Description

The XR79206 is part of a family of 40V synchronous step-down power modules combining the controller, drivers, inductor, passive components and MOSFETs in a single package for point-of-load supplies. This module requires very few external components, leading to ease of design and fast time to market. The XR79206 has a load current rating of 6A. A wide 5V to 40V input voltage range allows for single supply operation from industry standard 24V ±10%, 18V to 36V and rectified 18VAC and 24VAC rails.

With a proprietary emulated current mode Constant On-Time (COT) control scheme, the XR79206 provides extremely fast line and load transient response using ceramic output capacitors. It requires no loop compensation, simplifying circuit implementation and reducing overall component count. The control loop also provides 0.2% load and 0.1% line regulation and maintains constant operating frequency. A selectable power saving mode, allows the user to operate in Discontinuous Current Mode (DCM) at light current loads significantly increasing the converter efficiency.

A host of protection features, including overcurrent, over temperature, short-circuit and UVLO, help achieve safe operation under abnormal operating conditions.

The XR79206 is available in a RoHS-compliant, green / halogen-free space-saving 10mm x 10mm x 4mm QFN package.

Typical Application

![Typical Application Diagram]

**Figure 1. Typical Application**
**Absolute Maximum Ratings**

These are stress ratings only and functional operation of the device at these ratings or any other above those indicated in the operation sections of the specifications below is not implied. Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device. Exposure to any absolute maximum rating condition for extended periods may affect device reliability and lifetime.

- $P_{VIN}, V_{IN}$: -0.3V to 43V
- $V_{CC}$: -0.3V to 6.0V
- BST: -0.3V to 48V
- BST-SW: -0.3V to 6V
- SW, ILIM: -1V to 43V
- All other pins: -0.3V to $V_{CC} + 0.3V$

**Operating Conditions**

- $PV_{IN}, V_{IN}$: 5V to 40V
- SW, ILIM: -1V to 40V
- PGOOD, $V_{CC}$, TON, SS, EN, FB: -0.3V to 5.5V
- Switching frequency: 400kHz-800kHz
- Junction temperature range ($T_J$): -40°C to 125°C
- Package power dissipation max at 25°C: 5.5W
- Package thermal resistance $\theta_{JA}$: 18.1°C/W

**Electrical Characteristics**

$T_J = 25°C$, $V_{IN} = 24V$, BST = $V_{CC}$, SW = AGND = PGND = 0V, $C_{VCC} = 4.7\mu F$, unless otherwise specified. Limits applying over the full operating temperature range are denoted by a •.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{IN}$</td>
<td>Input voltage range</td>
<td>$V_{CC}$ regulating</td>
<td>•</td>
<td>5</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>$I_{VIN}$</td>
<td>$V_{IN}$ supply current</td>
<td>Not switching, $V_{IN} = 24V$, $V_{FB} = 0.7V$</td>
<td>•</td>
<td>0.7</td>
<td>2</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 500kHz$, $R_{ON} = 124k\Omega$, $V_{FB} = 0.58V$</td>
<td></td>
<td>10</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>$I_{OFF}$</td>
<td>Shutdown current</td>
<td>Enable = 0V, $P_{VIN} = V_{IN} = 24V$</td>
<td>1</td>
<td></td>
<td></td>
<td>$\mu$A</td>
</tr>
</tbody>
</table>

**Enable and Undervoltage Lock-Out (UVLO)**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{IH_EN_1}$</td>
<td>EN pin rising threshold</td>
<td></td>
<td>1.8</td>
<td>1.9</td>
<td>2.0</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EN_HYS_1}$</td>
<td>EN pin hysteresis</td>
<td></td>
<td>70</td>
<td></td>
<td></td>
<td>mV</td>
</tr>
<tr>
<td>$V_{IH_EN_2}$</td>
<td>EN pin rising threshold for DCM / CCM</td>
<td></td>
<td>2.8</td>
<td>3.0</td>
<td>3.1</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EN_HYS_2}$</td>
<td>EN pin hysteresis</td>
<td></td>
<td>110</td>
<td></td>
<td></td>
<td>mV</td>
</tr>
<tr>
<td>$V_{CC_UVLO}$</td>
<td>UVLO start threshold</td>
<td>Rising edge</td>
<td>4.00</td>
<td>4.25</td>
<td>4.40</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CC_UVLO}$</td>
<td>UVLO hysteresis</td>
<td></td>
<td>195</td>
<td></td>
<td></td>
<td>mV</td>
</tr>
</tbody>
</table>
## Electrical Characteristics (Continued)

$T_J = 25°C$, $V_{IN} = 24V$, BST = $V_{CC}$, SW = AGND = PGND = 0V, $C_{VCC} = 4.7μF$, unless otherwise specified. Limits applying over the full operating temperature range are denoted by a •.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>• Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{REF}$</td>
<td>Reference voltage</td>
<td>$V_{IN} = 5V$ to 40V, $V_{CC}$ regulating</td>
<td>0.596</td>
<td>0.600</td>
<td>0.604</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• $V_{IN} = 40V$</td>
<td>0.594</td>
<td>0.600</td>
<td>0.606</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>DC load regulation</td>
<td>$CCM$ operation, closed loop, applies to any $C_{OUT}$</td>
<td>±0.2</td>
<td>%</td>
<td></td>
<td>%</td>
</tr>
<tr>
<td></td>
<td>DC line regulation</td>
<td></td>
<td>±0.1</td>
<td>%</td>
<td></td>
<td>%</td>
</tr>
<tr>
<td>$T_{ON(MIN)}$</td>
<td>Minimum programmable on-time</td>
<td>$R_{ON} = 14kΩ$, $V_{IN} = 40V$</td>
<td>120</td>
<td>ns</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$T_{ON1}$</td>
<td>On-time 1</td>
<td>$R_{ON} = 14kΩ$, $V_{IN} = 24V$</td>
<td>• 180</td>
<td>200</td>
<td>220</td>
<td>ns</td>
</tr>
<tr>
<td>$T_{ON2}$</td>
<td>On-time 2</td>
<td>$R_{ON} = 35.7kΩ$, $V_{IN} = 24V$</td>
<td>• 420</td>
<td>470</td>
<td>520</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>On-time 2 frequency</td>
<td>$R_{ON} = 35.7kΩ$, $V_{OUT} = 5.0V$, $I_{OUT} = 6A$</td>
<td>425</td>
<td>470</td>
<td>525</td>
<td>kHz</td>
</tr>
<tr>
<td>$T_{OFF(MIN)}$</td>
<td>Minimum off-time</td>
<td>•</td>
<td>250</td>
<td>350</td>
<td></td>
<td>ns</td>
</tr>
</tbody>
</table>

### Diode Emulation Mode

- Zero crossing threshold: DC value measured during test -2 mV

### Soft-Start

- SS charge current: • -14 -10 -6 µA
- SS discharge current: Fault present • 1 mA

### $V_{CC}$ Linear Regulator

- $V_{CC}$ output voltage: $V_{IN} = 6V$ to 40V, $I_{LOAD} = 0$ to 30mA • 4.8 5.0 5.2 V
  - $V_{IN} = 5V$, $I_{LOAD} = 0$ to 20mA • 4.51 4.8 V

### Power Good Output

- Power Good threshold: -10 -7 -5 %
- Power Good hysteresis: 1.5 4 %
- Power Good sink current: 1 mA
### Electrical Characteristics (Continued)

\( T_J = 25^\circ\text{C}, \; V_{\text{IN}} = 24\text{V}, \; \text{BST} = V_{\text{CC}}, \; \text{SW} = \text{AGND} = \text{PGND} = 0\text{V}, \; C_{\text{VCC}} = 4.7\mu\text{F}, \) unless otherwise specified. Limits applying over the full operating temperature range are denoted by a •.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>•</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Protection: OCP, OTP, Short-Circuit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hiccup timeout</td>
<td></td>
<td></td>
<td>110</td>
<td></td>
<td>ms</td>
<td></td>
</tr>
<tr>
<td>( I_{\text{LIM}} / R_{\text{DS}} )</td>
<td></td>
<td></td>
<td></td>
<td>2.40</td>
<td>2.85</td>
<td>3.20</td>
<td>( \mu\text{A/m}\Omega )</td>
</tr>
<tr>
<td>( I_{\text{LIM}} ) current temperature coefficient</td>
<td></td>
<td></td>
<td></td>
<td>0.4</td>
<td></td>
<td>%/°C</td>
<td></td>
</tr>
<tr>
<td>( I_{\text{LIM}} ) comparator offset</td>
<td>•</td>
<td></td>
<td>-8</td>
<td>0</td>
<td>8</td>
<td>mV</td>
<td></td>
</tr>
<tr>
<td>Current limit blanking</td>
<td>GL rising &gt; 1V</td>
<td></td>
<td></td>
<td>100</td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Thermal shutdown threshold</td>
<td>Rising temperature</td>
<td></td>
<td></td>
<td>150</td>
<td></td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Thermal hysteresis</td>
<td></td>
<td></td>
<td></td>
<td>15</td>
<td></td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Feedback pin short-circuit threshold</td>
<td>Percent of ( V_{\text{REF}} ), short circuit is active. After PGOOD is asserted</td>
<td>•</td>
<td></td>
<td>50</td>
<td>60</td>
<td>70</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td>Output Power Stage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( R_{\text{DSON}} )</td>
<td>High-side MOSFET ( R_{\text{DSON}} ) ( I_{\text{DS}} = 2\text{A} )</td>
<td></td>
<td></td>
<td>41</td>
<td>59</td>
<td></td>
<td>mΩ</td>
</tr>
<tr>
<td>( R_{\text{DSON}} )</td>
<td>Low-side MOSFET ( R_{\text{DSON}} )</td>
<td></td>
<td></td>
<td>17.6</td>
<td>21.5</td>
<td></td>
<td>mΩ</td>
</tr>
<tr>
<td>( I_{\text{OUT}} )</td>
<td>Maximum output current</td>
<td>•</td>
<td></td>
<td>6</td>
<td></td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>( L )</td>
<td>Output inductance</td>
<td></td>
<td></td>
<td>1.8</td>
<td>2.2</td>
<td>2.6</td>
<td>( \mu\text{H} )</td>
</tr>
<tr>
<td>( C_{\text{IN}} )</td>
<td>Input capacitance</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td>( \mu\text{F} )</td>
<td></td>
</tr>
<tr>
<td>( C_{\text{BST}} )</td>
<td>Bootstrap capacitance</td>
<td></td>
<td></td>
<td>0.1</td>
<td></td>
<td>( \mu\text{F} )</td>
<td></td>
</tr>
</tbody>
</table>
## Pin Configuration

![Pin Configuration Diagram]

### Pin Functions

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Pin Name</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SS</td>
<td>A</td>
<td>Soft-start pin. Connect an external capacitor between SS and AGND to program the soft-start rate based on the 10μA internal source current.</td>
</tr>
<tr>
<td>2</td>
<td>PGOOD</td>
<td>OD, O</td>
<td>Power-good output. This open-drain output is pulled low when V\textsubscript{OUT} is outside the regulation.</td>
</tr>
<tr>
<td>3</td>
<td>FB</td>
<td>A</td>
<td>Feedback input to feedback comparator. Connect with a set of resistors to VOUT and AGND in order to program V\textsubscript{OUT}.</td>
</tr>
<tr>
<td>4, 5, 69, 70, AGND Pad</td>
<td>AGND</td>
<td>A</td>
<td>Analog ground. Control circuitry of the IC is referenced to this pin. Connect to PGND.</td>
</tr>
<tr>
<td>6</td>
<td>VIN</td>
<td>PWR</td>
<td>IC supply input. Provides power to the internal LDO. Connect to PVIN pins.</td>
</tr>
<tr>
<td>7</td>
<td>VCC</td>
<td>PWR</td>
<td>The output of LDO. Bypass with a 4.7μF capacitor to AGND.</td>
</tr>
<tr>
<td>8</td>
<td>PGND</td>
<td>PWR</td>
<td>Controller low-side driver ground. Connect with a short trace to the closest PGND pins or PGND pad.</td>
</tr>
<tr>
<td>13-23, 51-56, PGND Pads</td>
<td>PGND</td>
<td>PWR</td>
<td>Ground of the power stage. Should be connected to the system’s power ground plane.</td>
</tr>
<tr>
<td>9-12, 24-30, SW Pad</td>
<td>SW</td>
<td>PWR</td>
<td>Switching node. It internally connects the source of the high-side FET, the drain of the low-side FET, the inductor and bootstrap capacitor. Use thermal vias and / or sufficient PCB land area in order to heatsink the low-side FET and the inductor.</td>
</tr>
<tr>
<td>31-50, VOUT Pad</td>
<td>VOUT</td>
<td>PWR</td>
<td>Output of the power stage. Place the output filter capacitors as close as possible to these pins.</td>
</tr>
<tr>
<td>58-65, PVIN Pad</td>
<td>PVIN</td>
<td>PWR</td>
<td>Power stage input voltage. Place the input filter capacitors as close as possible to these pins.</td>
</tr>
<tr>
<td>66, 67, BST Pad</td>
<td>BST</td>
<td>A</td>
<td>Controller high-side driver supply pin. It is internally connected to SW via a 0.1μF bootstrap capacitor. Leave these pins floating.</td>
</tr>
<tr>
<td>68</td>
<td>ILIM</td>
<td>A</td>
<td>Overcurrent protection programming. Connect with a short trace to the SW pins.</td>
</tr>
<tr>
<td>71</td>
<td>EN/MODE</td>
<td>I</td>
<td>Precision enable pin. Pulling this pin above 1.9V will turn the IC on and it will operate in Forced CCM. If the voltage is raised above 3.0V, then the IC will operate in DCM or CCM depending on load.</td>
</tr>
<tr>
<td>72</td>
<td>TON</td>
<td>A</td>
<td>Constant on-time programming pin. Connect with a resistor to AGND.</td>
</tr>
</tbody>
</table>

**NOTE:**
- A = Analog
- O = Output
- OD = Open Drain
- PWR = Power
Typical Performance Characteristics

\( T_A = 25^\circ \text{C}, \ V_{\text{IN}} = 24\text{V}, \ V_{\text{OUT}} = 3.3\text{V}, \ I_{\text{OUT}} = 6\text{A}, \ f = 500\text{kHz}, \) unless otherwise specified. The schematic is shown in Figure 27.

![Figure 3. Load Regulation](image1)
![Figure 4. Line Regulation](image2)
![Figure 5. \( t_{\text{ON}} \) vs. \( R_{\text{ON}} \)](image3)
![Figure 6. \( t_{\text{ON}} \) vs. \( V_{\text{IN}} \), \( R_{\text{ON}} = 14\text{k\Omega} \)](image4)
![Figure 7. Switching Frequency vs. \( I_{\text{OUT}} \)](image5)
![Figure 8. Switching Frequency vs. \( V_{\text{IN}} \)](image6)
Typical Performance Characteristics (Continued)

$T_A = 25^\circ C, V_{IN} = 24V, V_{OUT} = 3.3V, I_{OUT} = 6A, f = 500kHz$, unless otherwise specified. The schematic is shown in Figure 27.

**Figure 9.** $I_{OCP}$ vs. $R_{LIM}$

**Figure 10.** $V_{REF}$ vs. Temperature

**Figure 11.** $t_{ON}$ vs. Temperature, $R_{ON} = 14k\Omega$

**Figure 12.** Inductance vs. Current

**Figure 13.** Inductor Current Ripple vs. $V_{OUT}$
Typical Performance Characteristics (Continued)

$T_A = 25^\circ C$, $V_{IN} = 24V$, $V_{OUT} = 3.3V$, $I_{OUT} = 6A$, $f = 500kHz$, unless otherwise specified. The schematic is shown in Figure 27.

Figure 14. Steady State CCM, $I_{OUT} = 6A$

Figure 15. Steady State DCM, $I_{OUT} = 0A$

Figure 16. Power Up, $I_{OUT} = 6A$

Figure 17. Power Up, $I_{OUT} = 0A$

Figure 18. Load Step, CCM, 0A-3A-0A

Figure 19. Load Step, DCM/CCM, 0.05A-3A-0.05A
Typical Performance Characteristics (Continued)

Efficiency and Package Thermal Derating

\( T_A = 25^\circ C, \) no airflow, \( f = 500kHz, \) unless otherwise specified. The schematic is shown in Figure 27.

![Figure 20. Efficiency, \( V_{IN} = 12V \)](image)

![Figure 21. Maximum \( T_{AMBIENT} \) vs. \( I_{OUT} \), \( V_{IN} = 12V \)](image)

![Figure 22. Efficiency, \( V_{IN} = 24V \)](image)

![Figure 23. Maximum \( T_{AMBIENT} \) vs. \( I_{OUT} \), \( V_{IN} = 24V \)](image)
Functional Block Diagram

Figure 24. Functional Block Diagram
Applications Information

Functional Description
XR79206 is a synchronous step-down, proprietary emulated current-mode Constant On-Time (COT) module. The on-time, which is programmed via \( R_{ON} \), is inversely proportional to \( V_{IN} \) and maintains a nearly constant frequency. The emulated current-mode control is stable with ceramic output capacitors.

Each switching cycle begins with the GH signal turning on the high-side (switching) FET for a preprogrammed time. At the end of the on-time, the high-side FET is turned off and the low-side (synchronous) FET is turned on for a preset minimum time (250ns nominal). This parameter is termed Minimum Off-Time. After the Minimum Off-Time, the voltage at the feedback pin FB is compared to an internal voltage ramp at the feedback comparator. When \( V_{FB} \) drops below the ramp voltage, the high-side FET is turned on and the cycle repeats. This voltage ramp constitutes an emulated current ramp and makes possible the use of ceramic capacitors, in addition to other capacitor types, for output filtering.

Enable / Mode Input (EN/MODE)
EN/MODE pin accepts a tri-level signal that is used to control turn on and turn off. It also selects between two modes of operation: forced CCM and DCM / CCM. If EN/MODE is pulled below 1.8V, the module shuts down. A voltage between 2.0V and 2.8V selects the forced CCM mode, which will run the module in continuous conduction at all times. A voltage higher than 3.1V selects the DCM / CCM mode, which will run the module in discontinuous conduction at light loads.

Selecting the Forced CCM Mode
In order to set the module to operate in forced CCM, a voltage between 2.0V and 2.8V must be applied to EN/MODE. This can be achieved with an external control signal that meets the above voltage requirement. Where an external control is not available, the EN/MODE can be derived from \( V_{IN} \). If \( V_{IN} \) is well regulated, use a resistor divider and set the voltage to 2.5V. If \( V_{IN} \) varies over a wide range, the circuit shown in Figure 25 can be used to generate the required voltage. Note that at \( V_{IN} \) of 5.0V and 40V, the nominal Zener voltage is 4.0V and 5.0V respectively. Therefore for \( V_{IN} \) in the range of 5.0V to 40V, the circuit shown in Figure 25 will generate the \( V_{EN} \) required for forced CCM.

Selecting the DCM/CCM Mode
In order to set the module operation to DCM / CCM, a voltage between 3.1V and 5.5V must be applied to the EN/MODE pin. If an external control signal is available, it can be directly connected to EN/MODE. In applications where an external control is not available, the EN/MODE input can be derived from \( V_{IN} \). If \( V_{IN} \) is well regulated, use a resistor divider and set the voltage to 4V. If \( V_{IN} \) varies over a wide range, the circuit shown in Figure 26 can be used to generate the required voltage for DCM / CCM operation.
Applications Information (Continued)

Programming the On-Time
The on-time $t_{ON}$ is programmed via resistor $R_{ON}$ according to following equation:

$$R_{ON} = \frac{V_{IN} \times [t_{ON} - (2.5 \times 10^9)]}{2.95 \times 10^{10}}$$

A graph of $t_{ON}$ vs. $R_{ON}$, using the above equation, is compared to typical test data in Figure 5. The graph shows that calculated data matches typical test data within 3%.

The $t_{ON}$ corresponding to a particular set of operating conditions can be calculated based on empirical data from:

$$t_{ON} = \frac{V_{OUT}}{V_{IN} \times 1.06 \times f \times Eff.}$$

Where:
- $f$ is the desired switching frequency at nominal $I_{OUT}$
- $Eff.$ is the converter efficiency corresponding to nominal $I_{OUT}$

Substituting for $t_{ON}$ in the first equation we get:

$$R_{ON} = \left(\frac{V_{OUT}}{1.06 \times f \times Eff.}\right) - \left[\frac{(2.5 \times 10^9) \times V_{IN}}{(2.95 \times 10^{10})}\right]$$

Now $R_{ON}$ can be calculated in terms of operating conditions $V_{IN}$, $V_{OUT}$, $f$ and $Eff.$ using the above equation. At $V_{IN} = 24V$, $f = 500kHz$, $I_{OUT} = 6A$ and using the efficiency numbers from Figure 22 we get the following $R_{ON}$:

<table>
<thead>
<tr>
<th>$V_{OUT}$ (V)</th>
<th>Eff. (%)</th>
<th>$f$ (kHZ)</th>
<th>$R_{ON}$ (kΩ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.0</td>
<td>94</td>
<td>700</td>
<td>56.3</td>
</tr>
<tr>
<td>5.0</td>
<td>90</td>
<td>500</td>
<td>33.5</td>
</tr>
<tr>
<td>3.3</td>
<td>87</td>
<td>500</td>
<td>22.2</td>
</tr>
<tr>
<td>1.8</td>
<td>80</td>
<td>500</td>
<td>12.4</td>
</tr>
</tbody>
</table>

Overcurrent Protection (OCP)
If the load current exceeds the programmed overcurrent threshold $I_{OCP}$ for four consecutive switching cycles, the module enters the hiccup mode of operation. In hiccup mode the MOSFET gates are turned off for 110ms (hiccup timeout). Following the hiccup timeout, a soft-start is attempted. If OCP persists, the hiccup timeout will repeat. The module will remain in hiccup mode until load current is reduced below the programmed $I_{OCP}$. In order to program overcurrent protection, use the following equation:

$$R_{LIM} = \left[\frac{(I_{OCP} + (0.5 \times \Delta I))}{\left(\frac{I_{LIM}}{R_{DS}}\right)}\right] + 0.16kΩ$$

Where:
- $R_{LIM}$ is the resistor value in kΩ for programming $I_{OCP}$
- $I_{OCP}$ is the overcurrent value to be programmed
- $\Delta I$ is the peak-to-peak inductor current ripple
- $I_{LIM} / R_{DS} = 2.4µA/mΩ$ is the minimum value of the parameter specified in the tabulated data
- 0.16kΩ accounts for OCP comparator offset

The above equation is for worst-case analysis and safeguards against premature OCP. The typical value of $I_{OCP}$ for a given $R_{LIM}$ will be higher than that predicted by the above equation. A graph of calculated $I_{OCP}$ vs. $R_{LIM}$ is compared to typical $I_{OCP}$ in Figure 9.

Short-Circuit Protection (SCP)
If the output voltage drops below 60% of its programmed value, the module will enter hiccup mode. Hiccup will persist until the short-circuit is removed. The SCP circuit becomes active after PGOOD asserts high.

Over Temperature Protection (OTP)
OTP triggers at a nominal controller temperature of 150°C. The gates of the switching FET and synchronous FET are turned off. When controller temperature cools down to 135°C, soft-start is initiated and operation resumes.
Applications Information (Continued)

Programming the Output Voltage
Use an external voltage divider as shown in Figure 27 to program the output voltage \( V_{OUT} \).

\[
RFB1 = RFB2 \times \left( \frac{VOUT}{0.6V} - 1 \right)
\]

Where \( R_{FB2} \) has a nominal value of 2kΩ.

Programming the Soft-Start
Place a capacitor \( C_{SS} \) between the SS and AGND pins to program the soft-start. In order to program a soft-start time of \( t_{SS} \), calculate the required capacitance \( C_{SS} \) from the following equation:

\[
C_{SS} = t_{SS} \times \frac{10\mu A}{0.6V}
\]

Feed-Forward Capacitor (\( C_{FF} \))
The feed-forward capacitor \( C_{FF} \) is used to set the necessary phase margin when using ceramic output capacitors. Calculate \( C_{FF} \) from the following equation:

\[
C_{FF} = \frac{1}{2 \times \pi \times RFB1 \times 5 \times f_{LC}}
\]

Where \( f_{LC} \) is the output filter double-pole frequency calculated from:

\[
f_{LC} = \frac{1}{2 \times \pi \times \sqrt{L \times C_{OUT}}}
\]

You must use the manufacturer’s DC derating curves to determine the effective capacitance corresponding to \( V_{OUT} \). A load step test and / or a loop frequency response test should be performed, and if necessary \( C_{FF} \) can be adjusted in order to get a critically damped transient load response.

In certain conditions an alternate compensation scheme may need to be employed using ripple injection from the inductor. An application note is being developed to provide more information about this compensation scheme.

Feed-Forward Resistor (\( R_{FF} \))
\( R_{FF} \), in conjunction with \( C_{FF} \), functions similar to a high frequency pole and adds gain margin to the frequency response. Calculate \( R_{FF} \) from:

\[
R_{FF} = \frac{1}{2 \times \pi \times f \times C_{FF}}
\]

Where \( f \) is the switching frequency.

If \( R_{FF} > 0.02 \times R1 \) then calculate \( R_{FF} \) value from \( R_{FF} = 0.02 \times R1 \).

Maximum Allowable Voltage Ripple at FB Pin
Note that the steady-state voltage ripple at feedback pin FB (\( V_{FB,RIPPLE} \)) must not exceed 50mV in order for the module to function correctly. If \( V_{FB,RIPPLE} \) is larger than 50mV, then \( C_{OUT} \) should be increased as necessary in order to keep the \( V_{FB,RIPPLE} \) below 50mV.
Applications Information (Continued)

Typical Application Circuit

Figure 27. Application Circuit
Mechanical Dimensions

**TERMINAL #1 INDEX AREA**

(Under view)

**SIDE VIEW**

**BOTTOM VIEW**

**TOP VIEW**

**DETAIL A**

**TERMINAL AND PAD EDGE DETAILS**

*Note: All dimensions are in millimeters, angles are in degrees.*

Drawing No.: POD-00000099

Revision: C
Recommended Land Pattern and Stencil

TYPICAL RECOMMENDED LAND PATTERN

TYPICAL RECOMMENDED STENCIL

NOTE: ALL DIMENSIONS ARE IN MILLIMETERS, ANGLES ARE IN DEGREES.

Drawing No.: POD-00000099
Revision: C
Ordering Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Operating Temperature Range</th>
<th>Package</th>
<th>Packaging Method</th>
<th>Lead-Free</th>
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<tbody>
<tr>
<td>XR79206EL-F</td>
<td>-40°C ≤ T_J ≤ 125°C</td>
<td>10mm x 10mm x 4mm QFN package</td>
<td>Tray</td>
<td>Yes(^2)</td>
</tr>
<tr>
<td>XR79206EVB</td>
<td></td>
<td>XR79206 evaluation board</td>
<td></td>
<td></td>
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NOTES:
1. Refer to [www.maxlinear.com/XR79206](http://www.maxlinear.com/XR79206) for most up-to-date Ordering Information
2. Visit [www.maxlinear.com](http://www.maxlinear.com) for additional information on Environmental Rating.

Revision History

<table>
<thead>
<tr>
<th>Revision</th>
<th>Date</th>
<th>Description</th>
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<tr>
<td>1B</td>
<td>03/04/2016</td>
<td>Initial Release</td>
</tr>
<tr>
<td>1C</td>
<td>06/15/2018</td>
<td>Update to MaxLinear logo. Update format, update Ordering Information format. Added Revision History.</td>
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</table>
| 1D       | 11/04/2019| Correct block diagram by changing the input gate that connects to the Hiccup Mode block from an AND gate to an OR \( \text{OR} \) gate and spacing the inverting latch output from the Short-Circuit Detection op amp output connection.