# Micropower 1.0A Low Voltage CMOS Regulators

## Features

- Regulated output options: 1.5, 1.8, 2.5 and 3.3 volts
- 1.0A output current
- Operates from 3.3V supply (5.0V for CM3002-33)
- Very low dropout voltage on CM3002-33 products (300mV@600mA)
- Enable Output Control for power-up sequencing
- Low quiescent operating current (< 600µA typical)
- Current limit protection
- Thermal overload protection
- Reverse voltage protection
- Thermally-enhanced SOIC-8 and MSOP-8 (CM3002-33MA only) packages

## Applications

- Low Voltage "Core" Processors
- Peripheral Adapter Cards
- Portable/Battery-Powered Devices

## Table 1: CM3002 Regulator Family

| PRODUCT | INPUT VOLTAGE | OUTPUT VOLTAGE |
|---|---|---|
| CM3002-15SA | 3.3V | 1.5V |
| CM3002-18SA | 3.3V | 1.8V |
| CM3002-25SA | 3.3V | 2.5V |
| CM3002-33SA | 5.0V or 3.3V | 3.3V |
| CM3002-33MA | 5.0V or 3.3V | 3.3V |

## Product Description

The CM3002 family of regulators are very low dropout regulators that deliver up to 1.0A of load current at a fixed voltage output. Input and output voltage options for the CM3002 family devices are presented in Table 1.

Operating from a single input supply, these devices are ideally suited for powering low voltage "core" processors, especially where a 3.3V source is already available.

These regulators feature a dedicated control input (EN, Active High) for power-up sequencing flexibility. When this input is taken low, the regulator output is disabled. In this state, the supply current will drop to a low level to ensure all the internal control circuitry still remains active. This provides excellent start-up response whenever the device comes out of shutdown.

The CM3002 family of regulators is fully protected, offering both overload current limiting and high temperature thermal shutdown. Housed in space saving thermally-enhanced SOIC-8 and MSOP-8 (CM3002-33MA only) packages, these devices ensure maximum junction-to-ambient power dissipation.

## Typical Application Circuit
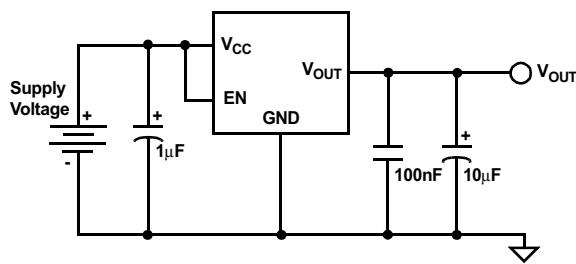


## Simplified Electrical Schematic
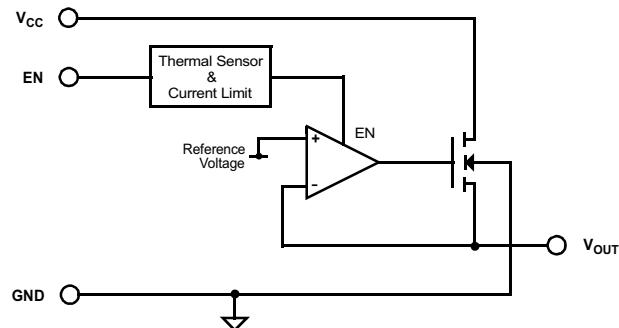
## PACKAGE / PINOUT DIAGRAMS

Top View

| EN | 1 | 8 | GND |
| $V_{CC}$ | 2 | 7 | GND |
| $V_{OUT}$ | 3 | 6 | GND |
| N.C. | 4 | 5 | GND |

8-pin SOIC

Top View

| EN | 1 | 8 | GND |
| $V_{CC}$ | 2 | 7 | GND |
| $V_{OUT}$ | 3 | 6 | GND |
| N.C. | 4 | 5 | GND |

8-pin MSOP
(CM3002-33MA only)
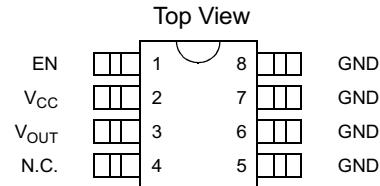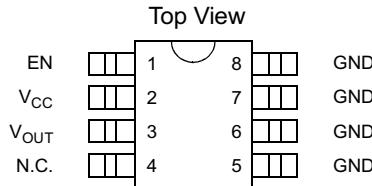
Note: These drawings are not to scale.

## PIN DESCRIPTIONS

| PIN(S) | NAME | DESCRIPTION |
|--------|------|-------------|
| 1 | EN | A logic input control to enable the regulator output. When EN is asserted (logic high), it allows output regulation to commence. When EN is deasserted (logic low), the regulator pass transistor (N-channel MOSFET) is forced into a high impedance mode. <br> All other internal circuitry is unaffected by the state of the EN input and will always remain powered whenever $V_{CC}$ is present. <br> An internal pull-up current (2µA) from $V_{CC}$ must be overdriven in order to apply a Logic Low to the EN control input. <br> The EN control input is intended to be used for power-up sequencing. |
| 2 | $V_{CC}$ | The input power supply for the regulator. If this input is within a few inches of the main supply filter, a capacitor may not be necessary. Otherwise an input filter capacitor of approximately 1uF to 10uF will ensure adequate filtering. |
| 3 | $V_{OUT}$ | The regulator voltage output used to power the load. A nominal output capacitor of 10uF is sufficient to minimize any transient disturbances under normal operating conditions. Additional output capacitance can be used to further improve transient load response. |
| 4 | N.C. | These pins have no connection to the internal device. To provide additional thermal performance, these pins can be connected directly to the PC board GND plane. |
| 5,6,7,8 | GND | The negative reference for all voltages. |

## Ordering Information

## PART NUMBERING INFORMATION

| Regulator | Pins | Package | Ordering Part Number[1] | Part Marking |
|-----------|------|---------|------------------------|--------------|
| CM3002-15SA | 8 | Power SOIC | CM3002-15SA | CM3002-15SA |
| CM3002-18SA | 8 | Power SOIC | CM3002-18SA | CM3002-18SA |
| CM3002-25SA | 8 | Power SOIC | CM3002-25SA | CM3002-25SA |
| CM3002-33SA | 8 | Power SOIC | CM3002-33SA | CM3002-33SA |
| CM3002-33MA | 8 | Power MSOP | CM3002-33MA | 233 |

Note 1:  Parts are shipped in Tape & Reel form unless otherwise specified.

## Specifications

| ABSOLUTE MAXIMUM RATINGS | | |
|---|---|---|
| PARAMETER | RATING | UNITS |
| ESD Protection (HBM) | $\pm$2000 | V |
| Pin Voltages<br>$V_{CC}$<br>EN<br>$V_{OUT}$ | <br>[GND - 0.4] to [+6.0]<br>[GND - 0.4] to [+6.0]<br>[GND - 0.4] to [+6.0] | <br>V<br>V<br>V |
| Storage Temperature Range | -40 to +150 | °C |
| Operating Temperature Range<br>Ambient<br>Junction | <br>0 to +70<br>0 to +150 | <br>°C<br>°C |
| Power Dissipation (Note 1) | Internally Limited | W |

Note 1:  The SOIC and MSOP packages are thermally enhanced through the use of a fused integral leadframe. The power rating is based on a printed circuit board heat spreading capability equivalent to 2 square inches of copper connected to the GND pins. Typical multi-layer boards using power plane construction will provide this heat spreading ability without the need for additional dedicated copper area. Please consult with factory for thermal evaluation assistance.

| STANDARD OPERATING CONDITIONS | | |
|---|---|---|
| PARAMETER | RATING | UNITS |
| $V_{CC}$ (CM3002-15SA, CM3002-18SA, CM3002-25SA) | 3.0 to 3.6 | V |
| $V_{CC}$ (CM3002-33SA, CM3002-33MA) | 3.0 to 5.5 | V |
| Ambient Operating Temperature Range | 0 to +70 | °C |
| Load Current | 0 to +1000 | mA |
| $C_{EXT}$ | 10 $\pm$20% | µF |

## Specifications (cont'd)

| ELECTRICAL OPERATING CHARACTERISTICS | | | | | | |
|---|---|---|---|---|---|---|
| SYMBOL | PARAMETER | CONDITIONS | MIN | TYP | MAX | UNITS |
| $V_{OUT}$ | Regulator Output Voltage | | | | | |
| | CM3002-15SA | $0mA < I_{LOAD} < 1000mA$ | 1.42 | 1.50 | 1.58 | V |
| | CM3002-18SA | $0mA < I_{LOAD} < 1000mA$ | 1.72 | 1.80 | 1.88 | V |
| | CM3002-25SA | $0mA < I_{LOAD} < 1000mA$ | 2.40 | 2.50 | 2.60 | V |
| | CM3002-33SA/-33MA | $0mA < I_{LOAD} < 1000mA$; $V_{CC}$=5.0 | 3.10 | 3.30 | 3.50 | V |
| $I_{LIM}$ | Overload Current Limit | | | 1500 | | mA |
| $V_{R\ LOAD}$ | Load Regulation | | | | | |
| | CM3002-15SA, CM3002-18SA & CM3002-25SA | $10mA < I_{LOAD} < 1000mA$; $V_{CC}$=3.3V | | 20 | | mV |
| | CM3002-33SA/-33MA | $10mA < I_{LOAD} < 1000mA$; $V_{CC}$=5.0V | | 20 | | mV |
| $V_{R\ LINE}$ | Line Regulation | | | | | |
| | CM3002-15SA | $I_{LOAD}$ = 5mA; $3.0V \leq V_{CC} \leq$ to 5.5V | | 20 | | mV |
| | CM3002-18SA | $I_{LOAD}$ = 5mA; $3.0V \leq V_{CC} \leq$ to 5.5V | | 20 | | mV |
| | CM3002-25SA | $I_{LOAD}$ = 5mA; $3.0V \leq V_{CC} \leq$ to 5.5V | | 30 | | mV |
| | CM3002-33SA-33MA | $I_{LOAD}$ = 5mA; $4.5V \leq V_{CC} \leq$ to 5.5V | | 20 | | mV |
| $I_Q$ | Quiescent Current | | | | | |
| | CM3002-15SA | EN tied to $V_{CC}$; $I_{LOAD}$= 0mA | | 500 | 900 | µA |
| | CM3002-18SA | EN tied to $V_{CC}$; $I_{LOAD}$= 0mA | | 500 | 900 | µA |
| | CM3002-25SA | EN tied to $V_{CC}$; $I_{LOAD}$= 0mA | | 500 | 900 | µA |
| | CM3002-33SA/-33MA | EN tied to $V_{CC}$; $I_{LOAD}$= 0mA | | 600 | 900 | µA |
| $I_Q$ | Quiescent Current | | | | | |
| | CM3002-15SA | EN tied to GND; $I_{LOAD}$= 0mA | | 150 | 300 | µA |
| | CM3002-18SA | EN tied to GND; $I_{LOAD}$= 0mA | | 150 | 300 | µA |
| | CM3002-25SA | EN tied to GND; $I_{LOAD}$= 0mA | | 150 | 300 | µA |
| | CM3002-33SA/-33MA | EN tied to GND; $I_{LOAD}$= 0mA | | 200 | 300 | µA |
| $I_{GND}$ | Ground Current | | | | | |
| | CM3002-15SA | $I_{LOAD}$ = 0mA | | 500 | 900 | µA |
| | CM3002-18SA | $I_{LOAD}$ = 0mA | | 500 | 900 | µA |
| | CM3002-25SA | $I_{LOAD}$ = 0mA | | 500 | 900 | µA |
| | CM3002-33SA/-33MA | $I_{LOAD}$ = 0mA | | 600 | 900 | µA |
| $I_{GND}$ | Ground Current | | | | | |
| | CM3002-15SA | $I_{LOAD}$ = 1000mA | | 500 | 900 | µA |
| | CM3002-18SA | $I_{LOAD}$ = 1000mA | | 500 | 900 | µA |
| | CM3002-25SA | $I_{LOAD}$ = 1000mA | | 500 | 900 | µA |
| | CM3002-33SA/-33MA | $I_{LOAD}$ = 1000mA | | 600 | 900 | µA |
| $I_{RCC}$ | $V_{CC}$ Pin Reverse Leakage | $V_{OUT}$ = 3.3V; $V_{CC}$ = 0V | | 1 | 100 | µA |
| $V_{IH}$ | Enable Input Logic High Threshold | | 1.5 | | | V |
| $V_{IL}$ | Enable Input Logic Low Threshold | | | | 0.3 | V |
| $I_{EN}$ | Enable Input Current | Internal current source from $V_{CC}$ | | 2 | 10 | µA |
| $T_{DISABLE}$ | Shutdown Temperature | | | 160 | | °C |
| $T_{HYST}$ | Thermal Hysteresis | | | 25 | | °C |

## Performance Information

**CM3002-15SA Typical DC Characteristics (nominal conditions unless specified otherwise)**

**Supply Current vs. Voltage (EN=V$_{CC}$)**

**Supply Current vs. Voltage (EN=GND)**

**Line Regulation with 1A Load**

**Ground Current vs. Output Load**

**Load Regulation**

**Current Limiting Protection**
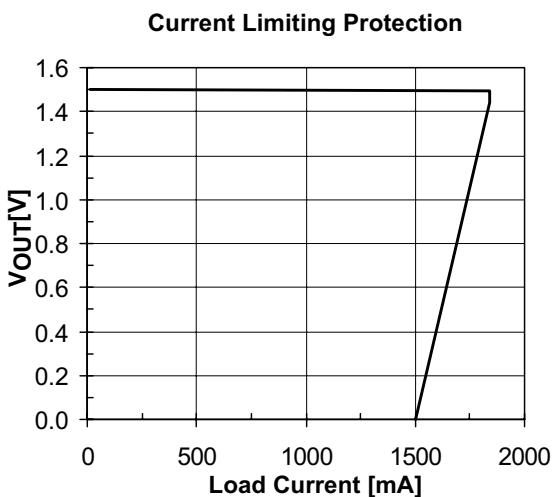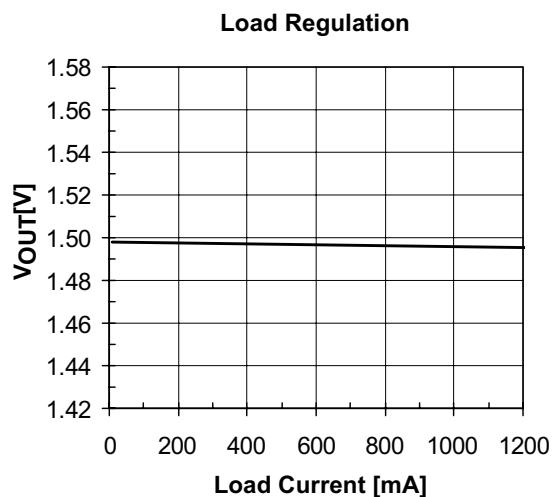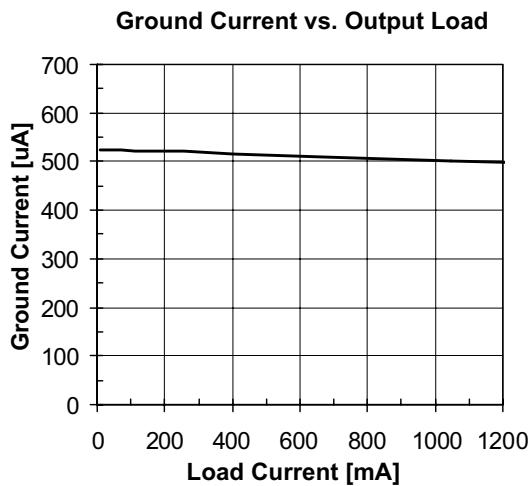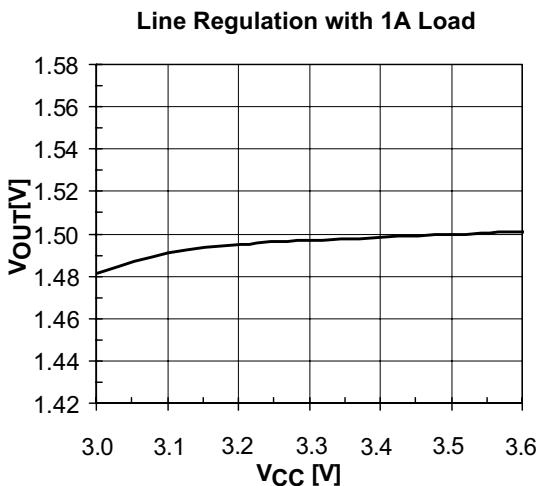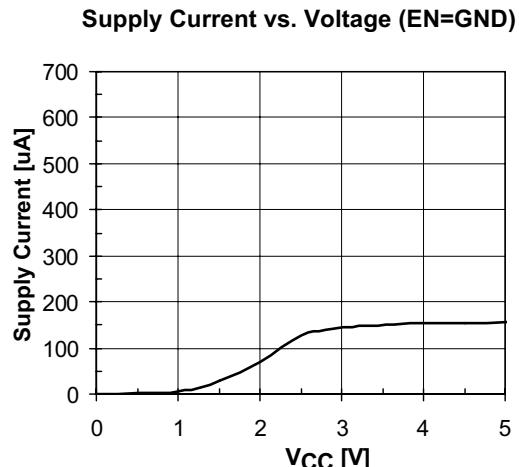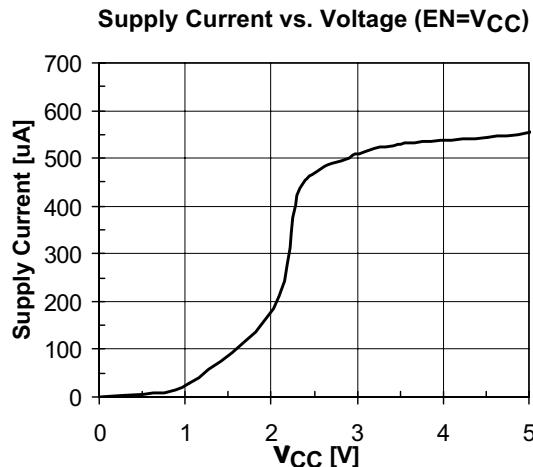
## Performance Information (cont'd)

**CM3002-18SA Typical DC Characteristics (nominal conditions unless specified otherwise)**
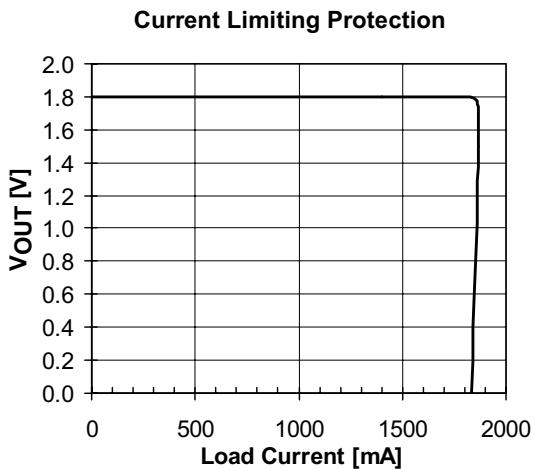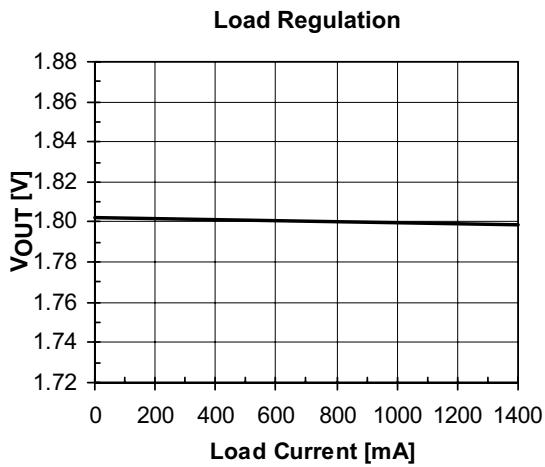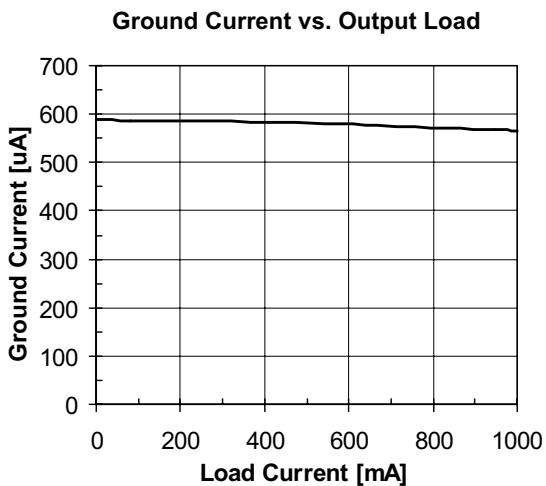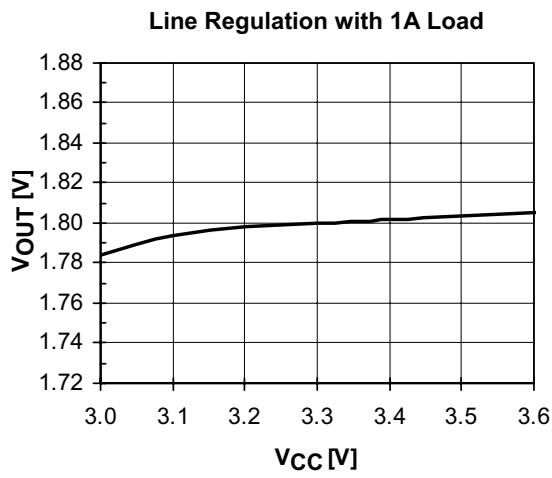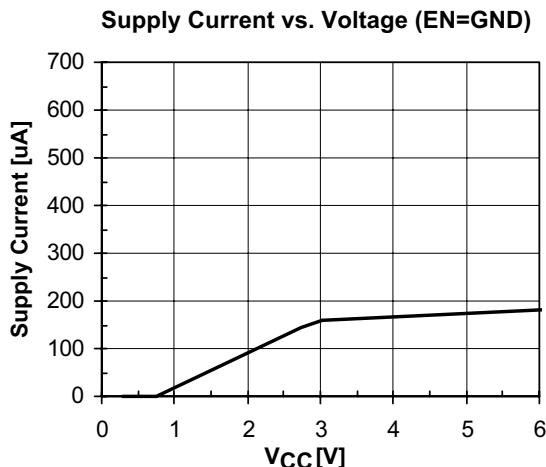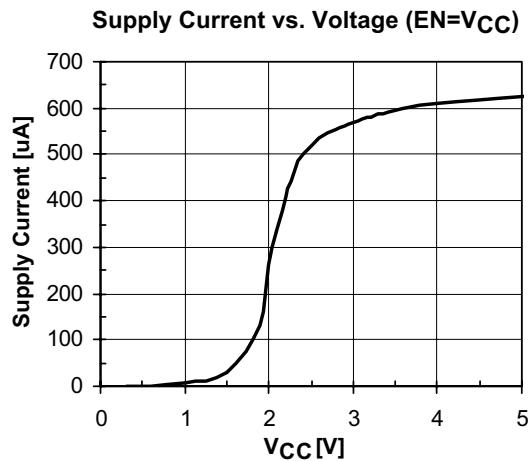
**Supply Current vs. Voltage (EN=V$_{CC}$)**

**Supply Current vs. Voltage (EN=GND)**

**Line Regulation with 1A Load**

**Ground Current vs. Output Load**

**Load Regulation**

**Current Limiting Protection**

# Performance Information (cont'd)

**CM3002-25SA Typical DC Characteristics (nominal conditions unless specified otherwise)**

**Supply Current vs. Voltage (EN=V$_{CC}$)**

**Supply Current vs. Voltage (EN=GND)**

**Line Regulation (rated 1.0 Amp Load)**

**Ground Current vs. Output Load**

**Load Regulation**

**Current Limiting Protection**
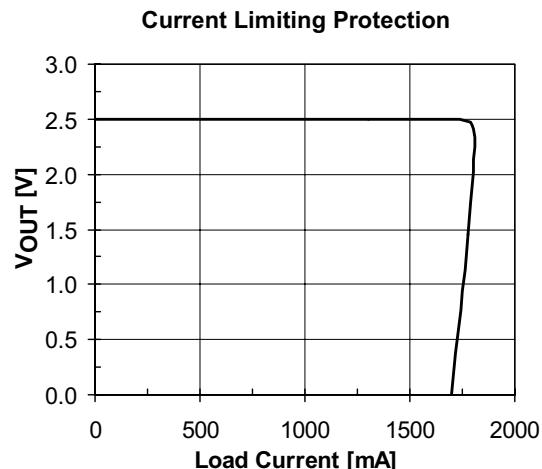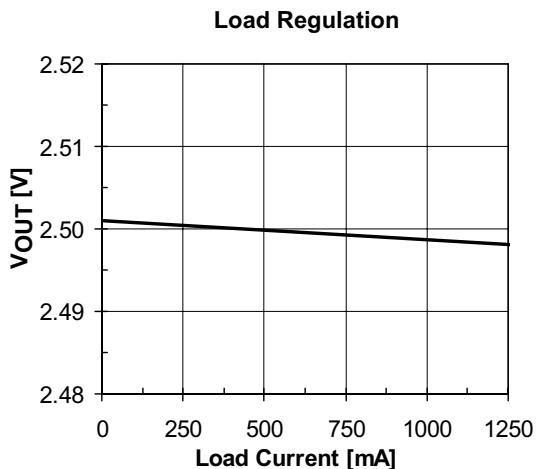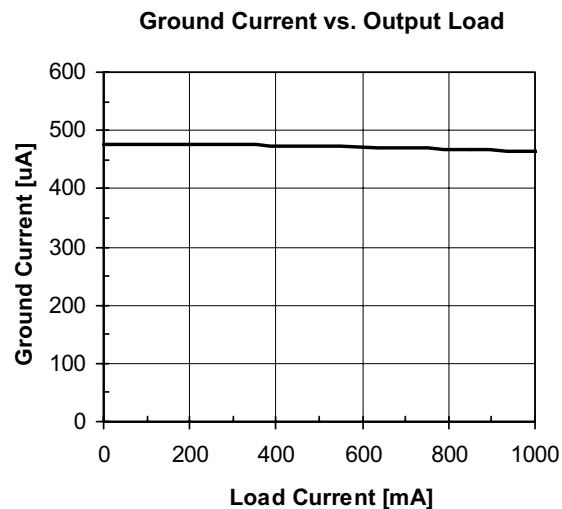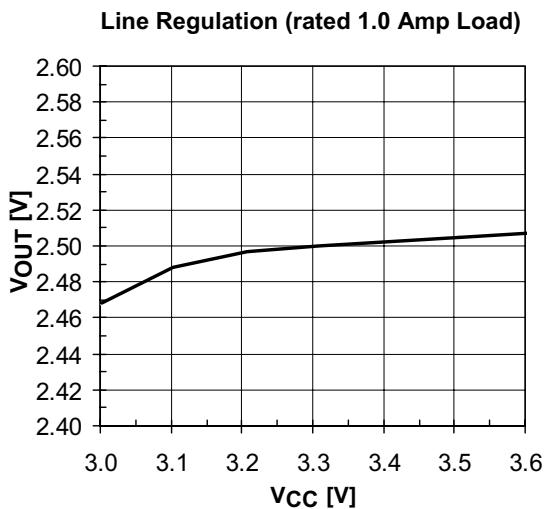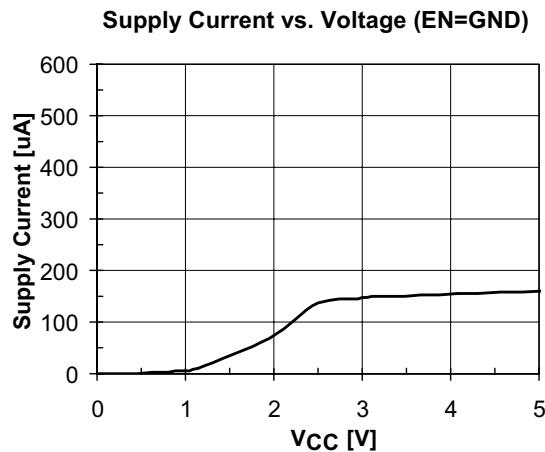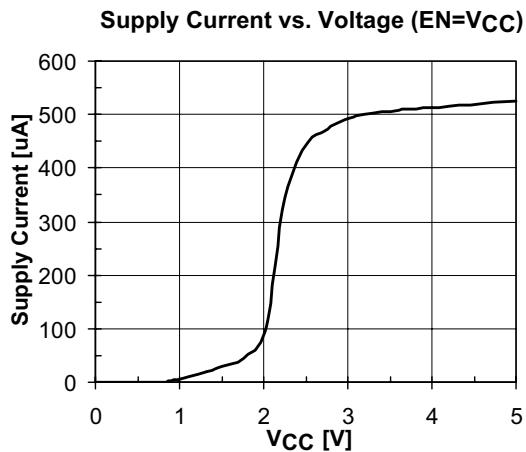
# Performance Information (cont'd)

**CM3002-33SA/CM3002-33MA Typical DC Characteristics**
**(nominal conditions unless specified otherwise, data representative of SOIC packaged -33SA devices)**

**Supply Current vs. Voltage (EN=V$_{CC}$)**
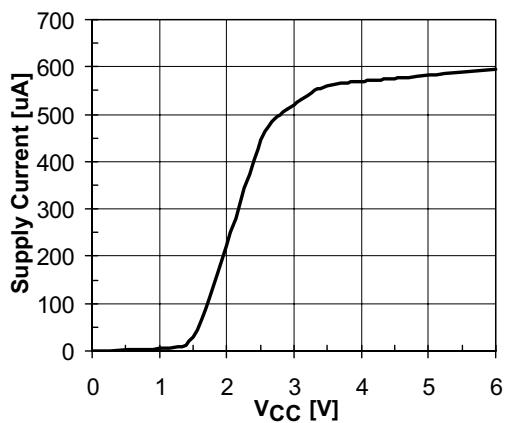
**Supply Current vs. Voltage (EN=GND)**
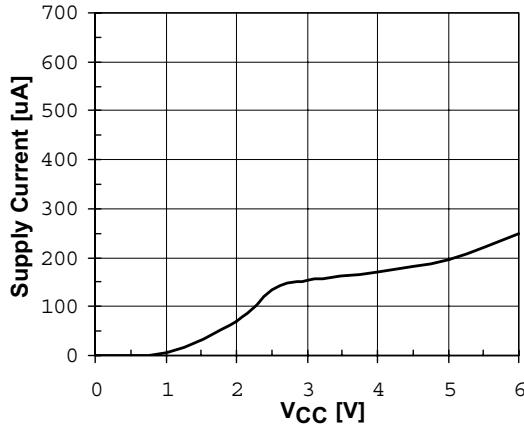
**Line Regulation with 5mA & 1A Load**
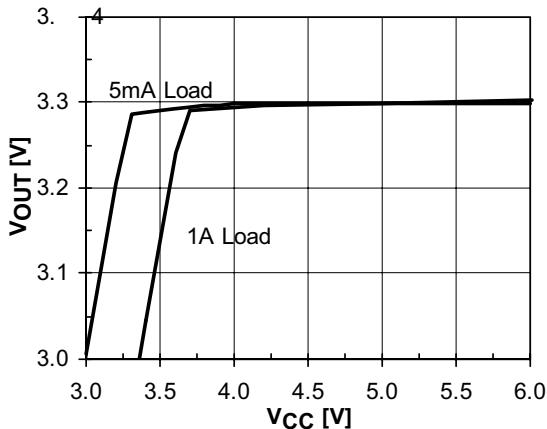
**Ground Current vs. Output Load**
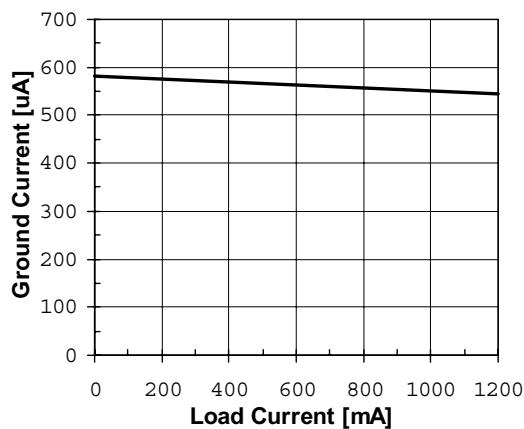
**Dropout Voltage vs. Load (Vout=3.2V)**
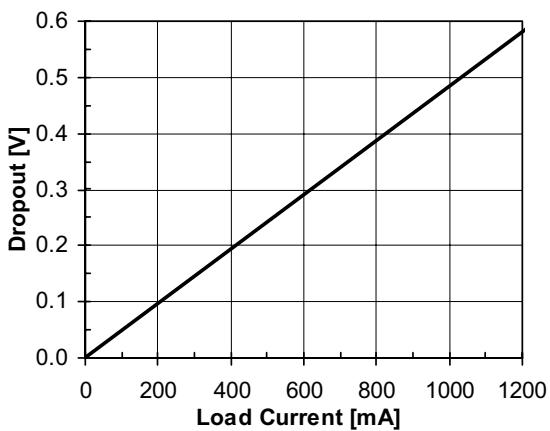
**Current Limiting Protection**
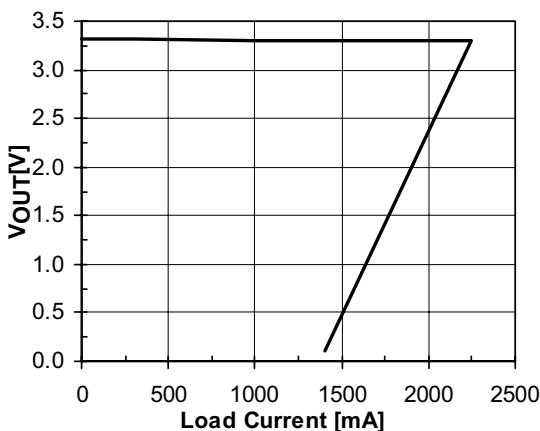
## Performance Information (cont'd)

**CM3002-33SA/CM3002-33MA Typical DC Characteristics (continued)**

**Load Regulation (V$_{CC}$ = 5V)**

**Load Regulation (V$_{CC}$ = 3.3V)**
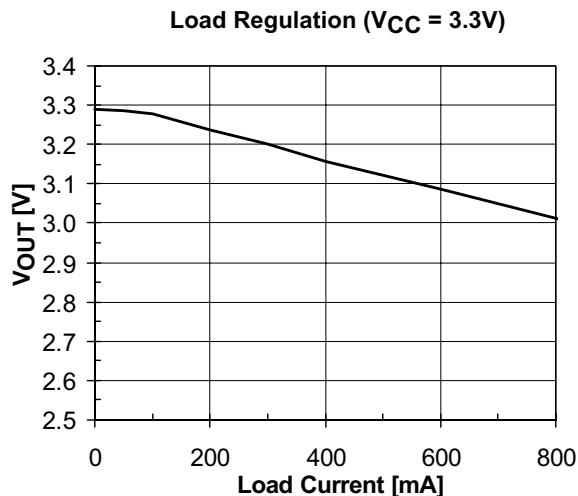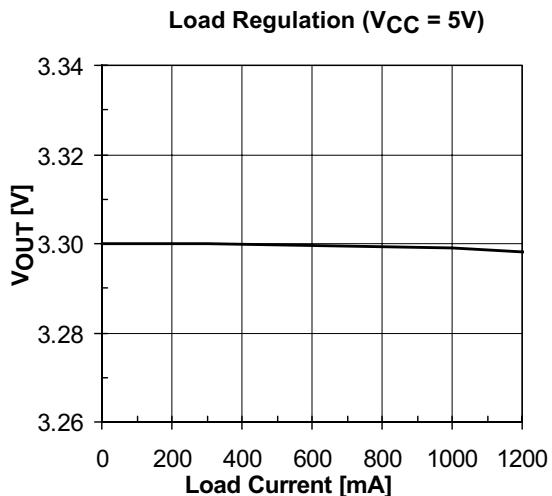
# Performance Information (cont'd)

## CM3002-15SA Typical Transient Characteristics (nominal conditions unless specified otherwise)

**Cold Start Power-up with Rated Load**

Tek Stop 50.0kS/s　　1 Acqs

Vcc

Vout

(1A load)

Ch1　500mV　　Ch2　1.00 V　　M2.00ms Ch2 ∫　440mV

**Full Power Down with Rated Load**

Tek Stop 50.0kS/s　　1 Acqs

Vcc

(1A load)

Vout

Ch1　500mV　　Ch2　1.00 V　　M2.00ms Ch2 ʅ　2.18 V

**Power-Up Sequencing using Enable Input**

Tek Stop 1.00MS/s　　1 Acqs

En

Vout

(1A load)

Ch1　500mV　　Ch2　2.00 V　　M 100µs Ch2 ∫　320mV

**Line Transient Step Response (0.6Vp-p)**

Tek Stop 1.00MS/s　　1 Acqs

3.6V

3.0V　　　　Vcc (offset=3.0V)

Vout (offset=1.5V)

(5mA load)

Ch1　50.0mV　　Ch2　300mV　　M 100µs Ch2 ∫　4.48 V

**Load Transient Response (50mA to 450mA)**

Tek Run: 5.00MS/s　　Sample

Load　　50mA to 450mA step

Vout (offset=1.5V)

Ch1　50.0mV　　Ch2　1.00 V　　M 20.0µs Ch2 ∫　100mV

**Load Transient Response (100mA to 900mA)**

Tek Stop 2.50MS/s　　1 Acqs

Load　　100mA to 900mA step

Vout (offset=1.5V)

Ch1　50.0mV　　Ch2　1.00 V　　M 40.0µs Ch2 ∫　640mV
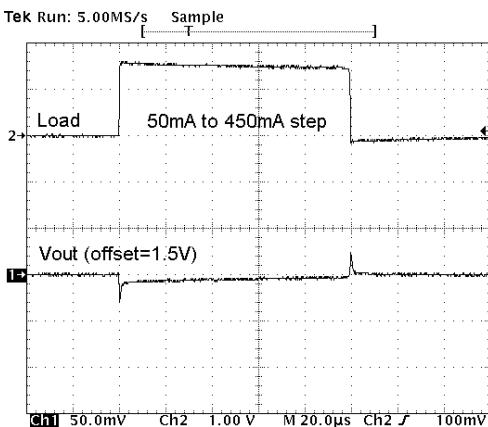
# Performance Information (cont'd)

## CM3002-18SA Typical Transient Characteristics (nominal conditions unless specified otherwise)

### Cold Start Power-up with Rated Load
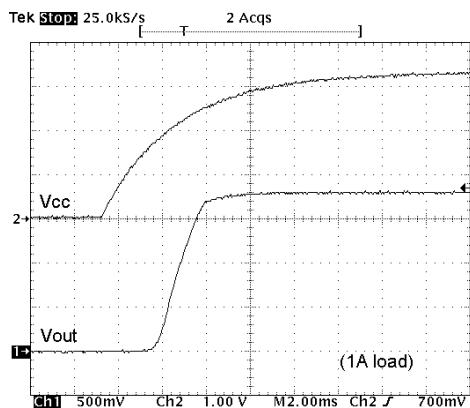


### Full Power Down with Rated Load
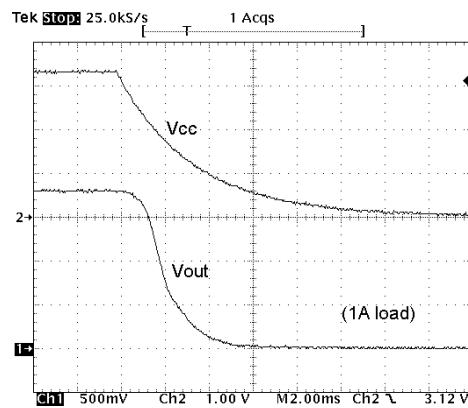


### Power-Up Sequencing using Enable Input
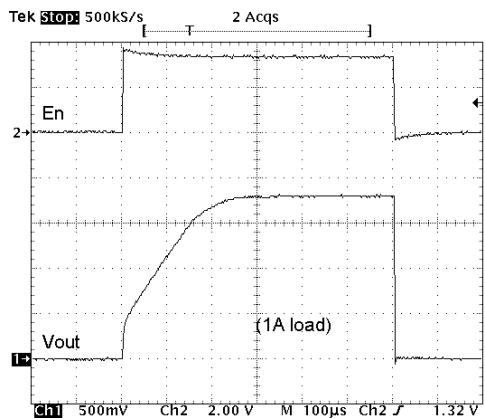


### Line Transient Step  Response (1Vp-p)
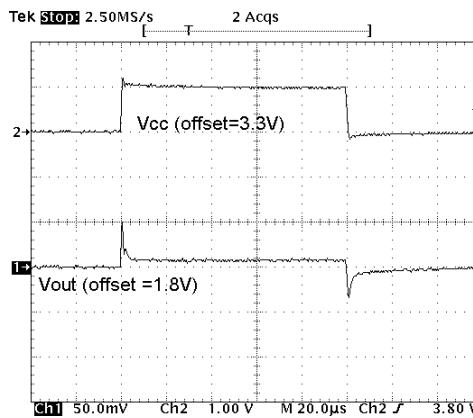


### Load Transient Response (50mA to 500mA)
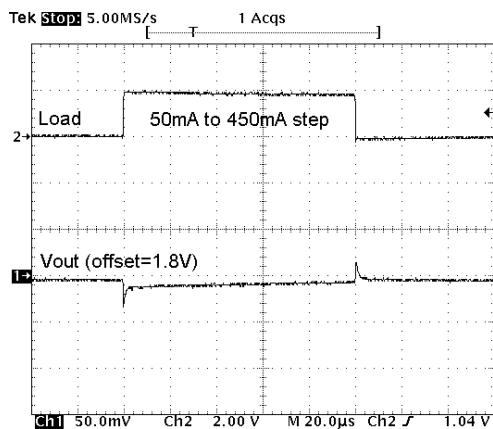


### Load Transient Response (100mA to 900mA)
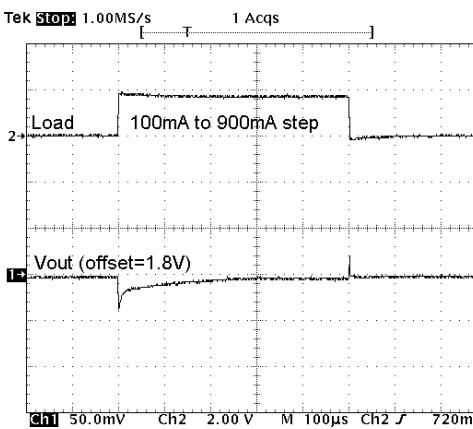
# Performance Information (cont'd)

## CM3002-25SA Typical Transient Characteristics (nominal conditions unless specified otherwise)

### Cold Start Power-up with Rated Load
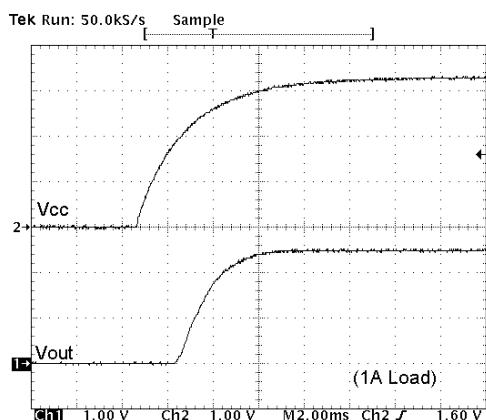


### Full Power Down with Rated Load
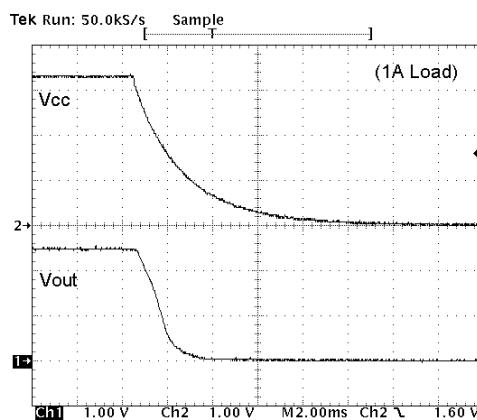


### Power-Up Sequencing using Enable Input
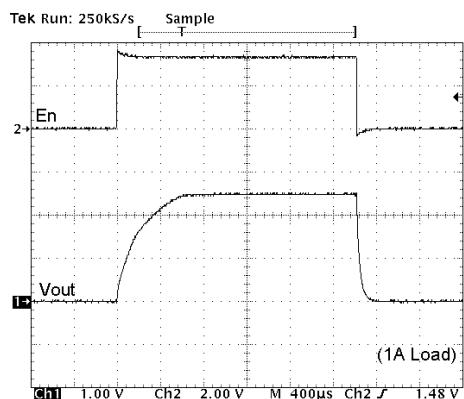


### Line Transient Step  Response (1Vp-p)
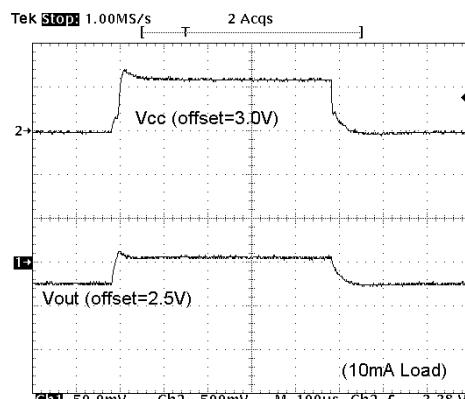


### Load Transient Response (50mA to 450mA)
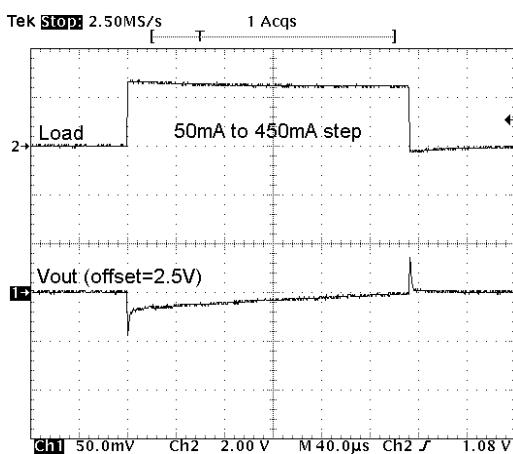


### Load Transient Response (100mA to 900mA)
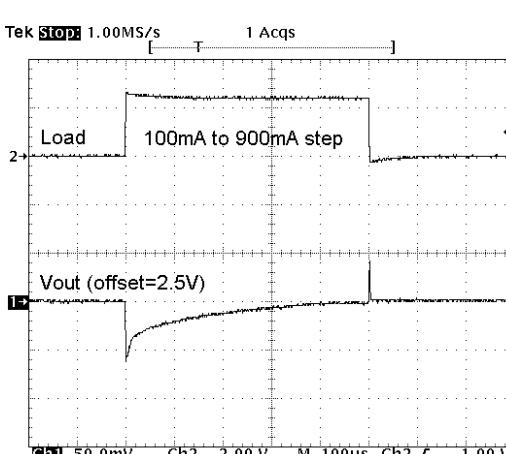
# Performance Information (cont'd)

**CM3002-33SA/-33MA Typical Transient Characteristics (nominal conditions unless specified otherwise)**

**Cold Start (1A Load)**

Tek Stop 50.0kS/s 　　1 Acqs

Vcc

Vout

(1A load)

Ch1 1.00 V Ch2 2.00 V M2.00ms Ch2 ʃ 1.68 V

**Full Power Down (1A Load)**

Tek Run: 50.0kS/s 　Sample

Vcc

Vout

(1A load)

Ch1 1.00 V Ch2 2.00 V M2.00ms Ch2 ʟ 3.12 V

**Line Transient Response (4.0V to 5.0V Line Step)**

Tek Stop 1.00MS/s 　1 Acqs

5.0V

4.0V 　Vcc (offset=4.0V)

Vout (offset=3.3V)

(5mA load)

Ch1 50.0mV Ch2 500mV M 100µs Ch2 ʃ 4.48 V

**Power-Up Sequencing using Enable Input (1A Load)**

Tek Run: 1.00MS/s 　Sample

En

Vout

(1A load)

Ch1 1.00 V Ch2 2.00 V M 100µs Ch2 ʃ 680mV

**Load Transient Response (V$_{CC}$=5V)**

Tek Stop 5.00MS/s 　1 Acqs

Load 　100mA to 1A step

Vout (offset=3.3V)

(Vcc=5V)

Ch1 50.0mV Ch2 2.00 V M 20.0µs Ch2 ʃ 1.24 V

**Load Transient Response (V$_{CC}$=3.3V)**

Tek Run: 5.00MS/s 　Sample

Load 　50mA to 450mA step

Vout (offset=3.3V)

(Vcc=3.3V)

Ch1 100mV Ch2 2.00 V M 20.0µs Ch2 ʃ 1.24 V

## Performance Information (cont'd)

**Typical Thermal Characteristics**

The overall junction to ambient thermal resistance ($\theta_{JA}$) for device power dissipation ($P_D$) consists primarily of two paths in series. The first path is the junction to the case ($\theta_{JC}$) which is defined by the package style, and the second path is case to ambient ($\theta_{CA}$) thermal resistance which is dependent on board layout. The final operating junction temperature for any set of conditions can be estimated by the following thermal equation:

$$T_{JUNC} = T_{AMB} + P_D * (\theta_{JC}) + P_D * (\theta_{CA})$$

$$= T_{AMB} + P_D * (\theta_{JA})$$

The CM3002 family uses thermally enhanced SOIC and MSOP packages where all the GND pins (5 through 8) are integral to the leadframe. When this package is mounted on a double sided printed circuit board with two square inches of copper allocated for "heat spreading", the resulting $\theta_{JA}$ is about 50°C/W for the SOIC package and 70°C/W for the MSOP package.

Based on a maximum power dissipation of 0.8W (Load x Vin-Vout = 1.0A x [3.3V-2.5V]) with an ambient of 70°C, the resulting junction temperature for a SOIC-packaged device will be:

$$T_{JUNC} = T_{AMB} + P_D * (\theta_{JA})$$

$$= 70°C + 0.8W * (50°C/W)$$

$$= 70°C + 40°C = 110°C$$

Thermal characteristics were measured using a double sided board with two square inches of copper area connected to the GND pins for "heat spreading".

Measurements showing performance up to a junction temperature of 125°C are presented in Figure 1, Figure 2, Figure 3 and Figure 4. They were performed under light load conditions (5mA); this allows the ambient temperature to be representative of the internal junction temperature.

**Note:** The use of multi-layer board construction with separate ground and power planes will further enhance the overall thermal performance. In the event of no copper area being dedicated for heat spreading, a multi-layer board construction using only the minimum size pad layout will typically provide a CM3002 device packaged in a SOIC package with an overall $\theta_{JA}$ of 50°C/W, which allows up to 0.8W to be dissipated safely.

Please consult CAMD Technical Support for assistance with thermal analysis of the CM3002 family of regulators with respect to a specific application.

**Output Voltage with Temperature (5mA Load)**

**Ground Current with Temperature (No Load)**
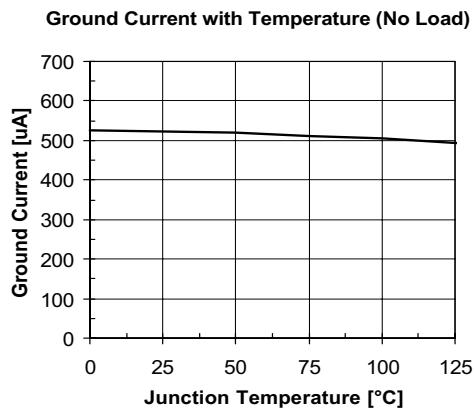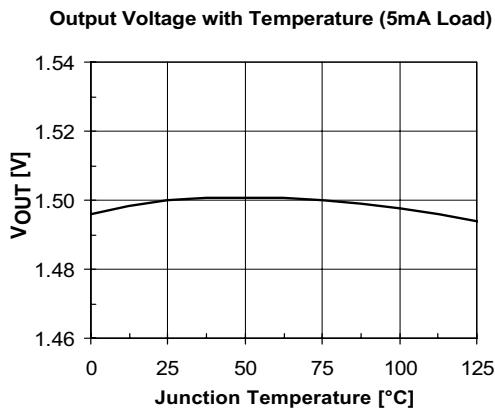
**Figure 1. CM3002-15SA Performance vs. Temperature**

# Performance Information (cont'd)

**Output Voltage with Temperature (5mA Load)**



**Ground Current with Temperature (No Load)**
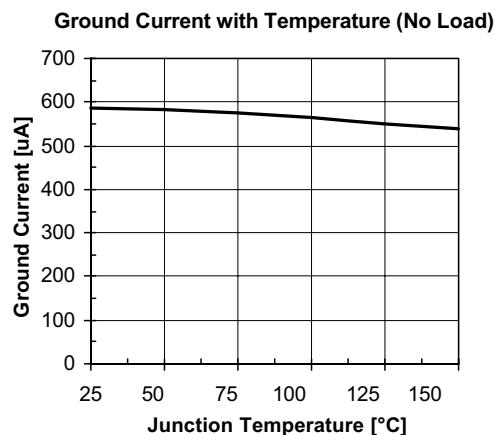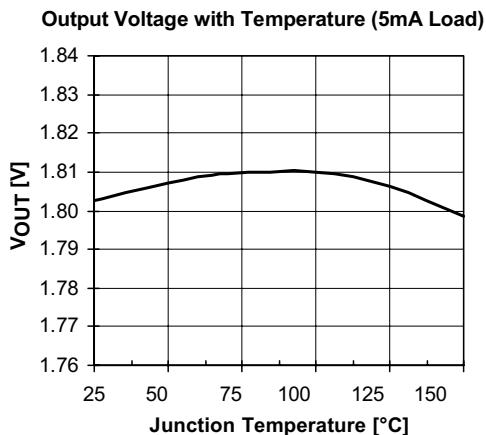


**Figure 2.  CM3002-18SA Performance vs. Temperature**

**Output Voltage with Temperature (5mA Load)**



**Ground Current with Temperature (No Load)**
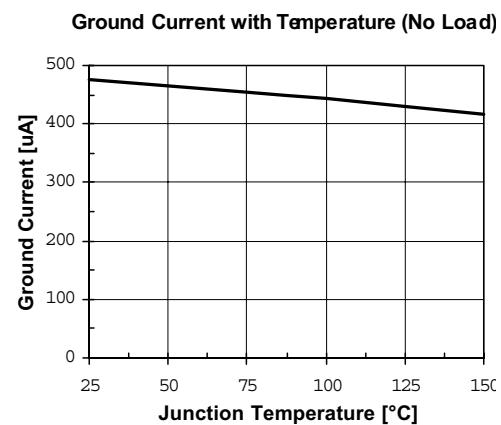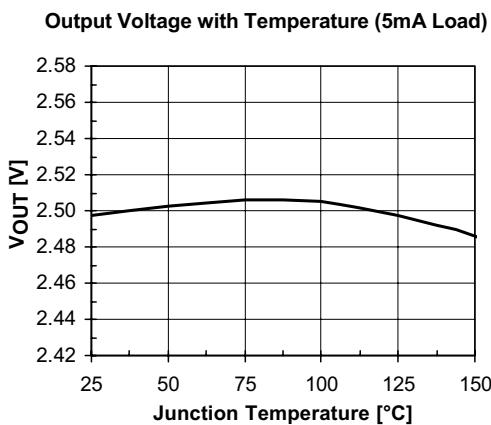


**Figure 3.  CM3002-25SA Performance vs. Temperature**

**Output Voltage with Temperature (5mA Load)**



**Ground Current with Temperature (No Load)**
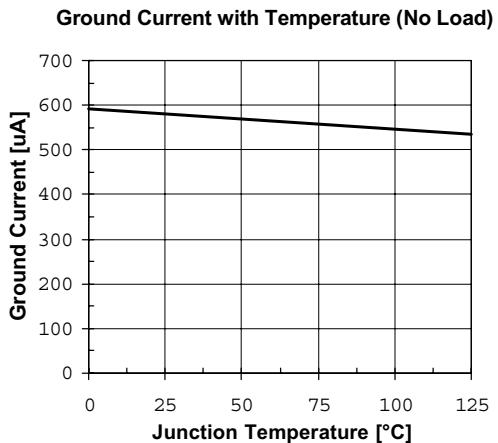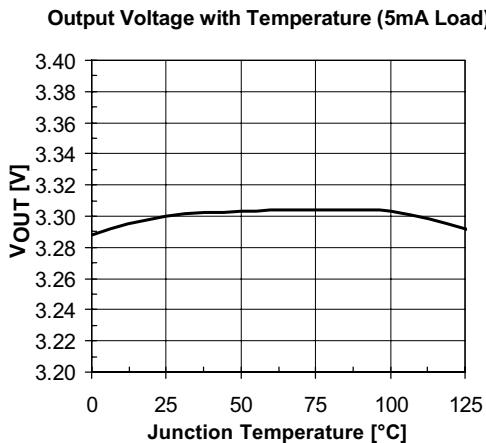


**Figure 4.  CM3002-33SA/-33MA Performance vs. Temperature**

# Mechanical Details

CM3002 devices are packaged in 8-pin Narrow SOIC and 8-pin MSOP (CM3002-33MA only) packages.

**SOIC-8 Mechanical Specifications:**

Dimensions for CM3002 devices packaged in 8-pin Narrow SOIC packages are presented below.

For complete information on the SOIC-8 package, see the California Micro Devices SOIC Package Information document.

| PACKAGE DIMENSIONS | | | | |
|---|---|---|---|---|
| **Package** | SOIC | | | |
| **Pins** | 8 | | | |
| **Dimensions** | **Millimeters** | | **Inches** | |
| | **Min** | **Max** | **Min** | **Max** |
| **A** | 1.35 | 1.75 | 0.053 | 0.069 |
| **A$_1$** | 0.10 | 0.25 | 0.004 | 0.010 |
| **B** | 0.33 | 0.51 | 0.013 | 0.020 |
| **C** | 0.19 | 0.25 | 0.007 | 0.010 |
| **D** | 4.80 | 5.00 | 0.189 | 0.197 |
| **E** | 3.80 | 4.19 | 0.150 | 0.165 |
| **e** | 1.27 BSC | | 0.050 BSC | |
| **H** | 5.80 | 6.20 | 0.228 | 0.244 |
| **L** | 0.40 | 1.27 | 0.016 | 0.050 |
| **# per tube** | 100 pcs* | | | |
| **# per tape and reel** | 2500 pcs | | | |
| Controlling dimension: inches | | | | |

* This is an approximate number which may vary.

**Mechanical Package Diagrams**
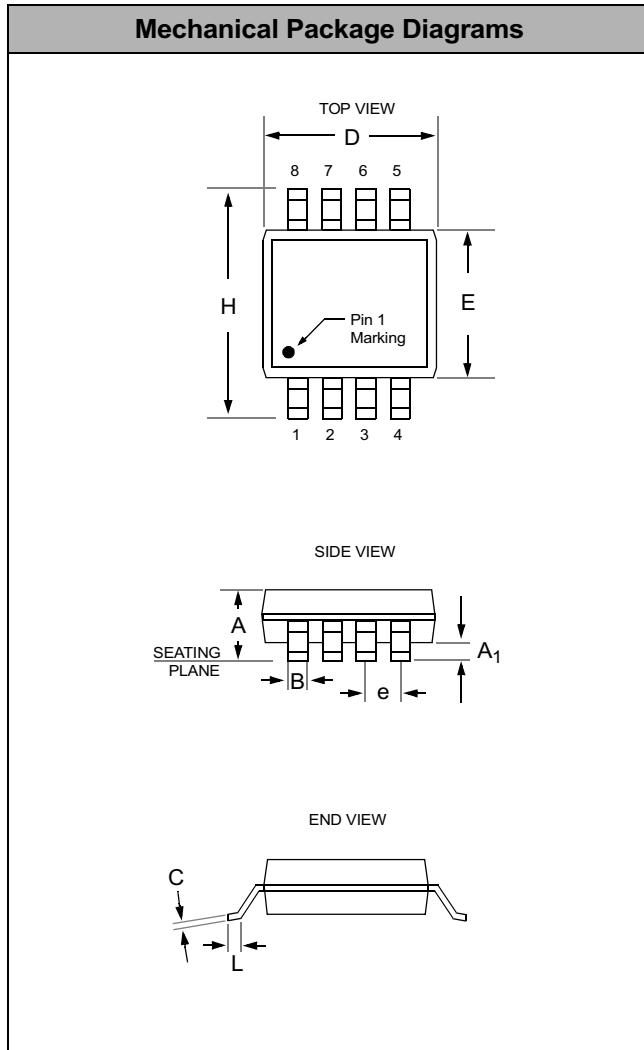


**Package Dimensions for SOIC-8**

# Mechanical Details (cont'd)

**MSOP-8 Mechanical Specifications:**

CM3002-33MA devices are packaged in 8-pin MSOP packages. Dimensions are presented below.

For complete information on the MSOP-8 package, see the California Micro Devices MSOP Package Information document.

| **PACKAGE DIMENSIONS** | | | | |
|---|---|---|---|---|
| **Package** | MSOP | | | |
| **Pins** | 8 | | | |
| **Dimensions** | **Millimeters** | | **Inches** | |
|  | **Min** | **Max** | **Min** | **Max** |
| **A** | 0.87 | 1.17 | 0.034 | 0.046 |
| **A1** | 0.05 | 0.25 | 0.002 | 0.010 |
| **B** | 0.30 (typ) | | 0.012 (typ) | |
| **C** | 0.18 | | 0.007 | |
| **D** | 2.90 | 3.10 | 0.114 | 0.122 |
| **E** | 2.90 | 3.10 | 0.114 | 0.122 |
| **e** | 0.65 BSC | | 0.025 BSC | |
| **H** | 4.78 | 4.98 | 0.188 | 0.196 |
| **L** | 0.52 | 0.54 | 0.017 | 0.025 |
| **# per tube** | 80 pcs* | | | |
| **# per tape and reel** | 4000 pcs | | | |
| Controlling dimension: inches | | | | |

* This is an approximate number which may vary.

**Mechanical Package Diagrams**

TOP VIEW

SIDE VIEW

END VIEW

**Package Dimensions for MSOP-8**