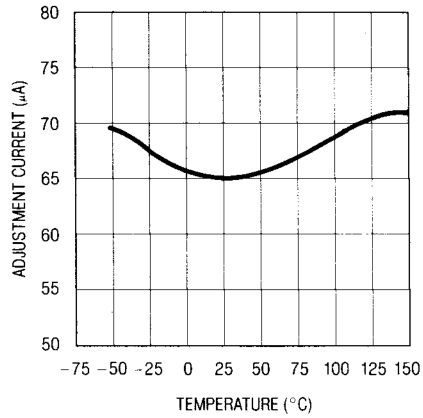


* The LT1033 has load regulation compensation which makes the typical unit read close to zero. This band represents the typical production spread.

Guaranteed Minimum Output Current



Adjustment Current



APPLICATION INFORMATION

Output Voltage: The output voltage is determined by two external resistors, R_1 & R_2 (see Figure 1). The exact formula for the output voltage is:

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

Where: V_{Ref} = Reference Voltage, I_{ADJ} = Adjustment Pin Current. In most applications, the second term is small enough to be ignored, typically about 0.5% of V_{OUT}. In more critical applications, the exact formula should be used, with I_{ADJ} equal to 65μA. Solving for R_2 yields:

$$R_2 = \frac{V_{OUT} - V_{Ref}}{\frac{V_{Ref}}{R_1} - I_{ADJ}}$$

Smaller values of R_1 and R_2 will reduce the influence of I_{ADJ} on the output voltage, but the no-load current drain on the regulator will be increased. Typical values for R_1 are between 100Ω and 300Ω, giving 12.5mA and 4.2mA no-load current respectively. There is an additional consideration in selecting R_1, the minimum load current specification of the regulator. The operating current of the LT1033 flows from input to output. If this current is not absorbed by the load, the output of the regulator will rise above the regulated value. The current drawn by R_1 and R_2 is normally high enough to absorb the current, but care must be taken in no-load situations where R_1 and R_2 have high values. The maximum value for the operating current, which must be absorbed, is 5mA for the LT1033. If input-output voltage differential is less than 10V, the operating current that must be absorbed drops to 3mA.

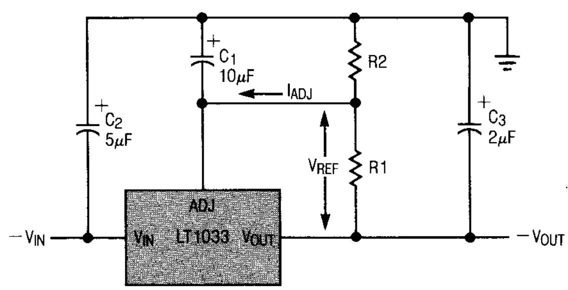
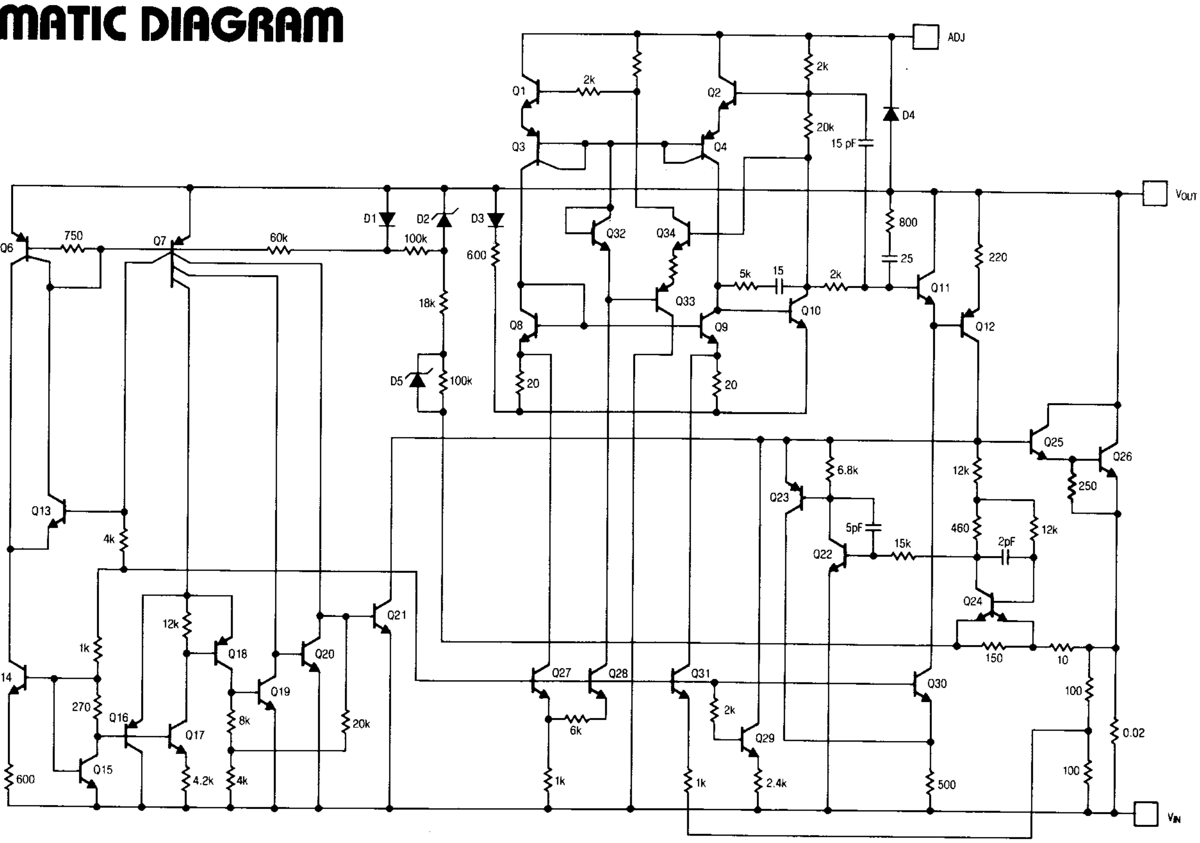


Figure 1

EXAMPLE:

1. A precision 10V regulator to supply up to 3 Amp load current.
   a. Select R_1 = 100Ω to minimize effect of I_{ADJ}
   b. Calculate $R_2 = \frac{V_{OUT} - V_{Ref}}{\frac{V_{Ref}}{R_1} - I_{ADJ}} = \frac{10V - 1.25V}{\frac{1.25V}{100\Omega} - 65\mu A} = 704\Omega$

SCHEMATIC DIAGRAM



The following table allows convenient selection of program resistors from standard 1% values.

V_{OUT}	R_1	R_2	OUTPUT ERROR (%)
5	100	301	0.6
6	121	453	−0.7
8	115	619	0.6
10	115	806	0.6
12	118	1020	1
15	100	1100	0.5
18	150	2000	0.2
20	121	1820	0.8
22	130	2150	0.2
24	121	2210	0.9
28	115	2430	−0.7
30	121	2740	−0.9