19-2532; Rev 1; 10/02

EVALUATION KIT AVAILABLE

# 300mA LDO Linear Regulators with Internal Microprocessor Reset Circuit



## General Description

The MAX6469–MAX6484 are low-dropout linear regulators with a fully integrated microprocessor reset circuit. Each is available with preset output voltages from +1.5V to +3.3V in 100mV increments and delivers up to 300mA of load current. These devices consume only 82µA of supply current. The low supply current, low dropout voltage, and integrated reset functionality make these devices ideal for battery-powered portable equipment.

The MAX6469–MAX6484 include a reset output that indicates when the regulator output drops below standard microprocessor supply tolerances (-7.5% or -12.5% of nominal output voltage). This eliminates the need for an external microprocessor supervisor, while ensuring that supply voltages and clock oscillators have stabilized before processor activity is enabled. Push-pull and open-drain active-low reset outputs are available, with reset timeout periods of 2.5ms, 20ms, 150ms, or 1200ms (min).

The MAX6469/MAX6470/MAX6473–MAX6478/MAX6481–MAX6484 also have a shutdown feature that reduces the supply current to 0.1µA (typ). The MAX6471–MAX6474/MAX6479–MAX6482 offer a manual reset input to assert a microprocessor reset while the regulator output is within specification. The MAX6475/MAX6476/MAX6483/MAX6484 feature a remote feedback sense pin for use with an external NPN transistor for higher-current applications. The MAX6469–MAX6476 are available in 6-pin SOT23 and 8-pin thin QFN packages. The MAX6477–MAX6484 are available in a 3 × 3 chip-scale package (UCSP™). All devices are specified for operation from -40°C to +85°C.

## Applications

Hand-Held Instruments (PDAs, Palmtops)
PCMCIA Cards/USB Devices
Cellular/Cordless Telephones
CD/DVD Drives
Notebook Computers
Digital Cameras
Bluetooth Modules/Wireless LAN

*UCSP is a trademark of Maxim Integrated Products, Inc.*

***Pin Configurations appear at end of data sheet.***

***Typical Operating Circuits appear at end of data sheet.***

## Features

- **3 × 3 UCSP, 6-Pin SOT23, and 8-Pin QFN Packages**
- **Preset +1.5V to +3.3V Output (100mV Increments)**
- **SET Pin for Adjustable Output Voltage**
- **75µV$_{RMS}$ LDO Output Voltage Noise (MAX6477–MAX6484)**
- **±2.0% Accuracy Over Temperature**
- **Guaranteed 300mA Output Current**
- **Low Dropout Voltage**
  **55mV at 150mA**
  **114mV at 300mA**
- **82µA Supply Current, 0.1µA Shutdown Current**
- **Input Reverse Current, Thermal and Short-Circuit Protection**
- **Microprocessor Reset with Four Timeout Options**
- **Push-Pull or Open-Drain $\overline{\text{RESET}}$**
- **Manual Reset Input**
- **Remote Feedback Sense**

## Ordering Information

| PART | TEMP RANGE | PIN-PACKAGE |
|---|---|---|
| **MAX6469**UT_ _ _D_-T | -40°C to +85°C | 6 SOT23-6 |
| MAX6469TA_ _ _D_* | -40°C to +85°C | 8 Thin QFN |
| **MAX6470**UT_ _ _D_-T | -40°C to +85°C | 6 SOT23-6 |
| MAX6470TA_ _ _D_* | -40°C to +85°C | 8 Thin QFN |

**Future product—contact factory for availability.*

***Note:*** *The first "_ _"are placeholders for the output voltage levels of the devices. Desired output voltages are set by the suffix found in the Output Voltage Suffix Guide (Table 1). The third "_" is a placeholder for the reset threshold accuracy. Desired reset threshold accuracy is set by the suffix found in the Reset Threshold Accuracy Guide (Table 2). The "_" following the D is a placeholder for the reset timeout delay time. Desired reset timeout delay time is set by the suffix found in the Reset Timeout Delay Guide (Table 3). For example, the MAX6481BL30BD4-T has a 3.0V output voltage, 12.5% reset threshold tolerance, and a 1200ms (min) reset timeout delay. Sample stock is generally available on standard versions only (Table 4). Standard versions require a minimum order increment of 2.5k units. Nonstandard versions must be ordered in 10k-unit increments. Contact factory for availability.*

***Ordering Information continued at end of data sheet.***

# 300mA LDO Linear Regulators with Internal Microprocessor Reset Circuit

## ABSOLUTE MAXIMUM RATINGS

(All voltages referenced to GND, unless otherwise noted.)
IN, $\overline{SHDN}$, OUT, FB .....-0.3V to +7V
$\overline{MR}$, SET .....-0.3V to ($V_{IN}$ + 0.3V)
$\overline{RESET}$ (push-pull) .....-0.3V to ($V_{OUT}$ + 0.3V)
$\overline{RESET}$ (open drain).....-0.3V to +7V
OUT Short Circuit .....Continuous
Input/Output Current (all pins except IN and OUT).....20mA

Continuous Power Dissipation ($T_A$ = +70°C)
3 x 3 UCSP (derate 10.5mW/°C above +70°C) .....840mW
6-Pin SOT23 (derate 9.1mW/°C above +70°C).....727mW
8-Lead Thin QFN
(derate 24.4mW/°C above +70°C).....1951mW
Operating Temperature Range .....-40°C to +85°C
Junction Temperature.....+150°C
Storage Temperature Range .....-65°C to +150°C
Lead Temperature (soldering, 10s) .....+300°C

**Note 1:** The MAX6477–MAX6484 are constructed using a unique set of packaging techniques that impose a limit on the thermal profile the devices can be exposed to during board-level solder attach and rework. This limit permits only the use of the solder profiles recommended in the industry-standard specification, JEDEC 020A, paragraph 7.6, Table 3 for IR/VPR and Convection reflow. Pre-heating is required. Hand or wave soldering is not allowed.

*Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.*

## ELECTRICAL CHARACTERISTICS

($V_{IN}$ = ($V_{OUT}$ + 0.5V) or +2.5V, whichever is greater, $C_{OUT}$ = 3.3µF, $T_A$ = -40°C to +85°C. Typical specifications are at $T_A$ = +25°C, unless otherwise noted.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| Input Voltage Range | $V_{IN}$ | | 2.5 | | 5.5 | V |
| Input Undervoltage Lockout | $V_{UVLO}$ | $V_{IN}$ falling | 2.25 | | 2.47 | V |
| Supply Current (Ground Current) | $I_Q$ | $I_{OUT}$ = 0 | | 82 | 136 | µA |
| | | $I_{OUT}$ = 300mA | | 96 | | |
| Shutdown Supply Current | $I_{SHDN}$ | $T_A$ = +25°C | | 0.1 | 1 | µA |
| **REGULATOR CIRCUIT** | | | | | | |
| Output Current | | | 300 | | | mA |
| Output Voltage Accuracy (Fixed Output Voltage Operation, Table 1) MAX6469–MAX6476 | | 1mA ≤ $I_{OUT}$ ≤ 150mA, $T_A$ = +25°C | -1.3 | | +1.3 | % |
| | | 1mA ≤ $I_{OUT}$ ≤ 150mA, $T_A$ = -40°C to +85°C | -2.3 | | +2.3 | |
| | | 1mA ≤ $I_{OUT}$ ≤ 300mA, $T_A$ = -40°C to +85°C | -2.7 | | +2.7 | |
| Output Voltage Accuracy (Fixed Output Voltage Operation, Table 1) MAX6477–MAX6484 | | 2mA ≤ $I_{OUT}$ ≤ 100mA, $T_A$ = +25°C | -1.1 | | +1.1 | % |
| | | 2mA ≤ $I_{OUT}$ ≤ 100mA, $T_A$ = -40°C to +85°C | -2.0 | | +2.0 | |
| | | 1mA ≤ $I_{OUT}$ ≤ 300mA, $T_A$ = -40°C to +85°C | -2.7 | | +2.7 | |
| Adjustable Output Voltage Range | | | $V_{SET}$ | | 5.0 | V |
| SET Reference Voltage | $V_{SET}$ | | 1.200 | 1.229 | 1.258 | V |
| SET Dual Mode™ Threshold | | | | 185 | | mV |
| SET Input Leakage Current | $I_{SET}$ | $V_{SET}$ = 0, +1.2V (Note 3) | | ±20 | ±100 | nA |

*Dual Mode is a trademark of Maxim Integrated Products, Inc.*

# Tiva™ TM4C123BE6PZ Microcontroller

## (identical to LM4F212E5QC)

## DATA SHEET

DS-TM4C123BE6PZ-15033.2672
SPMS366B

## ELECTRICAL CHARACTERISTICS (continued)

($V_{IN}$ = ($V_{OUT}$ + 0.5V) or +2.5V, whichever is greater, $C_{OUT}$ = 3.3µF, $T_A$ = -40°C to +85°C. Typical specifications are at $T_A$ = +25°C, unless otherwise noted.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Dropout Voltage (Notes 3, 4) | $\Delta V_{DO}$ | $V_{OUT}$ = +3.3V (fixed output operation) | $I_{OUT}$ = 50mA | | 23 | 32 | mV |
| | | | $I_{OUT}$ = 150mA | | 55 | 90 | |
| | | | $I_{OUT}$ = 300mA | | 114 | 180 | |
| | | $V_{OUT}$ = +3.0V (fixed output operation) | $I_{OUT}$ = 50mA | | 25 | 40 | |
| | | | $I_{OUT}$ = 150mA | | 61 | 100 | |
| | | | $I_{OUT}$ = 300mA | | 114 | 190 | |
| | | $V_{OUT}$ = +2.8V (fixed output operation) | $I_{OUT}$ = 50mA | | 26 | 50 | |
| | | | $I_{OUT}$ = 150mA | | 65 | 110 | |
| | | | $I_{OUT}$ = 300mA | | 137 | 210 | |
| | | $V_{OUT}$ = +2.5V (fixed output operation) | $I_{OUT}$ = 50mA | | 30 | 60 | |
| | | | $I_{OUT}$ = 150mA | | 75 | 150 | |
| | | | $I_{OUT}$ = 300mA | | 158 | 250 | |
| Output Current Limit | | $V_{IN}$ ≥ 2.5V (Note 3) | | 450 | | | mA |
| Input Reverse Leakage Current (OUT to IN Leakage Current) | | $V_{IN}$ = 4V, $V_{OUT}$ = 5.5V, $\overline{SHDN}$ deasserted | | | 0.01 | 1.5 | µA |
| Startup Time Response | | Rising edge of $V_{IN}$ or $\overline{SHDN}$ to $V_{OUT}$ within specification, $R_L$ = 68Ω, SET = GND, $I_{OUT}$ = 10mA | | | 20 | | µs |
| $\overline{SHDN}$ Input Low Voltage | $V_{IL}$ | | | | | 0.3 × $V_{IN}$ | V |
| $\overline{SHDN}$ Input High Voltage | $V_{IH}$ | | | 0.7 × $V_{IN}$ | | | V |
| $\overline{SHDN}$ Input Current | | $\overline{SHDN}$ = $V_{IN}$ or GND | | -1 | 0.1 | +1 | µA |
| Thermal-Shutdown Temperature | $T_{SHDN}$ | | | | 180 | | °C |
| Thermal-Shutdown Hysteresis | $\Delta T_{SHDN}$ | | | | 20 | | °C |
| Line Regulation | | $V_{OUT}$ = 1.5V, 2.5V ≤ $V_{IN}$ ≤ 5.5V, $I_{OUT}$ = 10mA | | | 0.09 | | %/V |
| Load Regulation | | $V_{OUT}$ = 1.5V, $V_{IN}$ = 2.5V, 1mA ≤ $I_{OUT}$ ≤ 150mA | | | 0.2 | | % |
| Output Voltage Noise | | 10Hz to 100kHz, $C_{IN}$ = 0.1µF, $I_{OUT}$ = 100mA, $V_{OUT}$ = 1.5V | MAX6469–MAX6476 | | 150 | | $\mu V_{RMS}$ |
| | | | MAX6477–MAX6484 | | 75 | | |
| **RESET CIRCUIT** | | | | | | | |
| $V_{OUT}$ Reset Threshold ($V_{FB}$ for MAX6475/MAX6476/ MAX6483/MAX6484) (Note 5) | $V_{THOUT}$ | MAX64_ _ _ _ _ _ A | | 90 | 92.5 | 95 | $\%V_{OUT}$ |
| | | MAX64_ _ _ _ _ _ B | | 85 | 87.5 | 90 | |
| $V_{OUT}$ to Reset Delay ($V_{FB}$ for MAX6475/MAX6476/ MAX6483/MAX6484) | | | | | 35 | | µs |
| Reset Timeout Period (Note 6) | $t_{RP}$ | D1 | | 2.5 | 3.75 | 5.0 | ms |
| | | D2 | | 20 | 30 | 40 | |
| | | D3 | | 150 | 225 | 300 | |
| | | D4 | | 1200 | 1800 | 2400 | |