# MCP1703

## 250 mA, 16V, Low Quiescent Current LDO Regulator

## Features

- 2.0 µA Typical Quiescent Current
- Input Operating Voltage Range: 2.7V to16.0V
- 250 mA Output Current for Output Voltages ≥ 2.5V
- 200 mA Output Current for Output Voltages < 2.5V
- Low Drop Out Voltage, 625 mV typical @ 250 mA for $V_R$ = 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 µF to 22 µF ceramic output capacitance
- 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
- Solar-Powered Instruments
- Consumer Products
- Battery Powered Data Loggers

## Description

The MCP1703 is a family of CMOS low dropout (LDO) voltage regulators that can deliver up to 250 mA of current while consuming only 2.0 µA of quiescent current (typical). The input operating range is specified from 2.7V to 16.0V, 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.
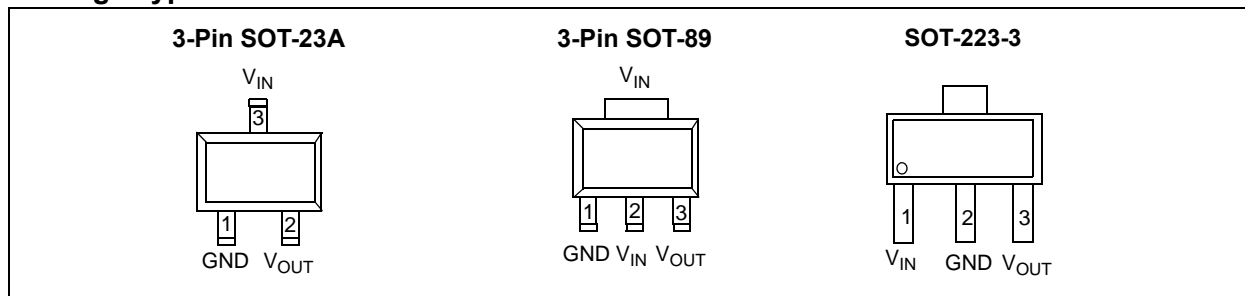
The MCP1703 is capable of delivering 250 mA with only 625 mV (typical) of input to output voltage differential ($V_{OUT}$ = 2.8V). The output voltage tolerance of the MCP1703 is typically ±0.4% at +25°C and ±3% maximum over the operating junction temperature range of -40°C to +125°C. Line regulation is ±0.1% typical at +25°C.

Output voltages available for the MCP1703 range from 1.2V to 5.5V. The LDO output is stable when using only 1 µF 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-223-3, SOT-23A, and SOT-89-3.

## 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

## Package Types



**3-Pin SOT-23A** — $V_{IN}$ (3), GND (1), $V_{OUT}$ (2)

**3-Pin SOT-89** — $V_{IN}$, GND (1), $V_{IN}$ (2), $V_{OUT}$ (3)

**SOT-223-3** — $V_{IN}$ (1), GND (2), $V_{OUT}$ (3)

## 1.0 ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings †

$V_{DD}$.................................................................................+18V

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

Operating Junction Temperature....................-40°C to +125°C

ESD protection on all pins (HBM;MM)..............$\geq$ 4 kV; $\geq$ 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, $T_J$ **(Note 7)** of -40°C to +125°C.

| Parameters | Symbol | Min | Typ | Max | Units | Conditions |
|---|---|---|---|---|---|---|
| **Input / Output Characteristics** | | | | | | |
| Input Operating Voltage | $V_{IN}$ | **2.7** | — | **16.0** | 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 $V_R \geq$ 2.5V |
| | | **50** | 100 | — | mA | For $V_R <$ 2.5V, $V_{IN} \geq$ 2.7V |
| | | **100** | 130 | — | mA | For $V_R <$ 2.5V, $V_{IN} \geq$ 2.95V |
| | | **150** | 200 | — | mA | For $V_R <$ 2.5V, $V_{IN} \geq$ 3.2V |
| | | **200** | 250 | — | mA | For $V_R <$ 2.5V, $V_{IN} \geq$ 3.45V |
| 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%** $V_R$-2.0% | $V_R$±0.4 % | **$V_R$+3.0%** $V_R$+2.0% | V | **Note 2** |
| $V_{OUT}$ Temperature Coefficient | $TCV_{OUT}$ | — | 50 | **150** | ppm/°C | **Note 3** |
| Line Regulation | $\Delta V_{OUT}$/ ($V_{OUT}$X$\Delta V_{IN}$) | **-0.3** | ±0.1 | **+0.3** | %/V | $(V_{OUT(MAX)} + V_{DROPOUT(MAX)}) \leq V_{IN} \leq$ 16V, **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 $V_{IN}$ = 3.65V, **Note 4** |

**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 $Vi_{IN}$ = 2.7V (whichever is greater); $I_{OUT}$ = 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 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., $T_A$, $T_J$, $\theta_{JA}$). 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.

# MCP1703

## 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), $T_A = +25°C$.
**Boldface** type applies for junction temperatures, $T_J$ **(Note 7)** of -40°C to +125°C.

| Parameters | Symbol | Min | Typ | Max | Units | Conditions |
|---|---|---|---|---|---|---|
| Dropout Voltage **Note 1**, **Note 5** | $V_{DROPOUT}$ | — | 330 | **650** | mV | $I_L = 250$ mA, $V_R = 5.0V$ |
| | | — | 525 | **725** | mV | $I_L = 250$ mA, $3.3V \leq V_R < 5.0V$ |
| | | — | 625 | **975** | mV | $I_L = 250$ mA, $2.8V \leq V_R < 3.3V$ |
| | | — | 750 | **1100** | mV | $I_L = 250$ 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 | | $\mu V/(Hz)^{1/2}$ | $I_L = 50$ mA, f = 1 kHz, $C_{OUT} = 1\ \mu F$ |
| Power Supply Ripple Rejection Ratio | PSRR | — | 44 | — | dB | f = 100 Hz, $C_{OUT} = 1\ \mu F$, $I_L = 100\ \mu A$, $V_{INAC} = 100$ mV pk-pk, $C_{IN} = 0\ \mu F$, $V_R = 1.2V$ |
| Thermal Shutdown Protection | $T_{SD}$ | — | 150 | — | °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 $Vi_{IN} = 2.7V$ (whichever is greater); $I_{OUT} = 100\ \mu A$.

**3:** $TCV_{OUT} = (V_{OUT-HIGH} - V_{OUT-LOW}) * 10^6 / (V_R * \Delta Temperature)$, $V_{OUT-HIGH}$ = 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., $T_A$, $T_J$, $\theta_{JA}$). 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

| 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, 3LD SOT-223 | $\theta_{JA}$ $\theta_{JC}$ | — — | 62 15 | — — | °C/W | EIA/JEDEC JESD51-7 FR-4 0.063 4-Layer Board |
| Thermal Resistance, 3LD SOT-23A | $\theta_{JA}$ $\theta_{JC}$ | — — | 336 110 | — — | °C/W | EIA/JEDEC JESD51-7 FR-4 0.063 4-Layer Board |
| Thermal Resistance, 3LD SOT-89 | $\theta_{JA}$ $\theta_{JC}$ | — — | 75 10 | — — | °C/W | 0.300 sq in copper on both sides of 2 sided board, with vias |

**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., $T_A$, $T_J$, $\theta_{JA}$). 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.

# MCP1703

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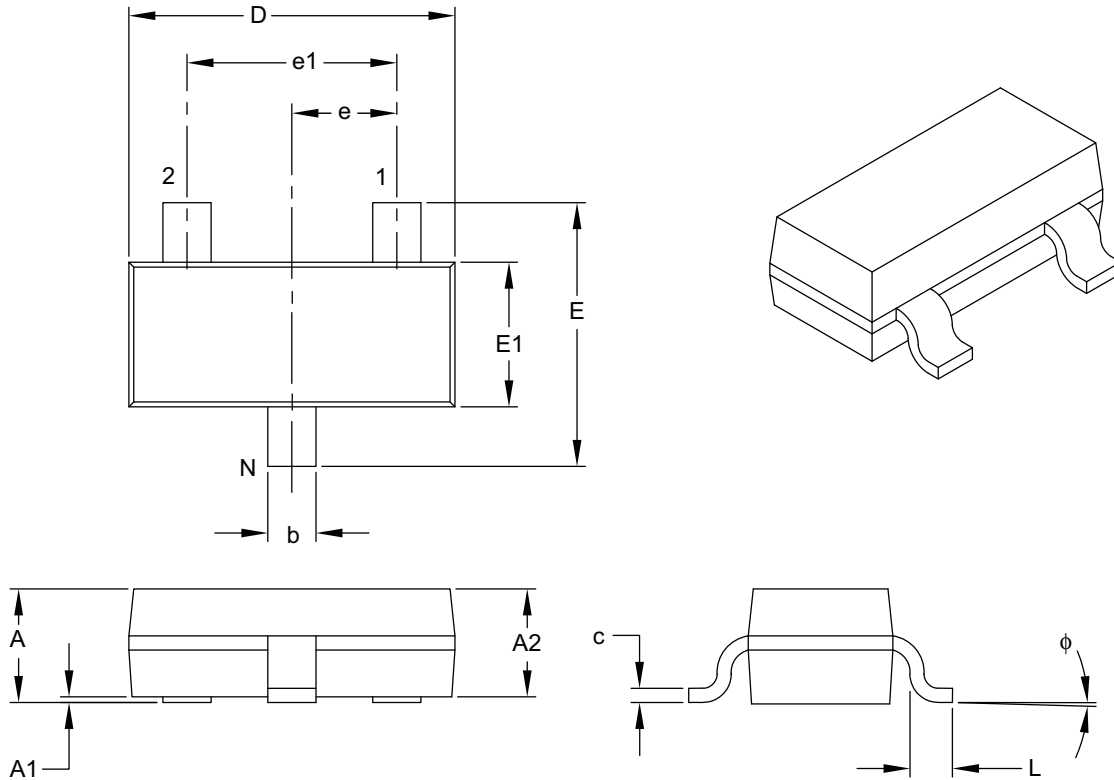


| | Units | | MILLIMETERS | |
|---|---|---|---|---|
| Dimension Limits | | MIN | NOM | MAX |
| Number of Pins | N | | 3 | |
| Lead Pitch | e | | 0.95 BSC | |
| Outside Lead Pitch | e1 | | 1.90 BSC | |
| Overall Height | A | 0.89 | – | 1.45 |
| Molded Package Thickness | A2 | 0.90 | – | 1.30 |
| Standoff | 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:**

1. Dimensions D and E1 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.

Microchip Technology Drawing C04-130B

## 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- | XX | X | X | X/ | XX |
|----------|-----|--------|---------|-----------|-------|---------|
| Device | Tape and Reel | Output Voltage | Feature Code | Tolerance | Temp. | Package |

Device: MCP1703: 250 mA, 16V Low Quiescent Current LDO

Tape and Reel: T = Tape and Reel

Output Voltage *:
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"
*Contact factory for other output voltage options.

Extra Feature Code: 0 = Fixed

Tolerance: 2 = 2.0% (Standard)

Temperature: E = -40°C to +125°C

Package Type:
CB = Plastic Small Outline Transistor (SOT-23A) 3-lead,
DB = Plastic Small Outline Transistor (SOT-223) 3-lead,
MB = Plastic Small Outline Transistor (SOT-89) 3-lead,

**Examples:**

a) MCP1703T-1202E/XX: Tape and Reel, 1.2V

b) MCP1703T-1502E/XX: Tape and Reel, 1.5V

c) MCP1703T-1802E/XX: Tape and Reel, 1.8V

d) MCP1703T-2502E/XX: Tape and Reel, 2.5V

e) MCP1703T-2802E/XX: Tape and Reel, 2.8V

f) MCP1703T-3002E/XX: Tape and Reel, 3.0V

g) MCP1703T-3302E/XX: Tape and Reel, 3.3V

h) MCP1703T-3602E/XX: Tape and Reel, 3.6V

i) MCP1703T-4002E/XX: Tape and Reel, 4.0V

j) MCP1703T-5002E/XX: Tape and Reel, 5.0V

XX = CB for 3LD SOT-23A package
= DB for 3LD SOT-223 package
= MB for 3LD SOT-89 package