



MC33275

Preliminary Information

Low Dropout 300 mA Voltage Regulator

The MC33275 series are micropower low dropout voltage regulators available in a wide variety of output voltages as well as packages, DPAK, 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.

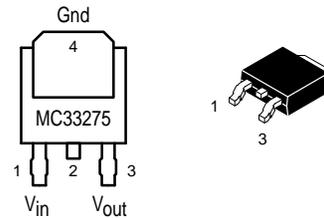
Additionally, the MC33275 is available (as MC33375) with an active HIGH off and LOW controls (PIN 4) that allows a logic level signal to turn-off or turn-on the regulator output.

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.

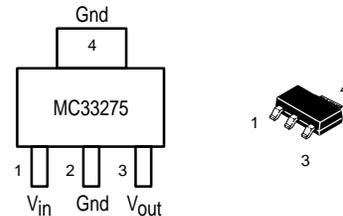
Features:

- Low Quiescent Current (125 μ A)
- 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 μ F for 2.5 V Output Voltage
- Internal Current and Thermal Limiting

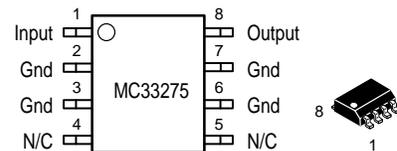
LOW DROPOUT MICROPOWER VOLTAGE REGULATOR SEMICONDUCTOR TECHNICAL DATA



DT SUFFIX
PLASTIC PACKAGE
CASE 369A
(DPAK)



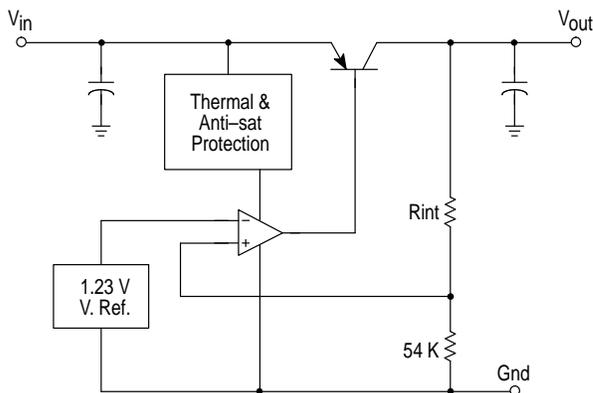
ST SUFFIX
PLASTIC PACKAGE
CASE 318E-04
(SOT-223)



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

Pins 4 and 5 Not Connected

Simplified Block Diagram



This device contains 41 active transistors

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ORDERING INFORMATION

Device	Type	Operating Temperature Range, Tolerance	Case	Package
MC33275DT-2.5 MC33275ST-2.5 MC33275D-2.5	2.5 V (Fixed Voltage)	1% Tolerance at $T_A = 25^\circ\text{C}$ 2% Tolerance at T_J from -40 to $+125^\circ\text{C}$	369A 318E 751-5	DPAK SOT-223 SOP-8
MC33275DT-3.0 MC33275ST-3.0 MC33275D-3.0	3.0 V (Fixed Voltage)		369A 318E 751-5	DPAK SOT-223 SOP-8
MC33275DT-3.3 MC33275ST-3.3 MC33275D-3.3	3.3 V (Fixed Voltage)		369A 318E 751-5	DPAK SOT-223 SOP-8
MC33275DT-5.0 MC33275ST-5.0 MC33275D-5.0	5.0 V (Fixed Voltage)		369A 318E 751-5	DPAK SOT-223 SOP-8

MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$, for min/max values $T_J = -40^\circ\text{C}$ to $+125^\circ\text{C}$)

Rating	Symbol	Value	Unit
Input Voltage	V_{CC}	13	Vdc
Power Dissipation and Thermal Characteristics $T_A = 25^\circ\text{C}$			
Maximum Power Dissipation	P_D	Internally Limited	W
Case 751 (SOP-8) D Suffix			
Thermal Resistance, Junction-to-Ambient	$R_{\theta JA}$	160	$^\circ\text{C/W}$
Thermal Resistance, Junction-to-Case	$R_{\theta JC}$	25	$^\circ\text{C/W}$
Case 369A (DPAK) DT Suffix			
Thermal Resistance, Junction-to-Air	$R_{\theta JA}$	92	$^\circ\text{C/W}$
Thermal Resistance, Junction-to-Case	$R_{\theta JC}$	6.0	$^\circ\text{C/W}$
Case 318E (SOT-223) ST Suffix			
Thermal Resistance, Junction-to-Air	$R_{\theta JA}$	245	$^\circ\text{C/W}$
Thermal Resistance, Junction-to-Case	$R_{\theta JC}$	15	$^\circ\text{C/W}$
Output Current	I_O	300	mA
Maximum Junction Temperature	T_J	150	$^\circ\text{C}$
Operating Junction Temperature Range	T_J	-40 to $+125$	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to $+150$	$^\circ\text{C}$

DEVICE MARKING

Device	Type	Version	Marking (1st Line)
MC33275	non-inhibit	2.5 V	27525
MC33275	non-inhibit	3.0 V	27530
MC33275	non-inhibit	3.3 V	27533
MC33275	non-inhibit	5.0 V	27550

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ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$, for min/max values $T_J = -40^\circ\text{C}$ to $+125^\circ\text{C}$, Note 1)

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

CURRENT PARAMETERS

Characteristic	Symbol	Min	Typ	Max	Unit	
Quiescent Current On Mode On Mode SAT	$V_{in} = [V_O + 1] \text{ V}, I_O = 0 \text{ mA}$ $V_{in} = [V_O - 0.5] \text{ V}, I_O = 0 \text{ mA}, \text{ Note } 2$	I_Q	— —	125 1100	200 1500	μA
Current Limit	$V_{in} = [V_O + 1], V_O$ shorted	I_{LIMIT}	—	450	—	mA

THERMAL SHUTDOWN

Characteristic	Symbol	Min	Typ	Max	Unit
Thermal Shutdown	—	—	150	—	$^\circ\text{C}$

- 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. $V_{in} = [V_O - 0.5] \text{ V}$ guarantees this condition.

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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 ($V_{CC} \times I_{CC}$) and the output power ($V_{out} \times I_{out}$) is increasing.

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

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

The maximum operating junction temperature T_J is specified at 125°C, if $T_A = 25^\circ\text{C}$, 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 MC33275) and ambient temperature.

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

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APPLICATIONS INFORMATION

INTRODUCTION

The MC33275 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 MC33275 input to ground if more than 4 inches of wire connects the input to either a battery or power supply filter capacitor.

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

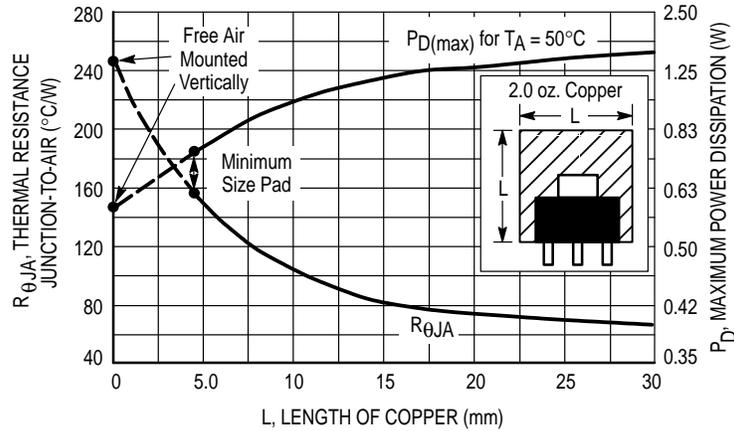


Figure 2. DPAK Thermal Resistance and Maximum Power Dissipation versus P.C.B. Copper Length

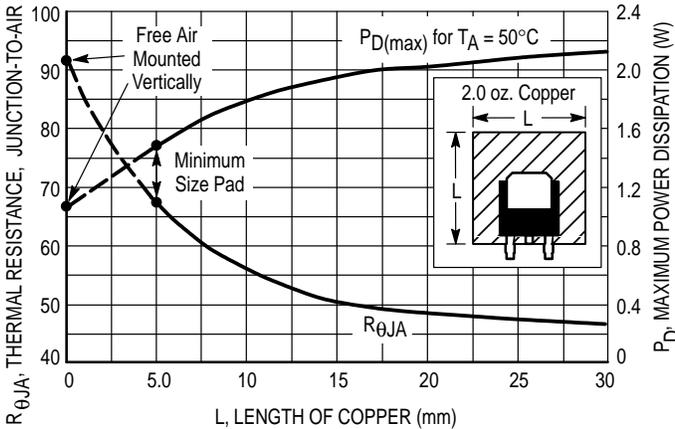
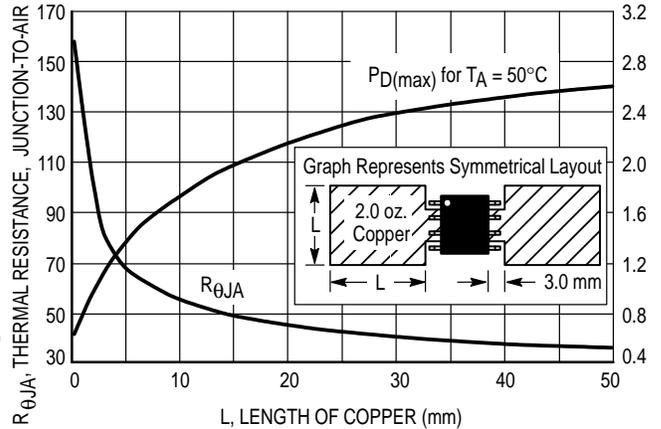


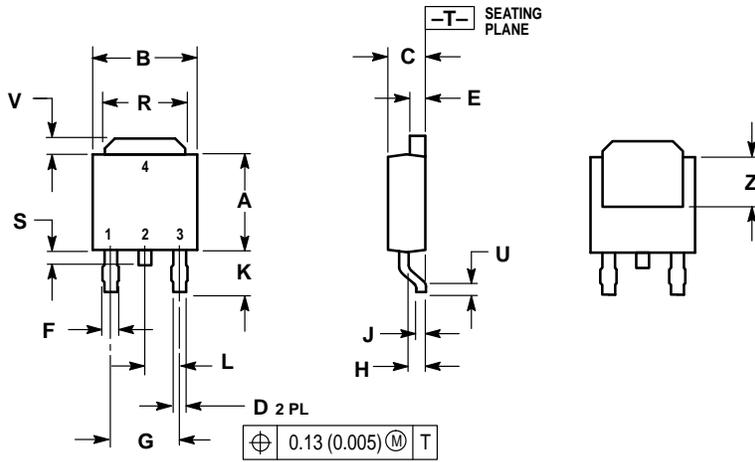
Figure 3. SOP-8 Thermal Resistance and Maximum Power Dissipation versus P.C.B. Copper Length



MC33275

OUTLINE DIMENSIONS

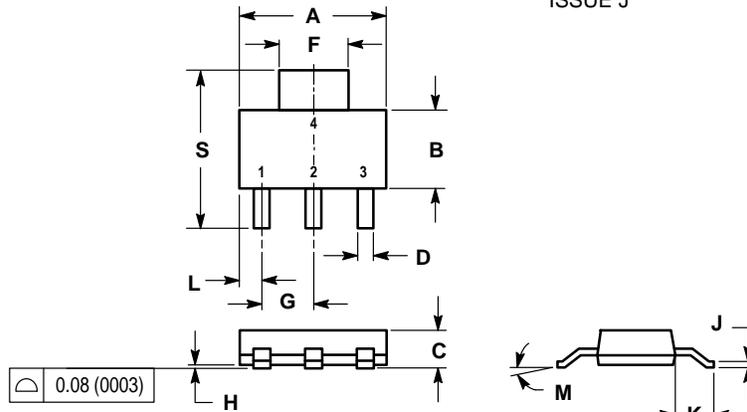
DT SUFFIX PLASTIC PACKAGE CASE 369A-13 (DPAK) ISSUE Z



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

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.235	0.250	5.97	6.35
B	0.250	0.265	6.35	6.73
C	0.086	0.094	2.19	2.38
D	0.027	0.035	0.69	0.88
E	0.033	0.040	0.84	1.01
F	0.037	0.047	0.94	1.19
G	0.180 BSC		4.58 BSC	
H	0.034	0.040	0.87	1.01
J	0.018	0.023	0.46	0.58
K	0.102	0.114	2.60	2.89
L	0.090 BSC		2.29 BSC	
R	0.175	0.215	4.45	5.46
S	0.020	0.050	0.51	1.27
U	0.020	—	0.51	—
V	0.030	0.050	0.77	1.27
Z	0.138	—	3.51	—

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



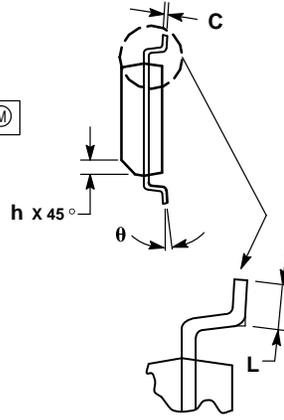
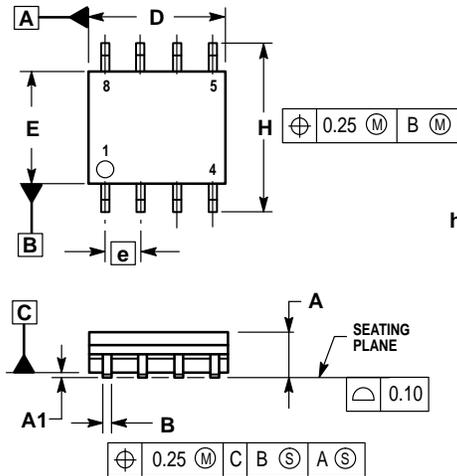
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.

DIM	INCHES		MILLIMETERS	
	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

MC33275

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°

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