UCC28517 100-W PFC power converter with 12-V, 8-W bias supply, Part 2

By Michael O’Loughlin (Email: michael_oloughlin@ti.com)
Member, Applications Engineering Staff

Introduction
Power factor corrected (PFC) preregulators are generally used in offline ac/dc power converters with a power level higher than 75 W or to meet line harmonic requirements such as EN61000-3-2. PFC is typically done with a boost converter ac/dc topology due to the continuous input current that can be manipulated through average current-mode control to achieve a near-unity power factor (PF). However, due to the high output voltage of a boost converter, a second dc/dc converter is generally needed to step down the output to a usable voltage. In the past this has been accomplished with two pulse-width modulators (PWMs). One PWM controlled and regulated the PFC power stage, while the second was used to control the step-down converter. The UCC28517 controller reduces the need for two PWMs and combines both of these functions into one control-integrated circuit. The UCC28517 operates the second converter at twice the switching frequency of the PFC stage, which reduces the size of the boost magnetics and the ripple current in the boost capacitor. For more information on this device, please see Reference 7. This article reviews the design of the second 12-V, 8-W power stage to be used as an auxiliary bias supply. A review of the PFC preregulator power stage can be found in the 3Q03 issue of the TI Analog Applications Journal.

Variable definitions

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Δt</td>
<td>Soft-start interval</td>
</tr>
<tr>
<td>η1</td>
<td>Output A efficiency</td>
</tr>
<tr>
<td>η2</td>
<td>Output B efficiency</td>
</tr>
<tr>
<td>CDIODE</td>
<td>Boost diode capacitance</td>
</tr>
<tr>
<td>CDS</td>
<td>FET drain-to-source capacitance</td>
</tr>
<tr>
<td>Dmax</td>
<td>Duty cycle maximum</td>
</tr>
<tr>
<td>ESR</td>
<td>Output capacitance equivalent resistance</td>
</tr>
<tr>
<td>fc</td>
<td>Voltage-loop crossover frequency</td>
</tr>
<tr>
<td>fopto_pole</td>
<td>Frequency where optoisolator gain is –3 dB from its dc operating point</td>
</tr>
<tr>
<td>fS</td>
<td>Minimum switching frequency</td>
</tr>
<tr>
<td>fSA</td>
<td>Output A switching frequency</td>
</tr>
<tr>
<td>fSB</td>
<td>Output B switching frequency</td>
</tr>
<tr>
<td>Gc(s)</td>
<td>Control transfer function</td>
</tr>
<tr>
<td>Gco(s)</td>
<td>Control to output transfer function</td>
</tr>
<tr>
<td>Gopto(s)</td>
<td>Optoisolator gain transfer function</td>
</tr>
<tr>
<td>H(s)</td>
<td>Voltage divider gain</td>
</tr>
<tr>
<td>lmin</td>
<td>Transformer magnetizing current</td>
</tr>
<tr>
<td>lmin</td>
<td>Minimum optocoupler current (1 mA)</td>
</tr>
<tr>
<td>IPK</td>
<td>Peak inductor current, peak diode current, peak switch current</td>
</tr>
<tr>
<td>lRMS</td>
<td>RMS device current</td>
</tr>
<tr>
<td>lSS</td>
<td>UCC28517 soft-start current of 10 µA</td>
</tr>
<tr>
<td>Lm</td>
<td>Transformer primary magnetizing inductance</td>
</tr>
<tr>
<td>N</td>
<td>Transformer turns ratio</td>
</tr>
<tr>
<td>Np</td>
<td>Primary turns</td>
</tr>
<tr>
<td>Ns</td>
<td>Secondary turns</td>
</tr>
<tr>
<td>PCOND</td>
<td>Device conduction losses</td>
</tr>
<tr>
<td>PCOSS</td>
<td>Power dissipated by the FET’s drain-to-source capacitance</td>
</tr>
<tr>
<td>PDIODE</td>
<td>Total loss in the boost diode</td>
</tr>
<tr>
<td>PDIODE_CAP</td>
<td>Loss due to boost diode capacitance</td>
</tr>
<tr>
<td>PFET_TR</td>
<td>FET transition losses</td>
</tr>
<tr>
<td>POUTA</td>
<td>Output A maximum power</td>
</tr>
<tr>
<td>POUTB</td>
<td>Output B maximum power</td>
</tr>
<tr>
<td>QGATE</td>
<td>Power dissipated by the FET gate</td>
</tr>
<tr>
<td>PDIODE</td>
<td>Power dissipated by the FET’s drain-to-source capacitance</td>
</tr>
<tr>
<td>PDIODE_CAP</td>
<td>Loss due to boost diode capacitance</td>
</tr>
<tr>
<td>PGATE</td>
<td>Power dissipated by the FET gate</td>
</tr>
<tr>
<td>POUTA</td>
<td>Output A maximum power</td>
</tr>
<tr>
<td>POUTB</td>
<td>Output B maximum power</td>
</tr>
<tr>
<td>q</td>
<td>Power dissipated by the FET gate</td>
</tr>
<tr>
<td>rblank</td>
<td>Amount of leading-edge blanking time</td>
</tr>
<tr>
<td>rf</td>
<td>FET fall time</td>
</tr>
<tr>
<td>rs</td>
<td>Forward diode drop (0.6 V)</td>
</tr>
<tr>
<td>s</td>
<td>Angular frequency (j2πf)</td>
</tr>
<tr>
<td>tbr</td>
<td>Lower breakover time of Zener diode</td>
</tr>
<tr>
<td>tSB</td>
<td>1/fSB = 5 µs</td>
</tr>
<tr>
<td>V</td>
<td>Voltage loop frequency response</td>
</tr>
<tr>
<td>Vb</td>
<td>Forward voltage of a diode</td>
</tr>
<tr>
<td>Vc</td>
<td>Control voltage</td>
</tr>
<tr>
<td>VREF</td>
<td>UCC28517 internal reference</td>
</tr>
<tr>
<td>Verrer</td>
<td>Feedback error voltage</td>
</tr>
<tr>
<td>Villoscope</td>
<td>Voltage ramp peak added for slope compensation</td>
</tr>
<tr>
<td>VLL431</td>
<td>TL431 (D13) internal reference</td>
</tr>
</tbody>
</table>
The following design example was generated using typical parameters rather than worst-case values. Please refer to Table 1 and Figures 1–3 for design specifications and component placement. All variables are defined in the sidebar on page 21.

12-V, 8-W auxiliary converter (OUTB)

Due to the high input voltage from the boost converter, this design required a dc/dc converter with a step-down transformer to achieve the desired output voltage of 12 V. The low power requirements permitted use of a discontinuous-mode flyback topology, which uses fewer components than a standard forward converter.

**Transformer turns ratio**

The following equation can be used to calculate the transformer turns ratio (N) needed for this power stage.

\[
N = \frac{D_{\text{max}} \times V_{\text{OUTA}} \times T_{\text{SB}}}{(0.9 - D_{\text{max}} \times (V_{\text{OUTB}} + V_d) \times T_{\text{SB}}}
\]

The UCC28517 PWM/PFC controller has a user-selectable duty-cycle clamp. For this design the duty-cycle clamp was set to a \(D_{\text{max}}\) of 0.55. The UCC28517 has a forward enable comparator that will not allow the forward converter to operate with a boost voltage less than 50% of the nominal value. This allows the cascaded step-down converter to

---

### Table 1. Design specifications

<table>
<thead>
<tr>
<th></th>
<th>Maximum</th>
<th>Typical</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>(V_{\text{IN}})</td>
<td>265 Vrms</td>
<td>85 Vrms</td>
<td></td>
</tr>
<tr>
<td>Output A ((V_{\text{OUTA}}))</td>
<td>410 V</td>
<td>390 V</td>
<td>370 V</td>
</tr>
<tr>
<td>Output B ((V_{\text{OUTB}}))</td>
<td>12.6 V</td>
<td>12 V</td>
<td>11.4 V</td>
</tr>
<tr>
<td>Output A efficiency ((\eta_1))</td>
<td>85%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output B efficiency ((\eta_2))</td>
<td>50%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(P_{\text{OUTA}})</td>
<td>100 W</td>
<td>10 W</td>
<td></td>
</tr>
<tr>
<td>(P_{\text{OUTB}})</td>
<td>8 W</td>
<td>4 W</td>
<td></td>
</tr>
<tr>
<td>Output ripple A ((V_{\text{ripple}}))</td>
<td>12 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output ripple B ((V_{\text{ripple}}))</td>
<td>750 mV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output A THD ((%) THD)</td>
<td>10%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PF</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output A switching frequency ((f_{\text{SA}}))</td>
<td>100 kHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output B switching frequency ((f_{\text{SB}}))</td>
<td>200 kHz</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Figure 1. PFC power stage schematic**

![PFC power stage schematic](image-url)
Figure 2. dc/dc power stage schematic

Figure 3. Controller schematic
operate during loss of line voltage. An auxiliary winding of
22 turns was added to power the UCC28517 control IC as
well. For this design Pulse Engineering designed a 22-turn
transformer (part number PB2039).

Power switch (Q2) and output diode (D8) selection
To select D8 and Q2 properly, a power budget is generally
set for these devices to maintain the desired efficiency
goal. The following equations were used to estimate power
loss in the switching devices. To meet the power budget
for this design, an IRFBF20S FET and a 20CJQ045 dual
diode from International Rectifier were chosen.

\[ I_{PK\_Q2} = \frac{2 \times V_{OUTB}}{\eta \times N} \]

\[ I_{RMS\_FET\_Q2} = \frac{P_{OUTB}}{\eta \times N} \times \sqrt{\frac{D_{max}}{3}} \]

\[ P_{COND\_FET\_Q2} = R_{DS(on)} \times I_{RMS\_FET}^2 \]

\[ P_{GATE\_Q2} = Q\_GATE \times V\_GATE \times f_S \]

\[ P_{COSS\_Q2} = \frac{1}{2} C\_COSS \times V_{OUTB}^2 \times f_S \]

\[ P_{FET\_TR\_Q2} = \frac{1}{2} V_{OUTB} \times I_{RMS\_Q2} \times (t_r + t_f) \times f_{SB} \]

\[ P_{Q2} = P_{GATE\_Q2} + P_{COSS\_Q2} + P_{COND\_FET} + P_{FET\_TR\_Q2} \]

\[ I_{PK\_D8} = \frac{2 \times P_{OUTB} \times (1 - D_{max})}{V_{OUTB}} \]

\[ P_{DIODE\_CAP\_D8} = \frac{C\_DIODE}{2} \times V_{OUTB}^2 \times f_{SB} \]

\[ P_{COND\_D8} = V_f \times I_{RMS\_D8} \]

\[ I_{RMS\_D8} = I_{PK\_D8} \times \sqrt{\frac{1 - D_{max}}{3}} \]

\[ P_{DIODE} = P_{COND\_D8} + P_{DIODE\_CAP\_D8} \]

Output capacitor
The output capacitor selection for the step-down converter
was based on requirements for energy storage, output ripple
voltage, RMS current, and peak current.

\[ I_{PK\_C30} = 2 \times \frac{P_{OUTB}}{V_{OUTB} \times (1 - D_{max})} \]

\[ ESR_{C30\_max} \leq \frac{V_{ripple}}{I_{PK\_C30}} \]

\[ C_{30} \geq \frac{0.5 \times I_{PK} \times (1 - D_{max})}{f_{SB} \times V_{OUTB}} \]

\[ I_{RMS\_C30} = I_{PK\_C30} \times \sqrt{(1 - D_{max}) \times \left[ \frac{4 - 3 \times (1 - D_{max})}{12} \right]} \]

\[ R_{SENSE2} \]

The dc/dc power converter is designed for peak-current-
mode control. R4 is the current sense resistor, which can
be sized through the following two equations.

\[ I_m = \frac{V_{OUTA} \times D_{max}}{I_m \times f_{SB}} \]

\[ R_4 = \frac{V_{dynamic}}{I_m + \frac{I_{PK\_C30}}{N}} \]

Soft start
The UCC28517 has soft-start circuitry to allow for a con-
trolled ramp of the second stage’s duty cycle during startup.
The following equation was used to calculate the approxi-
mate capacitance needed to achieve a soft start of roughly
5 ms (∆t).

\[ C_{16} = \frac{I_{SS} \times \Delta t}{5 \, V} \]

Slope compensation
Designing a power converter that uses peak-current-mode
control generally requires slope compensation to remove
instabilities in the control loop and to make the design less
susceptible to noise. Resistors R11 and R8 (Figure 3) sum
in a portion of the oscillator signal to the current sense
signal for slope compensation. Generally the added slope
\( (V_{slope}) \) required is equal to half the down slope of
the change in output current. By selecting R11 first, you can
calculate the required value of R8 to generate the required
slope compensation.

\[ V_{slope} = \left( I_{m} + \frac{I_{PK\_C30}}{2N} \right) R_4 \]

\[ R_8 \leq \frac{R_1 (V_f - V_{slope})}{V_{slope}} \]
Leading-edge blanking circuit

The typical current sense signal for a converter using peak-current-mode control is shown in Figure 4. As shown, during time T1 there is a leading current spike. This is partly caused by the parasitic gate-to-source capacitance of the power stage switch Q4 and the voltage divider formed off the gate drive by R4 and R7. This leading-edge spike can cause the peak-current-mode signal to terminate the gate drive prematurely. To remove this instability, a leading-edge blanking circuit was constructed.

Electronic components Q4, R40, R42, and C10 form a leading-edge blanking circuit. This circuit is used to clamp leading-edge current spikes. The timing of the leading-edge blanking can be adjusted by modifying the size of timing capacitor C10:

\[ C_{10} = \frac{t_{\text{blank}}}{2(R40 + R42)} \]

Control loop for the dc/dc converter

Figure 5 shows the control block diagram for the control loop of the dc/dc converter. \( G_c(s) \) is the compensation network’s transfer function (TF), \( G_{\text{opto}}(s) \) is the optoisolator gain TF, \( G_{\text{co}}(s) \) is the control-to-output gain TF, and \( H(s) \) is the divider gain TF. To estimate the frequency response of each gain block, the following equations can be used.

\[ f_{\text{opto\_pole}} \] is the frequency where the optoisolator gain is –3 dB from its dc operating point; and \( V_{\text{REF\_TL431}} \) is the internal reference voltage of the TL431 shunt regulator. \( R_{\text{load}} \) represents the typical load impedance for the design.

\[
H(s) = \frac{R27}{R27 + R32} \times \frac{1}{1 + \frac{s}{2\pi f_{\text{opto\_pole}}}}
\]

\[
G_{\text{opto}}(s) = \frac{R13}{R30} \times \frac{1}{s + \frac{1}{2\pi f_{\text{opto\_pole}}}}
\]

\[
G_c(s) = \frac{s \times R35 \times C14 + 1}{s \times C14 \times R31 \times (1 + s \times R35 \times C15)} \times \frac{R13}{R36} \times \frac{1}{1 + \frac{s}{2\pi f_{\text{opto\_pole}}}}
\]

\[
G_{\text{co}}(s) = \frac{V_{\text{OUTB}}}{V_c} = \frac{R_{\text{load}}}{R4} \times \frac{N_b}{N_s} \times \frac{1 + s \times C30 \times \text{ESR}}{1 + s \times C30 \times R_{\text{load}}}
\]

Figure 6 shows the circuitry that was used for the voltage feedback loop. D13 is a TL431 shunt regulator that can function as an operational amplifier to provide feedback control when set up in this configuration. 
Initially the resistor values for the divider gain, \( H(s) \), must be selected. The following equation can be used to size these resistors, where \( V_{OUTB} \) is the desired output voltage and \( V_{VREF\_TL431} \) is the internal reference of the TL431.

\[
R_{32} = \frac{R_{27}(V_{OUTB} - V_{VREF\_TL431})}{V_{VREF\_TL431}}
\]

It is important to bias the TL431 and the optoisolator correctly for proper operation. Resistors \( R_{16} \) and \( R_{13} \) provide the minimum bias currents for the TL431 and the optoisolator, respectively, and can be selected with the following equations. The optoisolator was configured to have a dc gain of roughly 20 dB, and the optoisolator had a crossover frequency of roughly 80 kHz. Figure 7 shows the small signal frequency response of the optoisolator.

\[
R_{16} = \frac{V_f}{I_{TL431\_min}}
\]

\[
R_{13} = \frac{V_{REF} - V_{ERR\_max}}{I_{op\_min}}
\]

Before attempting to compensate the control loop, \( T_s(f) \), we must define some design goals for the closed-loop frequency response. Typically the loop is designed to cross over at a frequency below one-sixth of the switching frequency (see Reference 3). For this design example to have good transient response, the design goal was to have the loop gain crossover frequency \( f_c \) at roughly 1 kHz, which is less than one-sixth of the switching frequency \( f_{SB} \). The following equation describes the frequency response of the system loop gain, \( T_s(f) \), in decibels.

\[
T_s(f) = G_{c(s)\_in} + G_{c(s)\_op} + H_{(s)\_in}
\]

The compensation network that is used \( (G_{c(s)}) \) has three poles and one zero. One pole occurs at the origin, and a second pole is caused by the limitations of the optoisolator. The third pole is set at one-half the switching frequency to attenuate the high frequency gain. The zero is set at the desired crossover frequency. The following equations can be used to select \( R_{35} \), \( C_{14} \), and \( C_{15} \) of \( G_{c(s)} \) to obtain the desired design goals.

\[
H_{(s)\_in} = 20\log(H_{(s)})
\]

\[
R_{35} = R_{32} \times 10^{-\frac{-(G_{c(s)\_in} + G_{c(s)\_op} + H_{(s)\_in})}{20}}
\]

\[
C_{14} = \frac{1}{2\pi R_{35} f_c}
\]

\[
C_{15} = \frac{1}{2\pi R_{35} f_c}\frac{f_c}{2}
\]

Figure 8 shows the measured loop gain frequency response, \( T_s(f) \). The frequency response characteristics in Figure 8 show that \( f_c \) was roughly equal to 800 Hz with a phase margin of roughly 50°. It is important to note that the equations used to compensate the control loop by selecting \( C_{14}, C_{15}, \) and \( R_{35} \) are estimates and the values may have to be adjusted to get the appropriate compensation.
Summary
In this design example we reviewed the design of a 100-W PFC ac/dc preregulator with an auxiliary 12-V, 8-W bias supply. The UCC2851x family of combination PWM controllers is perfect for offline applications that require PFC and auxiliary power supplies to meet different system requirements. The design performance of this two-stage power converter is shown in Figures 9–12.

References
For more information related to this article, you can download an Acrobat Reader file at www-s.ti.com/sc/techlit/litnumber and replace “litnumber” with the TI Lit. # for the materials listed below.

Document Title  
3. Lloyd Dixon, “Control Loop Cookbook,” p. 5-17 .......................................................... slup113
5. James P. Noon, “A 250kHz, 500W Power Factor Correction Circuit Employing Zero Voltage Transitions,” pp. 1-11–1-14 ........ slup100
6. “Practical Considerations in Current Mode Power Supplies,” Unitrode Application Note ... slua110
7. ”Advanced PFC/PWM Combination Controllers,” Data Sheet ........................... slus517

Related Web sites
analog.ti.com
www.ti.com/sc/device/TL431
www.ti.com/sc/device/UCC28517
Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI’s terms and conditions of sale supplied at the time of order acknowledgment. TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI’s standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all associated warranties, conditions, limitations, and conditions of sale supplied at the time of order acknowledgment.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

**Products**
- Amplifiers: [amplifier.ti.com](http://amplifier.ti.com)
- Data Converters: [dataconverter.ti.com](http://dataconverter.ti.com)
- DSP: [dsp.ti.com](http://dsp.ti.com)
- Interface: [interface.ti.com](http://interface.ti.com)
- Logic: [logic.ti.com](http://logic.ti.com)
- Power Mgmt: [power.ti.com](http://power.ti.com)
- Microcontrollers: [microcontroller.ti.com](http://microcontroller.ti.com)

**Applications**
- Audio: [www.ti.com/audio](http://www.ti.com/audio)
- Automotive: [www.ti.com/automotive](http://www.ti.com/automotive)
- Broadband: [www.ti.com/broadband](http://www.ti.com/broadband)
- Digital control: [www.ti.com/digitalcontrol](http://www.ti.com/digitalcontrol)
- Military: [www.ti.com/military](http://www.ti.com/military)
- Telephony: [www.ti.com/telephony](http://www.ti.com/telephony)
- Video & Imaging: [www.ti.com/video](http://www.ti.com/video)
- Wireless: [www.ti.com/wireless](http://www.ti.com/wireless)

**Important Notice**

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI’s terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI’s standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all associated warranties, conditions, limitations, and conditions of sale supplied at the time of order acknowledgment.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

**Products**
- Amplifiers: [amplifier.ti.com](http://amplifier.ti.com)
- Data Converters: [dataconverter.ti.com](http://dataconverter.ti.com)
- DSP: [dsp.ti.com](http://dsp.ti.com)
- Interface: [interface.ti.com](http://interface.ti.com)
- Logic: [logic.ti.com](http://logic.ti.com)
- Power Mgmt: [power.ti.com](http://power.ti.com)
- Microcontrollers: [microcontroller.ti.com](http://microcontroller.ti.com)

**Applications**
- Audio: [www.ti.com/audio](http://www.ti.com/audio)
- Automotive: [www.ti.com/automotive](http://www.ti.com/automotive)
- Broadband: [www.ti.com/broadband](http://www.ti.com/broadband)
- Digital control: [www.ti.com/digitalcontrol](http://www.ti.com/digitalcontrol)
- Military: [www.ti.com/military](http://www.ti.com/military)
- Telephony: [www.ti.com/telephony](http://www.ti.com/telephony)
- Video & Imaging: [www.ti.com/video](http://www.ti.com/video)
- Wireless: [www.ti.com/wireless](http://www.ti.com/wireless)