MOTOROLA

MC33264

Prototype Information

Micropower Voltage Regulators with On/Off Control

The MC33264 series are micropower low dropout voltage regulators available in SO–8 and MICRO–8 surface mount packages and a wide range of output voltages. These devices feature a very low quiescent current (100 μA in the ON mode; 0.1 μA in the OFF mode), and are capable of supplying output currents up to 100 mA. Internal current and thermal limiting protection is provided.

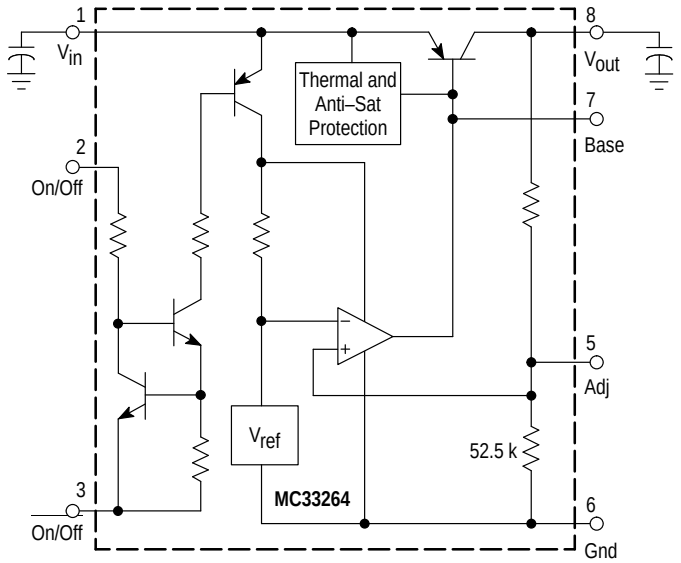
Additionally, the MC33264 has either active HIGH or active LOW control (Pins 2 and 3) that allows a logic level signal to turn–off or turn–on the regulator output.

Due to the low input–to–output voltage differential and bias current specifications, these devices are ideally suited for battery powered computer, consumer, and industrial equipment where an extension of useful battery life is desirable.

MC33264 Features:

- Low Quiescent Current (0.1 μA in OFF Mode; 100 μA in ON Mode)
- Low Input–to–Output Voltage Differential of 10 mV at 1.0 mA, 45 mA at 10 mA, and 120 mV at 50 mA
- Multiple Output Voltages Available
- Extremely Tight Line and Load Regulation
- Requires Only a 1.0 μF Output Capacitor for Stability
- Internal Current and Thermal Limiting
- Logic Level ON/OFF Control
- Functionally Equivalent to TK115XXMC and LP2980

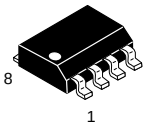
Representative Block Diagram



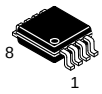
This device contains 000 active transistors.

LOW DROPOUT MICROPOWER VOLTAGE REGULATORS WITH ON/OFF CONTROL

SEMICONDUCTOR TECHNICAL DATA

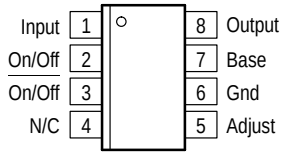


D SUFFIX
PLASTIC PACKAGE
CASE 751
(SO–8)



DM SUFFIX
PLASTIC PACKAGE
CASE 846A
(MICRO–8)

PIN CONNECTIONS



(Top View)

ORDERING INFORMATION

Device	Operating Temperature Range	Package
MC33264D–2.5 MC33264D–3.0 MC33264D–3.3 MC33264D–3.8 MC33264D–4.0 MC33264D–4.75 MC33264D–5.0	T_A = – 40° to +85°C	SO–8
MC33264DM–2.5 MC33264DM–3.0 MC33264DM–3.3 MC33264DM–3.8 MC33264DM–4.0 MC33264DM–4.75 MC33264DM–5.0		MICRO–8

This document contains information on a new product. Specifications and information herein are subject to change without notice.

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MAXIMUM RATINGS (T_C = 25°C, unless otherwise noted.)

Rating	Symbol	Value	Unit
Input Voltage	V_{CC}	13	Vdc
Power Dissipation and Thermal Characteristics Maximum Power Dissipation Case 751(SO–8) D Suffix Thermal Resistance Junction–to–Ambient Thermal Resistance Junction–to–Case	 P_D $R_{\theta JA}$ $R_{\theta JC}$	 Internally Limited 180 45	 W °C/W °C/W
Output Current	I_O	150	mA
Maximum Adjustable Output Voltage	V_O	1.15 x V_{nom}	Vdc
Operating Junction Temperature	T_J	125	°C
Operating Ambient Temperature	T_A	–40 to +85	°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

NOTE: ESD data available upon request.

ELECTRICAL CHARACTERISTICS (V_{in} = 6.0 V, I_O = 10 mA, C_O = 1.0 µF, T_J = 25°C (Note 1), unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
Output Voltage (I_O = 0 mA) 3.0 Suffix (V_{CC} = 4.0 V) 3.3 Suffix (V_{CC} = 4.3 V) 5.0 Suffix (V_{CC} = 6.0 V) V_{in} = (V_O + 1.0) V to 12 V, I_O < 60 mA, T_A = –40° to +85°C 3.0 Suffix 3.3 Suffix 5.0 Suffix	V_O	 2.96 3.23 4.9 2.9 3.18 4.83	 3.0 3.3 5.0 – – –	 3.04 3.37 5.1 3.1 3.42 5.17	V
Line Regulation (V_{in} = [V_O + 1.0] V to 12 V, I_O = 60 mA) 3.0 Suffix 3.3 Suffix 5.0 Suffix	Reg_{line}	 – – –	 0.05 0.05 0.05	 0.10 0.10 0.10	%
Load Regulation (V_{in} = [V_O + 1.0], I_O = 0 mA to 60 mA) 3.0 Suffix 3.3 Suffix 5.0 Suffix	Reg_{load}	 – – –	 4.0 4.0 4.0	 10 10 10	mV
Dropout Voltage I_O = 1.0 mA I_O = 10 mA I_O = 50 mA I_O = 60 mA	$V_I – V_O$	 – – – –	 10 45 120 150	 15 90 200 230	mV
Quiescent Current (V_{in} = [V_O + 1.0] V, I_O = 60 mA) ON Mode OFF Mode	I_Q	 – –	 1000 0.5	 2000 1.0	µA
Ripple Rejection (V_{in} peak–to–peak = [V_O + 1.5] V to [V_O + 5.5] V)	–	55	70	–	dB
Output Voltage Temperature Coefficient	TC	–	±200	–	ppm/°C
Current Limit (V_{in} = [V_O + 1.0], V_O Shorted)	I_{Limit}	100	–	–	mA
Output Noise Voltage (10 Hz to 100 kHz) (Note 2) C_L = 1.0 µF C_L = 100 µF	V_n	 – –	 126 56	 – –	µVrms

NOTES: 1. Low duty pulse techniques are used during test to maintain junction temperature as close to ambient as possible.
2. Noise tests on the MC33264 are made with a 0.01 µF capacitor connected across Pins 8 and 5.

ELECTRICAL CHARACTERISTICS (continued) (V_{in} = 6.0 V, I_O = 10 mA, C_O = 1.0 µF, T_J = 25°C (Note 1), unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON/OFF INPUTS					
On/Off Input (Pin 3 Tied to Ground)	$V_{On/Off}$				V
Logic "1" (Regulator ON)		2.4	–	V_{in}	
Logic "0" (Regulator OFF)		0	–	0.5	
On/Off Input (Pin 2 Tied to V_{in})					
Logic "1" (Regulator ON)		0	–	V_{in} – 2.4	
Logic "0" (Regulator OFF)		V_{in} – 0.2	–	V_{in}	
On/Off Pin Input Current (Pin 3 Tied to Ground)	$I_{On/Off}$				µA
$V_{On/Off}$ = 2.4 V		–	30	–	
On/Off Pin Input Current (Pin 2 Tied to V_{in})					
$V_{On/Off} = V_{in}$ – 2.4 V		–	30	–	

NOTES: 1. Low duty pulse techniques are used during test to maintain junction temperature as close to ambient as possible.
2. Noise tests on the MC33264 are made with a 0.01 µF capacitor connected across Pins 8 and 5.

DEFINITIONS

Dropout Voltage – The input/output voltage differential at which the regulator output no longer maintains regulation against further reductions in input voltage. Measured when the output drops 100 mV below its nominal value (which is measured at 1.0 V differential), dropout voltage is affected by junction temperature, load current and minimum input supply requirements.

Line Regulation – The change in output voltage for a change in input voltage. The measurement is made under conditions of low dissipation or by using pulse techniques such that average chip temperature is not significantly affected.

Load Regulation – The change in output voltage for a change in load current at constant chip temperature.

Maximum Power Dissipation – The maximum total device dissipation for which the regulator will operate within specifications.

Quiescent Current – Current which is used to operate the regulator chip and is not delivered to the load.

Output Noise Voltage – The rms ac voltage at the output, with constant load and no input ripple, measured over a specified frequency range.

Figure 1. Quiescent Current versus Load Current

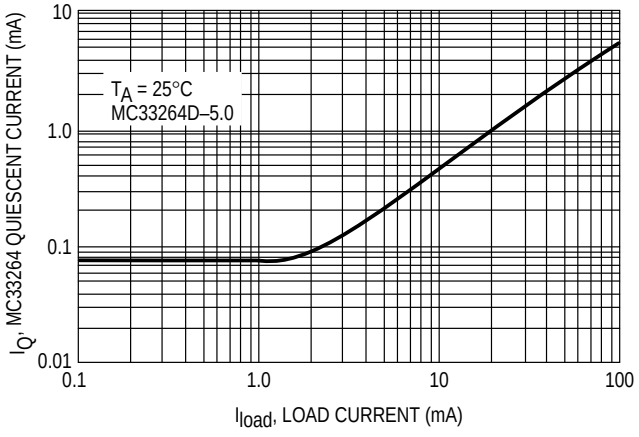


Figure 2. Dropout Voltage versus Input Voltage

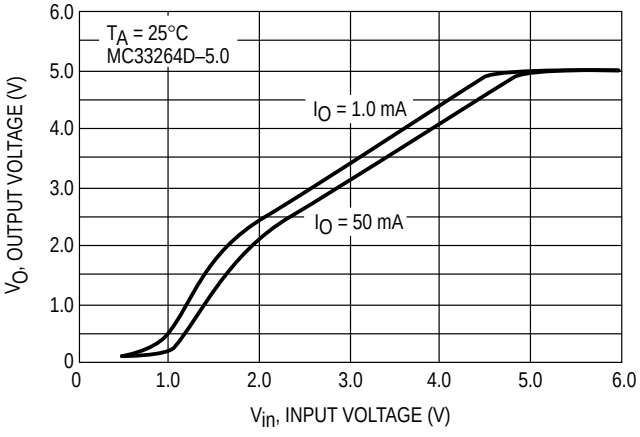


Figure 3. Input Current versus Input Voltage

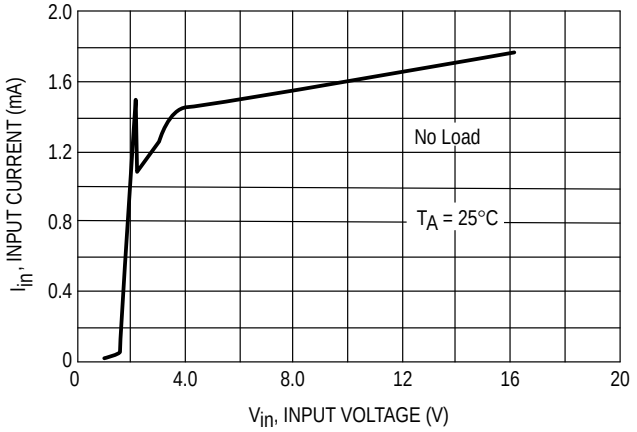


Figure 4. Output Voltage versus Temperature

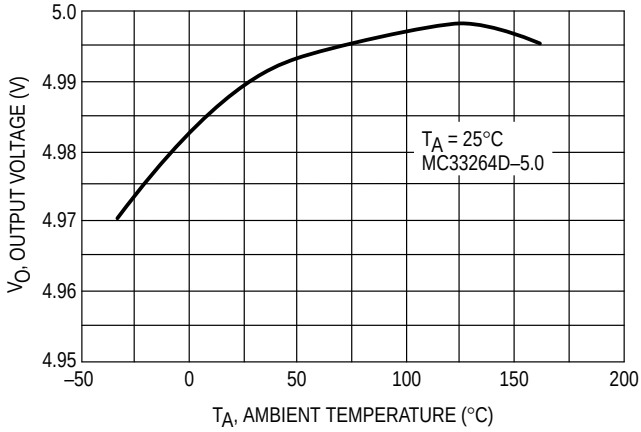


Figure 5. Dropout Voltage versus Output Current

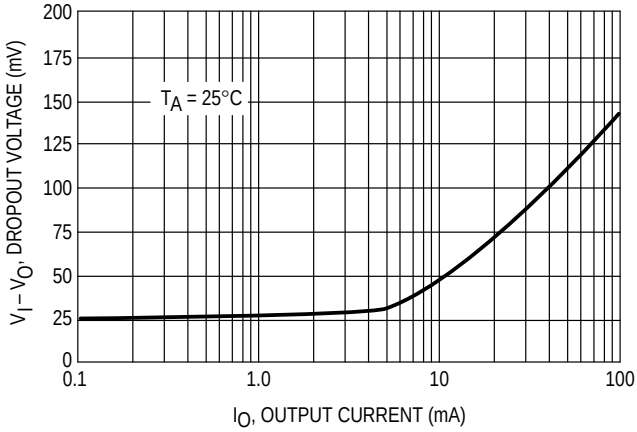
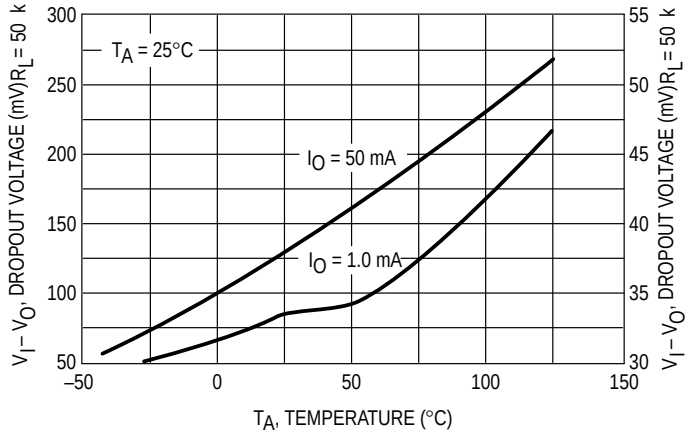


Figure 6. Dropout Voltage versus Temperature



APPLICATION INFORMATION

Introduction

The MC33264 regulators are designed with internal current limiting and thermal shutdown making them user–friendly. These regulators are not internally compensated and thus require a 1.0 μF (or greater) capacitance between the output terminal and ground for stability. Most types of aluminum, tantalum or multilayer ceramic will perform adequately. Solid tantalums or appropriate multilayer ceramic capacitors are recommended for operation below 25°C.

At lower values of output current, less output capacitance is required for output stability. The MC33264 will remain stable and in regulation when operated with no output load. When setting the output voltage with external resistors, the resistance values should be chosen to draw a minimum of 1.0 μA.

A bypass capacitor is recommended across the MC33264 input to ground if more than 4.0 inches of wire connects the input to either a battery or power supply filter capacitor.

Input capacitance at the Adjust (Pin 5) can create a pole, causing instability if high value external resistors are used to set the output voltage. Adding a 0.01 μF capacitor between the Output Pin 8 and the Feedback Pin 5 and increasing the output filter capacitor to at least 3.3 μF will stabilize the feedback loop.

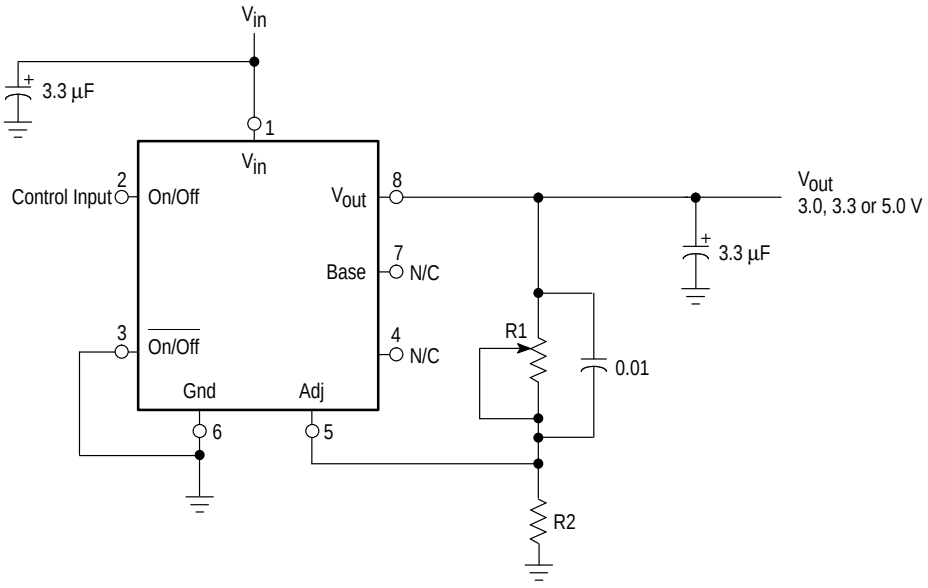
On/Off Control

On/Off control of the regulator may be accomplished in either of two ways. Pin 3 may be tied to circuit ground and a positive logic control applied to Pin 2. The regulator will be turned on by a positive (>2.4 V) level with respect to ground. The regulator will turn off if the control input is a logic “0” (<0.5 V). Alternatively, Pin 2 may be tied to the regulator input voltage and a negative logic control applied to Pin 3. The regulator will be turned on when the control voltage is less than V_{in} – 2.4 V. The regulator is off when the control input is open or greater than V_{in} – 0.2 V.

Programming The Output Voltage

The MC33264 output voltage is automatically set using its internal voltage divider. Alternatively, it may be programmed within a typical ±15% range of its preset output voltage. An external pair of resistors is required, as shown in Figure 7.

Figure 7. Regulator Output Voltage Trim



The complete equation for the output voltage is:

$$V_{out} = V_{ref}\left(1 + \frac{R1}{R2}\right) + I_{FB}\ R1$$

where V_{ref} is the nominal 1.235 V reference voltage and I_{FB} is the feedback pin bias current, nominally –20 nA. The minimum recommended load current of 1.0 µA forces an upper limit of 1.2 MΩ on the value of R2, if the regulator must work with no load. I_{FB} will produce a 2% typical error in V_{out} which may be eliminated at room temperature by adjusting R1. For better accuracy, choosing R2 = 100 K reduces this error to 0.17% while increasing the resistor program current to 12 µA.

Output Noise

In many applications it is desirable to reduce the noise present at the output. Reducing the regulator bandwidth by increasing the size of the output capacitor is the only method for reducing noise.

Noise can be reduced fourfold by a bypass capacitor across R1, since it reduces the high frequency gain from 4 to unity for the MC33264D–5.0. Pick

$$C_{BYPASS} = \frac{1}{2\pi\ R1\ x\ 200\ Hz}$$

or about 0.01 µF. When doing this, the output capacitor must be increased to 3.3 µF to maintain stability. These changes reduce the output noise from 430 µV to 100 Vrms for a 100 kHz bandwidth for the 5.0 V output device. With the bypass capacitor added, noise no longer scales with output voltage so that improvements are more dramatic at higher output voltages.

TYPICAL APPLICATIONS

Figure 8. Lithium Ion Battery Cell Charger

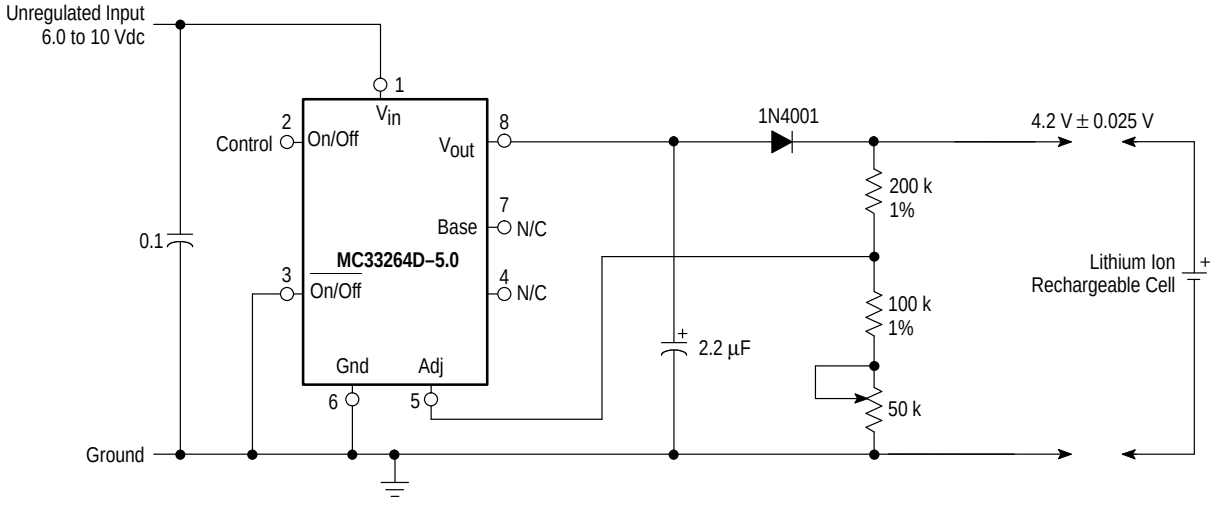


Figure 9. Low Drift Current Source

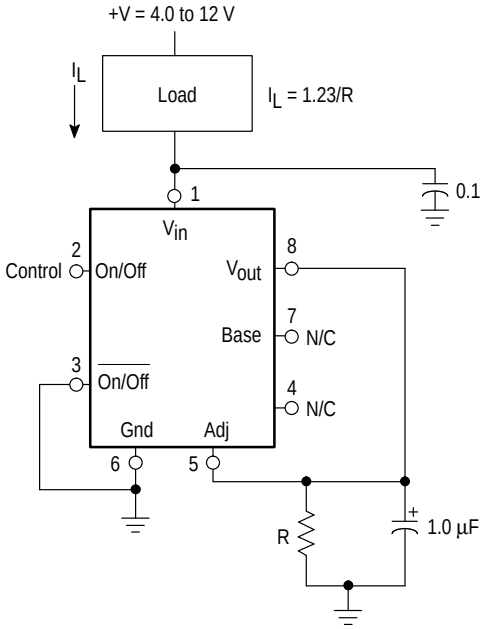


Figure 10. 2.0 Ampere Low Dropout Regulator

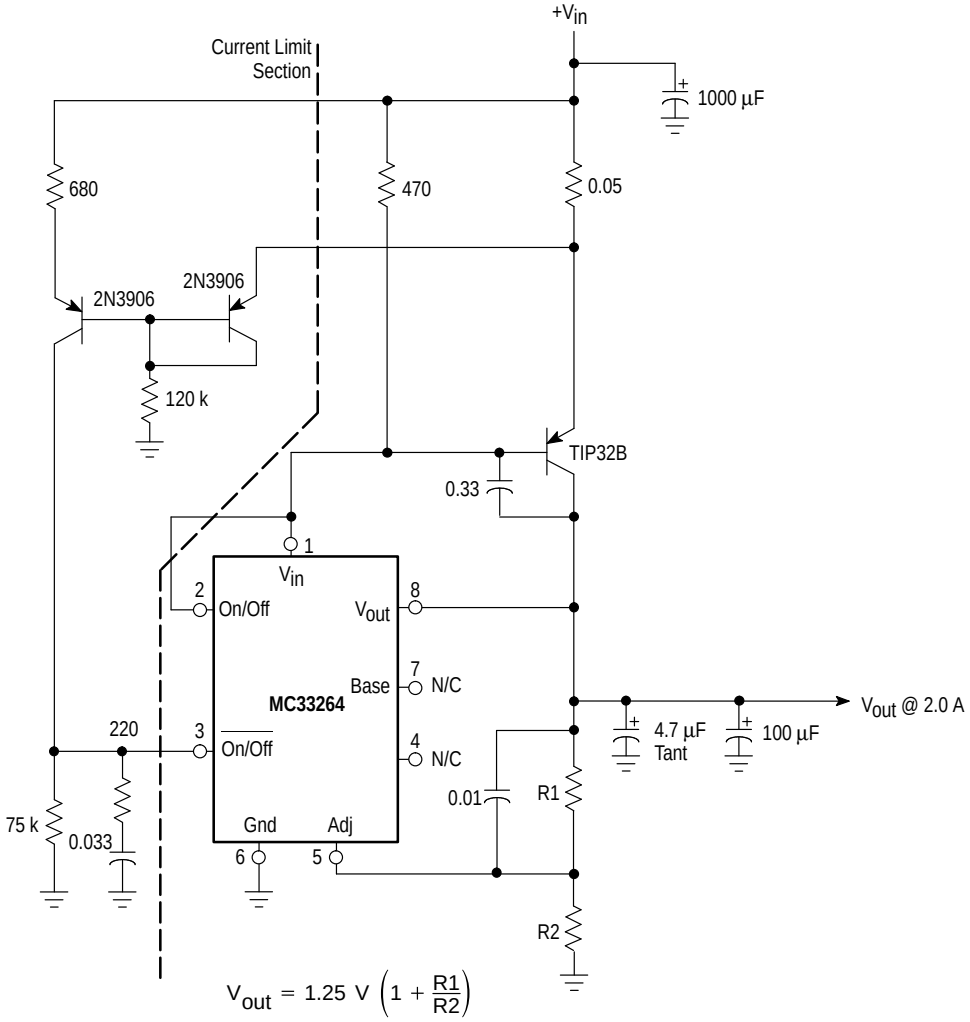


Figure 11. Low Battery Disconnect

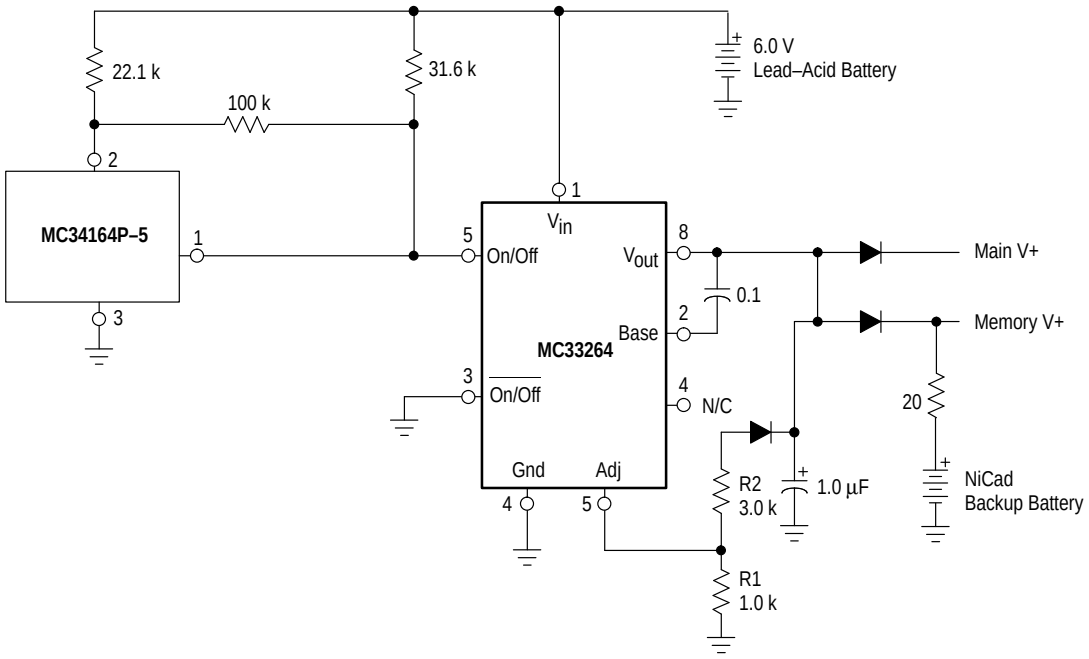
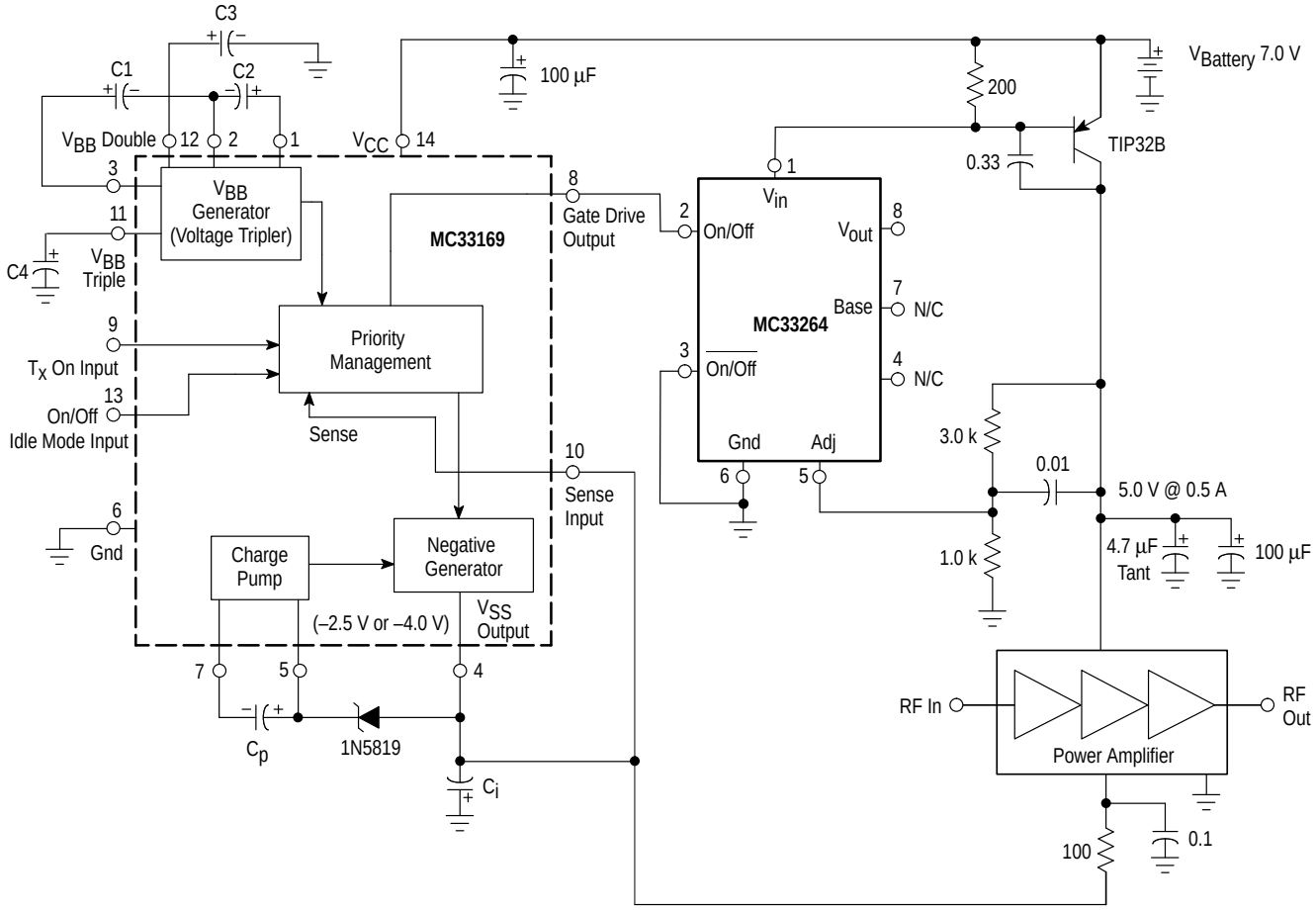
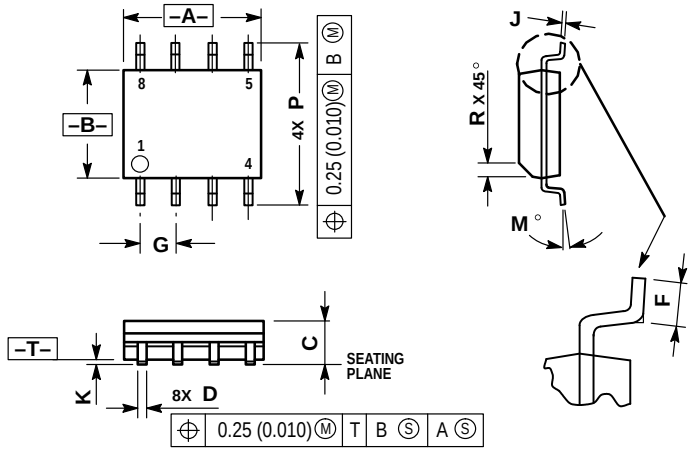


Figure 12. RF Amplifier Supply



OUTLINE DIMENSIONS

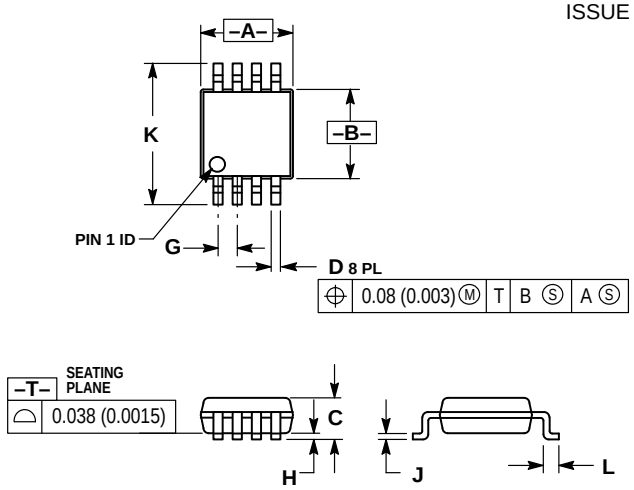
D SUFFIX
PLASTIC PACKAGE
CASE 751–05
(SO–8)
ISSUE P



NOTES:
1. DIMENSIONS A AND B ARE DATUMS AND T IS A DATUM SURFACE.
2. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
3. DIMENSIONS ARE IN MILLIMETER.
4. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
5. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.
6. DIMENSION D DOES NOT INCLUDE MOLD PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

	MILLIMETERS	
DIM	MIN	MAX
A	4.80	5.00
B	3.80	4.00
C	1.35	1.75
D	0.35	0.49
F	0.40	1.25
G	1.27 BSC	
J	0.18	0.25
K	0.10	0.25
M	0 °	7 °
P	5.80	6.20
R	0.25	0.50

DM SUFFIX
PLASTIC PACKAGE
CASE 846A–02
(MICRO–8)
ISSUE B



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION D DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	2.90	3.10	0.114	0.122
B	2.90	3.10	0.114	0.122
C	—	1.10	—	0.043
D	0.25	0.40	0.010	0.016
G	0.65 BSC		0.026 BSC	
H	0.05	0.15	0.002	0.006
J	0.13	0.23	0.005	0.009
K	4.75	5.05	0.187	0.199
L	0.40	0.70	0.016	0.028

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