Automotive Wide $V_{\text{IN}}$ DC/DC
Power Solutions for Emerging Applications

Precision References
Wide $V_{\text{IN}}$ Buck Controllers
Ultra Small Wide $V_{\text{IN}}$ Buck Converter
Wide $V_{\text{IN}}$ Boost and Buck-Boost Controllers
Wide $V_{\text{IN}}$ LDOs

WIDEVERIN

>40V Peak
Nominal
Load Dump
Steady State
Jump Start
Min 3V Start Stop
Reverse Battery
Noise
Crank
Noise

ti.com/widevin

2014
Why Wide $V_{IN}$ for Automotive?
Addressing Transient Ranges in Advanced Electronics

Texas Instruments Wide $V_{IN}$ portfolio withstands the wide range of voltage transients providing highly reliable, affordable solutions. Automotive electronics operate from the car battery which experiences transient loads such as cold-cranks and load dumps which can range from 5V to >40V. In addition, technologies such as start-stop increase the transient range dropping down to 3V in certain cases. This requires off-battery power ICs to withstand the harsh operating conditions and reliably provide power to the whole vehicle.

**Typical Automotive Power Tree**

- **Infotainment**
  - Instrument Cluster and Displays
  - Telematics
  - USB Hub/Charger
  - Audio Amplifiers

- **ADAS**
  - Camera Modules
  - Radar Systems
  - Ultrasonic Park Assist
  - LIDAR

- **Powertrain**
  - Start-Stop Voltage Conditioning
  - Fuel Pump
  - Fuel injection
  - Emission control/sensors

- **Body Electronics**
  - LED headlamps/lighting
  - HVAC Controls
  - Door sensors/locking

Wide $V_{IN}$ Power for Automotive
Powertrain
Start-Stop Voltage Conditioning System

Start-stop technology helps vehicles to improve fuel mileage and emissions, but also poses the challenge of harsher operating conditions for the electronics. Fluctuations from a worst case cold crank can reduce the off-battery voltage to as low as 3V requiring either a pre-boost or buck-boost converter that can handle the drop while still surviving 40V transients from load dumps. TI offers off-battery boost and buck-boost solutions that can handle the full input voltage range without the need to pre-condition the battery circuit which reduces BOM size and cost.

Start-Stop Requirements
Cold-crank and stat-stop conditions require the use of either pre-boost or buck-boost converter blocks to ensure continuous operation of the downstream electronics.

The LM3481 Boost Controller provides a Buck-Boost (SEPIC) converter for low power needs ≤50W

The LM5122 Pre-Boost can be scaled from 50W to >400W

Nominal Operating Voltage: ~12V
Regulated Voltage
Crank: ~6 to 8V
Worst Crank: ~3V
0
2
4
6
8
10
12
14
Voltage

Time (not to scale)
Infotainment applications require a wide range of power solutions from low power telematics to high power audio amplifier solutions. TI’s wide range of power portfolio include buck, boost, and buck-boost controllers with external FETs for high power needs which help dissipate heat, as well as converters for more integrated solutions for lower power applications.

**Infotainment System Electronics**

- **Power Supply for USB Port / Charging**
  - Buck Converter
  - or Controller
  - TPS54340-Q1
  - LM29117-Q1
  - 5V / 5A
  - **USB Charging Switch**
  - TPS2543-Q1

- **Boost Supply for High-Performance Audio Amplifier**
  - Stackable Boost Controller
  - LM5122-Q1 x 2-4
  - 24V to 30V / 20A
  - **100 to 600W Class D Audio Amplifier**

- **Dual-Channel Supply for Head Unit**
  - Dual Buck Controller
  - LM5119-Q1
  - TPS4350-Q1
  - 5V / 5A
  - 3.3V / 5A
  - **Infotainment Processor**

- **Quad-Channel for Display Lighting**
  - Boost Controller and LED Driver
  - LP8860-Q1
  - **Infotainment / Telematics Display**

- **Buck-Boost Supply for Telematics**
  - Buck-Boost Controller
  - or Converter
  - LM29118-Q1
  - TPS55905-Q1
  - 5V / 75V / 2A
  - **Telematics / eCall**

- **Backup Battery**

**DC/DC Converters and the AM Bandwidth**

The AM bandwidth spans from 500 to 1800 kHz which requires switching regulators to operate outside of this range to prevent interference.
Automotive camera modules are placed in constrained and concealed spaces. This necessitates designs that require small solution sizes and low power dissipation. Texas Instruments’ power portfolio provides ultra-small power solutions while maintaining high efficiency and low EMI.

Changes in the USA
The National Highway Traffic Safety Administration (NHTSA) will require all vehicles to have a rear-view visibility system starting in May, 2018.
### Wide $V_{IN}$ Part Selection Guide

#### Wide $V_{IN}$ Step-Down Devices

<table>
<thead>
<tr>
<th>Part No</th>
<th>$I_{OUT}$ (A)</th>
<th>$V_{IN}$ (V)</th>
<th>$V_{OUT}$ (V)</th>
<th>$F_{SW}$</th>
<th>Synchronous</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>LM34919C-Q1</td>
<td>0.6</td>
<td>4.5 to 50</td>
<td>3.5 to 45</td>
<td>2.6 MHz</td>
<td></td>
<td>Ultra-small footprint</td>
</tr>
<tr>
<td>LM5010-Q1/0Q0</td>
<td>1</td>
<td>6 to 75</td>
<td>1.5 to 70</td>
<td>1.0 MHz</td>
<td></td>
<td>Available in Q1 and Q0 grades</td>
</tr>
<tr>
<td>TPS65310A-Q1</td>
<td>1 / 2</td>
<td>4 to 40</td>
<td>0.8 to 5.5</td>
<td>0.98 MHz</td>
<td>✓</td>
<td>Supports up to 5 outputs</td>
</tr>
<tr>
<td>LM26001/Q3</td>
<td>1.5 / 3</td>
<td>3 to 38</td>
<td>1.25 to 35</td>
<td>500 kHz</td>
<td>✓</td>
<td>High-efficiency sleep mode</td>
</tr>
<tr>
<td>LM25011-Q1</td>
<td>2</td>
<td>6 to 42</td>
<td>2.5 to 40</td>
<td>2.0 MHz</td>
<td></td>
<td>Adjustable Current Limit</td>
</tr>
<tr>
<td>TPS65320-Q1</td>
<td>3.2</td>
<td>3.6 to 40</td>
<td>1.1 to 20</td>
<td>2.5 MHz</td>
<td></td>
<td>LDO input auto sourcing</td>
</tr>
<tr>
<td>TPS54340/540</td>
<td>3.5 / 5</td>
<td>4.5 to 60</td>
<td>0.8 to 58.8</td>
<td>2.5 MHz</td>
<td>✓</td>
<td>Eco-mode</td>
</tr>
<tr>
<td>LM(2)5119Q</td>
<td>N/A</td>
<td>5.5 to 65</td>
<td>0.8 to 64</td>
<td>750 kHz</td>
<td>✓</td>
<td>Dual-channel, dual-phase</td>
</tr>
<tr>
<td>LM(2)5117-Q1</td>
<td>N/A</td>
<td>4.5 to 65</td>
<td>0.8 to 62</td>
<td>750 kHz</td>
<td>✓</td>
<td>Analog Current Monitor</td>
</tr>
<tr>
<td>TPS40170-Q1</td>
<td>N/A</td>
<td>4.5 to 60</td>
<td>0.6 to 57</td>
<td>600 KHz</td>
<td>✓</td>
<td>Pre-biased output support</td>
</tr>
</tbody>
</table>

#### Wide $V_{IN}$ Step-Up (Boost) Devices

<table>
<thead>
<tr>
<th>Part No</th>
<th>$I_{OUT}$ (A)</th>
<th>$V_{IN}$ (V)</th>
<th>$V_{OUT}$ (V)</th>
<th>$F_{SW}$</th>
<th>Synchronous</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>LM3478/81-Q1</td>
<td>N/A</td>
<td>2.95 to 40</td>
<td>1.26 to 7.5</td>
<td>1.0 MHz</td>
<td>Sync</td>
<td>Versatile topologies</td>
</tr>
<tr>
<td>LM5001-Q1</td>
<td>1</td>
<td>3.1 to 75</td>
<td>1.26 to 75</td>
<td>1.5 MHz</td>
<td></td>
<td>Adjustable UVLO</td>
</tr>
<tr>
<td>TPS55332-Q1</td>
<td>3</td>
<td>3.6 to 60</td>
<td>2.5 to 50</td>
<td>2.2 MHz</td>
<td>Sync</td>
<td>Fast negative transient response</td>
</tr>
<tr>
<td>LM5122-Q1</td>
<td>N/A</td>
<td>3 to 65</td>
<td>3 to 100</td>
<td>1.0 MHz</td>
<td></td>
<td>Multi-phase capability</td>
</tr>
</tbody>
</table>

#### Wide $V_{IN}$ Buck / Boost Devices

<table>
<thead>
<tr>
<th>Part No</th>
<th>$I_{OUT}$ (A)</th>
<th>$V_{IN}$ (V)</th>
<th>$V_{OUT}$ (V)</th>
<th>$F_{SW}$</th>
<th>Synchronous</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPS55065-Q1</td>
<td>0.5 / 1</td>
<td>1.5 to 40</td>
<td>5</td>
<td>440 kHz</td>
<td></td>
<td>Low-power operation mode</td>
</tr>
<tr>
<td>TPC74100-Q1</td>
<td>N/A</td>
<td>3 to 75</td>
<td>1.23 to 70</td>
<td>500 kHz</td>
<td></td>
<td>Emulated Current Mode control</td>
</tr>
</tbody>
</table>

#### LDOs

<table>
<thead>
<tr>
<th>Part No</th>
<th>$I_{OUT}$ (A)</th>
<th>$V_{IN}$ (V)</th>
<th>$V_{OUT}$ (V)</th>
<th>$I_q$ (µA)</th>
<th>Tolerance</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>LM2936Q-Q1</td>
<td>0.05</td>
<td>5.5 to 40</td>
<td>3, 3.3, 5</td>
<td>15</td>
<td>3%</td>
<td>Reverse transient protection</td>
</tr>
<tr>
<td>TPS7A66/69xx-Q1</td>
<td>0.15</td>
<td>5.5 to 40</td>
<td>1.5 to 5.0</td>
<td>12</td>
<td>2%</td>
<td>Power Good output</td>
</tr>
<tr>
<td>TPS709xx-Q1</td>
<td>0.2</td>
<td>2.7 to 30</td>
<td>1.2 to 6.5V</td>
<td>1</td>
<td>2%</td>
<td>Ultra-low Shutdown Current</td>
</tr>
</tbody>
</table>

### Reference design library

#### PMP7919
Voltage Stabilizer
Dual phase synchronous boost converter for start-stop vehicle applications.

#### TIDA-00160
USB Battery Charging
Automotive USB battery charger optimized for size.

#### TIDA-00098
Camera Module
Complete automotive camera module using a single coaxial cable connection.
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