DESCRIPTION

The MPM3808C is an easy-to-use, fully integrated, synchronous step-down power module with a built-in inductor and MOSFET switches. It can achieve up to 3A of continuous output current (I_{OUT}), with excellent load and line regulation.

The constant-on-time (COT) control scheme provides fast transient response and eases loop stabilization. Fault protections include cycle-by-cycle current limiting and thermal shutdown. An open-drain power good (PG) signal indicates whether the output voltage (V_{OUT}) exceeds 90% of its nominal voltage.

The MPM3808C is well-suited for a wide range of applications, including high-performance digital signal processors (DSPs), advanced driver assistance system (ADAS) sensors, portable and mobile devices, and other low-power systems with constrained areas.

The MPM3808C requires a minimal number of readily available, standard external components, and is available in a small QFN-15 (3mmx4mmx1.6mm) package.

FEATURES

- Designed for Automotive Applications:
  - Wide 2.5V to 5.5V Operating \( V_{IN} \) Range
  - Up to 3A Output Current (I_{OUT})
  - 1\% Feedback (FB) Accuracy
  - -40°C to +150°C Operating \( T_J \) Range
  - Available in AEC-Q100 Grade 1

- High Performance for Improved Thermals:
  - 65mΩ and 35mΩ Integrated Internal Power MOSFETs

- Optimized for EMC and EMI:
  - FCCM Across the Full Load Range
  - 2.4MHz Switching Frequency (f\(_{SW}\))
  - MeshConnect™ Flip-Chip Package

- Optimized for Board Size and BOM:
  - Integrated Internal Power MOSFETs
  - Integrated Compensation Network
  - Available in a QFN-15 (3mmx4mmx1.6mm) Package
  - Fixed Output Options (1): 0.8V, 1V, 1.1V, 1.2V, 1.25V, 1.5V, 1.8V, 2.5V, 2.8V, and 3.3V

- Additional Features:
  - Enable (EN) for Power Sequencing
  - Power Good (PG)
  - 100\% Duty Cycle
  - External Soft Start (SS) Control
  - Output Discharge
  - Output Over-Voltage Protection (OVP)
  - Short-Circuit Protection (SCP) with Hiccup Mode
  - Available in a Wettable Flank Package

APPLICATIONS

- Camera Modules
- ADAS Sensors
- Automotive Infotainment
- Automotive V2X

Note:

1) See the Ordering Information section on page 3 for the availability of each fixed output version. Contact MPS for details on additional output voltages that may be available.

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TYPICAL APPLICATION

Typical Application (Adjustable Output)

Typical Application (Fixed Output)

Efficiency vs. Load Current

VOUT = 1.2V
Vin=2.5V
Vin=3.3V
Vin=5.5V

Efficiency (%)
LOAD CURRENT (mA)

0 10 20 30 40 50 60 70 80 90 100
1 10 100 1000
ORDERING INFORMATION

<table>
<thead>
<tr>
<th>Part Number* (2)</th>
<th>Output Voltage</th>
<th>Package</th>
<th>Top Marking</th>
<th>MSL Rating**</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPM3808CGLE-AEC1***</td>
<td>Adjustable</td>
<td>QFN-15 (3mmx4mmx1.6mm)</td>
<td>See Below</td>
<td>1</td>
</tr>
<tr>
<td>MPM3808CGLE-12-AEC1***</td>
<td>Fixed 1.2V</td>
<td>QFN-15 (3mmx4mmx1.6mm)</td>
<td>See Below</td>
<td>1</td>
</tr>
<tr>
<td>MPM3808CGLE-18-AEC1***</td>
<td>Fixed 1.8V</td>
<td>QFN-15 (3mmx4mmx1.6mm)</td>
<td>See Below</td>
<td>1</td>
</tr>
</tbody>
</table>

* For Tape & Reel, add suffix -Z (e.g. MPM3808CGLE-AEC1-Z).
** Moisture Sensitivity Level Rating
*** Wettable flank

Note:
2) Contact MPS for details on additional output voltages that may be available.

TOP MARKING (MPM3808CGLE-AEC1)

MPYW
3808
CLLL
ME

MP: MPS prefix
Y: Year code
W: Week code
3808: First four digits of the part number
C: FCCM
LLL: Lot number
M: Module
E: Wettable flank frame

TOP MARKING (MPM3808CGLE-12-AEC1)

MPYW
3808
CLLL
ME12

MP: MPS prefix
Y: Year code
W: Week code
3808: First four digits of the part number
C: FCCM
LLL: Lot number
M: Module
E: Wettable flank frame
12: 1.2V fixed-output version of the MPM3808C
TOP MARKING (MPM3808CGLE-18-AEC1)

MPYW
3808
CLLL
ME18

MP: MPS prefix
Y: Year code
W: Week code
3808: First four digits of the part number
C: FCCM
LLL: Lot number
M: Module
E: Wettable flank frame
18: 1.8V fixed-output version of the MPM3808C

PACKAGE REFERENCE

QFN-15 (3mm x 4mm x 1.6mm)
PIN FUNCTIONS

<table>
<thead>
<tr>
<th>Pin #</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FB</td>
<td>Feedback. In the adjustable-output version of the MPM3808C, connect the FB pin to an external resistor divider from the output to GND to set the output voltage (V_{OUT}). To set the regulation voltage, the FB voltage (V_{FB}) is compared to the 0.6V internal reference voltage (V_{REF}). In the fixed-output version of the MPM3808C, float this pin.</td>
</tr>
<tr>
<td>2</td>
<td>PG</td>
<td>Power good indicator. The PG pin is an open-drain output. Connect PG to a voltage source using an external resistor. When V_{FB} exceeds 90% of V_{REF}, PG is pulled high. If V_{FB} drops below 85% of V_{REF}, PG is pulled low to GND. Float this pin if it is not used.</td>
</tr>
<tr>
<td>3</td>
<td>VIN</td>
<td>Input supply. The MPM3808C operates from a 2.5V to 5.5V input. A decoupling capacitor is required to prevent large voltage spikes at the input.</td>
</tr>
<tr>
<td>4, 5, 6</td>
<td>SW</td>
<td>Switch output. The SW pin is the internal, high-side P-channel MOSFET drain, and is connected internally to the power inductor.</td>
</tr>
<tr>
<td>7, 8, 9</td>
<td>OUT</td>
<td>Power output. Connect the OUT pin to the load. An output capacitor (C_{OUT}) is required to reduce the voltage ripple.</td>
</tr>
<tr>
<td>10, 11</td>
<td>GND</td>
<td>IC ground. Connect the GND pin to the negative terminals of the input and output capacitors using large copper areas. Use several vias to connect GND to the ground plane.</td>
</tr>
<tr>
<td>12</td>
<td>EN</td>
<td>Enable. Pull EN below the 0.65V falling threshold to shut down the chip. Pull EN above the 0.9V rising threshold to enable the chip. There is an internal 2MΩ resistor from EN to ground.</td>
</tr>
<tr>
<td>13</td>
<td>SS</td>
<td>Soft start. Connect a capacitor between SS and GND to set the soft-start (SS) timer to avoid start-up inrush current. The minimum recommended soft-start capacitance (C_{SS}) is 1nF.</td>
</tr>
<tr>
<td>14</td>
<td>OUT_S</td>
<td>Output sense. OUT_S is the sensing pin for V_{OUT} and the discharge path to the 150Ω resistor load.</td>
</tr>
<tr>
<td>15</td>
<td>DNC</td>
<td>Do not connect. This pad is connected internally to SW. Do not route or place vias under this area.</td>
</tr>
</tbody>
</table>

ABSOLUTE MAXIMUM RATINGS (3)

All pins..........................-0.3V to +6.5V
Continuous power dissipation (T_A = 25°C) (4) (8)
QFN-15 (3mmx4mmx1.6mm)..................2.4W
Operating junction temperature ..........150°C
Lead temperature..........................260°C
Storage temperature.............-65°C to +150°C

ESD Ratings

Human body model (HBM)..............Class 2 (5)
Charged device model (CDM).............Class 2b (6)

Recommended Operating Conditions

Input voltage (V_{IN})...................2.5V to 5.5V
Output voltage (V_{OUT}).............0.6V to V_{IN} - 0.5V
Load current range.....................0A to 3A
Operating junction temp (T_J) .........-40°C to +150°C

Thermal Resistance \( \theta_{JA} \) \( \theta_{JC} \)

QFN-15 (3mmx4mmx1.6mm)
JESD51-7................................65......14..°C/W (7)
EVM3808C-LE-00A.............53........10..°C/W (8)

Notes:

3) Exceeding these ratings may damage the device.
4) The maximum allowable power dissipation is a function of the maximum junction temperature, \( T_J \) (MAX), the junction-to-ambient thermal resistance, \( \theta_{JA} \), and the ambient temperature, \( T_A \). The maximum allowable continuous power dissipation at any ambient temperature is calculated by \( P_D (MAX) = (T_J (MAX) - T_A) / \theta_{JA} \). Exceeding the maximum allowable power dissipation can produce an excessive die temperature, and the regulator may go into thermal shutdown. Internal thermal shutdown circuitry protects the device from permanent damage.

5) Per AEC-Q100-002.
6) Per AEC-Q100-011.
7) Measured on JESD51-7, a 4-layer PCB. The values given in this table are only valid for comparison with other packages and cannot be used for design purposes. These values were calculated in accordance with JESD51-7, and simulated on a specified JEDEC board. They do not represent the performance obtained in an actual application. The \( \theta_{JC} \) value shows the thermal resistance from the junction-to-case bottom.
8) Measured on the standard EVB, a 4-layer, 2oz, copper PCB (6.3cmx6.3cm). The \( \theta_{JC} \) value shows the thermal resistance from the junction-to-case top.
ELECTRICAL CHARACTERISTICS

\( V_{\text{IN}} = 3.6\, \text{V}, \ T_{J} = -40^\circ\text{C} \) to \( +150^\circ\text{C}, \) typical values are at \( T_{J} = 25^\circ\text{C}, \) unless otherwise noted.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input Supply</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Under-voltage lockout (UVLO) rising threshold</td>
<td>( V_{\text{UVLO_RISING}} )</td>
<td></td>
<td>2.3</td>
<td>2.45</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>( V_{\text{IN}} ) UVLO falling threshold</td>
<td>( V_{\text{UVLO_FALLING}} )</td>
<td>2.1</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( V_{\text{IN}} ) UVLO hysteresis</td>
<td>( V_{\text{UVLO_HYS}} )</td>
<td>0.2</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( V_{\text{IN}} ) quiescent current</td>
<td>( I_{Q} )</td>
<td>( V_{\text{EN}} = 2, \text{V}, \ V_{\text{FB}} = 0.63, \text{V}, \ V_{\text{IN}} = 3.6, \text{V}, \ T_{J} = 25^\circ\text{C} )</td>
<td>460</td>
<td>650</td>
<td></td>
<td>( \mu\text{A} )</td>
</tr>
<tr>
<td>( V_{\text{IN}} ) shutdown current</td>
<td>( I_{\text{SHDN}} )</td>
<td>( V_{\text{EN}} = 0, \text{V}, \ T_{J} = 25^\circ\text{C} )</td>
<td>0.01</td>
<td>1</td>
<td></td>
<td>( \mu\text{A} )</td>
</tr>
<tr>
<td>( V_{\text{IN}} ) shutdown current</td>
<td>( I_{\text{SHDN}} )</td>
<td>( V_{\text{EN}} = 0, \text{V}, \ T_{J} = -40^\circ\text{C} ) to ( +150^\circ\text{C} )</td>
<td>3</td>
<td></td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>( V_{\text{IN}} ) over-voltage protection (OVP) rising threshold</td>
<td>( V_{\text{IN}_\text{OVP_RISING}} )</td>
<td>After ( V_{\text{OUT}} ), OVP is enabled</td>
<td>6.15</td>
<td>6.15</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>( V_{\text{IN}} ) OVP falling threshold</td>
<td>( V_{\text{IN}_\text{OVP_FALLING}} )</td>
<td>5.95</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( V_{\text{IN}} ) OVP hysteresis</td>
<td>( V_{\text{IN}_\text{OVP_HYS}} )</td>
<td>0.2</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Frequency, Switches, and Inductors</strong></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Switching frequency</td>
<td>( f_{\text{SW}} )</td>
<td></td>
<td>2000</td>
<td>2400</td>
<td>2640</td>
<td>kHz</td>
</tr>
<tr>
<td>Minimum on time</td>
<td>( t_{\text{ON_MIN}} )</td>
<td>( V_{\text{IN}} = 5, \text{V} )</td>
<td>50</td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Minimum off time</td>
<td>( t_{\text{OFF_MIN}} )</td>
<td>( V_{\text{IN}} = 5, \text{V} )</td>
<td>80</td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Maximum duty cycle</td>
<td>( D_{\text{MAX}} )</td>
<td></td>
<td>100</td>
<td></td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Switch leakage current</td>
<td>( I_{\text{SW_LKG}} )</td>
<td>( V_{\text{EN}} = 0, \text{V}, \ V_{\text{IN}} = 6, \text{V}, \ V_{\text{SW}} = 0, \text{V} ) or ( 6, \text{V}, \ T_{J} = 25^\circ\text{C} )</td>
<td>0</td>
<td>1</td>
<td></td>
<td>( \mu\text{A} )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( V_{\text{EN}} = 0, \text{V}, \ V_{\text{IN}} = 6, \text{V}, \ V_{\text{SW}} = 0, \text{V} ) or ( 6, \text{V}, \ T_{J} = -40^\circ\text{C} ) to ( +125^\circ\text{C} )</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>High-side MOSFET (HS-FET) on resistance</strong></td>
<td>( R_{\text{DS(on)_HS}} )</td>
<td>( V_{\text{IN}} = 5, \text{V} )</td>
<td>65</td>
<td>85</td>
<td>mΩ</td>
<td></td>
</tr>
<tr>
<td><strong>Low-side MOSFET (LS-FET) on resistance</strong></td>
<td>( R_{\text{DS(on)_LS}} )</td>
<td>( V_{\text{IN}} = 5, \text{V} )</td>
<td>35</td>
<td>55</td>
<td>mΩ</td>
<td></td>
</tr>
<tr>
<td><strong>Integrated inductor value</strong></td>
<td>( L )</td>
<td></td>
<td>376</td>
<td>470</td>
<td>564</td>
<td>nH</td>
</tr>
<tr>
<td><strong>Integrated inductor DC resistance</strong></td>
<td>( R_{L} )</td>
<td></td>
<td>25</td>
<td>65</td>
<td>mΩ</td>
<td></td>
</tr>
<tr>
<td><strong>Integrated inductor saturation current</strong></td>
<td>( I_{\text{L_SAT}} )</td>
<td></td>
<td>4.8</td>
<td>5.4</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td><strong>Output and Regulation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FB voltage (adjustable output)</td>
<td>( V_{\text{FB}} )</td>
<td>( T_{J} = 25^\circ\text{C} )</td>
<td>0.594</td>
<td>0.6</td>
<td>0.606</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( T_{J} = -40^\circ\text{C} ) to ( +150^\circ\text{C} )</td>
<td>0.591</td>
<td>0.6</td>
<td>0.609</td>
<td>V</td>
</tr>
<tr>
<td>Output regulation voltage (fixed output)</td>
<td>( V_{\text{OUT_REG}} )</td>
<td>1.2V fixed output</td>
<td>1.176</td>
<td>1.2</td>
<td>1.224</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.8V fixed output</td>
<td>1.764</td>
<td>1.8</td>
<td>1.836</td>
<td>V</td>
</tr>
<tr>
<td>FB input current</td>
<td>( I_{\text{FB}} )</td>
<td>Adjustable output</td>
<td>50</td>
<td>100</td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.2V fixed output</td>
<td>3</td>
<td>8</td>
<td></td>
<td>( \mu\text{A} )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.8V fixed output</td>
<td>5</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( V_{\text{OUT}} ) discharge resistance</td>
<td>( R_{\text{DIS}} )</td>
<td>( V_{\text{EN}} = 0, \text{V}, \ V_{\text{OUT}} = 1.2, \text{V} )</td>
<td>150</td>
<td></td>
<td>Ω</td>
<td></td>
</tr>
</tbody>
</table>
ELECTRICAL CHARACTERISTICS (*continued*)

$V_{IN} = 3.6V$, $T_J = -40^\circ C$ to $+150^\circ C$, typical values are at $T_J = 25^\circ C$, unless otherwise noted.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enable (EN)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EN rising threshold</td>
<td>$V_{EN,RISING}$</td>
<td></td>
<td>0.9</td>
<td>1.2</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>EN falling threshold</td>
<td>$V_{EN,FALLING}$</td>
<td></td>
<td>0.4</td>
<td>0.65</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>EN threshold hysteresis</td>
<td>$V_{EN,HYS}$</td>
<td></td>
<td>0.25</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EN turn-on delay</td>
<td></td>
<td>Pull EN high to enable SW</td>
<td>100</td>
<td></td>
<td>µs</td>
<td></td>
</tr>
<tr>
<td>EN turn-off delay</td>
<td></td>
<td>Pull EN low to stop switching</td>
<td>30</td>
<td></td>
<td>µs</td>
<td></td>
</tr>
<tr>
<td>EN pull-down resistor</td>
<td></td>
<td></td>
<td>2</td>
<td>MΩ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EN input current</td>
<td>$I_{EN}$</td>
<td>$V_{EN} = 2V$</td>
<td>1.2</td>
<td></td>
<td>µA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{EN} = 0V$</td>
<td>0</td>
<td></td>
<td>µA</td>
<td></td>
</tr>
<tr>
<td>Soft Start (SS)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soft-start current</td>
<td>$I_{SS}$</td>
<td></td>
<td>1.5</td>
<td>3</td>
<td>4.5</td>
<td>µA</td>
</tr>
<tr>
<td>Power Good (PG)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PG rising threshold</td>
<td>$PG_{VTH,RISING}$</td>
<td>FB rising edge</td>
<td>87</td>
<td>90</td>
<td>93</td>
<td>% of $V_{FB}$</td>
</tr>
<tr>
<td>PG falling threshold</td>
<td>$PG_{VTH,FALLING}$</td>
<td>FB falling edge</td>
<td>82</td>
<td>85</td>
<td>88</td>
<td>% of $V_{FB}$</td>
</tr>
<tr>
<td>PG logic high voltage</td>
<td>$V_{PG,HIGH}$</td>
<td>$V_{IN} = 5V$, $V_{FB} = 0.6V$</td>
<td>4.9</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>PG sink current capability</td>
<td>$V_{PG,LOW}$</td>
<td>Sink 1mA</td>
<td>0.4</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>PG rising deglitch</td>
<td>$t_{PGOOD_R}$</td>
<td></td>
<td>80</td>
<td></td>
<td>µs</td>
<td></td>
</tr>
<tr>
<td>PG falling deglitch</td>
<td>$t_{PGOOD_F}$</td>
<td></td>
<td>80</td>
<td></td>
<td>µs</td>
<td></td>
</tr>
<tr>
<td>PG leakage current (high)</td>
<td></td>
<td>5V logic high</td>
<td>100</td>
<td></td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>PG self-bias</td>
<td></td>
<td>$V_{IN} = 0V$, $V_{EN} = 0V$, PG is pulled up between 3V and 5.5V via a 100kΩ resistor</td>
<td></td>
<td></td>
<td></td>
<td>0.7</td>
</tr>
<tr>
<td>Protections</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High-side (HS) peak current limit</td>
<td>$I_{LIMIT,HS}$</td>
<td></td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>A</td>
</tr>
<tr>
<td>Low-side (LS) valley current limit</td>
<td>$I_{LIMIT,LS}$</td>
<td></td>
<td>1.5</td>
<td>3</td>
<td>4.5</td>
<td>A</td>
</tr>
<tr>
<td>LS reverse current limit</td>
<td></td>
<td>Current flows from SW to GND</td>
<td>1.2</td>
<td></td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Thermal shutdown</td>
<td>$T_{SD}$</td>
<td></td>
<td>170</td>
<td></td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Thermal shutdown hysteresis</td>
<td>$T_{SD,HYS}$</td>
<td></td>
<td>20</td>
<td></td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Output over-voltage (OV) threshold</td>
<td>$V_{OVP}$</td>
<td></td>
<td>110</td>
<td>115</td>
<td>120</td>
<td>% of $V_{FB}$</td>
</tr>
<tr>
<td>Output OVP hysteresis</td>
<td>$V_{OVP,HYS}$</td>
<td></td>
<td>10</td>
<td></td>
<td>% of $V_{FB}$</td>
<td></td>
</tr>
<tr>
<td>OVP delay</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>µs</td>
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**Note:**

9) Not tested in production. Guaranteed by design and characterization.
TYPICAL CHARACTERISTICS

\(V_{\text{IN}} = 3.6V, T_J = -40^\circ\text{C} \text{ to } +150^\circ\text{C}, \) unless otherwise noted.
TYPICAL CHARACTERISTICS (continued)

$V_{\text{in}} = 3.6\,\text{V}$, $T_J = -40^\circ\text{C}$ to $+150^\circ\text{C}$, unless otherwise noted.

- **HS-FET On Resistance vs. Temperature**
  - $R_{\text{DS(ON)}_\text{HS}}$ (m$\Omega$) vs. Temperature ($^\circ\text{C}$)

- **LS-FET On Resistance vs. Temperature**
  - $R_{\text{DS(ON)}_\text{LS}}$ (m$\Omega$) vs. Temperature ($^\circ\text{C}$)

- **N-Channel MOSFET Valley Current Limit vs. Temperature**
  - $I_{\text{LIMIT}\_\text{VALLEY}}$ (A) vs. Temperature ($^\circ\text{C}$)

- **P-Channel MOSFET Peak Current Limit vs. Temperature**
  - $I_{\text{LIMIT}\_\text{PEAK}}$ (A) vs. Temperature ($^\circ\text{C}$)

- **LS-FET Reverse Current Limit vs. Temperature**
  - $I_{\text{LIMIT}\_\text{REVERSE}}$ (A) vs. Temperature ($^\circ\text{C}$)

- **PG Threshold vs. Temperature**
  - PG Threshold (% of $V_{FB}$) vs. Temperature ($^\circ\text{C}$)
**TYPICAL CHARACTERISTICS (continued)**

$V_{IN} = 3.6V$, $T_J = -40°C$ to $+150°C$, unless otherwise noted.

![Soft-Start Current vs. Temperature](chart.png)
TYPICAL PERFORMANCE CHARACTERISTICS

\( V_{\text{IN}} = 3.3\, \text{V}, \; V_{\text{OUT}} = 1.2\, \text{V}, \; C_{\text{OUT}} = 22\mu\text{F}, \; T_{\text{A}} = 25^\circ\text{C}, \) unless otherwise noted.

![Efficiency vs. Load Current](image1)

![Power Loss vs. Load Current](image2)

![Efficiency vs. Load Current](image3)

![Power Loss vs. Load Current](image4)

![Case Temperature Rise](image5)

![Case Temperature Rise](image6)
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

\( V_{\text{IN}} = 3.3\, \text{V}, \quad V_{\text{OUT}} = 1.2\, \text{V}, \quad C_{\text{OUT}} = 22\, \mu\text{F}, \quad T_{\text{A}} = 25^\circ\text{C}, \) unless otherwise noted.

![Load Regulation](image)

\( V_{\text{OUT}} = 1.2\, \text{V} \)

![Line Regulation](image)

\( V_{\text{OUT}} = 1.2\, \text{V} \)
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

$V_{\text{IN}} = 3.3\text{V}, V_{\text{OUT}} = 1.2\text{V}, C_{\text{OUT}} = 22\mu\text{F}, T_A = 25^\circ\text{C}$, unless otherwise noted.
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

\[ V_{IN} = 3.3V, \quad V_{OUT} = 1.2V, \quad C_{OUT} = 22\mu F, \quad T_A = 25^\circ C, \quad \text{unless otherwise noted.} \]

Start-Up through EN
\[ I_{OUT} = 0A \]

Shutdown through EN
\[ I_{OUT} = 0A \]

SCP Entry
\[ I_{OUT} = 0A \]

\[ V_{EN}, \quad V_{OUT}, \quad I_L, \quad V_{SW} \]
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

\( V_{IN} = 3.3 \text{V}, \ V_{OUT} = 1.2 \text{V}, \ C_{OUT} = 22 \mu\text{F}, \ T_A = 25^\circ\text{C}, \) unless otherwise noted.

**SCP Recovery**

\( I_{OUT} = 0 \text{A} \)

**Short-Circuit Protection**

\( I_{OUT} = 0 \text{A} \)

**PG Start-Up through VIN**

\( I_{OUT} = 3 \text{A} \)

**PG Shutdown through VIN**

\( I_{OUT} = 3 \text{A} \)

**PG Start-Up through EN**

\( I_{OUT} = 3 \text{A} \)
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

\[ V_{IN} = 3.3V, \quad V_{OUT} = 1.2V, \quad C_{OUT} = 22\mu F, \quad T_{A} = 25°C, \quad \text{unless otherwise noted.} \]

---

**PG Shutdown through EN**

- \( I_{OUT} = 3A \)

**Load Transient Response**

- \( I_{OUT} = 0A \) to \( 1.5A \), \( 1A/\mu s \)

---

**Load Transient Response**

- \( I_{OUT} = 1.5 \) to \( 3A \), \( 1A/\mu s \)
FUNCTIONAL BLOCK DIAGRAM

Figure 1: Functional Block Diagram (Adjustable Output)

Figure 2: Functional Block Diagram (Fixed Output)
OPERATION

The MPM3808C employs input voltage ($V_{IN}$) feed-forward and constant-on-time (COT) control to stabilize the switching frequency ($f_{SW}$) across the entire $V_{IN}$ range. The device can achieve 3A of output current ($I_{OUT}$) across a 2.5V to 5.5V $V_{IN}$ range, with excellent load and line regulation. The output voltage ($V_{OUT}$) can be regulated to as low as 0.6V. A 100% maximum duty cycle can be reached in low-dropout (LDO) mode.

Constant-On-Time (COT) Control and Forced Continuous Conduction Mode (FCCM)

The MPM3808C’s COT control provides a simpler control loop and faster transient response. The switching cycles have a fixed minimum off time ($t_{OFF\_MIN}$) to prevent inductor current ($I_L$) runaway during load transients. If the low-side MOSFET (LS-FET) turns on, it remains on for at least $t_{MIN\_OFF}$ (typically 80ns). The high-side MOSFET (HS-FET) turns on once the feedback (FB) voltage ($V_{FB}$) drops below the reference voltage ($V_{REF}$). This indicates an insufficient $V_{OUT}$. $V_{IN}$ feed-forward allows the device to maintain a nearly constant $f_{SW}$ across the input range and load range. The $f_{SW}$ on time ($t_{ON}$) can be calculated with Equation (1):

$$t_{ON} = \frac{V_{OUT}}{V_{IN}} \times 400\text{ns} \quad (1)$$

To improve frequency stability and reduce output voltage ripple, the MPM3808C operates in forced continuous conduction mode (FCCM), which has a constant $f_{SW}$ (see Figure 3).

Enable (EN) Control

The enable (EN) pin is a digital control pin that turns the MPM3808C on and off. Pull EN above 0.9V to turn the converter on; pull EN below 0.65V or float EN to turn it off. Pulling EN to GND also disables the device. There is an internal 2MΩ resistor connected between EN and GND.

Output Discharge

If the MPM3808C shuts down, the device initiates output discharge mode. The internal discharge MOSFET provides a resistive discharge path for the output capacitor (C2) between the OUT pin and GND. To block the output discharge path, add an external capacitor between $V_{OUT}$ and the OUT pin.

Soft Start (SS)

The MPM3808C features external soft start (SS). To avoid overshoot during start-up, the SS pin ramps up $V_{OUT}$ at a controlled slew rate. SS’s charge current is typically 3µA. The soft-start time ($t_{SS}$) is determined by the external SS capacitor ($C_{SS}$). $t_{SS}$ can be calculated with Equation (2):

$$t_{SS}(\text{ms}) = \frac{C_{SS} \text{(nF)} \times 0.6\text{V}}{I_{SS}(\mu\text{A})} \quad (2)$$

Where $I_{SS}$ is the internal SS charge current (3µA).

It is recommended for $C_{SS}$ to be ≥1nF.

The MPM3808C has a pre-biased start-up function. Once EN is pulled above 0.9V, the converter starts up regardless of any pre-biased voltage on the output. Pre-biased start-up works even while the output discharge path is blocked.

Peak Current Limit and Valley Current Limit

Both the HS-FET and LS-FET feature current-limit protection. If $I_L$ reaches the HS-FET’s peak current limit ($I_{LIMIT\_PEAK}$) threshold (typically 5A), the HS-FET turns off and the LS-FET turns on to discharge the energy. The HS-FET does not turn on again until $I_L$ drops below the valley current limit ($I_{LIMIT\_VALLEY}$) threshold (typically 3A). This prevents current runaway during overload and short-circuit events. The valley current limit is blocked unless the HS-FET turns off due to the triggered peak current limit.

---

**Figure 3: FCCM**
Short-Circuit Protection (SCP) and Recovery
If a short-circuit condition occurs, the MPM3808C reaches its current limit immediately. Meanwhile, \( V_{\text{OUT}} \) drops until \( V_{\text{FB}} \) falls below 50% of \( V_{\text{REF}} \), which is considered an output dead short. Short-circuit protection (SCP) with hiccup mode is triggered to periodically restart the part. In hiccup mode, the output power stage is disabled, and the SS voltage (\( V_{\text{SS}} \)) is discharged. Once \( V_{\text{SS}} \) is discharged completely, the device initiates a new SS. This process repeats until the fault condition is removed.

Over-Voltage Protection (OVP)
The MPM3808C monitors \( V_{\text{FB}} \) to detect over-voltage (OV) conditions. If \( V_{\text{FB}} \) exceeds 115% of \( V_{\text{REF}} \), then the converter enters its dynamic regulation period. During this period, the LS-FET remains on until its current reaches -1.2A. This process discharges \( V_{\text{OUT}} \) to keep it within its normal range. If the OV condition still remains after this process, there is a 1.5\( \mu \text{s} \) delay before the LS-FET turns on again. Once \( V_{\text{FB}} \) falls below 105% of \( V_{\text{REF}} \), the converter exits the regulation period.

If the dynamic regulation period cannot prevent \( V_{\text{OUT}} \) from increasing, and a 6.1V \( V_{\text{IN}} \) is detected, then over-voltage protection (OVP) is triggered. The device stops switching until \( V_{\text{IN}} \) drops below 6V. Once \( V_{\text{IN}} \) drops below 6V, the MPM3808C resumes normal operation.

Power Good (PG) Indicator
The MPM3808C has a power good (PG) output to indicate whether the converter is operating normally after start-up. PG is the open drain of an internal MOSFET. It is recommended that this MOSFET's maximum on resistance (\( R_{\text{DS(ON)}} \)) be below 400\( \Omega \). PG can be connected to \( V_{\text{IN}} \) or an external voltage source via an external resistor (10k\( \Omega \) to 100k\( \Omega \)). Once \( V_{\text{IN}} \) is applied, the MOSFET turns on and PG is pulled to GND before SS is ready. After \( V_{\text{FB}} \) reaches 90% of \( V_{\text{REF}} \), PG is pulled high by the external voltage source. If \( V_{\text{FB}} \) drops to 85% of \( V_{\text{REF}} \), then the PG voltage (\( V_{\text{PG}} \)) is pulled to GND to indicate an output failure.

If \( V_{\text{IN}} \) and EN are not available, and PG is pulled up via an external power supply, then PG self-biases and asserts. If a 100k\( \Omega \) pull-up resistor is being used, then \( V_{\text{PG}} \) should be below 0.7V.
APPLICATION INFORMATION

Setting the Output Voltage

The external resistor divider sets the MPM3808C’s adjustable V_{OUT}, which can be set from 0.6V to V_{IN} - 0.5V. Select a feedback (FB) resistor (R1) to reduce the V_{OUT} leakage current (typically between 10kΩ and 100kΩ). R2 can then be calculated with Equation (3):

\[ R2 = \frac{R1}{V_{OUT} - 1} \times 0.6 \]  

Figure 4 shows the FB network.

![Figure 4: Feedback Network](image)

Table 1 shows the recommended resistor values for common output voltages.

<table>
<thead>
<tr>
<th>V_{OUT} (V)</th>
<th>R1 (kΩ)</th>
<th>R2 (kΩ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30.9 (1%)</td>
<td>47 (1%)</td>
</tr>
<tr>
<td>1.2</td>
<td>100 (1%)</td>
<td>100 (1%)</td>
</tr>
<tr>
<td>1.8</td>
<td>36 (1%)</td>
<td>18 (1%)</td>
</tr>
<tr>
<td>2.5</td>
<td>51 (1%)</td>
<td>16 (1%)</td>
</tr>
<tr>
<td>3.3</td>
<td>68 (1%)</td>
<td>15 (1%)</td>
</tr>
</tbody>
</table>

For the fixed-output version of the MPM3808C, it is not necessary to connect the external divider resistor. FB can be floated.

Frequency Scaling at Low Input Voltages

Under heavy-load conditions, the HS-FET voltage decreases as t_{ON} increases, and the duty cycle is extended. If t_{OFF_MIN} is reached at a low V_{IN} and under heavy-load conditions, then f_{SW} scales down. To maintain a constant f_{SW} during heavy-load operation, a larger V_{OUT} is required for a larger V_{IN}. For a 1.8V V_{OUT} at a 3A load, V_{IN} should exceed 2.9V to keep f_{SW} above 2MHz.

If the frequency begins to scale down, V_{IN} can be estimated with Equation (4):

\[ V_{IN} = \frac{V_{OUT} + R_{DS(ON)_HS} \times I_{OUT}}{1 - \frac{t_{OFF_MIN}}{400 \times 10^{-9}}} \]  

Where the maximum t_{OFF_MIN} is 125ns. (10)

Note:
10) Guaranteed by design and bench characterization. Not tested in production.

Selecting the Input Capacitor

The step-down converter has a discontinuous input current (I_{IN}), and requires a capacitor to supply AC current to the converter while maintaining the DC V_{IN}. For the best performance, it is recommended to use low-ESR capacitors. Ceramic capacitors with X5R or X7R dielectrics are strongly recommended due to their low ESR and small temperature coefficients. For most applications, a 10µF capacitor is sufficient. Higher output voltages may require a 22µF capacitor to increase system stability.

The input capacitor (C1) requires an adequate ripple current rating to absorb the switching I_{IN}. C1’s RMS current rating (I_{C1}) can be estimated with Equation (5):

\[ I_{C1} = I_{LOAD} \times \sqrt{\frac{V_{OUT}}{V_{IN}} \left(1 - \frac{V_{OUT}}{V_{IN}}\right)} \]  

The worst-case scenario occurs at V_{IN} = 2 x V_{OUT}, which can be calculated with Equation (6):

\[ I_{C1} = \frac{I_{LOAD}}{2} \]  

For simplification, choose an input capacitor with an RMS current rating that exceeds half of the maximum load current.

C1 can be an electrolytic, tantalum, or ceramic capacitor. When using electrolytic or tantalum capacitors, place a small, high-quality, 0.1µF ceramic capacitor as close to the IC as possible. When using ceramic capacitors, ensure that the capacitor has sufficient capacitance to prevent excessive voltage ripple at the input.

The V_{IN} ripple (\Delta V_{IN}) can be estimated with Equation (7):
\[ \Delta V_{IN} = \frac{I_{LOAD}}{f_{SW}} \times \frac{V_{OUT}}{C1} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right) \]  

(7)

Selecting the Output Capacitor

The output capacitor (C2) stabilizes the DC \( V_{OUT} \). It is recommended to use ceramic capacitors for C2. Low-ESR capacitors are recommended to effectively limit the \( V_{OUT} \) ripple (\( \Delta V_{OUT} \)). \( \Delta V_{OUT} \) can be estimated with Equation (8):

\[ \Delta V_{OUT} = \frac{V_{OUT}}{f_{SW} \times L_1} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right) \times \left(\frac{R_{ESR}}{8} + \frac{1}{f_{SW} \times C2}\right) \]  

(8)

Where \( L_1 \) is the inductance, and \( R_{ESR} \) is C2's equivalent series resistance (ESR).

When using ceramic capacitors, the capacitance dominates the impedance at \( f_{SW} \) and causes the majority of \( \Delta V_{OUT} \). For simplification, \( \Delta V_{OUT} \) can be estimated with Equation (9):

\[ \Delta V_{OUT} = \frac{V_{OUT}}{8 \times f_{SW}^2 \times L_1 \times C2} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right) \]  

(9)

Ceramic capacitors with X7R or X5R dielectrics are highly recommended due to their low ESR and small temperature coefficients.

For tantalum or electrolytic capacitors, the ESR dominates the impedance at \( f_{SW} \). For simplification, \( \Delta V_{OUT} \) can be estimated with Equation (10):

\[ \Delta V_{OUT} = \frac{V_{OUT}}{f_{SW} \times L_1} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right) \times R_{ESR} \]  

(10)

C2's characteristics can also affect the stability of the regulation system.

Output Discharge Blocking

If the device is disabled, an internal resistive discharge path between the OUT_S pin and GND is enabled to discharge C2. The discharge path can be blocked by adding an external capacitor between \( V_{OUT} \) and the OUT_S pin (see Figure 5).

\[ \Delta V_{OUT} = \frac{V_{OUT}}{8 \times f_{SW}^2 \times L_1 \times C2} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right) \]  

(9)

Figure 5: Circuit with \( V_{OUT} \) Discharge Blocking

Discharge blocking is supported by the adjustable-output version. For the fixed-output versions, the OUT_S pin should be directly connected to the output to regulate \( V_{OUT} \).

To avoid influencing the loop and load transient, select a \( \geq 10nF \) blocking capacitor. It is recommended to use a 10nF to 100nF blocking capacitor. A larger-value blocking capacitor does not have an impact on loop performance, but it is physically larger and is typically unnecessary for the best results.
PCB Layout Guidelines (11)
The MPM3808C’s integrated inductor simplifies the PCB layout design, but some considerations must still be taken to ensure proper operation. A 4-layer layout is recommended to improve EMC and thermal performance, although the device can operate sufficiently in a 2-layer layout. For the best results, refer to Figure 6 and follow the guidelines below:

1. Place the high-current paths (GND and VIN) very close to the device using short, direct, and wide traces.
2. Use large copper areas to minimize conduction loss and thermal stress.
3. Place the ceramic input capacitors as close to VIN as possible.
4. Place several vias close to the capacitor’s GND terminal and the GND pin on the IC to minimize high-frequency noise.
5. Place the FB resistors as close as possible to the FB pin to ensure that the trace connected to FB is as short as possible.
6. Use multiple vias to connect the power planes to the internal layer.

Note:
11) The recommended PCB layout is based on Figure 7 on page 23.
TYPICAL APPLICATION CIRCUITS

Figure 7: Typical Application (Adjustable Output, \( V_{OUT} = 1.2V \))

Figure 8: Typical Application (Adjustable Output, \( V_{OUT} = 1.8V \))
TYPICAL APPLICATION CIRCUITS (continued)

Figure 9: Typical Application (Fixed Output, \( V_{\text{OUT}} = 1.2V \))

Figure 10: Typical Application (Fixed Output, \( V_{\text{OUT}} = 1.8V \))
PACKAGE INFORMATION

QFN-15 (3mmx4mmx1.6mm)
Wettable Flank

NOTE:
1) ALL DIMENSIONS ARE IN MILLIMETERS.
2) SHADED AREA IS THE KEEP-OUT ZONE. ANY PCB METAL TRACE AND VIA ARE NOT ALLOWED TO CONNECT TO THIS AREA ELECTRICALLY OR MECHANICALLY.
3) THE LEAD SIDE IS WETTABLE.
4) LEAD COPLANARITY SHALL BE 0.08 MILLIMETERS MAX.
5) JEDEC REFERENCE IS MO-220.
6) DRAWING IS NOT TO SCALE.

RECOMMENDED LAND PATTERN
# CARRIER INFORMATION

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<th>Package Description</th>
<th>Quantity/Reel</th>
<th>Quantity/Tube</th>
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<th>Carrier Tape Width</th>
<th>Carrier Tape Pitch</th>
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<td>8mm</td>
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<td>2500</td>
<td>N/A</td>
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<td>12mm</td>
<td>8mm</td>
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**Feed Direction**

[Diagrams and labels for feed direction and carrier information are not visible in this text representation.]
## REVISION HISTORY

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<th>Revision Date</th>
<th>Description</th>
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