

PMP10654 Test Report



Table of Contents

I. Overview.....	3
II. Power Specification	4
III. Reference Board.....	4
IV. Efficiency	6
V. Cross Regulation.....	6
VI. Thermal	10
VII. Power Up	11
VIII. Switching Waveforms.....	12
IX. Load Transients.....	14
X. Output Voltage Ripples.....	15
XI. Short Circuit Test.....	16

I. Overview

The PMP10654 reference design is a dual output isolated Fly-Buck power module for single IGBT driver bias. It takes 12V nominal input and generates isolated +15V and -9V outputs with 200mA current capability. The two voltage rails are suitable for providing the positive and negative bias to an IGBT gate driver in motor drives for EV/HEV and industrial applications, as shown in Figure 1. The reference board is designed as a power module with a miniature size of 28 x 18 mm (1.1 x 0.7 inch), and its footprint is compatible with the standard DIP package.

The reference design employs the Fly-Buck topology, and uses the LM5160 synchronous buck converter. The Fly-Buck has the advantages of primary side regulation (with no need of opto-coupler feedback) and good cross regulation. In order to achieve the low input voltage operation (down to 8V), the primary side is configured as an inverting buck in the design.

The input voltage range of the design is 8V to 20V. The output regulation is within +/-5% tolerance over line and load variations. The peak efficiency is about 87%. The insulation voltage rating provided by the transformer is 2500VDC/1min.

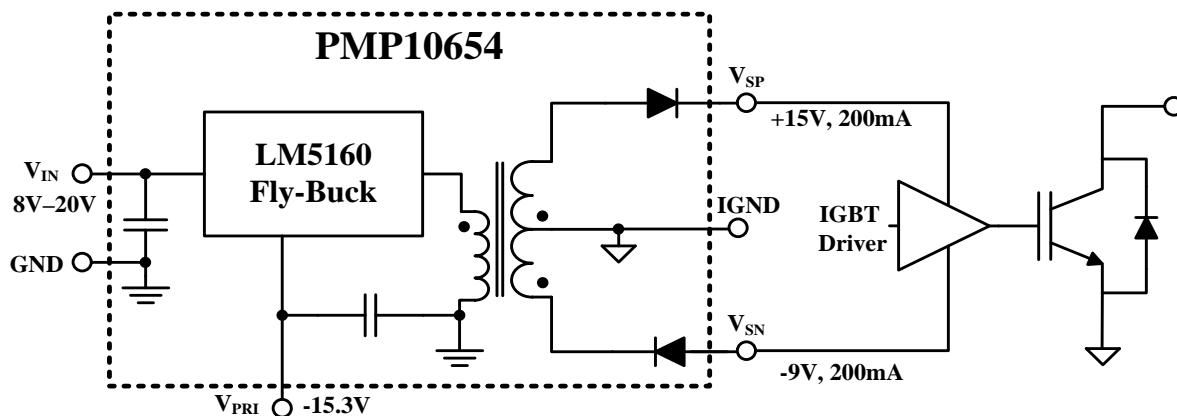


Figure 1 The single IGBT gate driver bias supply with PMP10654

II. Power Specification

Input Voltage: 12V nominal, 8V – 20V
 Output: Isolated +15V, -9V @ 200mA each
 Total output power: 4.8W
 Switching frequency: 210 kHz

III. Reference Board

The reference board is designed as a power module in standard DIP 22-pin package (100mil pin pitch, 600mil row spacing). The footprint of the board is shown in Figure 2. Note that the pin 7, 8 (VPRI) are the -15.3V primary output voltage of the Fly-Buck, and they are unused in the design. The reference board uses 1oz copper 2-layer PCB, and its dimensions are as follows:

Board size: 28 x 18 mm (1.1 x 0.7 inch).

Total height: 12.5mm when mounted on a PCB

Component height: top side 8.5mm, bottom side 2.5mm

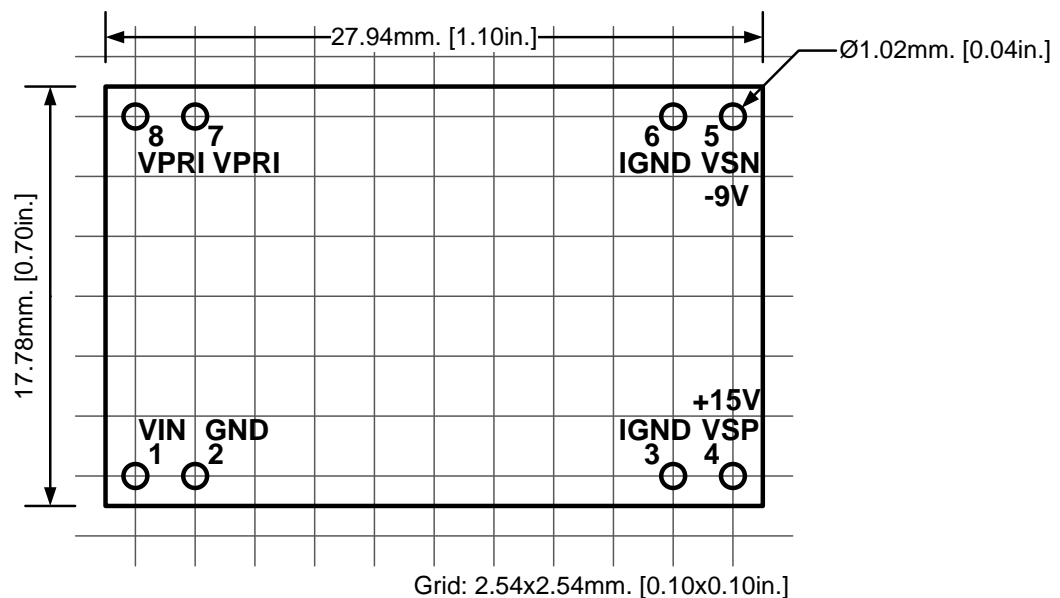


Figure 2 Reference board footprint

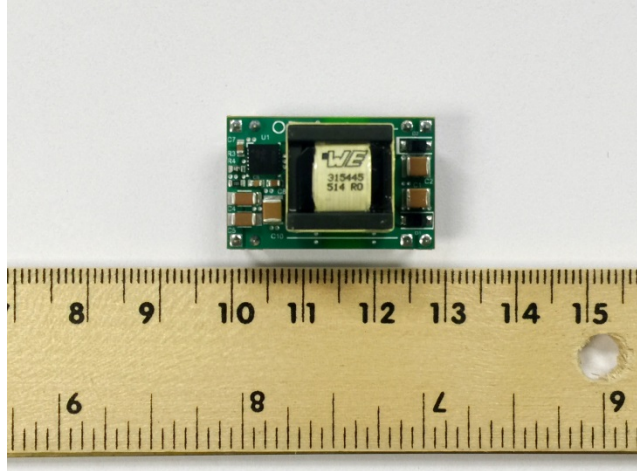


Figure 3 Reference board top view

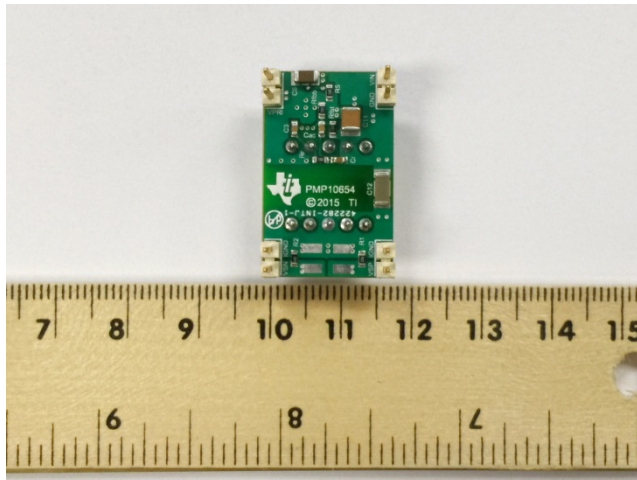


Figure 4 Reference board bottom view

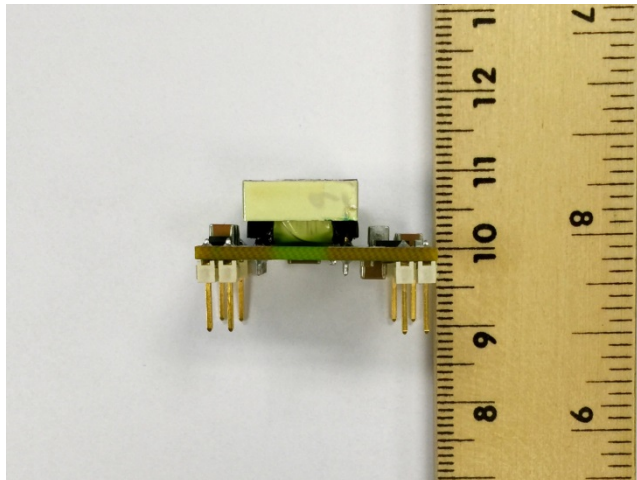


Figure 5 Reference board side view

IV. Efficiency

The efficiency was measured at different input voltages under balanced load, where both outputs were loaded with the same current.

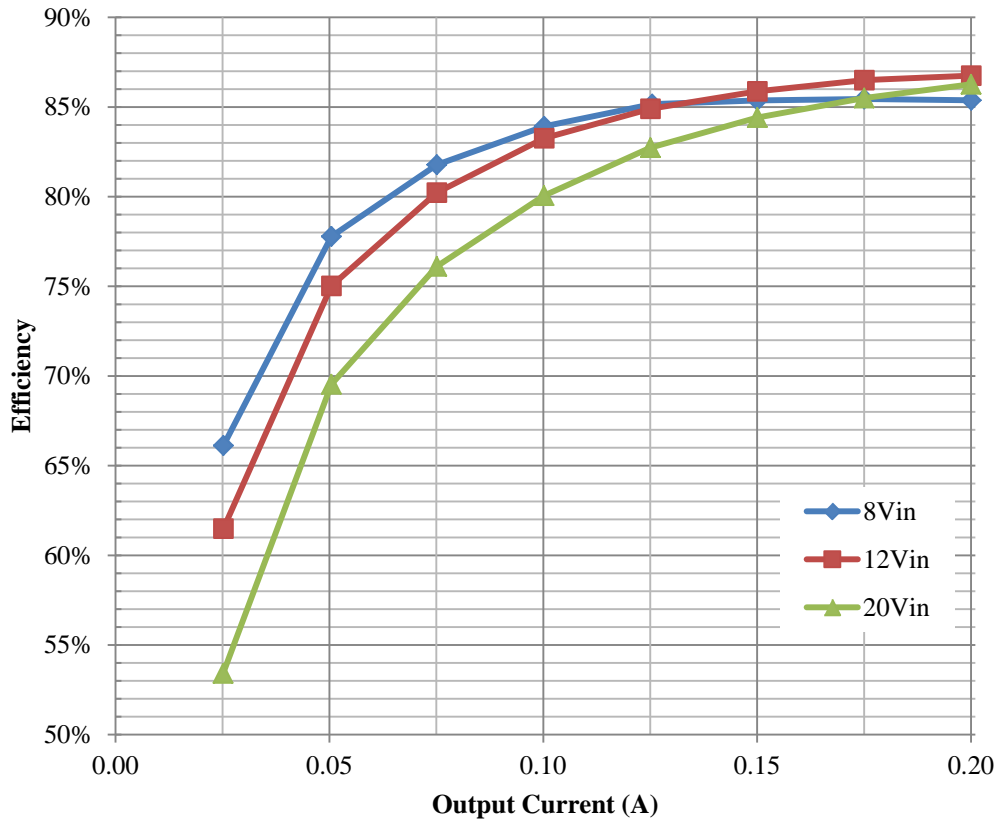


Figure 6 Power efficiency under balanced load

V. Cross Regulation

The output regulation of the reference design was examined at different input voltage under balanced and unbalanced load condition. The test results show that both outputs were within +/-5% variation under all the input and load conditions.

Under balanced load, the two outputs were loaded with the same output current. Figure 7 and Figure 8 shows the output variations under balanced load.

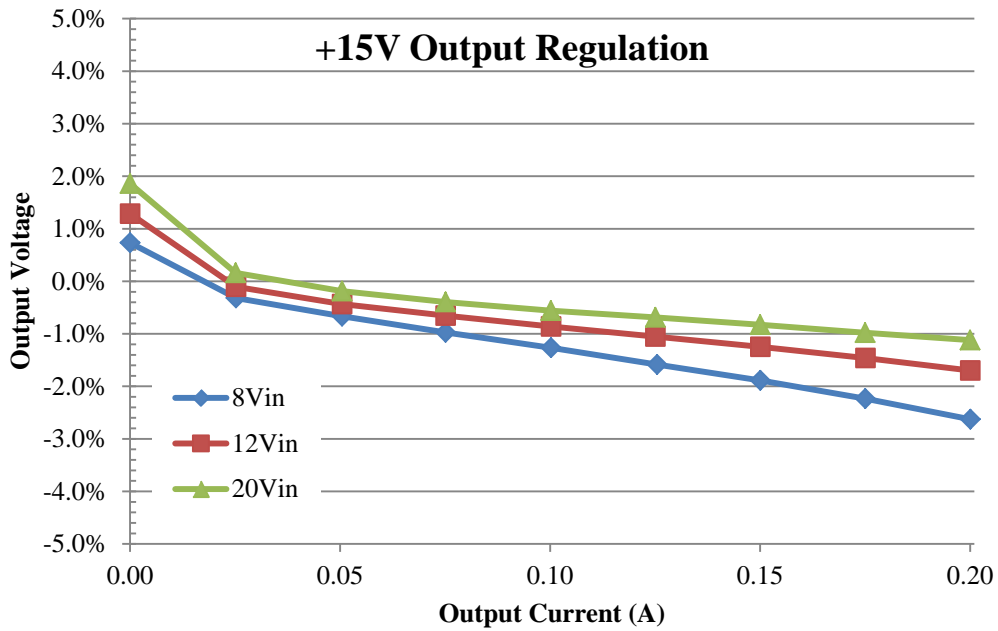


Figure 7 +15V output regulation under balanced load

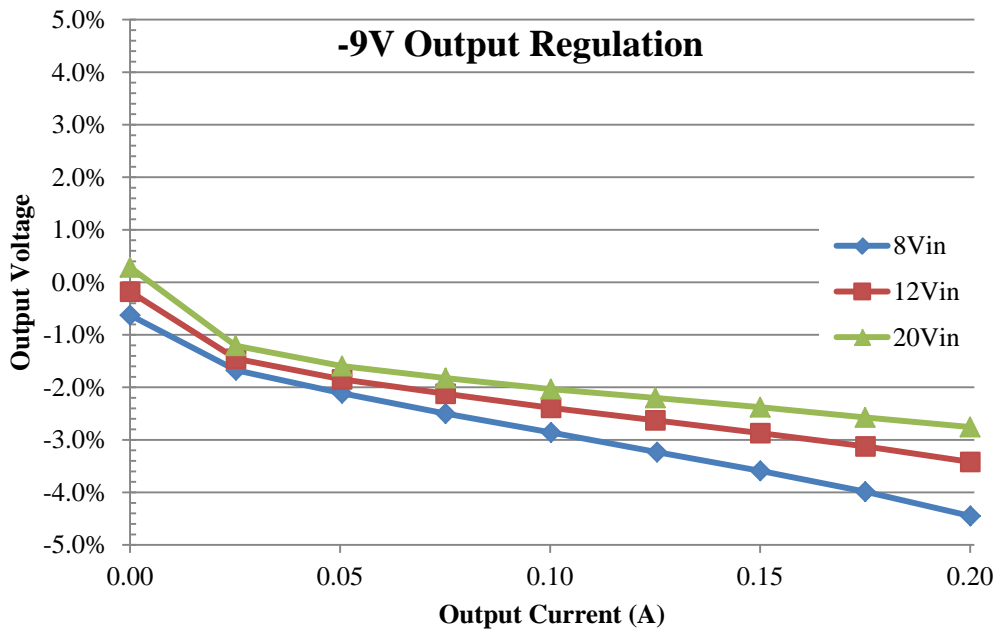


Figure 8 -9V output regulation under balanced load

The unbalanced load condition was tested by varying the load on one output while fixing the load on the other output. Figure 9 and Figure 10 show the output variations with fixed load on the -9V output, while Figure 11 and Figure 12 show the results with fixed load on the +15V output.

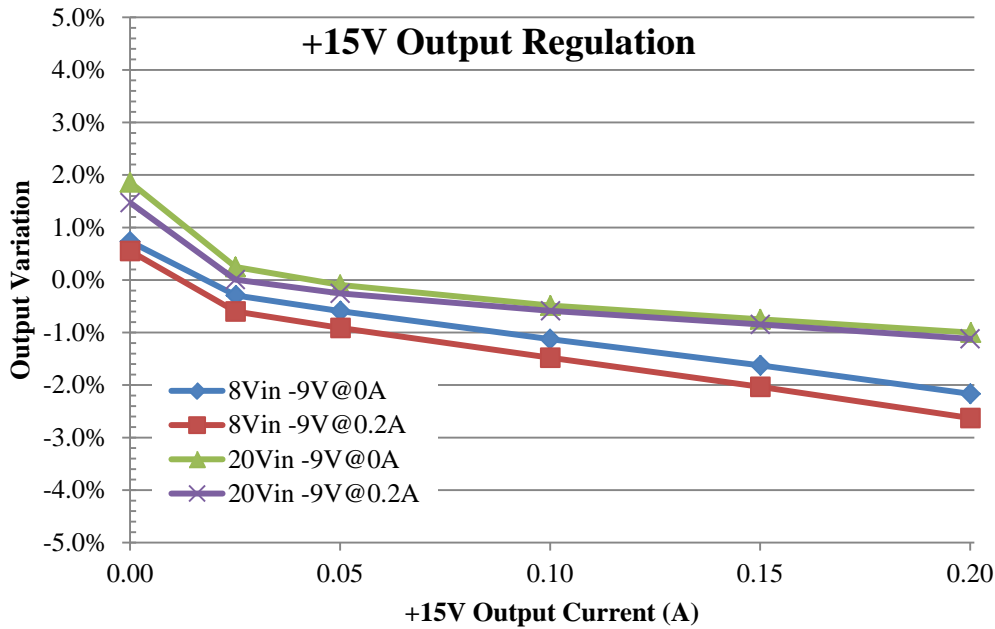


Figure 9 +15V output regulation under unbalanced load, fixed load on -9V output

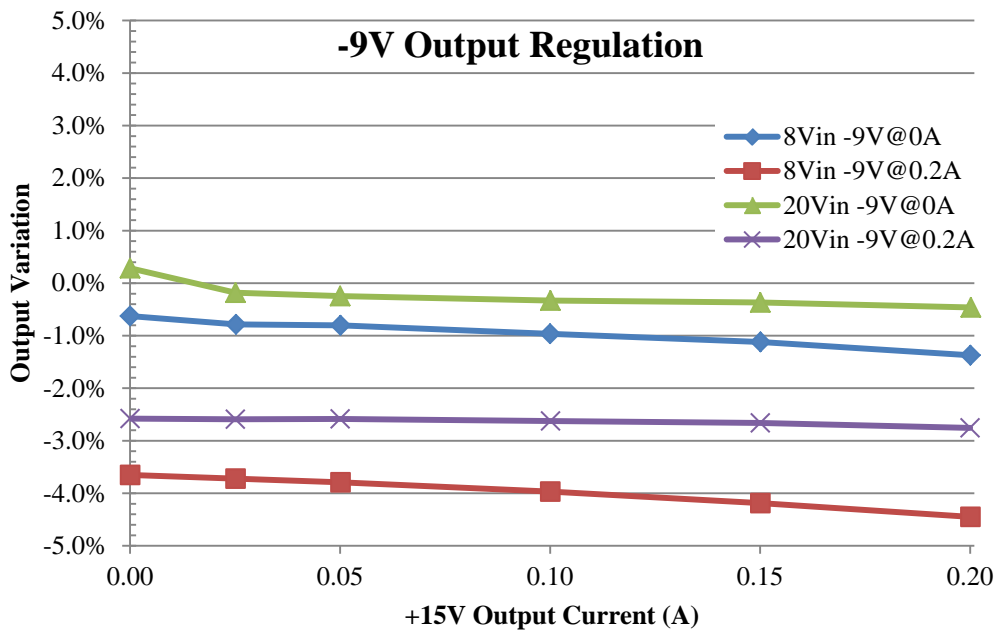


Figure 10 -9V output regulation under unbalanced load, fixed load on -9V output

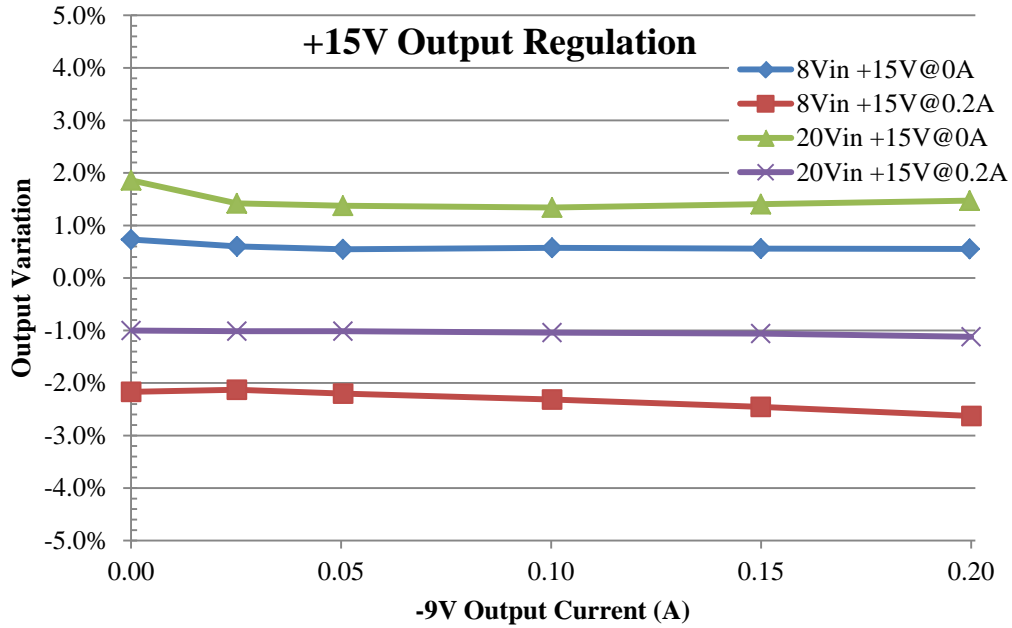


Figure 11 +15V output regulation under unbalanced load, fixed load on +15V output

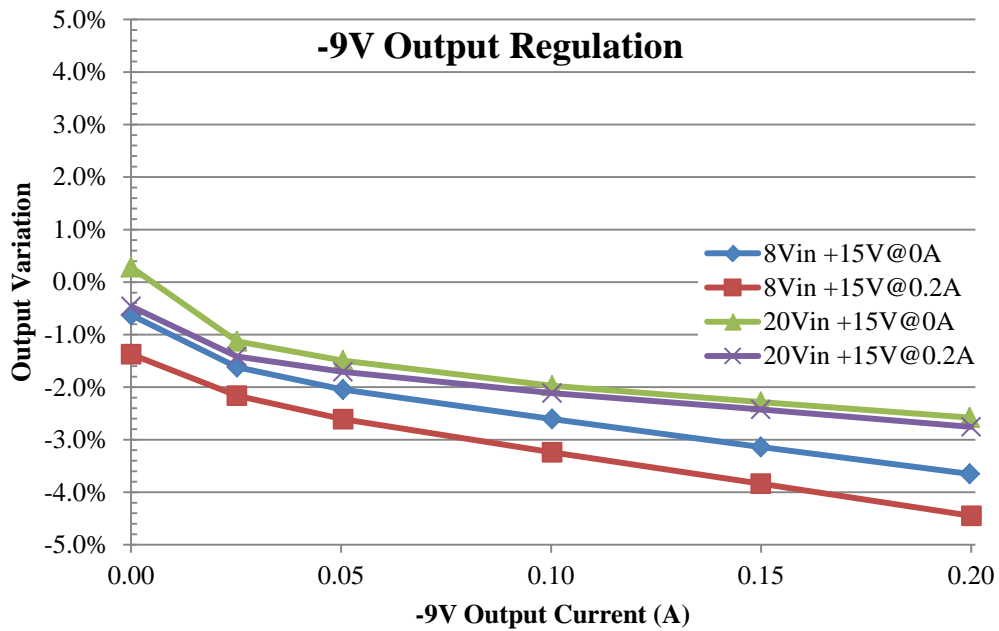


Figure 12 -9V output regulation under unbalanced load, fixed load on +15V output

VI. Thermal

The thermal image was taken at 23°C room temperature, no air flow. The board was operating at 12V input, full load on the two outputs.

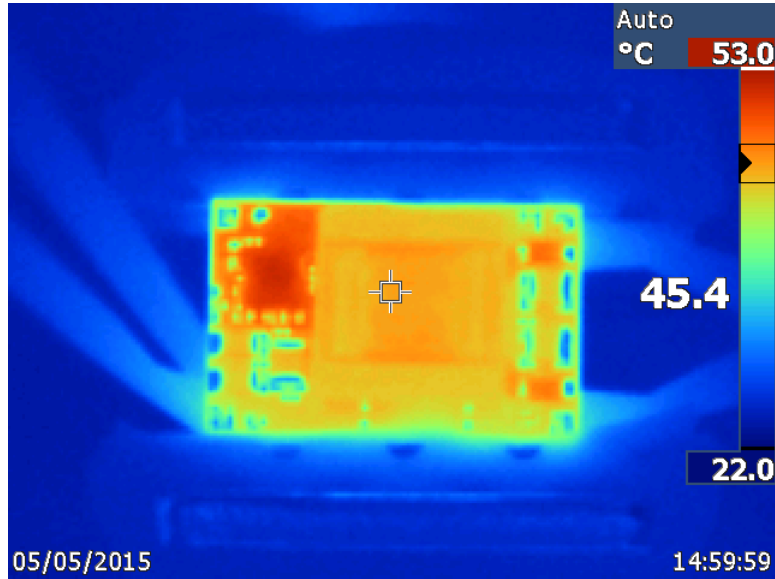


Figure 13 Thermal image from top view

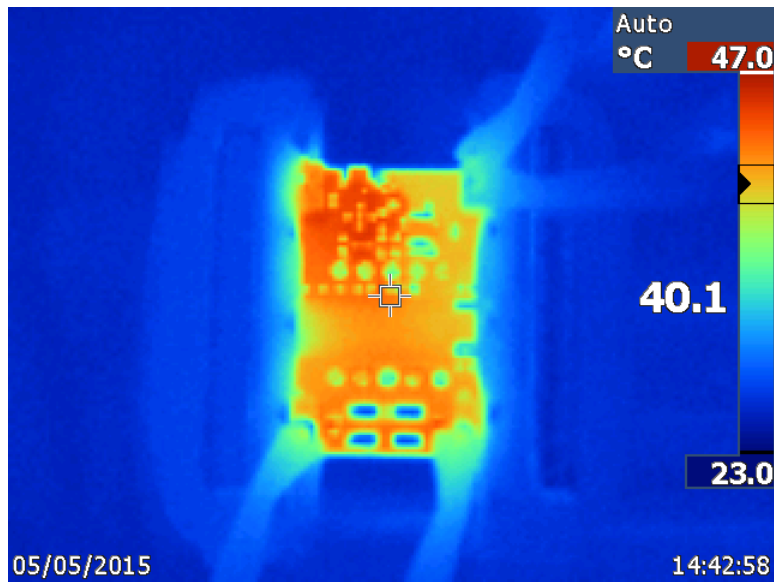


Figure 14 Thermal image from bottom view

VII. Power Up

The reference board was tested under no load and full load at 12V input. Ch1 (yellow) is the input voltage, Ch2 (green) is the +15V output voltage, Ch3 (purple) is the -9V output voltage.



Figure 15 Power up into no load at 12V input



Figure 16 Power up into full load at 12V input

VIII. Switching Waveforms

The primary side switch node voltage was measured at no load and full load condition at 12V input. Ch1 (yellow) is the switch node voltage.

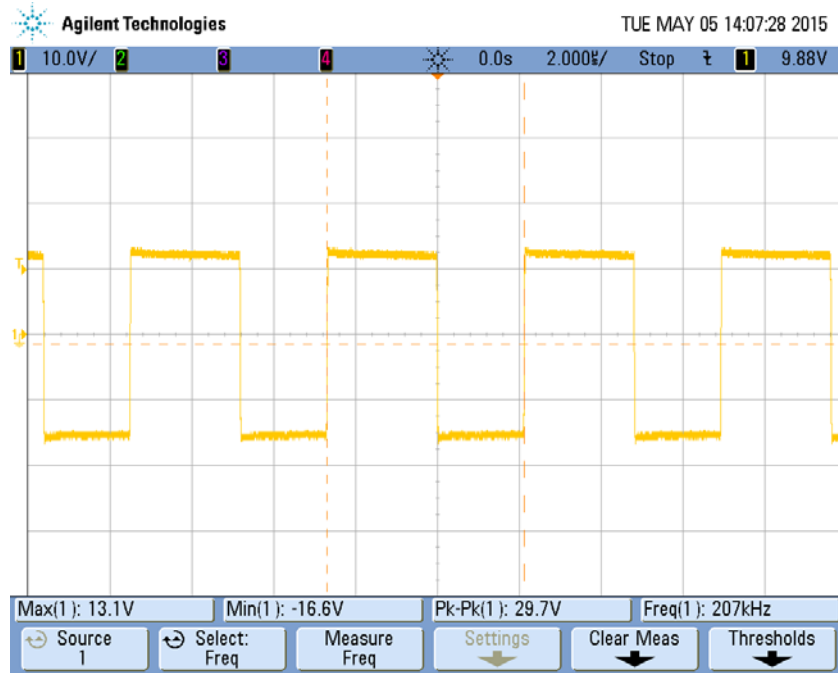


Figure 17 Switch node voltage at no load, 12V input

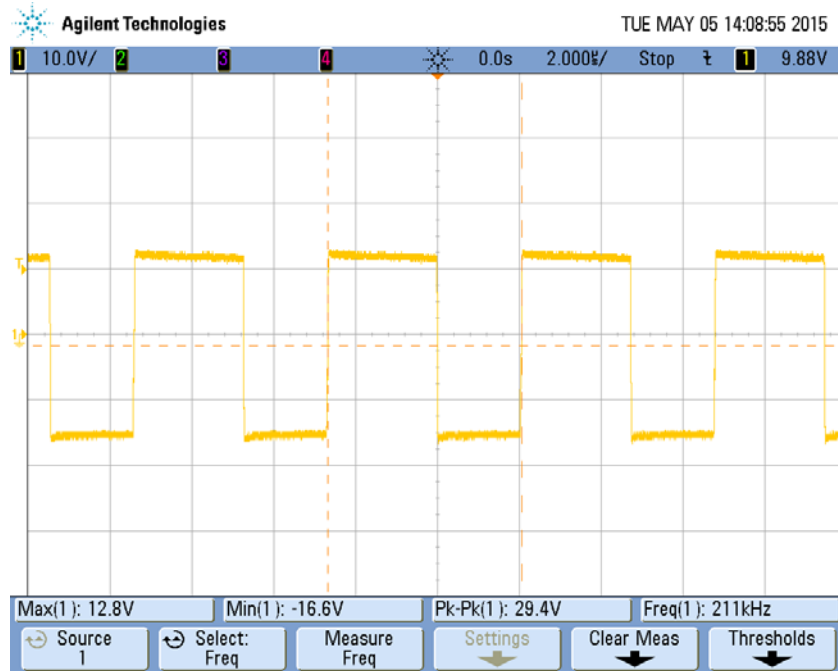


Figure 18 Switch node voltage at full load, 12V input

On the isolated secondary side, the voltages across the rectifier diodes were measured at full load and 20V input, as the condition represented the worst case for the highest blocking voltage on the diodes. Ch1 (yellow) shows the voltage across the diode.

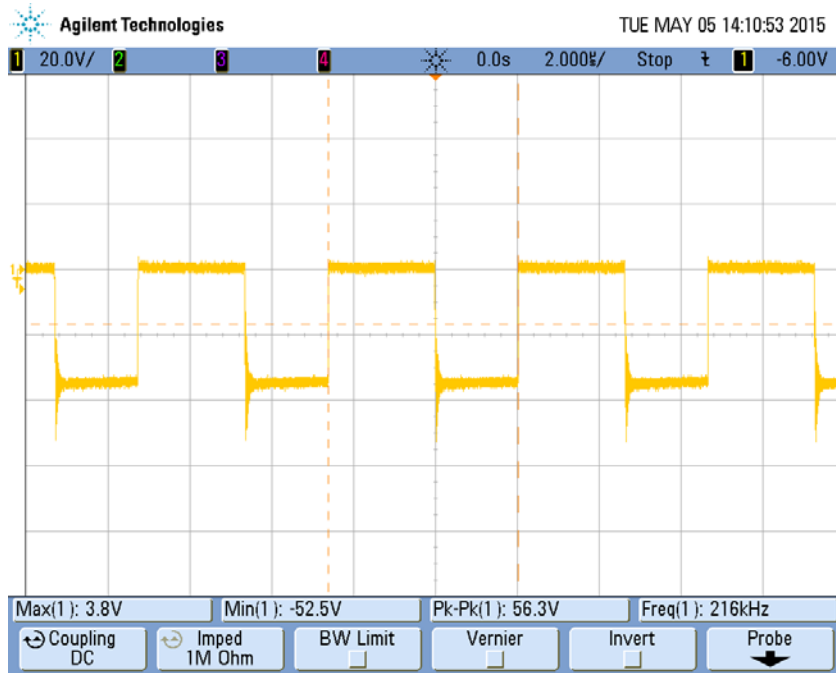


Figure 19 +15V output diode anode (+) to cathode (-) voltage at full load, 20V input

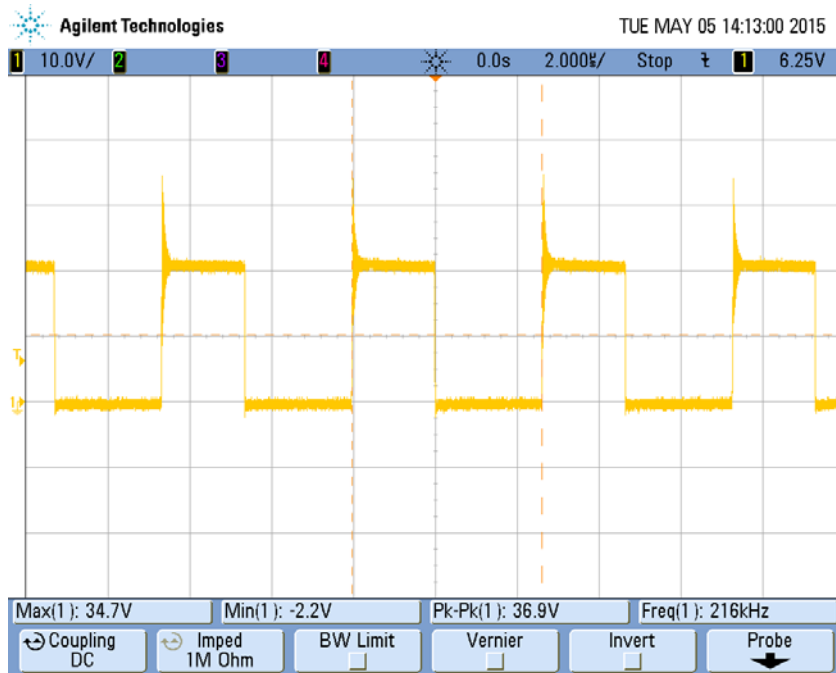


Figure 20 -9V output diode cathode (-) to anode (+) voltage at full load, 20V input

IX. Load Transients

The load transient response was tested by applying 0 to 0.2A load steps from the +15V to -9V as one output. Ch1 (yellow) is the output voltage in AC mode, and Ch4 (magenta) is the output current.

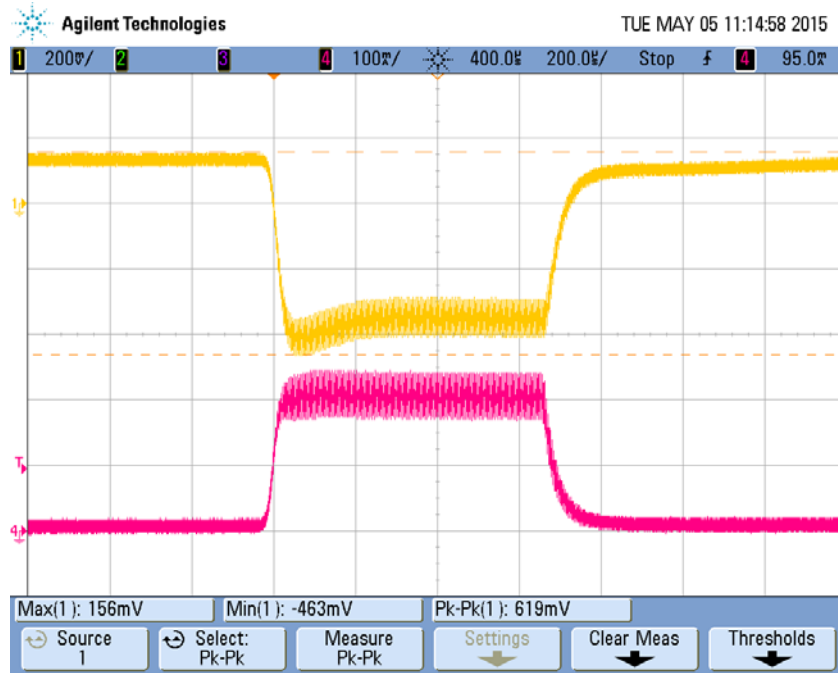


Figure 21 +15V output load transient at 12V input

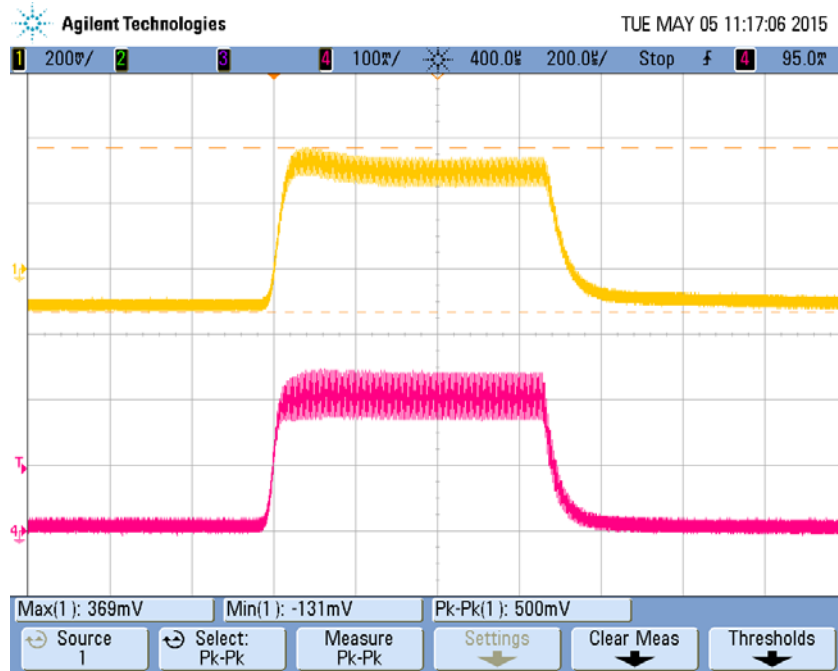


Figure 22 -9V output load transient at 12V input

X. Output Voltage Ripples

The output ripples were measured directly at the output capacitors. Ch1 (yellow) is the output voltage ripple in AC mode.

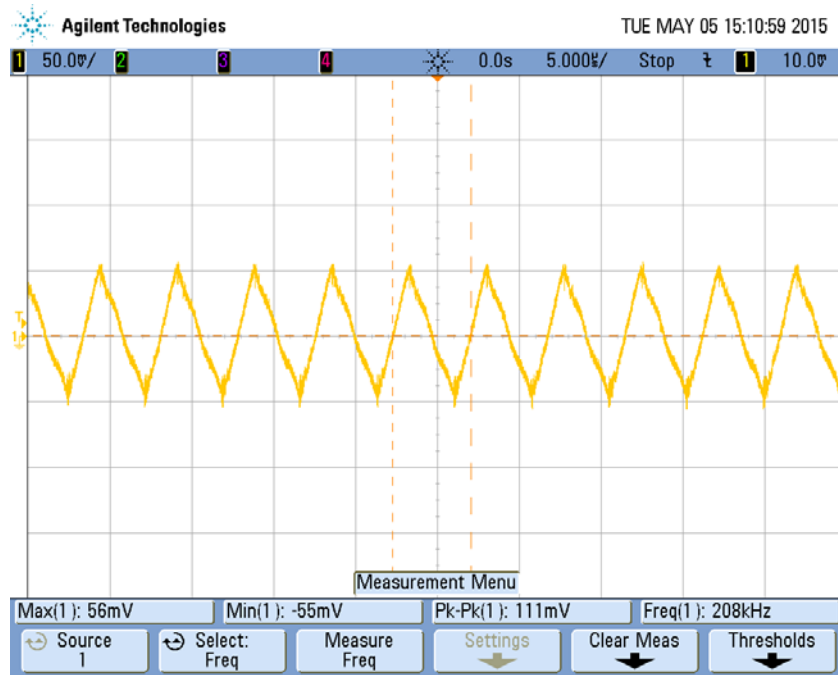


Figure 23 +15V output ripple at 12V input, full load

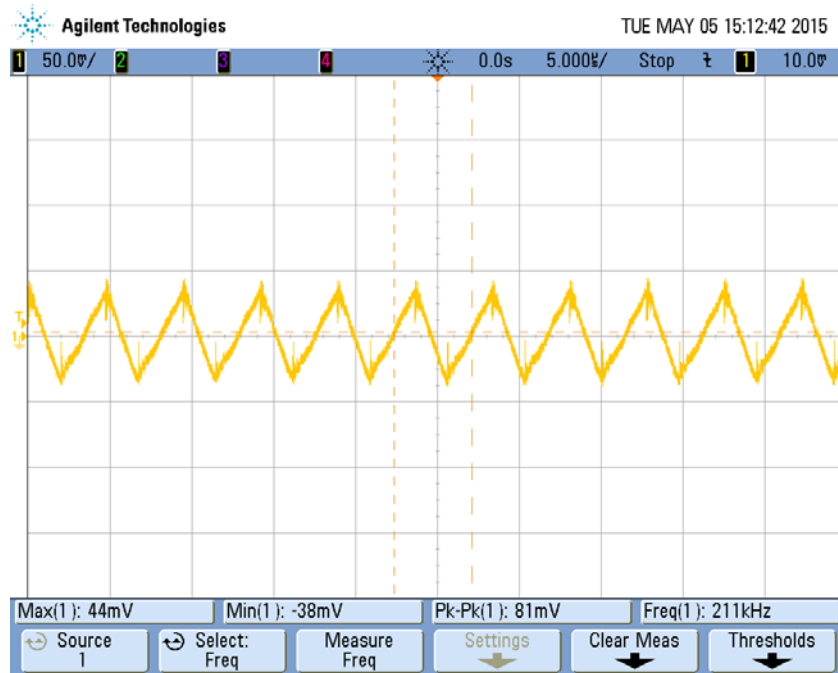


Figure 24 -9V output ripple at 12V input, full load

To further reduce the ripple, more capacitors can be added to the output. There is one extra 1210 solder pad available for each output on the bottom of the board.

XI. Short Circuit Test

The short circuit test was conducted by shorting the +15V and -9V output together when the board was operating at full load and 12V input. While in short circuit, the LM5160 IC can protect itself from over current by limiting the on-time of the integrated high side FET. The board can still recover to normal operation once the short circuit condition is released. However, the rectifier diodes on the secondary side will still experience high current pulse in short circuit, and thus have high temperature rise. To prevent damaging the diodes, it is not suggested to have the board undergo the short circuit for too long.

Ch1 (yellow) is the switch node voltage, Ch2 (green) is the +15V output voltage, Ch3 (purple) is the -9V output voltage, and Ch4 (magenta) is the input current.



Figure 25 From full load operation to short circuit at 12V input



Figure 26 Short circuit removed into full load operation at 12V input

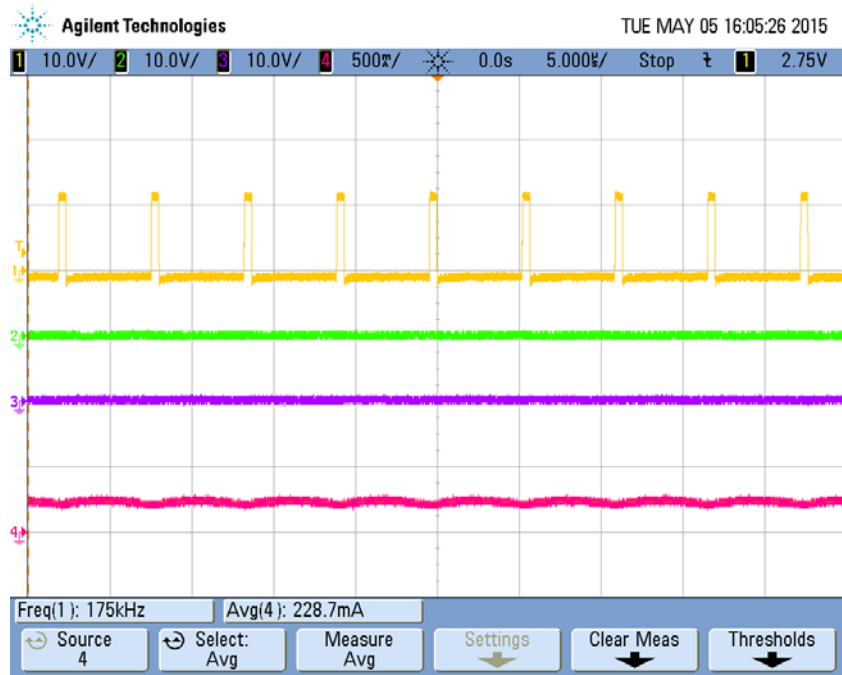


Figure 27 Operation in short circuit at 12V input

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 (<https://www.ti.com/legal/termsofsale.html>) or other applicable terms available either on [ti.com](https://www.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 © 2021, Texas Instruments Incorporated