MOTOROLA

MC33375

Preliminary Information

Low Dropout 300 mA Voltage Regulator with On/Off Control

The MC33375 series are micropower low dropout voltage regulators available in a wide variety of output voltages as well as packages, SOT–223, and SOP–8 surface mount packages. These devices feature a very low quiescent current and are capable of supplying output currents up to 300 mA. Internal current and thermal limiting protection are provided by the presence of a short circuit at the output and an internal thermal shutdown circuit.

Additionally, the MC33375 is available with an active HIGH off and LOW controls that allows a logic level signal to turn–off or turn–on the regulator output. (125 µA Quiescent Current in the On Mode, 0.3 µA in the Off Mode)

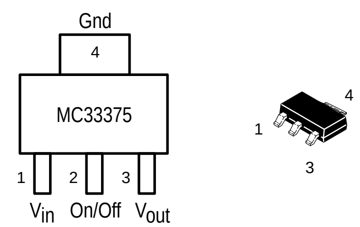
Due to the low input–to–output voltage differential and bias current specifications, these devices are ideally suited for battery powered computer, consumer, and industrial equipment where an extension of useful battery life is desirable.

Features:

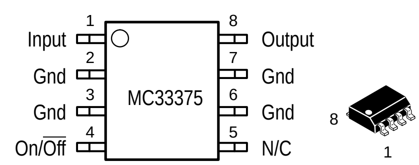
- Low Quiescent Current (0.3 µA in Off Mode; 125 µA in On Mode)
- Low Input–to–Output Voltage Differential of 25 mV at I_O = 10 mA, and 260 mV at I_O = 300 mA
- Extremely Tight Line and Load Regulation
- Stable with Output Capacitance of only 0.33 µF for 2.5 V Output Voltage
- Internal Current and Thermal Limiting
- Logic Level On/Off Control

LOW DROPOUT MICROPOWER VOLTAGE REGULATOR WITH ON/OFF CONTROL

SEMICONDUCTOR TECHNICAL DATA

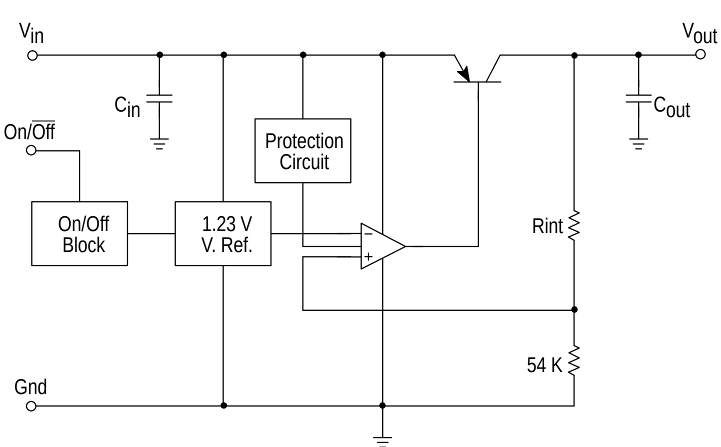


ST SUFFIX
PLASTIC PACKAGE
CASE 318E–04
(SOT–223)



D SUFFIX
PLASTIC PACKAGE
CASE 751–06
(SOP–8)

Simplified Block Diagram



This device contains 41 active transistors

This document contains information on a product under development. Motorola reserves the right to change or discontinue this product without notice.

ORDERING INFORMATION

Device	Type	Operating Temperature Range, Tolerance	Case	Package
MC33375ST–2.5 MC33375D–2.5	2.5 V (Fixed Voltage)	1% Tolerance at T_A = 25°C 2% Tolerance at T_J from –40 to +125°C	318E 751–5	SOT–223 SOP–8
MC33375ST–3.0 MC33375D–3.0	3.0 V (Fixed Voltage)		318E 751–5	SOT–223 SOP–8
MC33375ST–3.3 MC33375D–3.3	3.3 V (Fixed Voltage)		318E 751–5	SOT–223 SOP–8
MC33375ST–5.0 MC33375D–5.0	5.0 V (Fixed Voltage)		318E 751–5	SOT–223 SOP–8

MAXIMUM RATINGS (T_A = 25°C, for min/max values T_J = –40°C to +125°C, Note 1)

Rating	Symbol	Value	Unit
Input Voltage	V_{CC}	13	Vdc
Power Dissipation and Thermal Characteristics T_A = 25°C Maximum Power Dissipation Case 751 (SOP–8) D Suffix Thermal Resistance, Junction–to–Ambient Thermal Resistance, Junction–to–Case Case 318E (SOT–223) ST Suffix Thermal Resistance, Junction–to–Air Thermal Resistance, Junction–to–Case	 P_D $R_{\theta JA}$ $R_{\theta JC}$ $R_{\theta JA}$ $R_{\theta JC}$	 Internally Limited 160 25 245 15	 W °C/W °C/W °C/W °C/W
Output Current	I_O	300	mA
Maximum Junction Temperature	T_J	150	°C
Operating Junction Temperature Range	T_J	– 40 to +125	°C
Storage Temperature Range	T_{stg}	– 65 to +150	°C

NOTE: 1. Low duty pulse techniques are used during test to maintain junction temperature as close to ambient as possible.
2. Before Thermal Shutdown.

DEVICE MARKING

Device	Type	Version	Marking (1st Line)
MC33375	inhibit	2.5 V	37525
MC33375	inhibit	3.0 V	37530
MC33375	inhibit	3.3 V	37533
MC33375	inhibit	5.0 V	37550

ELECTRICAL CHARACTERISTICS (T_A = 25°C, for min/max values T_J = –40°C to +125°C, Note 1)

Characteristic		Symbol	Min	Typ	Max	Unit
Output Voltage	I_O = 0 mA to 250 mA	V_O				Vdc
2.5 V Suffix	T_A = 25°C, V_{in} = [V_O + 1] V		2.475	2.50	2.525	
3.0 V Suffix			2.970	3.00	3.030	
3.3 V Suffix			3.267	3.30	3.333	
5.0 V Suffix			4.950	5.00	5.50	
2.5 V Suffix	V_{in} = [V_O + 1] V, 0 < I_O < 100 mA		2.450	—	2.550	
3.0 V Suffix	2% Tolerance from T_J = –40 to +125°C		2.940	—	3.060	
3.3 V Suffix			3.234	—	3.366	
5.0 V Suffix			4.900	—	5.100	
Line Regulation	V_{in} = [V_O + 1] V to 12 V, I_O = 250 mA, All Suffixes T_A = 25°C	Reg_{line}	–	2.0	10	mV
Load Regulation	V_{in} = [V_O + 1] V, I_O = 0 mA to 250 mA, All Suffixes T_A = 25°C	Reg_{load}	–	5.0	25	mV
Dropout Voltage		$V_{in} – V_O$				mV
I_O = 10 mA	T_J = –40°C to +125°C		—	25	100	
I_O = 100 mA			—	115	200	
I_O = 250 mA			—	220	400	
I_O = 300 mA			—	260	500	
Ripple Rejection (1 kHz)	$V_{in(peak–peak)}$ = [V_O + 1.5] V to [V_O + 5.5] V	—	65	75	—	dB
Output Noise Voltage		V_n				µVrms
C_L = 1 µF	I_O = 50 mA (10 Hz to 100 kHz),		—	160	—	
C_L = 200 µF	V_{in} = [V_O + 1] V		—	46	—	

CURRENT PARAMETERS

Characteristic		Symbol	Min	Typ	Max	Unit
Quiescent Current		I_Q				µA
On Mode	V_{in} = [V_O + 1] V, I_O = 0 mA		—	125	200	
Off Mode			—	0.3	4.0	
On Mode SAT	V_{in} = [V_O – 0.5] V, I_O = 0 mA, Note 2		—	1100	1500	
Current Limit	V_{in} = [V_O + 1], V_O shorted, T_A = 25°C	I_{LIMIT}	—	450	—	mA

ON/OFF INPUTS

Characteristic		Symbol	Min	Typ	Max	Unit
On/Off Input Voltage		$V_{On/Off}$				V
Logic "1" (Regulator On)	Pin 4 tied to the ground		2.4	—	—	
Logic "0" (Regulator Off)			—	—	0.3	

THERMAL SHUTDOWN

Characteristic	Symbol	Min	Typ	Max	Unit
Thermal Shutdown	—	—	150	—	°C

NOTE: 1. Low duty pulse techniques are used during test to maintain junction temperature as close to ambient as possible.
2. Quiescent Current is measured where the PNP pass transistor is in saturation. V_{in} = V_O – 0.5 V guarantees this condition.

DEFINITIONS

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

Dropout Voltage – The input/output 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.

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

Maximum Power Dissipation – The maximum total 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.

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

Thermal Protection – Internal thermal shutdown circuitry is provided to protect the integrated circuit in the event that the maximum junction temperature is exceeded. When activated, typically 150°C, the regulator turns off. This feature is provided to prevent catastrophic failures from accidental overheating.

Maximum Package Power Dissipation – The maximum package power dissipation is the power dissipation level at which the junction temperature reaches its maximum value i.e. 125°C. The junction temperature is rising while the difference between the input power (V_{CC} X I_{CC}) and the output power (V_{out} X I_{out}) is increasing.

Depending on ambient temperature, it is possible to calculate the maximum power dissipation and so the maximum current as following:

$$Pd = \frac{T_J - T_A}{R_{\theta JA}}$$

The maximum operating junction temperature T_J is specified at 125°C, if T_A = 25°C, then P_D can be found. By neglecting the quiescent current, the maximum power dissipation can be expressed as:

$$I_{out} = \frac{P_D}{V_{CC} - V_{out}}$$

The maximum power dissipation supported by the device is a lot increased when using appropriate application design. Mounting pad configuration on the PCB, the board material and also the ambient temperature are affected the rate of temperature rise. It means that when the I_C has good thermal conductivity through PCB, the junction temperature will be "low" even if the power dissipation is great.

The thermal resistance of the whole circuit can be evaluated by deliberately activating the thermal shutdown of the circuit (by increasing the output current or raising the input voltage for example).

Then you can calculate the power dissipation by subtracting the output power from the input power. All variables are then well known: power dissipation, thermal shutdown temperature (150°C for MC33375) and ambient temperature.

$$R_{\theta JA} = \frac{T_J - T_A}{P_D}$$

APPLICATIONS INFORMATION

INTRODUCTION

The MC33375 regulators are designed with internal current limiting and thermal shutdown making them user–friendly. These regulators require only a 0.33 μF (or greater) capacitance between the output terminal and ground for stability for 2.5 V, 3.0 V, and 3.3 V output voltage options. Output voltage options of 5.0 V require only 0.22 μF for stability. The output capacitor must be mounted as close as possible to the MC33275. If the output capacitor must be mounted further than two centimeters away from the MC33275, then a larger value of output capacitor may be required for stability. A value of 0.68 μF or larger is recommended. 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.

A bypass capacitor is recommended across the MC33375 input to ground if more than 4 inches of wire connects the input to either a battery or power supply filter capacitor.

ON/OFF CONTROL

On/Off control of the regulator may be accomplished in the following way. Pin 4 of the SOP–8 may be turned off if PIN 4 is tied to circuit ground. The regulator will be turned on when more than 2.4 V are applied to PIN 4, typically V_{out} with respect to ground, sourcing a typical current of 6.0 μA. The regulator will turn off if the control input is a logic “0” (<0.3 V).

Figure 1. SOT–223 Thermal Resistance and Maximum Power Dissipation versus P.C.B. Copper Length

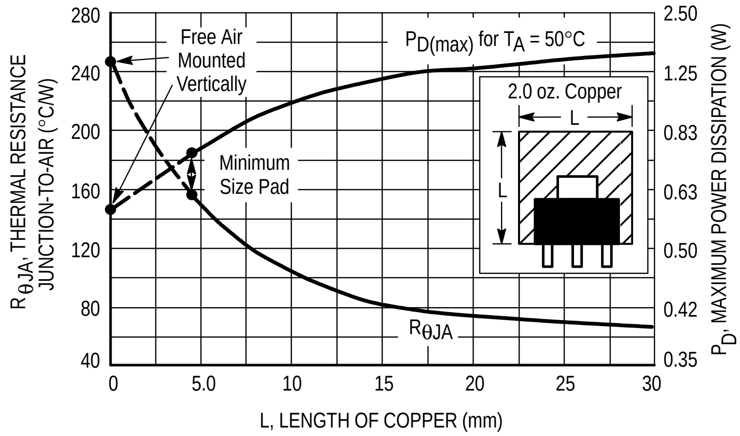
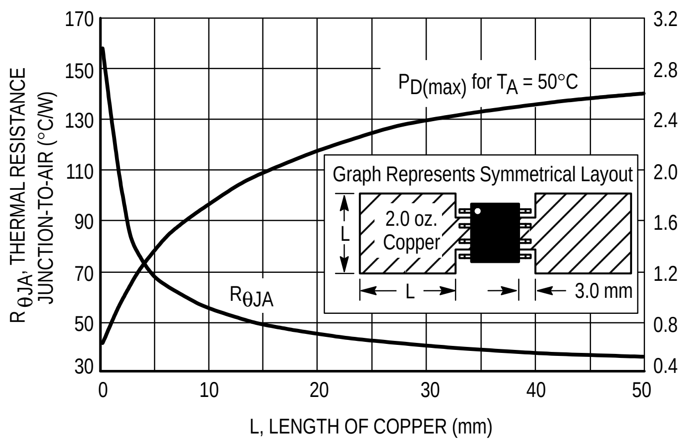
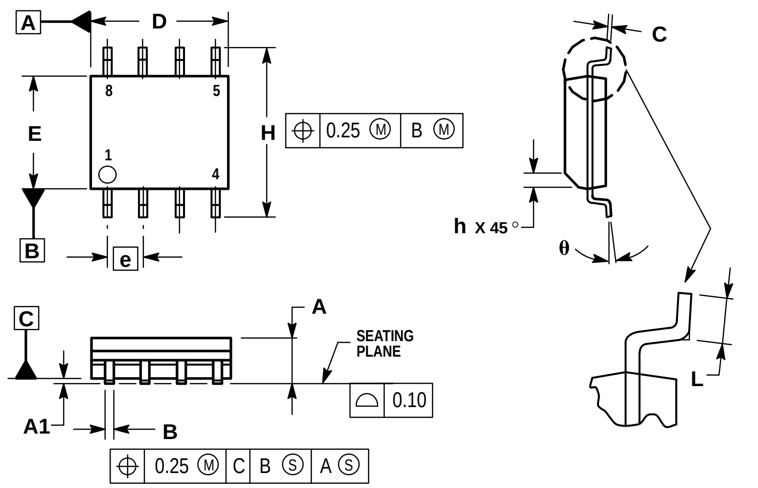


Figure 2. SOP–8 Thermal Resistance and Maximum Power Dissipation versus P.C.B. Copper Length



OUTLINE DIMENSIONS

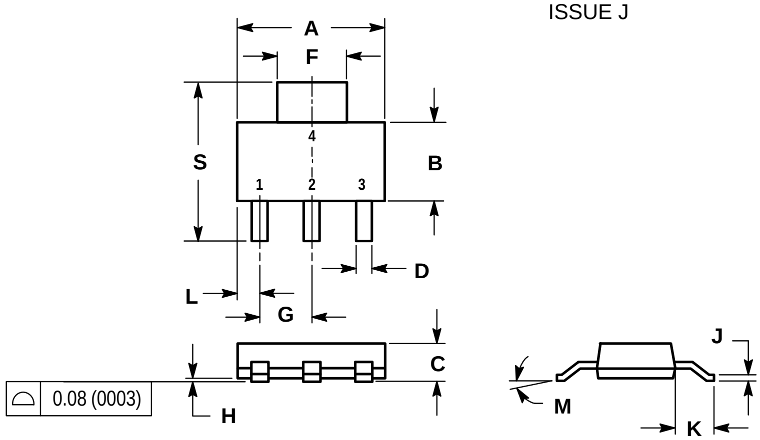
D SUFFIX
PLASTIC PACKAGE
CASE 751–06
(SOP–8)
ISSUE T



NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. DIMENSIONS ARE IN MILLIMETER.
3. DIMENSION D AND E DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.
5. DIMENSION B DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 TOTAL IN EXCESS OF THE B DIMENSION AT MAXIMUM MATERIAL CONDITION.

	MILLIMETERS	
DIM	MIN	MAX
A	1.35	1.75
A1	0.10	0.25
B	0.35	0.49
C	0.19	0.25
D	4.80	5.00
E	3.80	4.00
e	1.27 BSC	
H	5.80	6.20
h	0.25	0.50
L	0.40	1.25
θ	0 °	7 °

ST SUFFIX
PLASTIC PACKAGE
CASE 318E–04
(SOT–223)
ISSUE J



NOTES:
1 DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2 CONTROLLING DIMENSION: INCH.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.249	0.263	6.30	6.70
B	0.130	0.145	3.30	3.70
C	0.060	0.068	1.50	1.75
D	0.024	0.035	0.60	0.89
F	0.115	0.126	2.90	3.20
G	0.087	0.094	2.20	2.40
H	0.0008	0.0040	0.020	0.100
J	0.009	0.014	0.24	0.35
K	0.060	0.078	1.50	2.00
L	0.033	0.041	0.85	1.05
M	0 °	10 °	0 °	10 °
S	0.264	0.287	6.70	7.30

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