# 200mΩ Power Distribution Switches

## Features

- 200mΩ Typ. High-Side MOSFET
- 0.8A Current Limit ($V_{IN}$=3.0V)
- Wide Input Voltage Range: 2V ～ 5.5V
- Soft Start
- Thermal Protection
- Small SOT-23-5 Package Minimizes Board Space

## Description

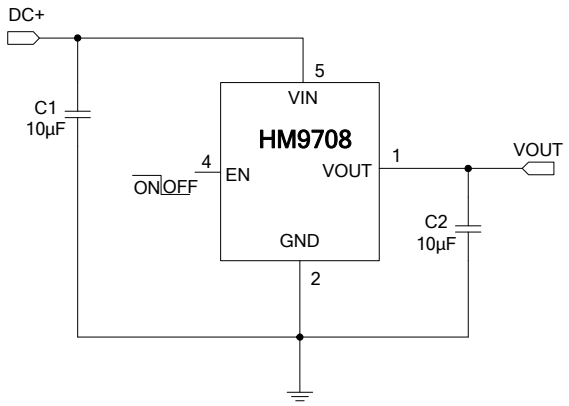
The HM9708 is an integrated 200mΩ power switch for self-powered and bus-powered Universal Series Bus (USB) applications. Its low quiescent supply current (50μA) and small package (SOT-23-5) is particularly suitable in battery-powered portable equipment.

Several protection functions include soft start to limit inrush current during plug-in, current limiting at 0.8A($V_{IN}$=3.0V) and thermal shutdown to protect damage under over current conditions.

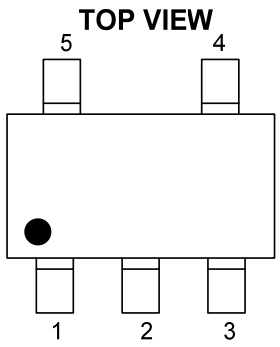
## Applications

- Battery-Powered Equipment
- Motherboard USB Power Switch
- USB Device Power Switch
- Hot-Plug Power Supplies
- Battery-Charger Circuits

## Typical Application Circuit



## Pin Assignment




| Number | Name | Function |
|---|---|---|
| 1 | VOUT | Output Pin |
| 2 | GND | Ground |
| 3 | NC | No Used |
| 4 | EN | ON/OFF Control (High Enable) |
| 5 | VIN | Power Input |

## Absolute Maximum Ratings (Note 1)

- Supply Voltage .....7V
- Chip Enable.....-0.3V ～ 7V
- Power Dissipation, $P_D$ @ $T_A$ = 25°C.....SOT-23-5 0.25W
- Operating Temperature Range..... -40℃ ～ +85℃
- Storage Temperature Range.....-65℃ ～ +150℃
- Junction Temperature .....-40℃ ～ +125℃
- Lead Temperature.....+265℃

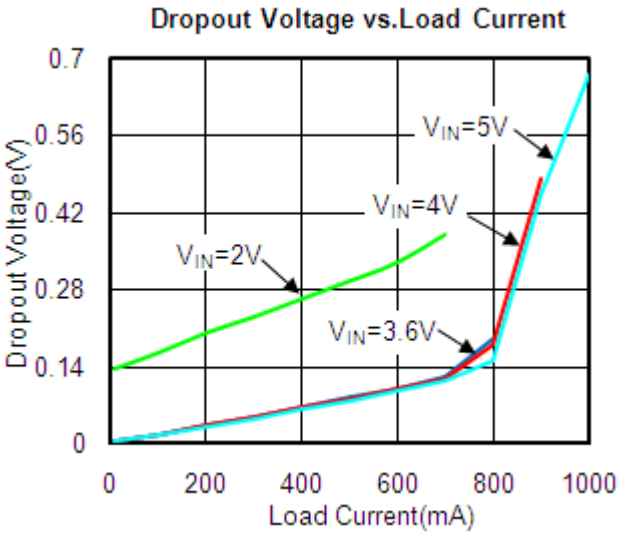
**Note 1:** Stresses listed as the above "Absolute Maximum Ratings" may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may remain possibility to affect device reliability.

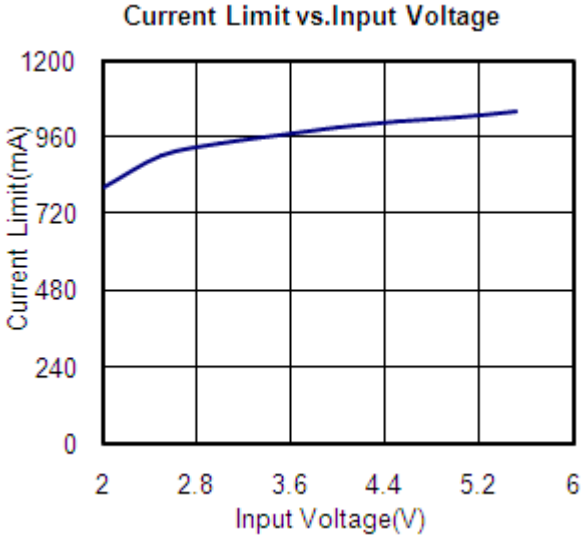
## Electrical Characteristics

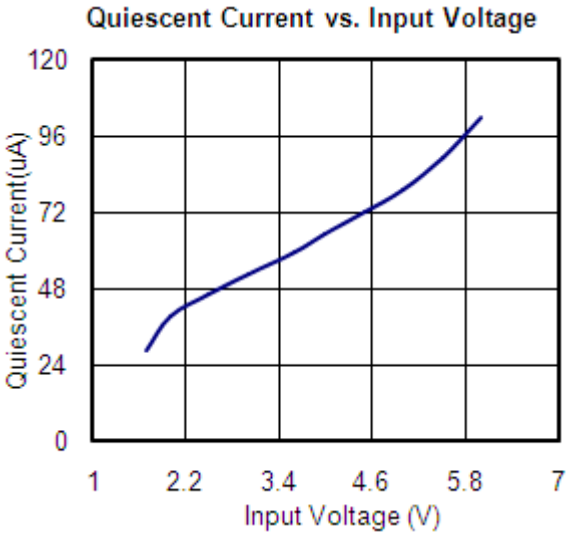
Operating Conditions: TA = 25℃, $V_{IN}$ = 5V, $C_{IN}$ = $C_{OUT}$ = 10μF, unless otherwise specified.

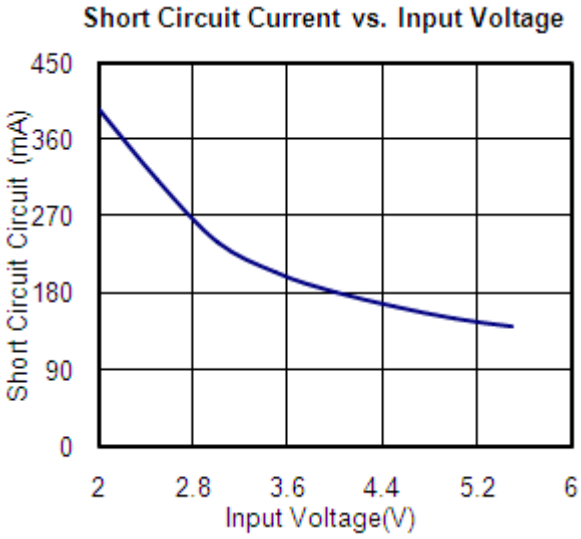
| SYMBOL | PARAMETER | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| $V_{IN}$ | Input Voltage Range | | 2 | | 5.5 | V |
| $R_{DS(ON)}$ | Output NMOFET $R_{DS(ON)}$ | $V_{IN}$=5.0V,$I_{LOAD}$=500 mA | 100 | 200 | 250 | mΩ |
| $I_Q$ | Supply Current | $V_{IN}$=3.0V | | 50 | | μA |
| | | $V_{IN}$=5.0V | 40 | 80 | 160 | μA |
| $I_{LIMIT}$ | Current Limit Threshold | $V_{IN}$=3.0V | | 800 | | mA |
| $V_{ENH}$ | EN Input High Threshold | | 1.5 | | | V |
| $V_{ENL}$ | EN Input Low Threshold | | | | 0.6 | V |
| $I_{OFF}$ | Shutdown Supply Current | $V_{EN}$ = 0V | | 0.5 | 1 | μA |
| $V_{UVLO}$ | VIN Under Voltage Lockout | $I_{OUT}$=300mA, $V_{IN}$: 2.4V→0V | | 1.7 | | V |
| $\Delta V_{UVLO}$ | VIN Under Voltage Hysterics | | | 150 | | mV |
| $T_{SD}$ | Thermal Limit | | | 130 | | ℃ |
| $\Delta T_{SD}$ | Thermal Limit Hysterics | | | 20 | | ℃ |

## Typical Operating Characteristics

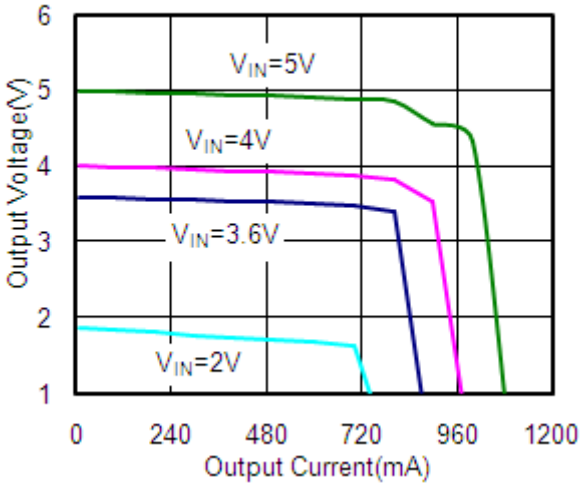


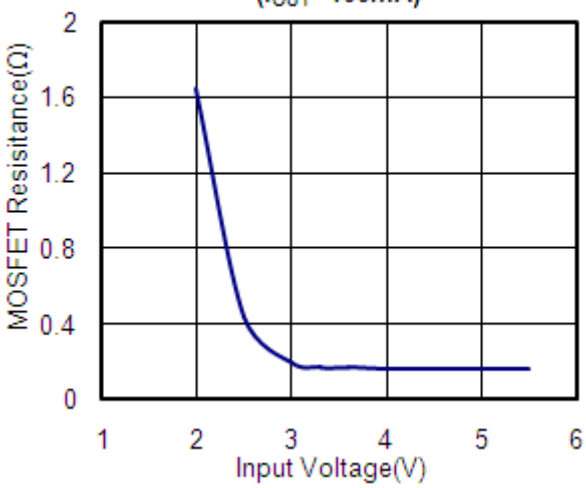



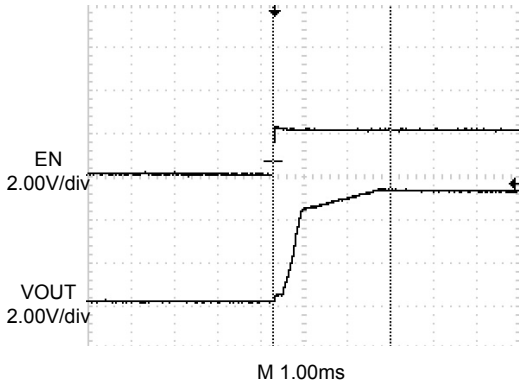
Output Voltage vs. Output Current



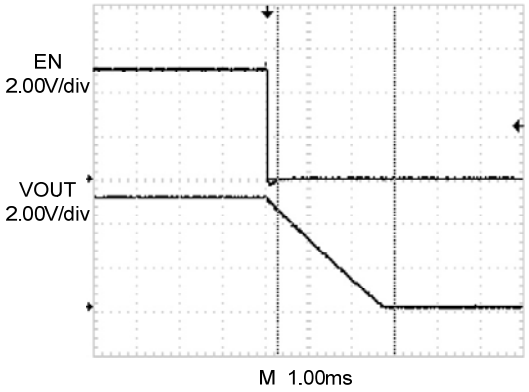

Resisitace
($I_{OUT}$=100mA)




EN Turn-On Response




EN Turn-Off Response



## Pin Description

**VOUT (Pin 1):** Ideal Diode Cathode and Output. Bypass VOUT with ESR capacitor. However stability improves with higher ESRs.

**GND (Pin 2):** Power and Signal Ground for the IC.

**NC (Pin 3):** No used.

**EN (Pin 4):** Status Condition Indicator. This pin indicates the conducting status of the HM9708. If the part is forward biased ($V_{IN} > V_{OUT} + V_{FWD}$) this pin will be Hi-Z. If the part is reverse biased ($V_{OUT} > V_{IN} + V_{RTO}$), then this pin will pull down 10mA through an open-drain. When terminated to a high voltage through a 470k resistor, a high voltage indicates diode conducting. May be left floating or grounded when not in use.

**VIN (Pin 5):** Ideal Diode Anode and Positive Power Supply for HM9708. When operating HM9708 as a switch it must be bypassed with a low ESR ceramic capacitor.

## Application Information

The HM9708 is a high-side single switch with active-high enable input.

**Input and Output**

VIN (input) is the power supply connection to the circuitry and the drain of the output MOSFET. VOUT (output) is the source of the output MOSFET. In a typical circuit, current flows through the switch from VIN to VOUT toward the load. Both VOUT pins must be short on the board and connected to the load and so do both VIN pins but connected to the power source.

**Thermal Shutdown**

Thermal shutdown shuts off the output MOSFET if the die temperature exceeds 130℃ and 20℃ of hysterics forces the switch turning off until the die temperature drops to 110℃.

**Filtering**

To limit the input voltage drop during hot-plug events connect a 10μF ceramic capacitor from $V_{IN}$ to GND. However, higher capacitor values will further reduce the voltage drop at the input.

Connect a sufficient capacitor from $V_{OUT}$ to GND. This capacitor helps to prevent inductive parasitics from pulling $V_{OUT}$ negative during turn-off or EMI damage to other components during the hot detachment. It is also necessary for meeting the USB specification during hot plug-in operation. If

HM9708 is implanted in device end application, minimum 1μF capacitor from $V_{OUT}$ to GND is recommended and higher capacitor values are also preferred.

In choosing these capacitors, special attention must be paid to the Effective Series Resistance, ESR, of the capacitors to minimize the IR drop across the capacitor's ESR. A lower ESR on this capacitor can get a lower IR drop during the operation.

Ferrite beads in series with all power and ground lines are recommended to eliminate or significantly reduce EMI. In selecting a ferrite bead, the DC resistance of the wire used must be kept to a minimum to reduce the voltage drop.

**Soft Start**

In order to eliminate the upstream voltage droop caused by the large inrush current during hot-plug events, the "soft-start" feature effectively isolates power supplies from such highly capacitive loads.

**Under-voltage Lockout**

UVLO prevents the MOSFET switch from turning on until input voltage exceeds 1.7V (typical). If input voltage drops below 1.7V (typical), UVLO shuts off the MOSFET switch.

**Current Limiting and Short Protection**

The current limit circuit is designed to protect the system supply, the MOSFET switch and the load from damage caused by excessive currents. The current limit threshold is set internally to limit the output current to approximately0.8A typical($V_{IN}$=3.0V). When the output is short to ground, it will limit to a constant current 30mA until thermal shutdown or short condition removed.

**Reverse current preventing**

The output MOSFET and driver circuitry are also designed to allow the MOSFET source to be externally forced to a higher voltage than the drain ($V_{OUT} > V_{IN} \geq 0$). To prevent reverse current from such condition, HM9708 will automatically shut off the MOSFET.

**Layout and Thermal Dissipation**

1. Place the switch as close to the USB connector as possible. Keep all traces as short as possible to reduce the effect of undesirable parasitic Inductance.

2. Place the output capacitor and ferrite beads as close to the USB connector as possible. If ferrite beads are used, use wires with minimum resistance and large solder pads to minimize connection resistance.

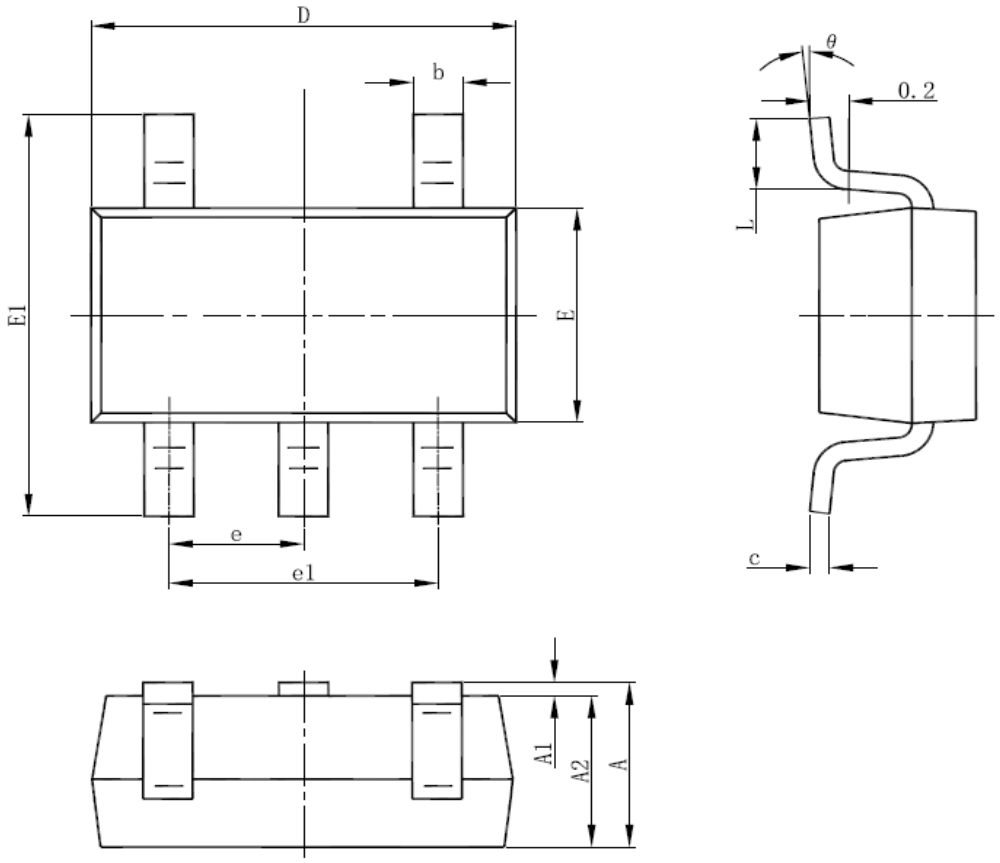
3. If ferrite beads are used, use wires with minimum resistance and large solder pads to minimize connection resistance.

4. If the package is with dual VOUT or VIN pins, short both the same function pins to reduce the internal turn-on resistance. If the output power will be delivered to two individual ports, it is especially necessary to short both VOUT pin at the switch output side in order to protect the switch when each port is plug-in separately.

5. Under normal operating conditions, the package can dissipate the channel heat away. Wide power bus planes connected to VIN and VOUT and a ground plane in contact with the device will help dissipate additional heat.

## Package Information

SOT-23-5 Package Outline Dimension




| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| A | 1.050 | 1.250 | 0.041 | 0.049 |
| A1 | 0.000 | 0.100 | 0.000 | 0.004 |
| A2 | 1.050 | 1.150 | 0.041 | 0.045 |
| b | 0.300 | 0.500 | 0.012 | 0.020 |
| c | 0.100 | 0.200 | 0.004 | 0.008 |
| D | 2.820 | 3.020 | 0.111 | 0.119 |
| E | 1.500 | 1.700 | 0.059 | 0.067 |
| E1 | 2.650 | 2.950 | 0.104 | 0.116 |
| e | 0.950(BSC) | | 0.037(BSC) | |
| e1 | 1.800 | 2.000 | 0.071 | 0.079 |
| L | 0.300 | 0.600 | 0.012 | 0.024 |
| θ | 0° | 8° | 0° | 8° |