MCP1700

Low Quiescent Current LDO

Features

- 1.6 µA Typical Quiescent Current
- Input Operating Voltage Range: 2.3V to 6.0V
- Output Voltage Range: 1.2V to 5.0V
- 250 mA Output Current for output voltages ≥ 2.5V
- 200 mA Output Current for output voltages < 2.5V
- Low Dropout (LDO) voltage
  - 178 mV typical @ 250 mA for V_{OUT} = 2.8V
- 0.4% Typical Output Voltage Tolerance
- Standard Output Voltage Options:
  - 1.2V, 1.8V, 2.5V, 3.0V, 3.3V, 5.0V
- Stable with 1.0 µF Ceramic Output capacitor
- Short Circuit Protection
- Overtemperature Protection

Applications

- Battery-powered Devices
- Battery-powered Alarm Circuits
- Smoke Detectors
- CO^2 Detectors
- Pagers and Cellular Phones
- Smart Battery Packs
- Low Quiescent Current Voltage Reference
- PDAs
- Digital Cameras
- Microcontroller Power

Related Literature

- AN765, “Using Microchip’s Micropower LDOs”, DS00765, Microchip Technology Inc., 2002
- AN766, “Pin-Compatible CMOS Upgrades to BiPolar LDOs”, DS00766, Microchip Technology Inc., 2002
- AN792, “A Method to Determine How Much Power a SOT23 Can Dissipate in an Application”, DS00792, Microchip Technology Inc., 2001

General Description

The MCP1700 is a family of CMOS low dropout (LDO) voltage regulators that can deliver up to 250 mA of current while consuming only 1.6 µA of quiescent current (typical). The input operating range is specified from 2.3V to 6.0V, making it an ideal choice for two and three primary cell battery-powered applications, as well as single cell Li-Ion-powered applications.

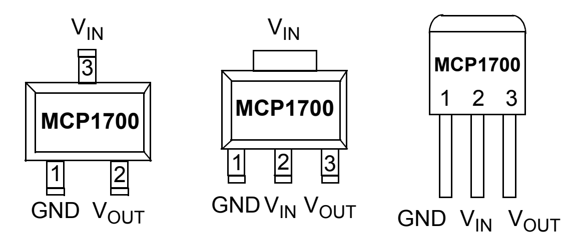
The MCP1700 is capable of delivering 250 mA with only 178 mV of input to output voltage differential (V_{OUT} = 2.8V). The output voltage tolerance of the MCP1700 is typically ±0.4% at +25°C and ±3% maximum over the operating junction temperature range of -40°C to +125°C.

Output voltages available for the MCP1700 range from 1.2V to 5.0V. The LDO output is stable when using only 1 µF output capacitance. Ceramic, tantalum or aluminum electrolytic capacitors can all be used for input and output. Overcurrent limit and overtemperature shutdown provide a robust solution for any application.

Package options include the SOT-23, SOT-89 and TO-92.

Package Types

3-Pin SOT-23 | 3-Pin SOT-89 | 3-Pin TO-92



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

V_{DD} ....+6.5V
All inputs and outputs w.r.t. ....(V_{SS}-0.3V) to (V_{IN}+0.3V)
Peak Output Current ....Internally Limited
Storage temperature ....-65°C to +150°C
Maximum Junction Temperature ....150°C
Operating Junction Temperature ....-40°C to +125°C
ESD protection on all pins (HBM;MM)..............≥ 4 kV; ≥ 400V

† Notice: Stresses above those listed under “Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

DC CHARACTERISTICS

Electrical Characteristics: Unless otherwise specified, all limits are established for $V_{IN} = V_R + 1$, I_{LOAD} = 100 µA, C_{OUT} = 1 µF (X7R), C_{IN} = 1 µF (X7R), T_A = +25°C.
Boldface type applies for junction temperatures, T_J **(Note 6)** of -40°C to +125°C.

Parameters	Sym	Min	Typ	Max	Units	Conditions
Input / Output Characteristics						
Input Operating Voltage	V_{IN}	**2.3**	—	**6.0**	V	**Note 1**
Input Quiescent Current	I_q	—	1.6	**4**	µA	I_L = 0 mA, $V_{IN} = V_R$ +1V
Maximum Output Current	I_{OUT_mA}	**250** **200**	— —	— —	mA	For $V_R \geq 2.5V$ For $V_R < 2.5V$
Output Short Circuit Current	I_{OUT_SC}	—	408	—	mA	$V_{IN} = V_R + V$, V_{OUT} = GND, Current (peak current) measured 10 ms after short is applied.
Output Voltage Regulation	V_{OUT}	**V_R-3.0%** V_R-2.0%	V_R±0.4 %	**V_R+3.0%** V_R+2.0%	V	**Note 2**
V_{OUT} Temperature Coefficient	TCV_{OUT}	—	50	—	ppm/°C	**Note 3**
Line Regulation	$\Delta V_{OUT}/(V_{OUT} X \Delta V_{IN})$	**-1.0**	±0.75	**+1.0**	%/V	$(V_R+1)V \leq V_{IN} \leq 6V$
Load Regulation	$\Delta V_{OUT}/V_{OUT}$	**-1.5**	±1.0	**+1.5**	%	I_L = 0.1 mA to 250 mA for $V_R \geq 2.5V$ I_L = 0.1 mA to 200 mA for $V_R < 2.5V$ **Note 4**
Dropout Voltage $V_R > 2.5V$	V_{IN}-V_{OUT}	—	178	**350**	mV	I_L = 250 mA, **(Note 1, Note 5)**
Dropout Voltage $V_R < 2.5V$	V_{IN}-V_{OUT}	—	150	**350**	mV	I_L = 200 mA, **(Note 1, Note 5)**
Output Rise Time	T_R	—	500	—	µs	10% V_R to 90% V_R V_{IN} = 0V to 6V, R_L = 50Ω resistive
Output Noise	e_N	—	3	—	$\mu V/(Hz)^{1/2}$	I_L = 100 mA, f = 1 kHz, C_{OUT} = 1 µF

Note 1: The minimum V_{IN} must meet two conditions: $V_{IN} \geq 2.3V$ and $V_{IN} \geq (V_R + 3.0\%) + V_{DROPOUT}$.

2: V_R is the nominal regulator output voltage. For example: V_R = 1.2V, 1.5V, 1.8V, 2.5V, 2.8V, 3.0V, 3.3V, 4.0V, 5.0V. The input voltage ($V_{IN} = V_R$ + 1.0V); I_{OUT} = 100 µA.

3: $TCV_{OUT} = (V_{OUT-HIGH} - V_{OUT-LOW}) *10^6 / (V_R * \Delta Temperature)$, $V_{OUT-HIGH}$ = highest voltage measured over the temperature range. $V_{OUT-LOW}$ = lowest voltage measured over the temperature range.

4: Load regulation is measured at a constant junction temperature using low duty cycle pulse testing. Changes in output voltage due to heating effects are determined using thermal regulation specification TCV_{OUT}.

5: Dropout voltage is defined as the input to output differential at which the output voltage drops 2% below its measured value with a V_R + 1V differential applied.

6: The maximum allowable power dissipation is a function of ambient temperature, the maximum allowable junction temperature and the thermal resistance from junction to air (i.e., T_A, T_J, θ_{JA}). Exceeding the maximum allowable power dissipation will cause the device operating junction temperature to exceed the maximum 150°C rating. Sustained junction temperatures above 150°C can impact the device reliability.

7: The junction temperature is approximated by soaking the device under test at an ambient temperature equal to the desired Junction temperature. The test time is small enough such that the rise in the Junction temperature over the ambient temperature is not significant.

DC CHARACTERISTICS (CONTINUED)

Electrical Characteristics: Unless otherwise specified, all limits are established for $V_{IN} = V_R + 1$, $I_{LOAD} = 100\ \mu A$, $C_{OUT} = 1\ \mu F$ (X7R), $C_{IN} = 1\ \mu F$ (X7R), $T_A = +25°C$.
Boldface type applies for junction temperatures, T_J **(Note 6)** of -40°C to +125°C.

Parameters	Sym	Min	Typ	Max	Units	Conditions
Power Supply Ripple Rejection Ratio	PSRR	—	44	—	dB	f = 100 Hz, $C_{OUT} = 1\ \mu F$, $I_L = 50$ mA, $V_{INAC} = 100$ mV pk-pk, $C_{IN} = 0\ \mu F$, $V_R = 1.2V$
Thermal Shutdown Protection	T_{SD}	—	140	—	°C	$V_{IN} = V_R + 1$, $I_L = 100\ \mu A$

Note 1: The minimum V_{IN} must meet two conditions: $V_{IN} \geq 2.3V$ and $V_{IN} \geq (V_R + 3.0\%) + V_{DROPOUT}$.

2: V_R is the nominal regulator output voltage. For example: V_R = 1.2V, 1.5V, 1.8V, 2.5V, 2.8V, 3.0V, 3.3V, 4.0V, 5.0V. The input voltage ($V_{IN} = V_R + 1.0V$); $I_{OUT} = 100\ \mu A$.

3: $TCV_{OUT} = (V_{OUT-HIGH} - V_{OUT-LOW}) * 10^6 / (V_R * \Delta Temperature)$, $V_{OUT-HIGH}$ = highest voltage measured over the temperature range. $V_{OUT-LOW}$ = lowest voltage measured over the temperature range.

4: Load regulation is measured at a constant junction temperature using low duty cycle pulse testing. Changes in output voltage due to heating effects are determined using thermal regulation specification TCV_{OUT}.

5: Dropout voltage is defined as the input to output differential at which the output voltage drops 2% below its measured value with a V_R + 1V differential applied.

6: The maximum allowable power dissipation is a function of ambient temperature, the maximum allowable junction temperature and the thermal resistance from junction to air (i.e., T_A, T_J, θ_{JA}). Exceeding the maximum allowable power dissipation will cause the device operating junction temperature to exceed the maximum 150°C rating. Sustained junction temperatures above 150°C can impact the device reliability.

7: The junction temperature is approximated by soaking the device under test at an ambient temperature equal to the desired Junction temperature. The test time is small enough such that the rise in the Junction temperature over the ambient temperature is not significant.

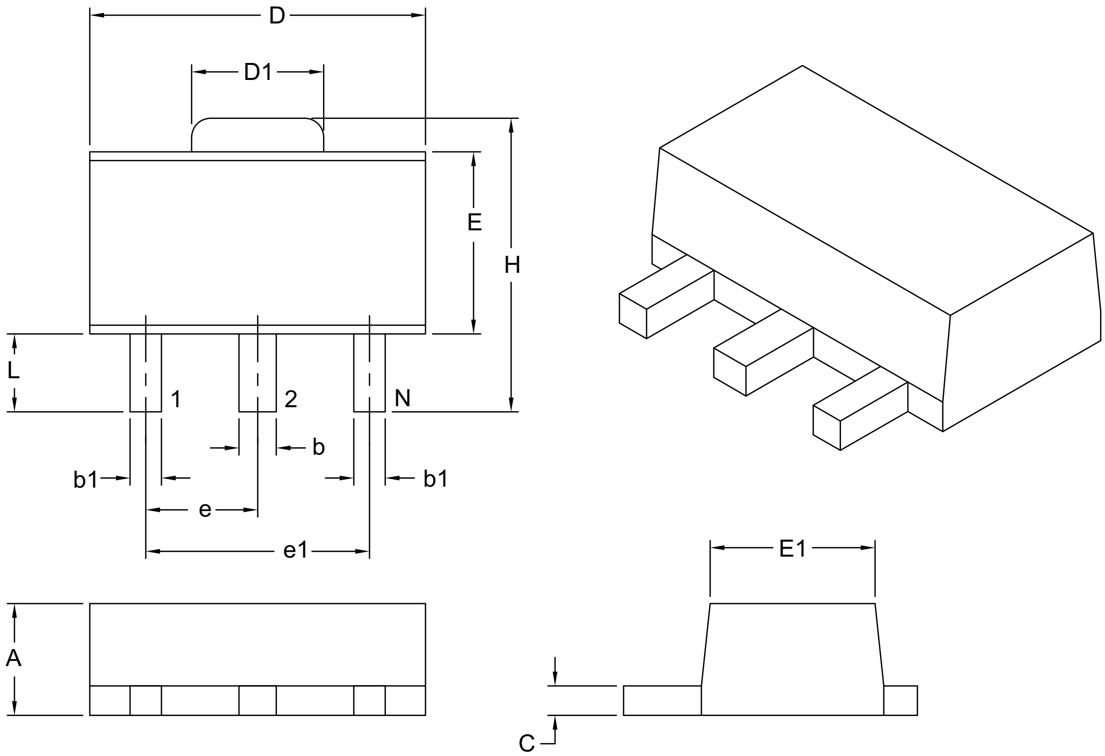
TEMPERATURE SPECIFICATIONS

Electrical Characteristics: Unless otherwise specified, all limits are established for $V_{IN} = V_R + 1$, $I_{LOAD} = 100\ \mu A$, $C_{OUT} = 1\ \mu F$ (X7R), $C_{IN} = 1\ \mu F$ (X7R), $T_A = +25°C$.
Boldface type applies for junction temperatures, T_J **(Note 1)** of -40°C to +125°C.

Parameters	Sym	Min	Typ	Max	Units	Conditions
Temperature Ranges						
Specified Temperature Range	T_A	-40		+125	°C	
Operating Temperature Range	T_A	-40		+125	°C	
Storage Temperature Range	T_A	-65		+150	°C	
Thermal Package Resistance						
Thermal Resistance, SOT-23	θ_{JA}	—	336	—	°C/W	Minimum Trace Width Single Layer Board
		—	230	—	°C/W	Typical FR4 4-layer Application
Thermal Resistance, SOT-89	θ_{JA}	—	52	—	°C/W	Typical, 1 square inch of copper
Thermal Resistance, TO-92	θ_{JA}	—	131.9	—	°C/W	EIA/JEDEC JESD51-751-7 4-Layer Board

Note 1: The maximum allowable power dissipation is a function of ambient temperature, the maximum allowable junction temperature and the thermal resistance from junction to air (i.e., T_A, T_J, θ_{JA}). Exceeding the maximum allowable power dissipation will cause the device operating junction temperature to exceed the maximum 150°C rating. Sustained junction temperatures above 150°C can impact the device reliability.

3-Lead Plastic Small Outline Transistor Header (MB) [SOT-89]



		Units	MILLIMETERS	
		Dimension Limits	MIN	MAX
Number of Leads	N		3	
Pitch	e		1.50 BSC	
Outside Lead Pitch	e1		3.00 BSC	
Overall Height	A		1.40	1.60
Overall Width	H		3.94	4.25
Molded Package Width at Base	E		2.29	2.60
Molded Package Width at Top	E1		2.13	2.29
Overall Length	D		4.39	4.60
Tab Length	D1		1.40	1.83
Foot Length	L		0.79	1.20
Lead Thickness	c		0.35	0.44
Lead 2 Width	b		0.41	0.56
Leads 1 & 3 Width	b1		0.36	0.48

Notes:

1. Dimensions D and E do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.127 mm per side.
2. Dimensioning and tolerancing per ASME Y14.5M.

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

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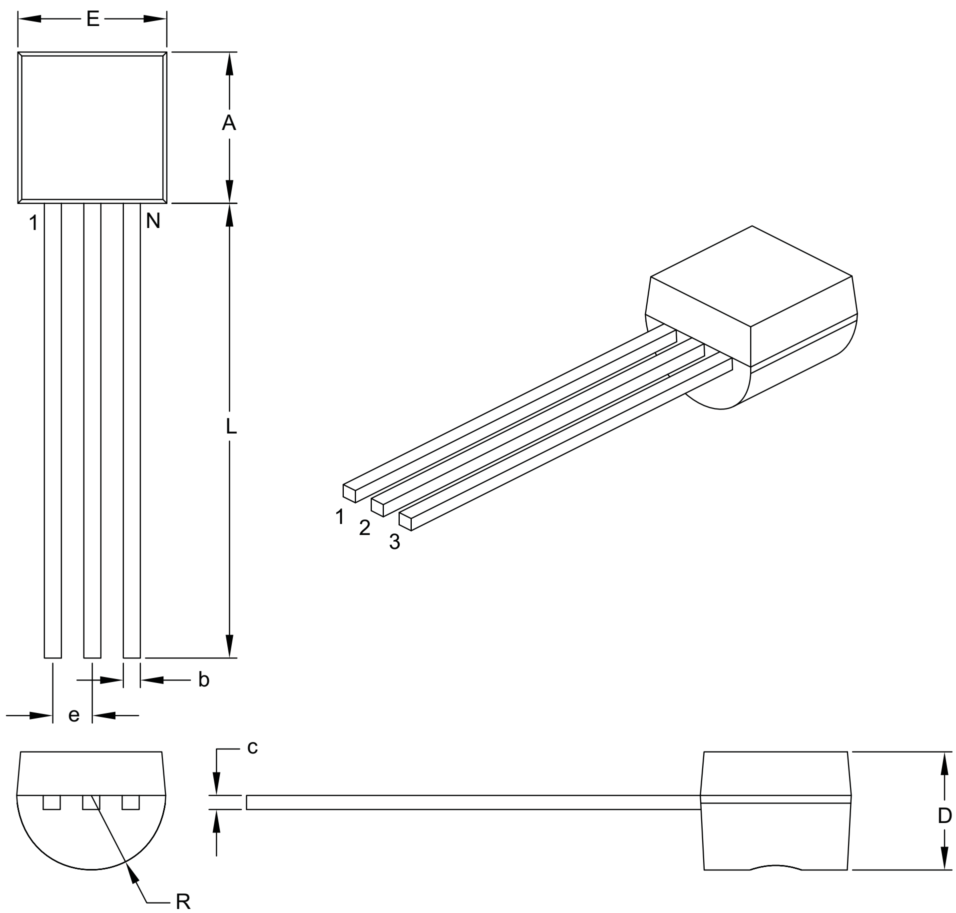
3-Lead Plastic Transistor Outline (TO or ZB) [TO-92]



Units		INCHES	
Dimension Limits		MIN	MAX
Number of Pins	N	3	
Pitch	e	.050 BSC	
Bottom to Package Flat	D	.125	.165
Overall Width	E	.175	.205
Overall Length	A	.170	.210
Molded Package Radius	R	.080	.105
Tip to Seating Plane	L	.500	–
Lead Thickness	c	.014	.021
Lead Width	b	.014	.022

Notes:

1. Dimensions A and E do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .005" per side.
2. Dimensioning and tolerancing per ASME Y14.5M.

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing C04-101B

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.

PART NO.	X-	XXX	X	X	/XX
MCP1700	Tape & Reel	Voltage Output	Tolerance	Temp. Range	Package

Device:	MCP1700: Low Quiescent Current LDO
Tape and Reel:	T: Tape and Reel only applies to SOT-23 and SOT-89 devices
Standard Output Voltage: *	120 = 1.2V 180 = 1.8V 250 = 2.5V 300 = 3.0V 330 = 3.3V 500 = 5.0V * Custom output voltages available upon request. Contact your local Microchip sales office for more information
Tolerance:	2 = 2%
Temperature Range:	E = -40°C to +125°C (Extended)
Package:	MB = Plastic Small Outline Transistor (SOT-89), 3-lead TO = Plastic Small Outline Transistor (TO-92), 3-lead TT = Plastic Small Outline Transistor SOT-23), 3-lead

Examples:

SOT-89 Package:

a) MCP1700T-1202E/MB: 1.2V V_{OUT}
b) MCP1700T-1802E/MB: 1.8V V_{OUT}
c) MCP1700T-2502E/MB: 2.5V V_{OUT}
d) MCP1700T-3002E/MB: 3.0V V_{OUT}
e) MCP1700T-3302E/MB: 3.3V V_{OUT}
f) MCP1700T-5002E/MB: 5.0V V_{OUT}

TO-92 Package:

g) MCP1700-1202E/TO: 1.2V V_{OUT}
h) MCP1700-1802E/TO: 1.8V V_{OUT}
i) MCP1700-2502E/TO: 2.5V V_{OUT}
j) MCP1700-3002E/TO: 3.0V V_{OUT}
k) MCP1700-3302E/TO: 3.3V V_{OUT}
l) MCP1700-5002E/TO: 5.0V V_{OUT}

SOT-23 Package:

a) MCP1700T-1202E/TT: 1.2V V_{OUT}
b) MCP1700T-1802E/TT: 1.8V V_{OUT}
c) MCP1700T-2502E/TT: 2.5V V_{OUT}
d) MCP1700T-3002E/TT: 3.0V V_{OUT}
e) MCP1700T-3302E/TT: 3.3V V_{OUT}
f) MCP1700T-5002E/TT: 5.0V V_{OUT}