# MCP1702

## 250 mA Low Quiescent Current LDO Regulator

### Features

- 2.0 µA Quiescent Current (typical)
- Input Operating Voltage Range: 2.7V to 13.2V
- 250 mA Output Current for Output Voltages ≥ 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 µF to 22 µF 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
- 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 µA 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.

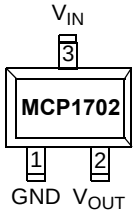
The MCP1702 is capable of delivering 250 mA with only 625 mV (typical) of input to output voltage differential ($V_{OUT}$ = 2.8V). The output voltage tolerance of the MCP1702 is typically ±0.4% at +25°C and ±3% maximum over the operating junction temperature range of -40°C to +125°C. Line regulation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

Output voltages available for the MCP1702 range from 1.2V to 5.0V. 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.

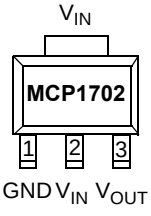
Package options include the SOT-23A, SOT-89-3, and TO-92.

### Package Types

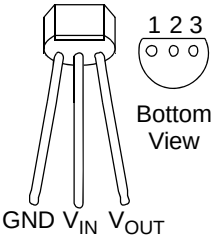
**3-Pin SOT-23A**




**3-Pin SOT-89**




**3-Pin TO-92**



# 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 $V_R \geq 2.5V$ |
| | | **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%** | $V_R$±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 | $\Delta V_{OUT}$/($V_{OUT}$X$\Delta V_{IN}$) | **-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 $V_R \geq 2.5V$<br>$I_L$ = 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: $V_{IN} \geq 2.7V$ 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 µA.

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

## 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 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 |
|---|---|---|---|---|---|---|
| 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 ≤ $V_R$ < 5.0V |
| | | — | 625 | **975** | mV | $I_L$ = 250 mA, 2.8V ≤ $V_R$ < 3.3V |
| | | — | 750 | **1100** | mV | $I_L$ = 250 mA, 2.5V ≤ $V_R$ < 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% $V_R$ $R_L$ = 50Ω resistive |
| Output Noise | $e_N$ | — | 8 | | µV/(Hz)$^{1/2}$ | $I_L$ = 50 mA, f = 1 kHz, $C_{OUT}$ = 1 µF |
| Power Supply Ripple Rejection Ratio | PSRR | — | 44 | — | dB | f = 100 Hz, $C_{OUT}$ = 1 µF, $I_L$ = 50 mA, $V_{INAC}$ = 100 mV pk-pk, $C_{IN}$ = 0 µF, $V_R$ = 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 $V_{IN}$ = 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.

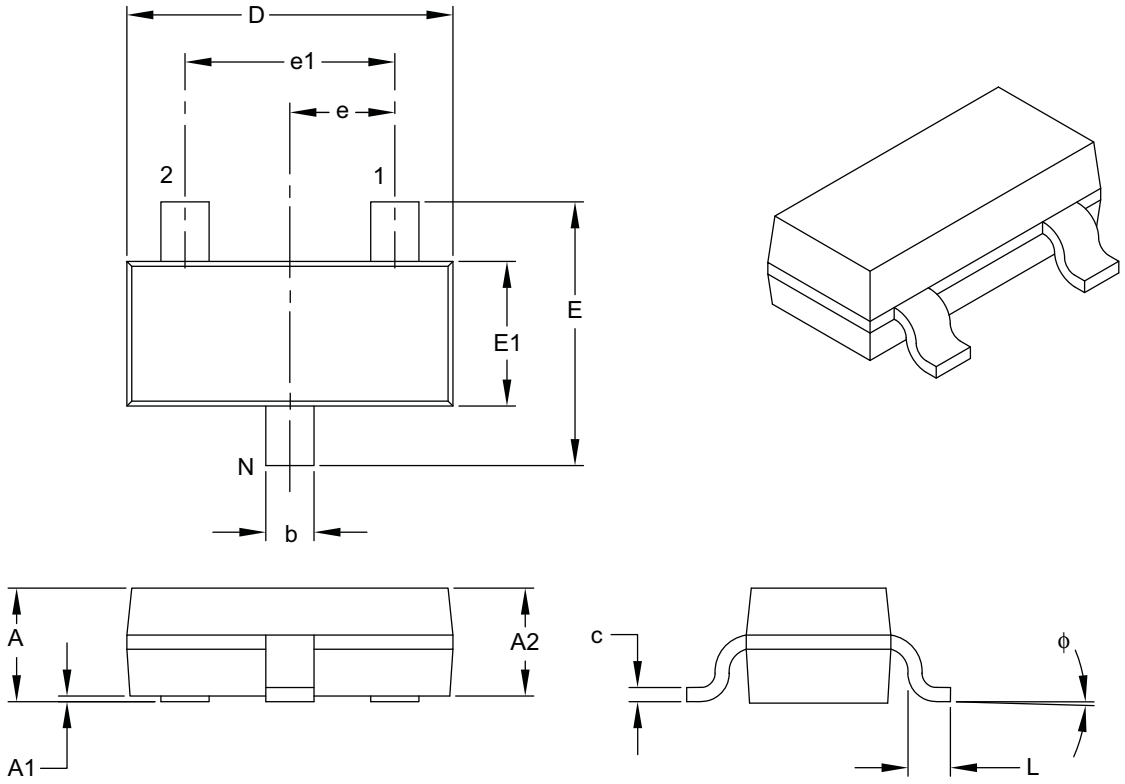
## TEMPERATURE SPECIFICATIONS (NOTE 1)

| 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 | $\theta_{JA}$ | — | 336 | — | °C/W | EIA/JEDEC JESD51-7<br>FR-4 0.063 4-Layer Board |
| | $\theta_{JC}$ | — | 110 | — | °C/W | |
| Thermal Resistance, 3L-SOT-89 | $\theta_{JA}$ | — | 153.3 | — | °C/W | EIA/JEDEC JESD51-7<br>FR-4 0.063 4-Layer Board |
| | $\theta_{JC}$ | — | 100 | — | °C/W | |
| Thermal Resistance, 3L-TO-92 | $\theta_{JA}$ | — | 131.9 | — | °C/W | |
| | $\theta_{JC}$ | — | 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., $T_A$, $T_J$, $\theta_{JA}$). 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.

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

### 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 |

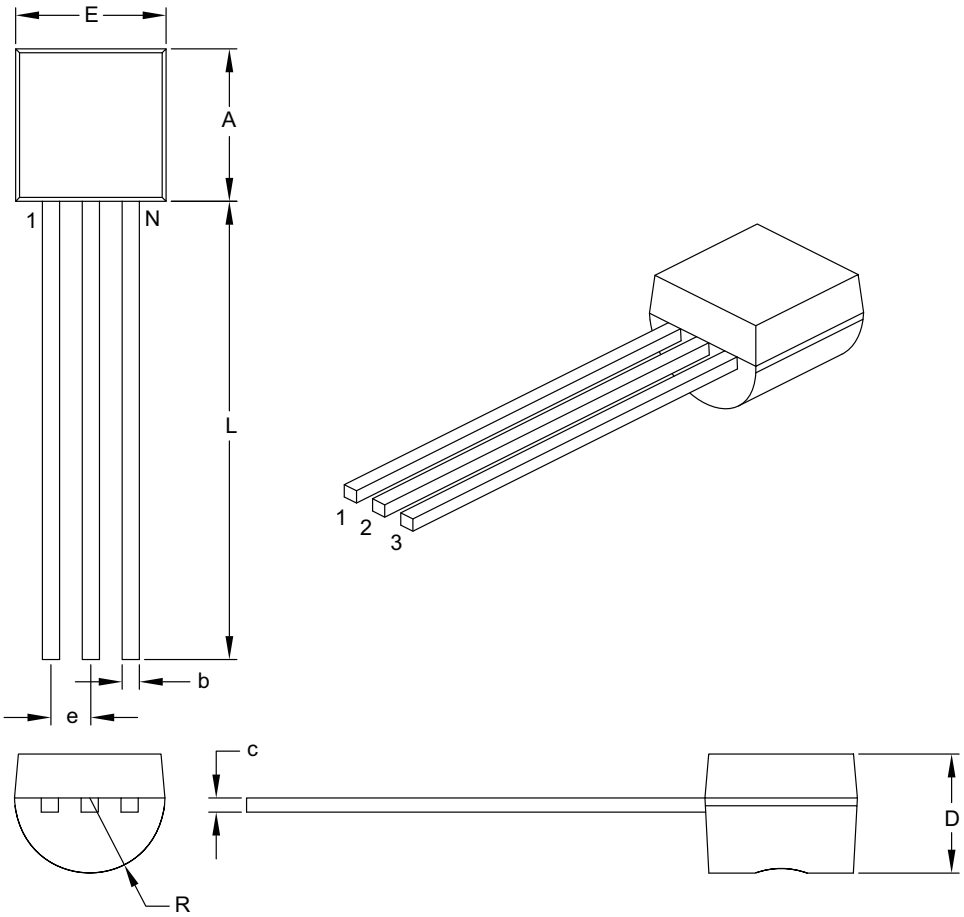
**Notes:**

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

### 3-Lead Plastic Transistor Outline (TO) [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- | XX | X | X | X/ | XX |
|---|---|---|---|---|---|---|
| Device | Tape and Reel | Output Voltage | Feature Code | Tolerance | Temp. | Package |

| | | |
|---|---|---|
| Device: | MCP1702: 2 µA Low Dropout Positive Voltage Regulator | |
| Tape and Reel: | T | = Tape and Reel |
| Output Voltage *: | 12<br>15<br>18<br>25<br>28<br>30<br>33<br>40<br>50 | = 1.2V “Standard”<br>= 1.5V “Standard”<br>= 1.8V “Standard”<br>= 2.5V “Standard”<br>= 2.8V “Standard”<br>= 3.0V “Standard”<br>= 3.3V “Standard”<br>= 4.0V “Standard”<br>= 5.0V “Standard”<br>*Contact factory for other output voltage options. |
| Extra Feature Code: | 0 | = Fixed |
| Tolerance: | 2<br>1 | = 2.0% (Standard)<br>= 1.0% (Custom) |
| Temperature: | E | = -40°C to +125°C |
| Package Type: | CB<br>MB<br>TO | = 3-Pin SOT-23A (equivalent to EIAJ SC-59)<br>= 3-Pin SOT-89<br>= 3-Pin TO-92 |

**Examples:**

a) MCP1702T-1202E/CB: 1.2V LDO Positive Voltage Regulator, SOT-23A-3 pkg.

b) MCP1702T-1802E/MB: 1.8V LDO Positive Voltage Regulator, SOT-89-3 pkg.

c) MCP1702T-2502E/CB: 2.5V LDO Positive Voltage Regulator, SOT-23A-3 pkg.

d) MCP1702T-3002E/CB: 3.0V LDO Positive Voltage Regulator, SOT-23A-3 pkg.

e) MCP1702T-3002E/MB: 3.0V LDO Positive Voltage Regulator, SOT-89-3 pkg.

f) MCP1702T-3302E/CB: 3.3V LDO Positive Voltage Regulator, SOT-23A-3 pkg.

g) MCP1702T-3302E/MB: 3.3V LDO Positive Voltage Regulator, SOT-89-3 pkg.

h) MCP1702T-4002E/CB: 4.0V LDO Positive Voltage Regulator, SOT-23A-3 pkg.

i) MCP1702-5002E/TO: 5.0V LDO Positive Voltage Regulator, TO-92 pkg.

j) MCP1702T-5002E/CB: 5.0V LDO Positive Voltage Regulator, SOT-23A-3 pkg.

k) MCP1702T-5002E/MB: 5.0V LDO Positive Voltage Regulator, SOT-89-3 pkg.