Description

This reference design showcases a non-synchronous boost converter with a 6V-18V, 36V input. The output voltage is programmable to 20V-36V using a 0-3.3V PWM signal generated by a signal generator or MCU.
1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1. Voltage and Current Requirements

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SPECIFICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{IN}$</td>
<td>6.0V-16.0V, 36V peak</td>
</tr>
<tr>
<td>$V_{OUT}$</td>
<td>20V-36V</td>
</tr>
<tr>
<td>$I_{OUT}$</td>
<td>2.0A</td>
</tr>
<tr>
<td>Nominal switching frequency</td>
<td>400kHz</td>
</tr>
</tbody>
</table>

1.2 Measurement

Oscilloscope: 20-MHz bandwidth and AC coupling. Measure the output voltage ripple directly across an output capacitor with a short ground lead. It is not recommended to use a long-leded ground connection due to the possibility of noise being coupled into the signal. To measure other waveforms, adjust the oscilloscope as needed.

1.3 Considerations

For 36V output voltage and 6V input a maximum load of 1.25A can be handled before thermal runaway starts. The thermal dissipation can be improved by increasing the copper area of the switch node in all layers. With a cooling fan the device can handle full load but the MOSFET reaches temperatures above 150 degrees Celsius.

The low-pass filter of the dynamic voltage regulator is set to 500Hz.

A place for an LC filter is available but not used in this particular design.
2 Testing and Results

2.1 Efficiency Graphs

![Efficiency Graphs](image1)

2.2 Load regulation

![Load regulation](image2)
2.3  **Thermal Images**

VIN = 6 V, VOUT = 24 V, IOUT = 2 A  
VIN = 6 V, VOUT = 36 V, IOUT = 1.25 A  
VIN = 12 V, VOUT = 24 V, IOUT = 2 A  
VIN = 12 V, VOUT = 36 V, IOUT = 2 A

2.4  **Dimensions**

PCB: 63.5 mm x 50.2 mm
3 Waveforms

3.1 Switching

VIN = 6 V, VOUT = 24 V, IOUT = 2 A

VIN = 12 V, VOUT = 24 V, IOUT = 2 A

VIN = 18 V, VOUT = 24 V, IOUT = 2 A

VIN = 6 V, VOUT = 36 V, IOUT = 2 A

VIN = 12 V, VOUT = 36 V, IOUT = 2 A

VIN = 18 V, VOUT = 36 V, IOUT = 2 A
3.2 Output Voltage Ripple

VIN = 6 V, VOUT = 24 V, IOUT = 2 A
484mV_{pp}

VIN = 6 V, VOUT = 36 V, IOUT = 2 A
739mV_{pp}

VIN = 12 V, VOUT = 24 V, IOUT = 2 A
208mV_{pp}

VIN = 12 V, VOUT = 36 V, IOUT = 2 A
367mV_{pp}

VIN = 18 V, VOUT = 24 V, IOUT = 2 A
163mV_{pp}

VIN = 18 V, VOUT = 36 V, IOUT = 2 A
246mV_{pp}
3.3  Bode Plot

VIN = 6 V, VOUT = 24 V, IOUT = 2 A
F_CO = 1.3 kHz;
71° Phase Margin;
-13 dB Gain Margin

VIN = 6 V, VOUT = 36 V, IOUT = 2 A
F_CO = 641 Hz;
67° Phase Margin;
-13 Gain Margin

VIN = 12 V, VOUT = 24 V, IOUT = 2 A
F_CO = 3.2 kHz;
71° Phase Margin;
-17 dB Gain Margin

VIN = 12 V, VOUT = 36 V, IOUT = 2 A
F_CO = 2 kHz;
75° Phase Margin;
-19 dB Gain Margin

VIN = 18 V, VOUT = 24 V, IOUT = 2 A
F_CO = 4.6 kHz;
68° Phase Margin;
-19 dB Gain Margin

VIN = 18 V, VOUT = 36 V, IOUT = 2 A
F_CO = 3.1 kHz;
74° Phase Margin;
-22 dB Gain Margin
3.4 **Load Transients**

- **VIN = 6V, VOUT=24V, IOUT = 1A to 2A**
- **VIN = 6V, VOUT=36V, IOUT = 1A to 2A**
- **VIN = 12V, VOUT=24V, IOUT = 1A to 2A**
- **VIN = 18V, VOUT=24V, IOUT = 1A to 2A**
- **VIN = 6V, VOUT=36V, IOUT = 1A to 2A**

**BLUE** – Output voltage

**GREEN** – Load current
3.5 Start-up Sequence

3.5.1 24V Output voltage

Start-Up, $V_{IN} = 6$ V, $I_{OUT} = 2$ A

Shutdown, $V_{IN} = 6$ V, $I_{OUT} = 2$ A

Start-Up, $V_{IN} = 12$ V, $I_{OUT} = 2$ A

Shutdown, $V_{IN} = 12$ V, $I_{OUT} = 2$ A

Start-Up, $V_{IN} = 18$ V, $I_{OUT} = 2$ A

Shutdown, $V_{IN} = 18$ V, $I_{OUT} = 2$ A

Purple – Input Voltage
Orange – Output Voltage
3.5.2  36V Output voltage

Start-Up, $V_{IN} = 6$ V, $I_{OUT} = 2$ A

Shutdown, $V_{IN} = 6$ V, $I_{OUT} = 2$ A

Start-Up, $V_{IN} = 12$ V, $I_{OUT} = 2$ A

Shutdown, $V_{IN} = 12$ V, $I_{OUT} = 2$ A

Start-Up, $V_{IN} = 18$ V, $I_{OUT} = 2$ A

Shutdown, $V_{IN} = 18$ V, $I_{OUT} = 2$ A

Purple – Input Voltage
Orange – Output Voltage
3.6 Other

3.6.1 Schematic and layout

Top layer with silkscreen

Signal layer 1

Signal layer 2

Bottom layer with silkscreen
IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to TI's Terms of Sale (www.ti.com/legal/termsofsale.html) or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2019, Texas Instruments Incorporated