

250 mA Low Quiescent Current LDO Regulator

Features

- 2.0 μ A Quiescent Current (typical)
- Input Operating Voltage Range: 2.7V to 13.2V
- 250 mA Output Current for Output Voltages \geq 2.5V
- 200 mA Output Current for Output Voltages $<$ 2.5V
- Low Dropout (LDO) voltage
 - 625 mV typical @ 250 mA ($V_{OUT} = 2.8V$)
- 0.4% Typical Output Voltage Tolerance
- Standard Output Voltage Options:
 - 1.2V, 1.5V, 1.8V, 2.5V, 2.8V, 3.0V, 3.3V, 4.0V, 5.0V
- Output voltage range 1.2V to 5.5V in 0.1V Increments (50 mV increments available upon request)
- Stable with 1.0 μ F to 22 μ F Output Capacitor
- Short-Circuit Protection
- Overtemperature Protection

Applications

- Battery-powered Devices
- Battery-powered Alarm Circuits
- Smoke Detectors
- CO² Detectors
- Pagers and Cellular Phones
- Smart Battery Packs
- Low Quiescent Current Voltage Reference
- PDAs
- Digital Cameras
- Microcontroller Power
- Solar-Powered Instruments
- Consumer Products
- Battery Powered Data Loggers

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 SOT-23 Can Dissipate in an Application", DS00792, Microchip Technology Inc., 2001

Description

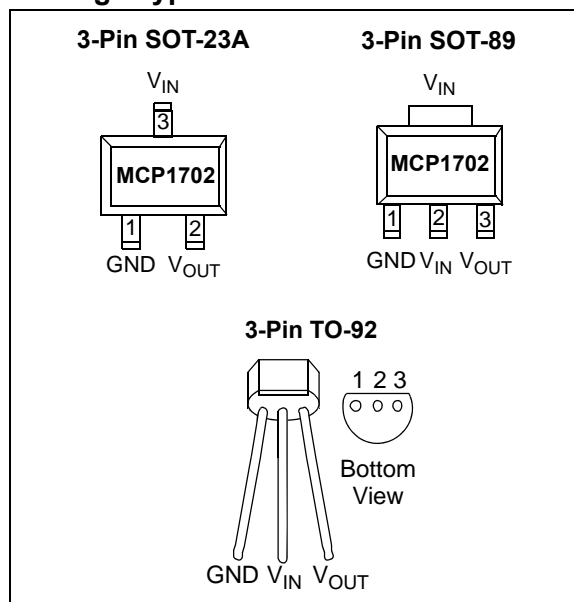
The MCP1702 is a family of CMOS low dropout (LDO) voltage regulators that can deliver up to 250 mA of current while consuming only 2.0 μ A of quiescent current (typical). The input operating range is specified from 2.7V to 13.2V, making it an ideal choice for two to six primary cell battery-powered applications, 9V alkaline and one or two cell Li-Ion-powered applications.

The MCP1702 is capable of delivering 250 mA with only 625 mV (typical) of input to output voltage differential ($V_{OUT} = 2.8V$). The output voltage tolerance of the MCP1702 is typically $\pm 0.4\%$ at $+25^{\circ}C$ and $\pm 3\%$ maximum over the operating junction temperature range of $-40^{\circ}C$ to $+125^{\circ}C$. Line regulation is $\pm 0.1\%$ typical at $+25^{\circ}C$.

Output voltages available for the MCP1702 range from 1.2V to 5.0V. The LDO output is stable when using only 1 μ F of 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-23A, SOT-89-3, and TO-92.

Package Types



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

V _{DD}	+14.5V
All inputs and outputs w.r.t.	(V _{SS} -0.3V) to (V _{IN} +0.3V)
Peak Output Current	500 mA
Storage temperature	-65°C to +150°C
Maximum Junction Temperature.....	150°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 Specifications: Unless otherwise specified, all limits are established for V_{IN} = V_{OUT(MAX)} + V_{DROPOUT(MAX)}, **Note 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 of -40°C to +125°C. (**Note 7**)

Parameters	Sym	Min	Typ	Max	Units	Conditions
Input / Output Characteristics						
Input Operating Voltage	V _{IN}	2.7	—	13.2	V	Note 1
Input Quiescent Current	I _q	—	2.0	5	μA	I _L = 0 mA
Maximum Output Current	I _{OUT_mA}	250	—	—	mA	For V _R ≥ 2.5V
		50	100	—	mA	For V _R < 2.5V, V _{IN} ≥ 2.7V
		100	130	—	mA	For V _R < 2.5V, V _{IN} ≥ 2.95V
		150	200	—	mA	For V _R < 2.5V, V _{IN} ≥ 3.2V
Maximum Output Current	I _{OUT_mA}	200	250	—	mA	For V _R < 2.5V, V _{IN} ≥ 3.45V
		—	400	—	mA	V _{IN} = V _{IN(MIN)} (Note 1), V _{OUT} = GND, Current (average current) measured 10 ms after short is applied.
Output Short Circuit Current	I _{OUT_SC}	—	400	—	mA	V _{IN} = V _{IN(MIN)} (Note 1), V _{OUT} = GND, Current (average current) measured 10 ms after short is applied.
Output Voltage Regulation	V _{OUT}	V_R-3.0%	V _R ±0.4%	V_R+3.0%	V	Note 2
		V _R -2.0%	V _R ±0.4%	V _R +2.0%	V	
		V _R -1.0%	V _R ±0.4%	V _R +1.0%	V	1% Custom
V _{OUT} Temperature Coefficient	TCV _{OUT}	—	50	150	ppm/°C	Note 3
Line Regulation	$\frac{\Delta V_{OUT}}{(V_{OUT} \times \Delta V_{IN})}$	-0.3	±0.1	+0.3	%/V	(V _{OUT(MAX)} + V _{DROPOUT(MAX)}) ≤ V _{IN} ≤ 13.2V, (Note 1)
Load Regulation	$\Delta V_{OUT}/V_{OUT}$	-2.5	±1.0	+2.5	%	I _L = 1.0 mA to 250 mA for V _R ≥ 2.5V I _L = 1.0 mA to 200 mA for V _R < 2.5V, V _{IN} = 3.45V Note 4

- Note 1:** The minimum V_{IN} must meet two conditions: V_{IN} ≥ 2.7V and V_{IN} ≥ V_{OUT(MAX)} + V_{DROPOUT(MAX)}.
- 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, or 5.0V. The input voltage V_{IN} = V_{OUT(MAX)} + V_{DROPOUT(MAX)} or V_{IN} = 2.7V (whichever is greater); I_{OUT} = 100 μA.
- 3:** TCV_{OUT} = (V_{OUT-HIGH} - V_{OUT-LOW}) * 10⁶ / (V_R * ΔTemperature), 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 an applied input voltage of V_{OUT(MAX)} + V_{DROPOUT(MAX)} or 2.7V, whichever is greater.
- 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.

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DC CHARACTERISTICS (CONTINUED)

Electrical Specifications: Unless otherwise specified, all limits are established for $V_{IN} = V_{OUT(MAX)} + V_{DROPOUT(MAX)}$, **Note 1**, $I_{LOAD} = 100 \mu A$, $C_{OUT} = 1 \mu F$ (X7R), $C_{IN} = 1 \mu F$ (X7R), $T_A = +25^\circ C$.
Boldface type applies for junction temperatures, T_J of $-40^\circ C$ to $+125^\circ C$. (Note 7)

Parameters	Sym	Min	Typ	Max	Units	Conditions
Dropout Voltage (Note 1, Note 5)	$V_{DROPOUT}$	—	330	650	mV	$I_L = 250 \text{ mA}$, $V_R = 5.0V$
		—	525	725	mV	$I_L = 250 \text{ mA}$, $3.3V \leq V_R < 5.0V$
		—	625	975	mV	$I_L = 250 \text{ mA}$, $2.8V \leq V_R < 3.3V$
		—	750	1100	mV	$I_L = 250 \text{ mA}$, $2.5V \leq V_R < 2.8V$
		—	—	—	mV	$V_R < 2.5V$, See Maximum Output Current Parameter
Output Delay Time	T_{DELAY}	—	1000	—	μs	$V_{IN} = 0V$ to $6V$, $V_{OUT} = 90\% V_R$ $R_L = 50\Omega$ resistive
Output Noise	e_N	—	8	—	$\mu V/(Hz)^{1/2}$	$I_L = 50 \text{ mA}$, $f = 1 \text{ kHz}$, $C_{OUT} = 1 \mu F$
Power Supply Ripple Rejection Ratio	PSRR	—	44	—	dB	$f = 100 \text{ Hz}$, $C_{OUT} = 1 \mu F$, $I_L = 50 \text{ mA}$, $V_{INAC} = 100 \text{ mV pk-pk}$, $C_{IN} = 0 \mu F$, $V_R = 1.2V$
Thermal Shutdown Protection	T_{SD}	—	150	—	$^\circ C$	

- Note 1:** The minimum V_{IN} must meet two conditions: $V_{IN} \geq 2.7V$ and $V_{IN} \geq V_{OUT(MAX)} + V_{DROPOUT(MAX)}$.
- 2:** V_R is the nominal regulator output voltage. For example: $V_R = 1.2V, 1.5V, 1.8V, 2.5V, 2.8V, 3.0V, 3.3V, 4.0V$, or $5.0V$. The input voltage $V_{IN} = V_{OUT(MAX)} + V_{DROPOUT(MAX)}$ or $V_{IN} = 2.7V$ (whichever is greater); $I_{OUT} = 100 \mu A$.
- 3:** $TCV_{OUT} = (V_{OUT-HIGH} - V_{OUT-LOW}) * 10^6 / (V_R * \Delta \text{Temperature})$, $V_{OUT-HIGH}$ = 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 an applied input voltage of $V_{OUT(MAX)} + V_{DROPOUT(MAX)}$ or $2.7V$, whichever is greater.
- 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 $150^\circ C$ rating. Sustained junction temperatures above $150^\circ C$ 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.

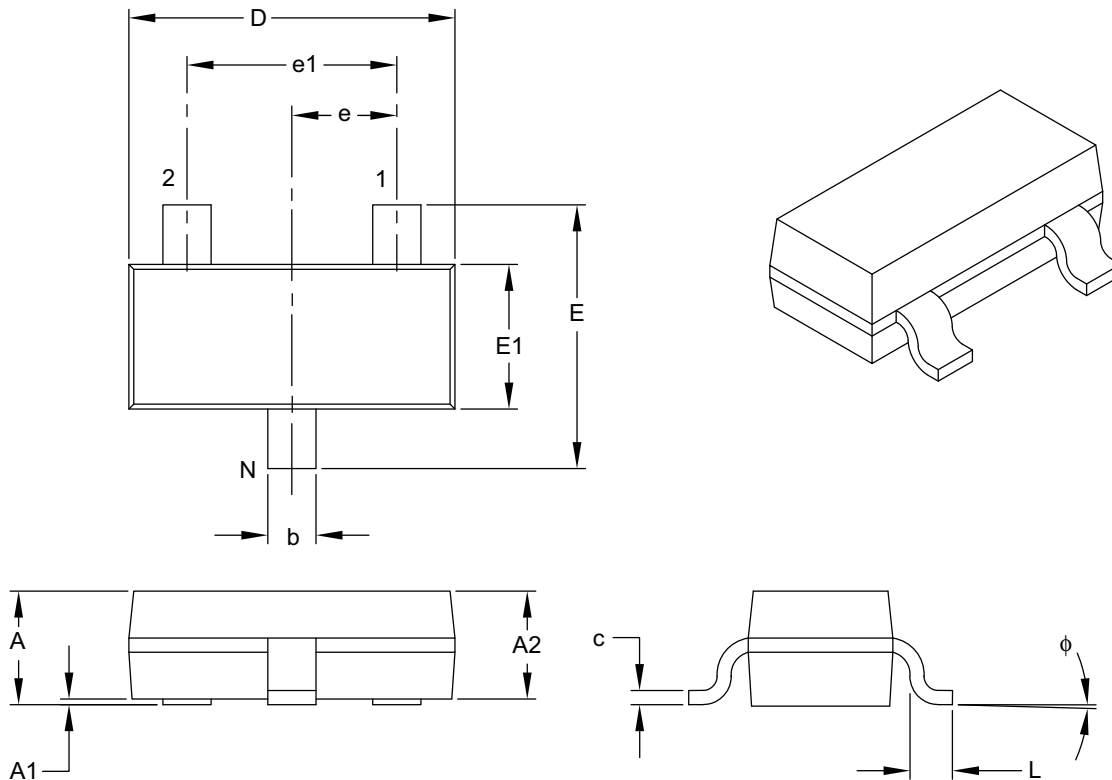
TEMPERATURE SPECIFICATIONS (NOTE 1)

Parameters	Sym	Min	Typ	Max	Units	Conditions
Temperature Ranges						
Operating Junction Temperature Range	T_J	-40		+125	°C	Steady State
Maximum Junction Temperature	T_J	—		+150	°C	Transient
Storage Temperature Range	T_A	-65		+150	°C	
Thermal Package Resistance (Note 2)						
Thermal Resistance, 3L-SOT-23A	θ_{JA}	—	336	—	°C/W	EIA/JEDEC JESD51-7 FR-4 0.063 4-Layer Board
	θ_{JC}	—	110	—	°C/W	
Thermal Resistance, 3L-SOT-89	θ_{JA}	—	153.3	—	°C/W	EIA/JEDEC JESD51-7 FR-4 0.063 4-Layer Board
	θ_{JC}	—	100	—	°C/W	
Thermal Resistance, 3L-TO-92	θ_{JA}	—	131.9	—	°C/W	
	θ_{JC}	—	66.3	—	°C/W	

- 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.
- 2:** Thermal Resistance values are subject to change. Please visit the Microchip Website for the latest packaging information.

MCP1702

3-Lead Plastic Small Outline Transistor (CB) [SOT-23A]



		Units	MILLIMETERS		
Dimension Limits			MIN	NOM	MAX
Number of Pins	N		3		
Lead Pitch	e		0.95 BSC		
Outside Lead Pitch	e1		1.90 BSC		
Overall Height	A		0.89	–	1.45
Molded Package Thickness	A2		0.90	–	1.30
Standoff	A1		0.00	–	0.15
Overall Width	E		2.10	–	3.00
Molded Package Width	E1		1.20	–	1.80
Overall Length	D		2.70	–	3.10
Foot Length	L		0.15	–	0.60
Foot Angle	ϕ		0°	–	30°
Lead Thickness	c		0.09	–	0.26
Lead Width	b		0.30	–	0.51

Notes:

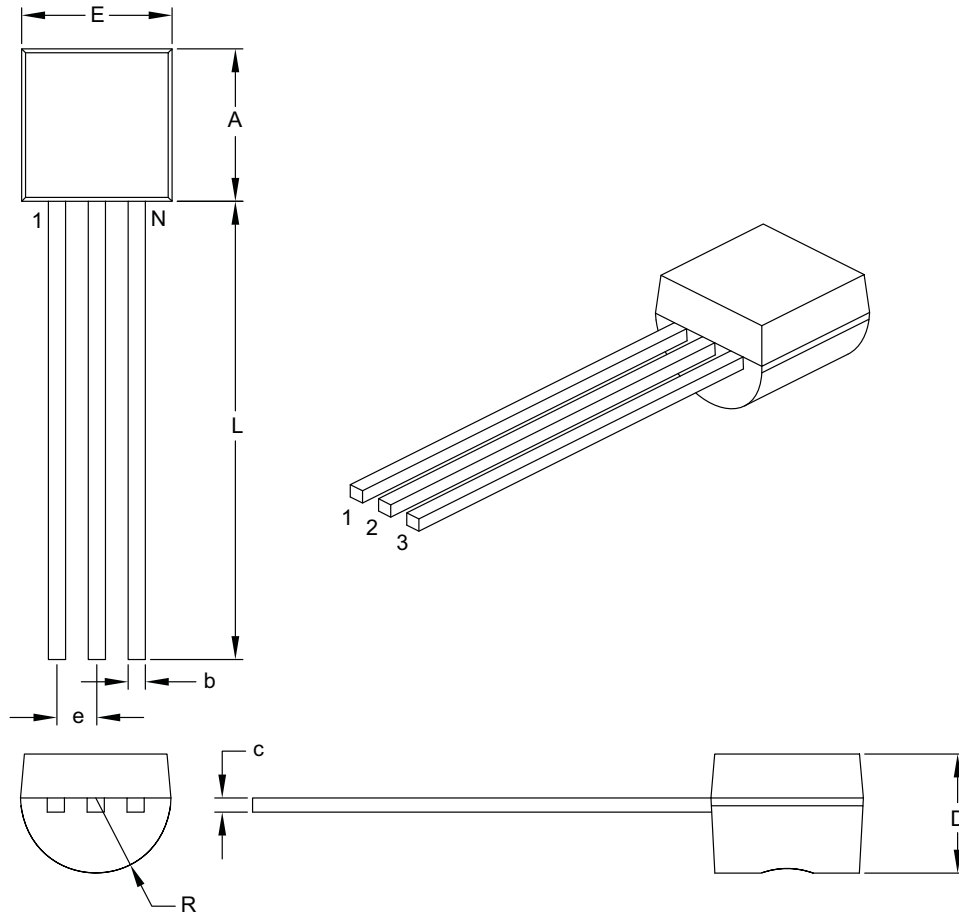
- Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.127 mm per side.
- Dimensioning and tolerancing per ASME Y14.5M.

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

Microchip Technology Drawing C04-130B

MCP1702

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



Dimension Limits	Units	INCHES	
		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:

- Dimensions A and E do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .005" per side.
- 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.

<u>PART NO.</u>	<u>X-</u>	<u>XX</u>	<u>X</u>	<u>X</u>	<u>X/</u>	<u>XX</u>	Examples:
Device	Tape and Reel	Output Voltage	Feature Code	Tolerance	Temp.	Package	
<p>Device: MCP1702: 2 μA Low Dropout Positive Voltage Regulator</p> <p>Tape and Reel: T = Tape and Reel</p> <p>Output Voltage *:</p> <ul style="list-style-type: none"> 12 = 1.2V "Standard" 15 = 1.5V "Standard" 18 = 1.8V "Standard" 25 = 2.5V "Standard" 28 = 2.8V "Standard" 30 = 3.0V "Standard" 33 = 3.3V "Standard" 40 = 4.0V "Standard" 50 = 5.0V "Standard" <p>*Contact factory for other output voltage options.</p> <p>Extra Feature Code: 0 = Fixed</p> <p>Tolerance:</p> <ul style="list-style-type: none"> 2 = 2.0% (Standard) 1 = 1.0% (Custom) <p>Temperature: E = -40°C to +125°C</p> <p>Package Type:</p> <ul style="list-style-type: none"> CB = 3-Pin SOT-23A (equivalent to EIAJ SC-59) MB = 3-Pin SOT-89 TO = 3-Pin TO-92 							
							<p>a) MCP1702T-1202E/CB: 1.2V LDO Positive Voltage Regulator, SOT-23A-3 pkg.</p> <p>b) MCP1702T-1802E/MB: 1.8V LDO Positive Voltage Regulator, SOT-89-3 pkg.</p> <p>c) MCP1702T-2502E/CB: 2.5V LDO Positive Voltage Regulator, SOT-23A-3 pkg.</p> <p>d) MCP1702T-3002E/CB: 3.0V LDO Positive Voltage Regulator, SOT-23A-3 pkg.</p> <p>e) MCP1702T-3002E/MB: 3.0V LDO Positive Voltage Regulator, SOT-89-3 pkg.</p> <p>f) MCP1702T-3302E/CB: 3.3V LDO Positive Voltage Regulator, SOT-23A-3 pkg.</p> <p>g) MCP1702T-3302E/MB: 3.3V LDO Positive Voltage Regulator, SOT-89-3 pkg.</p> <p>h) MCP1702T-4002E/CB: 4.0V LDO Positive Voltage Regulator, SOT-23A-3 pkg.</p> <p>i) MCP1702-5002E/TO: 5.0V LDO Positive Voltage Regulator, TO-92 pkg.</p> <p>j) MCP1702T-5002E/CB: 5.0V LDO Positive Voltage Regulator, SOT-23A-3 pkg.</p> <p>k) MCP1702T-5002E/MB: 5.0V LDO Positive Voltage Regulator, SOT-89-3 pkg.</p>