## GENERAL DESCRIPTION

The BM9164 family of a linear voltage linear regulators developed utilizing BM unique BiCMOS technology featured low quiescent current (<1mA), low dropout voltage, and high output voltage accuracy. The space-efficient SOT-223 package is attractive for “Pocket” and “Hand Held” applications.

Output voltages are set at the factory and trimmed to 1.5% accuracy. Voltages from 1.8V to 5.0V are available.

These rugged devices have both Thermal Shutdown, and Current Fold-back to prevent device failure under the “Worst” of operating conditions.

The BM9164 is stable with an output capacitance of 22μF or greater.

## FEATURES

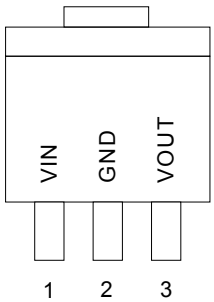
- Very Low Dropout Voltage , <700mV when 1A
- Low Current Consumption: Typ. <1mA
- High Accuracy Output Voltage: +/- 1.5%
- Guaranteed 1A Output (if Vin-Vout>700mV)
- Thermal Shutdown
- Current Limiting
- Compact Package: SOT-223
- Factory Pre-set Output Voltages
- Short Circuit Current Fold-Back
- Low Temperature Coefficient

## APPLICATIONS

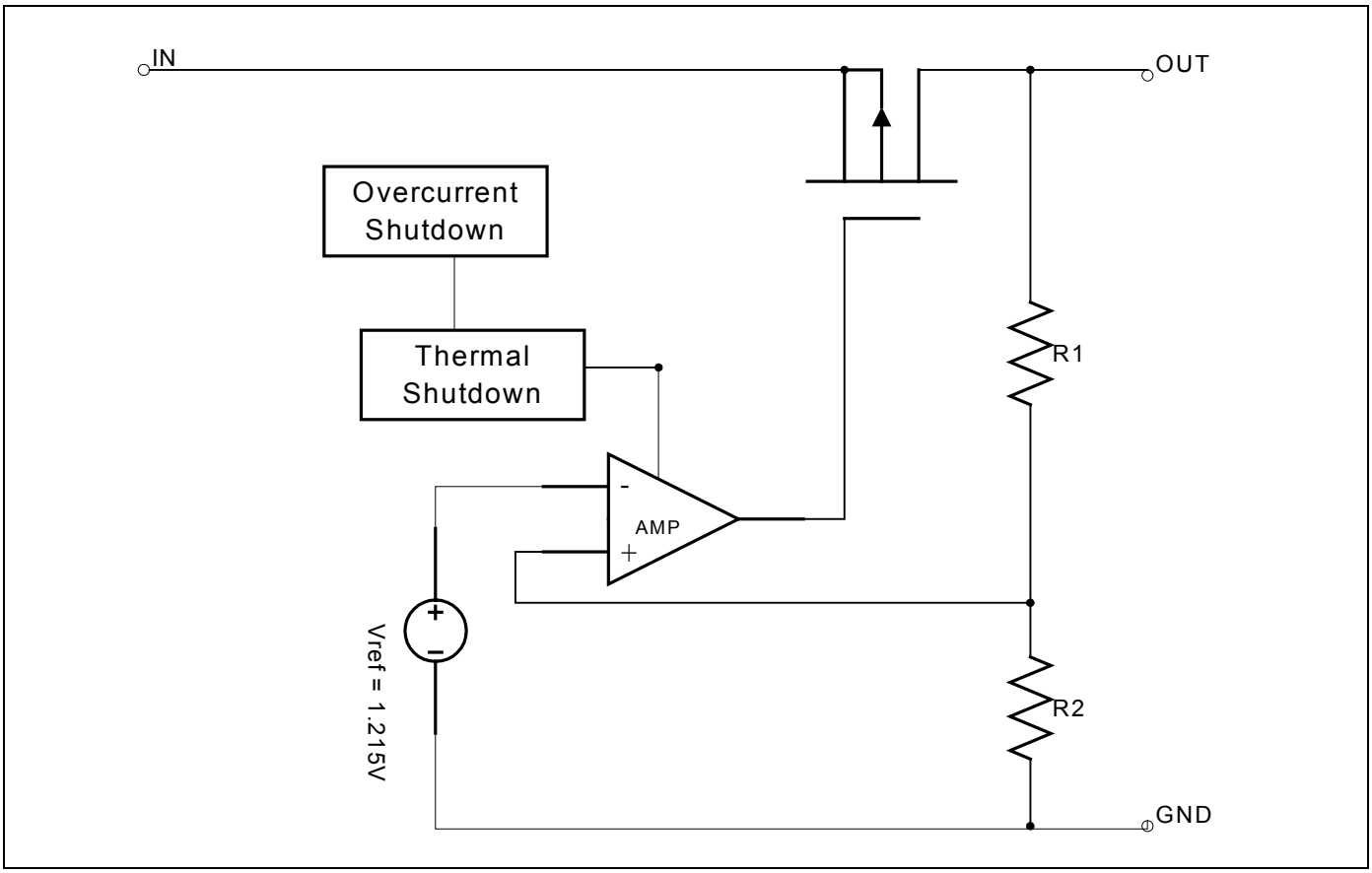
- Battery-powered devices
- Personal communication devices
- Home electric/electronic appliances
- PC peripherals , hard-disk

## PIN CONFIGURATION

SOT-223
Top View



## BLOCK DIAGRAM




## ORDERING INFORMATION

| Part Number | Output Voltage | Temperature Range | Package |
|---|---|---|---|
| BM9164-1.8 | 1.8V | -40℃ ~ +85℃ | SOT-223 |
| BM9164-3.3 | 3.3V | -40℃ ~ +85℃ | SOT-223 |
| BM9164-4.9 | 4.9V | -40℃ ~ +85℃ | SOT-223 |

## ABSOLUTE MAXIMUM RATINGS

Input Voltage ..... +9V
Output Current ..... 2.2A
Output Voltage ..... GND-0.3V to $V_{IN}$+0.3V
ESD Classification ..... B

## OPERATING RATINGS

Supply Voltage ..... +2V to +8V
Ambient Temperature Range ($T_A$) ..... -40℃ to +85℃
Junction Temperature Range ..... -40℃ to +125℃

## THERMAL INFORMATION

| Parameter | | Maximum | Unit |
|---|---|---|---|
| Thermal Resistance ($\Theta_{jc}$) | SOT-223 | 160 | ℃/W |
| Internal Power Dissipation ($P_D$) ($\triangle T$ = 100℃) | SOT-223 | 625 | mW |
| Maximum Junction Temperature | | 150 | ℃ |
| Maximum Lead Temperature (10 Sec) | | 300 | ℃ |

*With Junction sink capable of twice times of $\Theta_{jc}$
Caution: Stress above the listed absolute rating may cause permanent damage to the device.

## ELECTRICAL CHARACTERISTICS

$T_A$ = +25℃; unless otherwise noted

| Parameter | Symbol | Test Conditions | | BM9164 | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| Input Voltage | $V_{IN}$ | | | +2 | | +8 | V |
| Output Voltage Accuracy | $V_{OUT}$ | $I_O$ = 1mA to 1.5A | | -1.5 | | 1.5 | % |
| Dropout Voltage | $V_{DROPOUT}$ | $V_{OUT}=V_{O(NOM)}$-4%, | Iout=1A | | | 700 | mV |
| | | | Iout=600mA | | | 350 | |
| | | | Iout=100mA | | | 100 | mV |
| Output Current | $I_O$ | $V_{OUT}$ > 1.5V | | | 1000 | | mA |
| Current Limit | $I_{LIM}$ | $V_{OUT}$ > 1.5V | | 2000 | 2200 | | mA |
| Short Circuit Current | $I_{SC}$ | $V_{OUT}$ < 0.4V | | | 750 | 1500 | mA |
| Quiescent Current | $I_Q$ | $I_O$ = 0mA | | | 1 | | mA |
| Ground Pin Current | $I_{GND}$ | $I_O$ = 1mA to 1A | | | 1 | | mA |
| Line Regulation | $REG_{LINE}$ | $I_{OUT}$=5mA | $V_{OUT}$ <= 2.0V | | | 0.15 | % |
| | | | $V_{OUT}$ > 2.0V | | 1.5 | 0.1 | % |
| Load Regulation | $REG_{LOAD}$ | $I_O$=1mA to 1A | | | 0.2 | 1.5 | % |
| Over Temperature Shutdown | OTS | | | | 150 | | ℃ |
| Over Temperature Hystersis | OTH | | | | 30 | | ℃ |
| $V_{OUT}$ Temperature Coefficient | TC | | | | 30 | | ppm/℃ |
| Power Supply Rejection | PSRR | $I_O$ = 100mA<br>$C_O$=22μF ceramic | f=1kHz | | 70 | | dB |
| | | | f=10kHz | | 50 | | |
| | | | f=100kHz | | 40 | | |
| Output Voltage Noise | eN | f=10Hz to 100kHz<br>$I_O$ = 10mA | $C_O$=22μF | | 30 | | μVrms |
| | | | $C_O$=47μF | | 20 | | |

**Note 1.** $V_{IN(MIN)} = V_{OUT} + V_{DROPOUT}$

## DETAILED DESCRIPTION

The BM9164 family of BiCMOS regulators contain a pass transistor, voltage reference, error amplifier, over-current protection, thermal shutdown, and short circuit protection.

The P-channel pass transistor receives data from the error amplifier, over-current shutdown, short output protection, and thermal protection circuits. During normal operation, the error amplifier compares the output voltage to a precision reference. Over-current and Thermal shutdown circuits become active when the junction temperature exceeds 150℃, or the current exceeds 2.2A. During thermal shutdown, the output voltage remains low. Normal operation is restored when the junction temperature drops below 120 ℃.

The BM9164 behaves like a current source when the load reaches 2.2A. However, if the load impedance drops below 0.3Ω, the current drops back to 600mA to prevent excessive power dissipation. Normal operation is restored when the load resistance exceeds 0.75Ω.

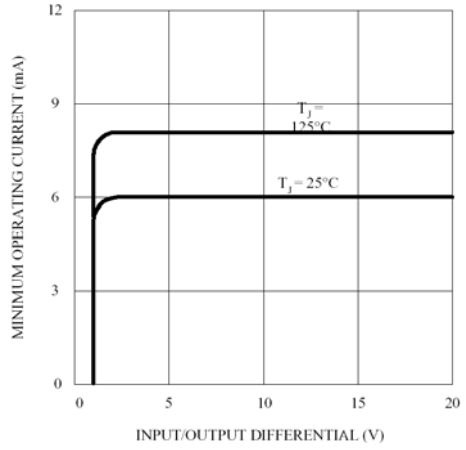
## EXTERNAL CAPACITOR

The BM9164 is stable with an output capacitor to ground of 22μF or greater. Ceramic capacitors have the lowest ESR, and will offer the best AC performance. Conversely, Aluminum Electrolytic capacitors exhibit the highest ESR, resulting in the poorest AC response. Unfortunately, large value ceramic capacitors are comparatively expensive. One option is to parallel a 0.1μF ceramic capacitor with a 22μF Aluminum Electrolytic. The benefit is low ESR, high capacitance, and low overall cost.

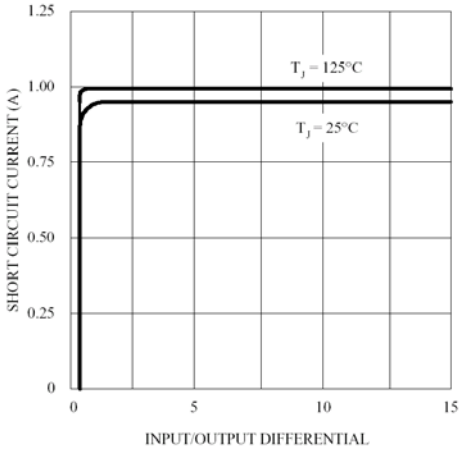
A second capacitor is recommended between the input and ground to stabilize VIN. The input capacitor should be larger than 22μF to have a beneficial effect. All capacitors should be placed in close proximity to the pins. A “quiet” ground termination is desirable.

## TYPICAL ELECTRICAL CHARACTERISTICS

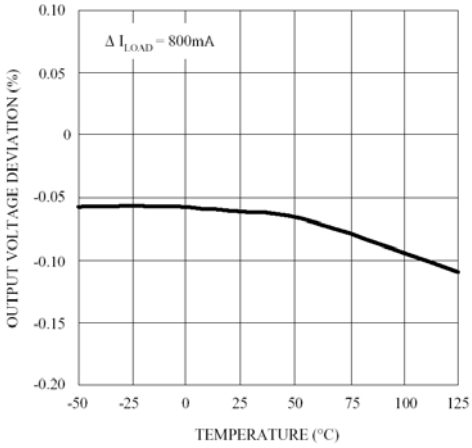
### Minimum Operating Current



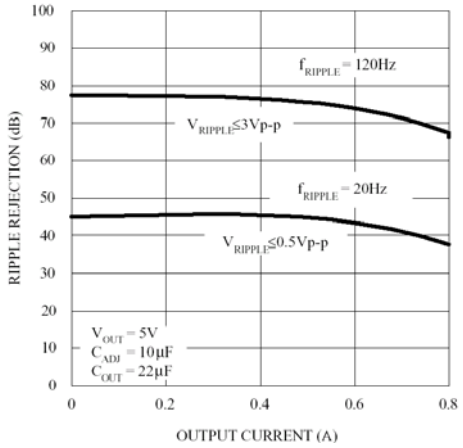

### Short-Circuit Current



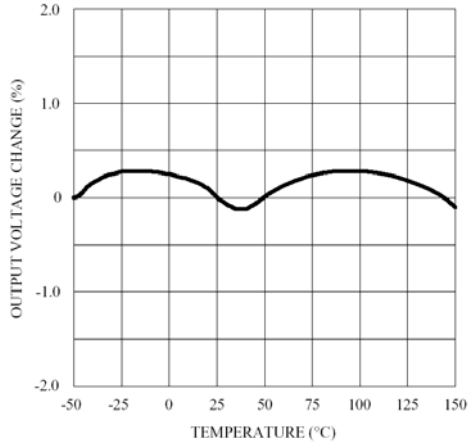

### Load Regulation



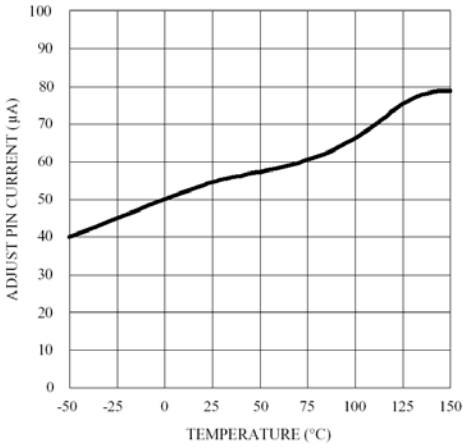

### Ripple Rejection vs. Current



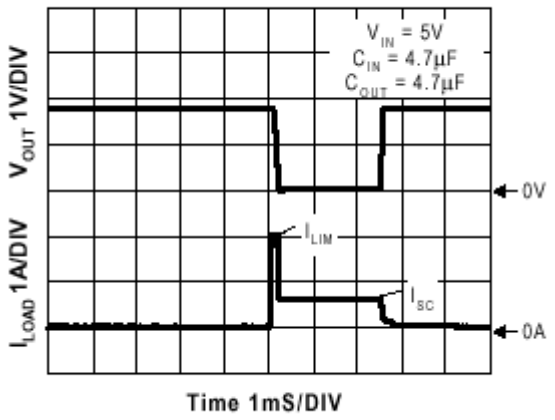

### Temperature Stability



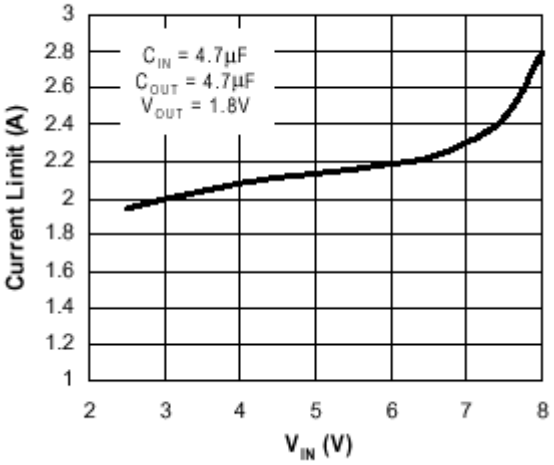

### GND Pin Current



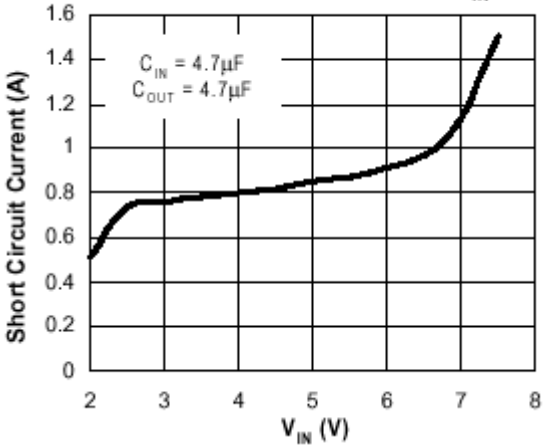
**Current Limit Response**



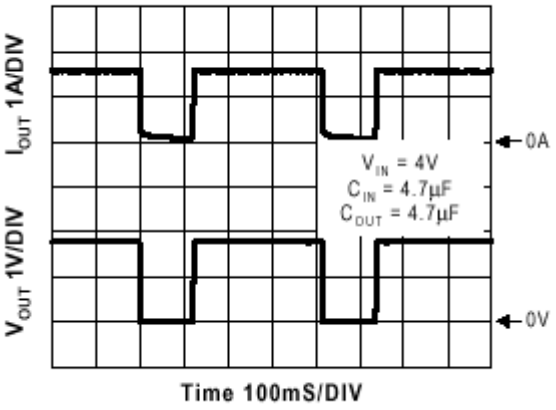

**Current Limit Vs. $V_{IN}$**

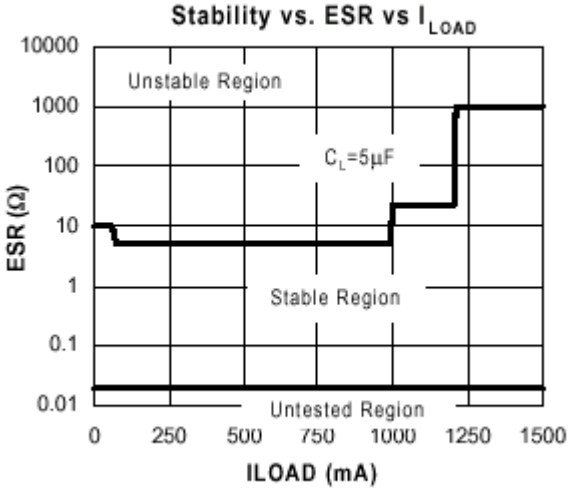


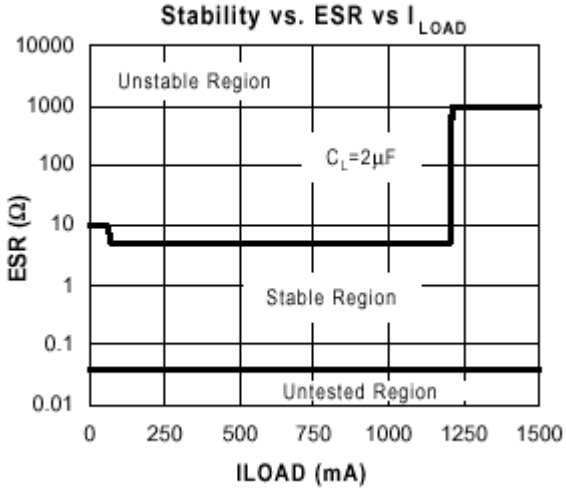

**Short Circuit Current VS. $V_{IN}$**

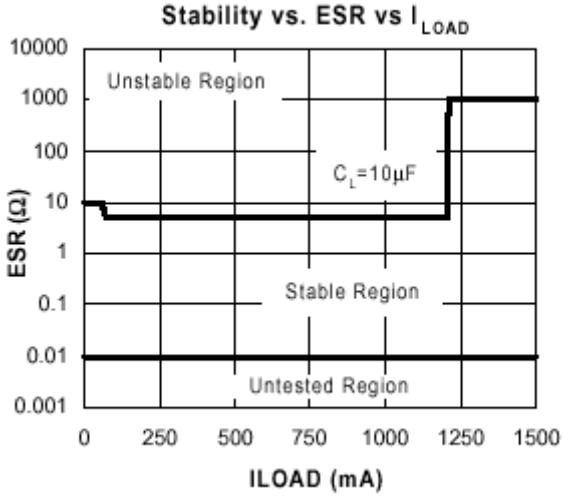



**Overtemperature Shutdown**



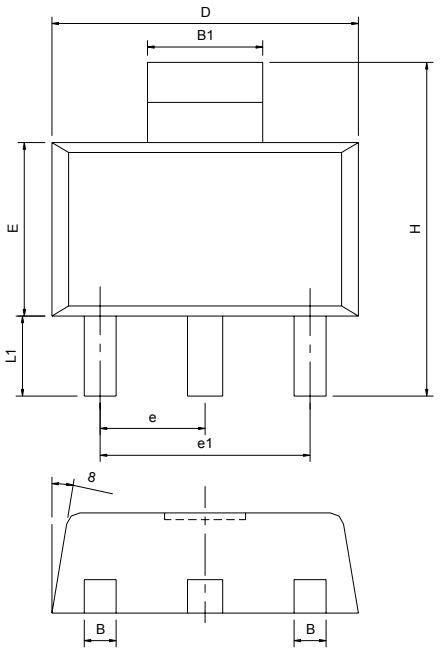

Stability vs. ESR vs I LOAD
10000
1000
100
10
1
0.1
0.01
ESR (Ω)
Unstable Region
C L=5µF
Stable Region
Untested Region
0
250
500
750
1000
1250
1500
ILOAD (mA)

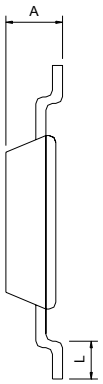

Stability vs. ESR vs I LOAD
10000
1000
100
10
1
0.1
0.01
ESR (Ω)
Unstable Region
C L=2µF
Stable Region
Untested Region
0
250
500
750
1000
1250
1500
ILOAD (mA)


Stability vs. ESR vs I LOAD
10000
1000
100
10
1
0.1
0.01
0.001
ESR (Ω)
Unstable Region
C L=10µF
Stable Region
Untested Region
0
250
500
750
1000
1250
1500
ILOAD (mA)

## PACKAGE DIMENSION

### SOT-223 (M223)




| SYMBOLS | DIMENSIONS IN MILLIMETERS | | | DIMENSIONS IN INCHS | | |
|---|---|---|---|---|---|---|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 1.50 | --- | 1.80 | 0.0591 | --- | 0.0709 |
| B | 0.60 | --- | 0.838 | 0.0236 | --- | 0.033 |
| B1 | 2.895 | --- | 3.15 | 0.114 | --- | 0.124 |
| D | 6.299 | --- | 6.706 | 0.248 | --- | 0.264 |
| E | 3.30 | --- | 3.708 | 0.1299 | --- | 0.146 |
| e | --- | 2.30BSC | --- | --- | 0.090SC | --- |
| e1 | --- | 4.60BSC | --- | --- | 0.181BSC | --- |
| H | 6.70 | --- | 7.30 | 0.2638 | --- | 0.2874 |
| L | --- | 0.91MIN | --- | --- | 0.036MIN | --- |
| L1 | --- | 2.00MAX | --- | --- | 0.079MAX | --- |
| θ | --- | --- | 13° | --- | --- | 13° |
| | | | | | | |