LM5020-2 Constant Current Input Boost Converter for 2 LED Strings

TI reference design number: PMP10527 REV A

Input: 205mA Constant Current
Output: 137 VDC @ 130mA

DC – DC Test Results

Table of Contents

1 Test Specifications....3
2 Circuit Description....3
3 Board Photos....4
4 Efficiency....6
4.1 Efficiency Results....6
4.2 Efficiency Data....6
4.3 Constant Current Ballast and LED Data....6
5 Thermal....7
5.1 Thermal Image....7
6 Startup and Shut Down....8
6.1 Startup and Shut Down using Ballast and LEDs....8
6.2 Startup Stability using Ballast and LEDs....8
7 Switch Voltage and Sense Voltage Ripple....9
8 Load Transient Response....10
9 Control Loop Frequency Response....11
9.1 Constant Current Ballast and LED Load....11

1 Test Specifications

Vin	**92 VDC**
Iin	**205mA Constant Current**
Vout	**137 VDC**
Iout	**130mA**

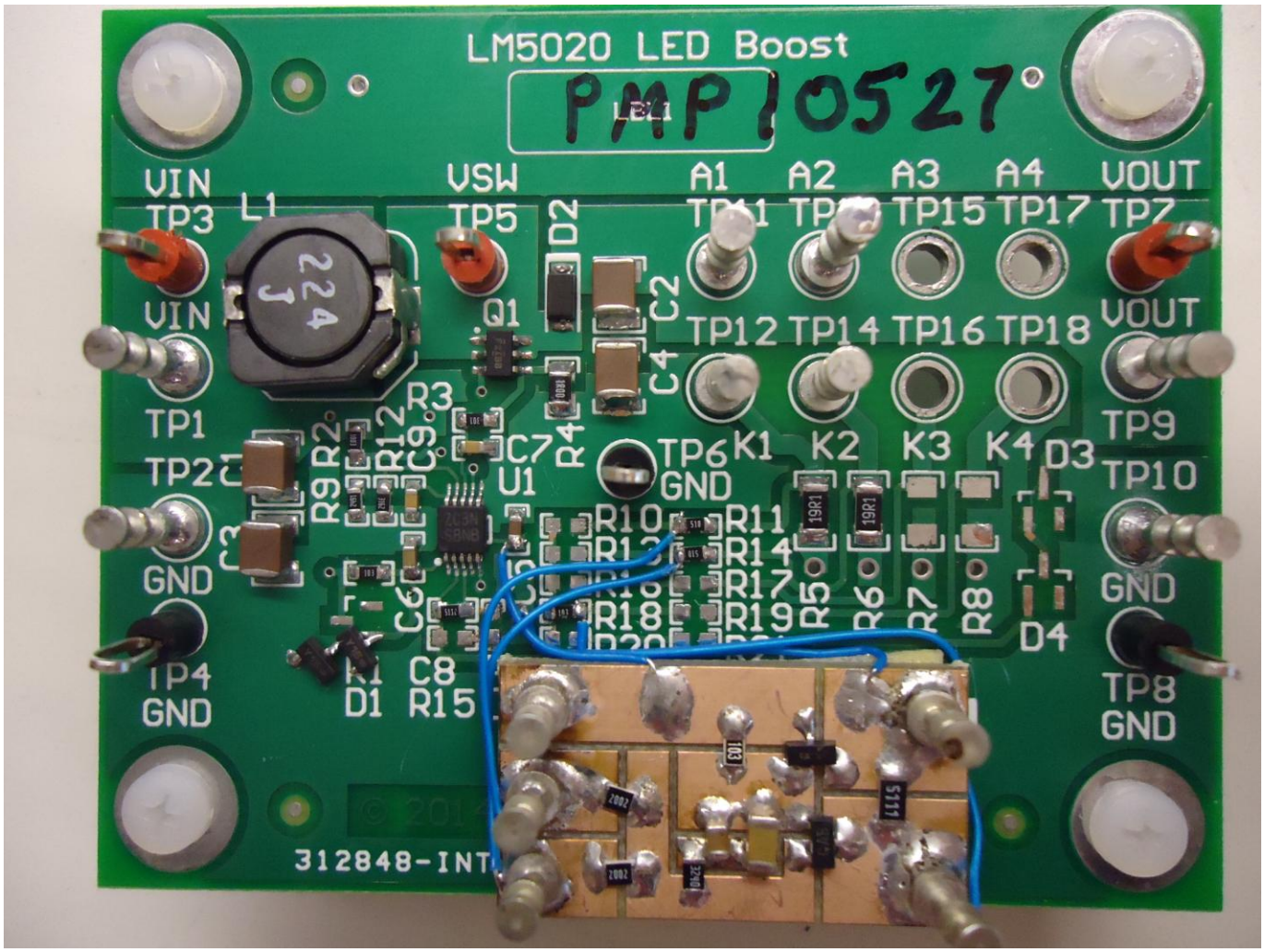
2 Circuit Description

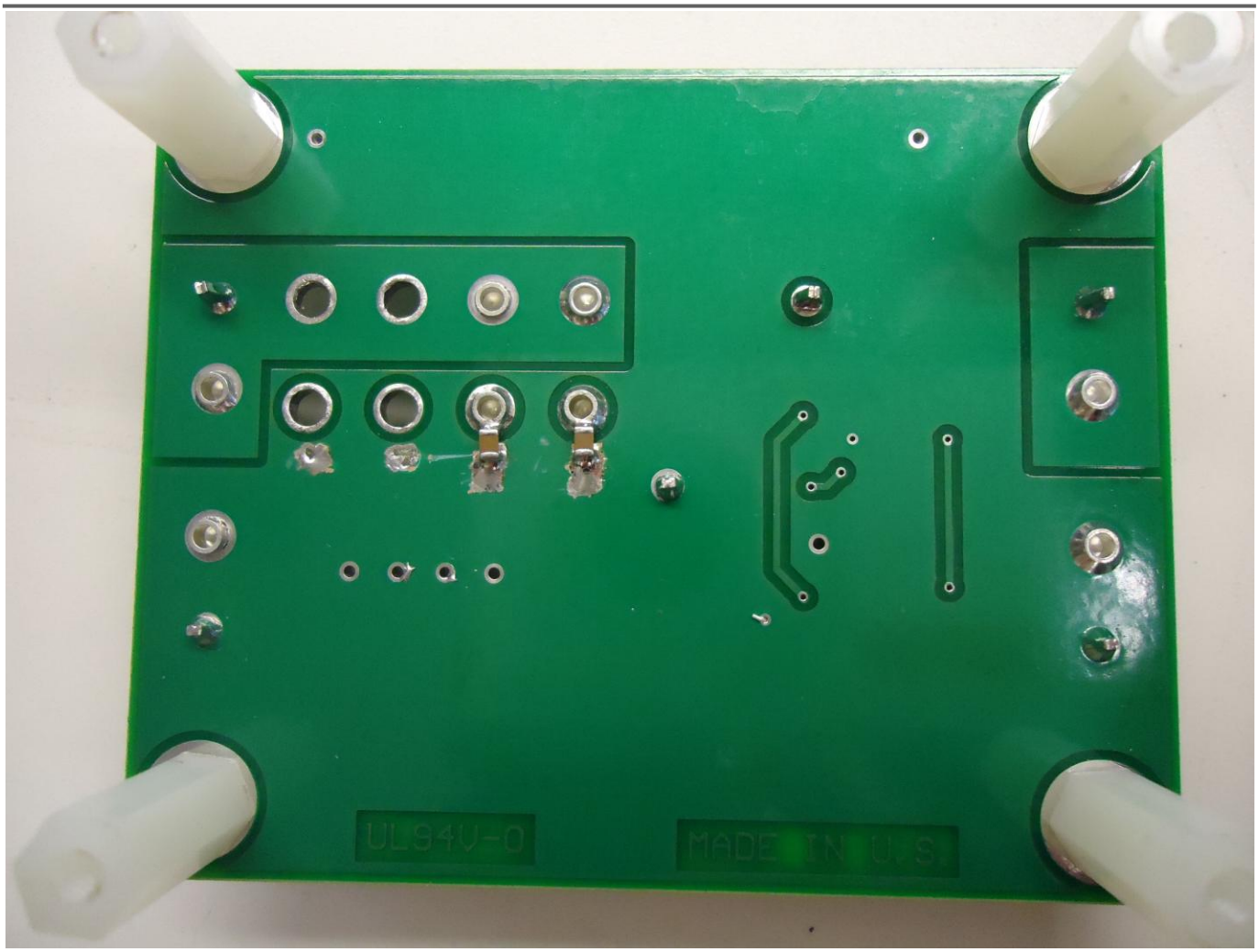
PMP10527 is a constant current input boost converter for LEDs which utilizes the LM5020-2 controller. The switching frequency is set to 100 kHz for high efficiency at a nominal output power of 18.5W. The design features switch current limiting and input under-voltage lockout. Summing feedback for multiple LED strings with constant current regulation allows for wide variation of input voltage.

Operating from a constant current source into the negative input impedance of a dc-dc converter creates a phase inversion of 180 degrees. The LMV431 shunt regulator is added in series with the LM5020-2 internal error amplifier to provide the required non-inverting feedback. The control to output transfer function is found to have multiple poles due to the input capacitor, output capacitor and string current filter capacitor. For stability the feedback compensation is set to be proportional to the value of input capacitance. The converter should be operated from a rectified ac source with known bridge capacitor. Due to excessive input capacitance the circuit will not be stable without modification when operated from a typical dc lab supply.

3 Board Photos

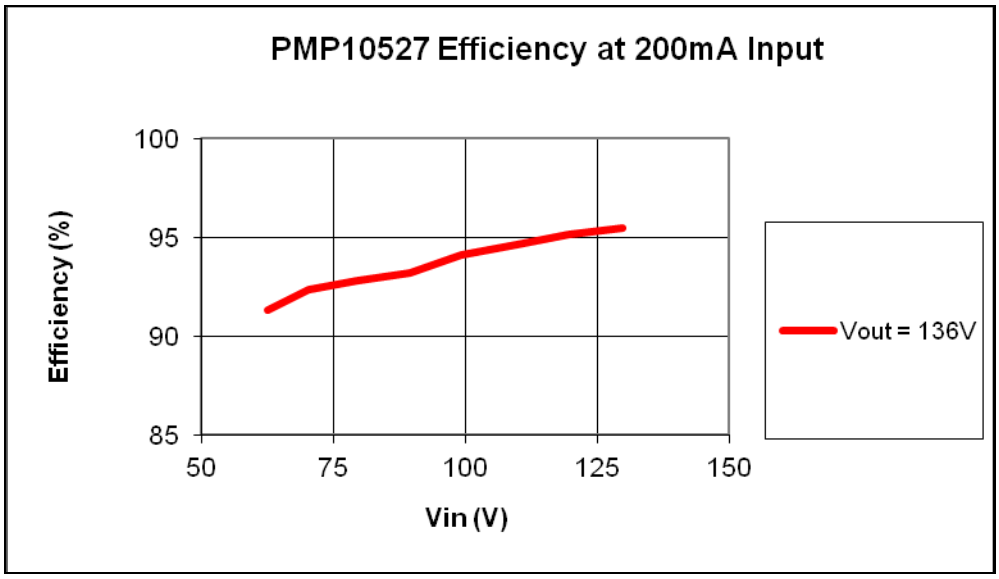
The design is built on PMP10505 Rev A printed circuit board. This is a 2-layer PCB with 1 oz. copper. PCB dimensions are 2.75 x 2.2 inch.




UL94V-0
MADE IN U.S.

4 Efficiency

4.1 Efficiency Results



4.2 Efficiency Data

A 20kΩ summing resistor to the LMV431 REF pin and external supply is used to adjust the LED current.

Vin (V)	Iin (A)	Vout (V)	Iout (A)	Pin (W)	Pout (W)	Pdis (W)	Efficiency (%)
62.50	0.2034	133.40	0.0870	12.71	11.61	1.10	91.344
70.29	0.2025	134.24	0.0979	14.23	13.14	1.09	92.336
79.48	0.2016	135.17	0.1100	16.02	14.87	1.15	92.813
89.36	0.2008	136.09	0.1229	17.94	16.72	1.22	93.200
99.08	0.2000	136.82	0.1363	19.82	18.65	1.17	94.118
109.55	0.1992	137.65	0.1500	21.82	20.65	1.17	94.639
119.47	0.1985	138.41	0.1630	23.71	22.56	1.16	95.113
129.66	0.1981	139.10	0.1762	25.69	24.51	1.17	95.440

4.3 Constant Current Ballast and LED Data

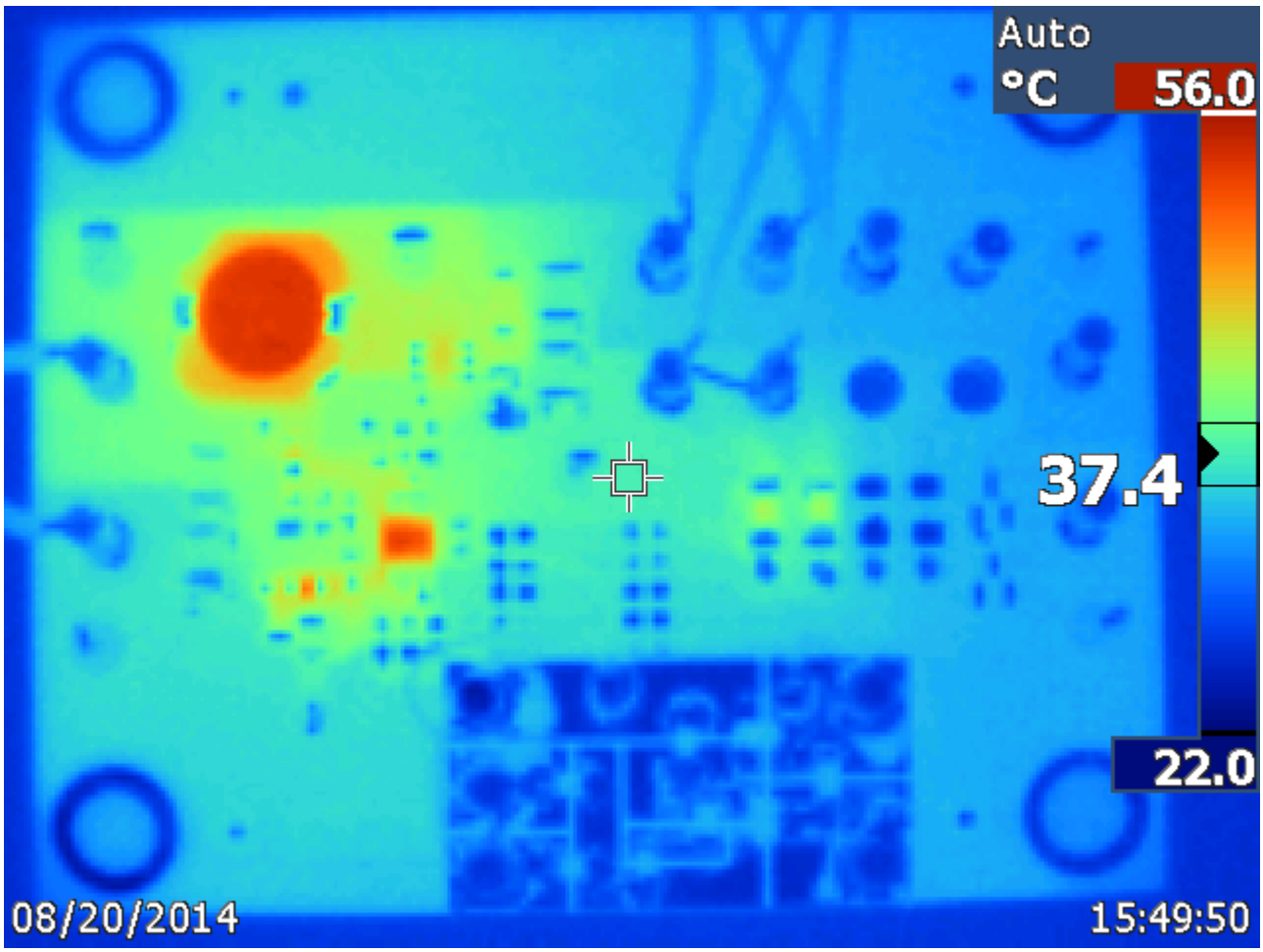
Test using ac ballast, bridge rectifier into 3.3µF 250V film capacitor at input and 2 strings of 24 LEDs.

Vac (V)	Iac (A)	Pac (W)	Power Factor	Vin (V)	Iin (A)	Vout (V)	Vs1 (V)	Vs2 (V)
120	0.2	24	0.999	92.07	0.2053	136.7	1.222	1.227

5 Thermal

5.1 Thermal Image

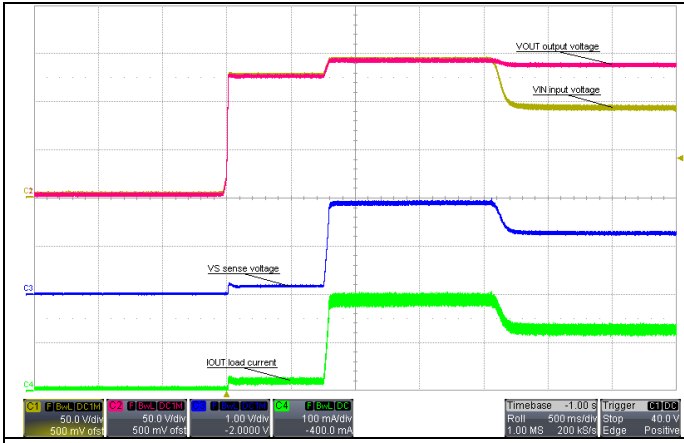
92V input 205mA to 137V output 130mA load.



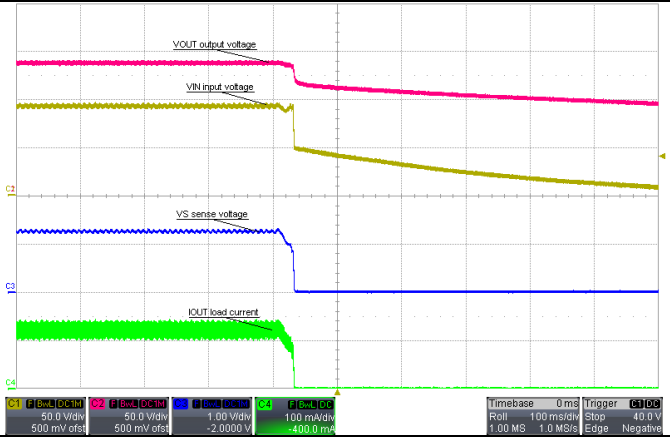
6 Startup and Shut Down

6.1 Startup and Shut Down using Ballast and LEDs

During startup the string current is limited by the source current until the control loop settles into regulation.



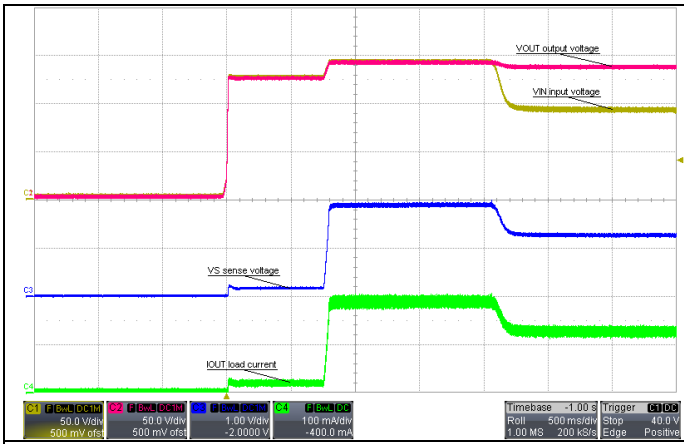
VIN VOUT VS IOUT startup using ballast and LED load



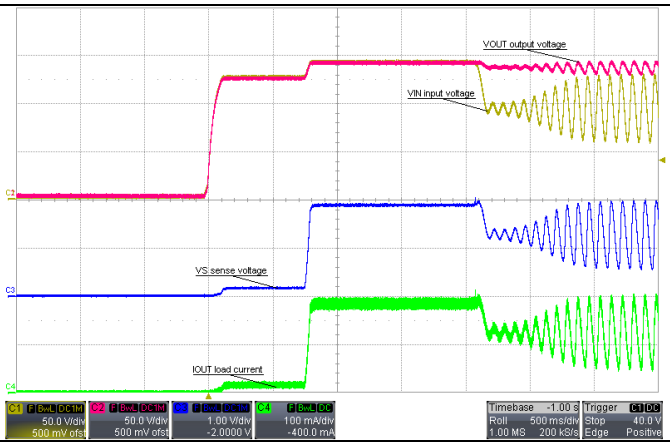
VIN VOUT VS IOUT shut down using ballast and LED load

6.2 Startup Stability using Ballast and LEDs

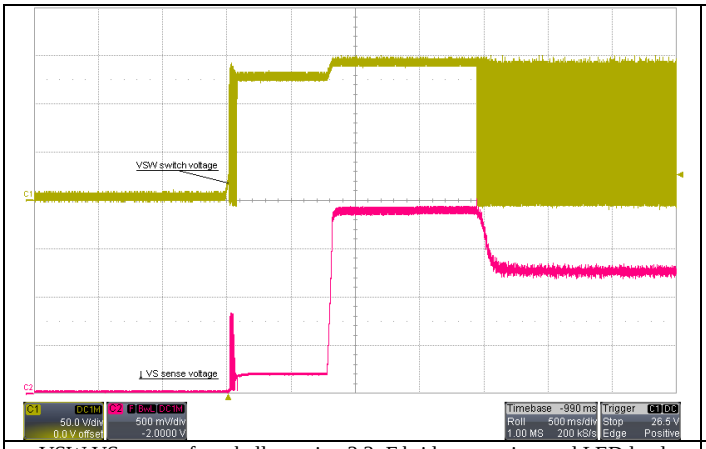
Increasing the input capacitor causes a control loop oscillation.



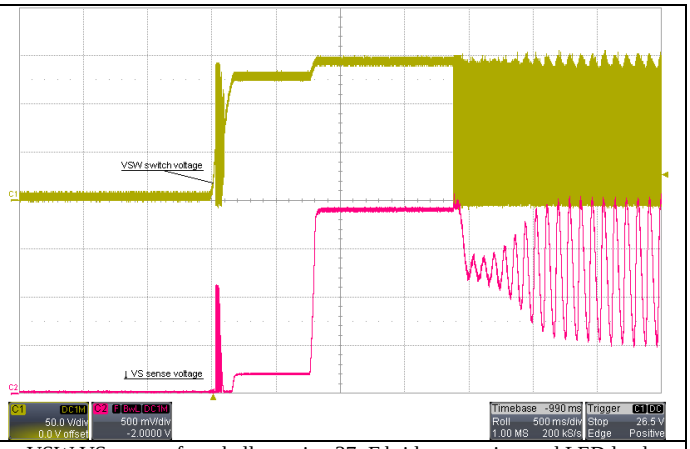
VIN VOUT VS IOUT startup from ballast using 3.3µF bridge capacitor and LED load



VIN VOUT VS IOUT startup from ballast using 37µF bridge capacitor and LED load



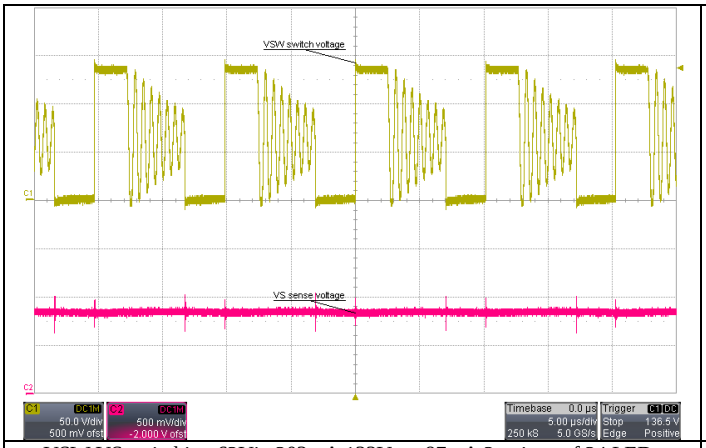
VSW VS startup from ballast using 3.3µF bridge capacitor and LED load



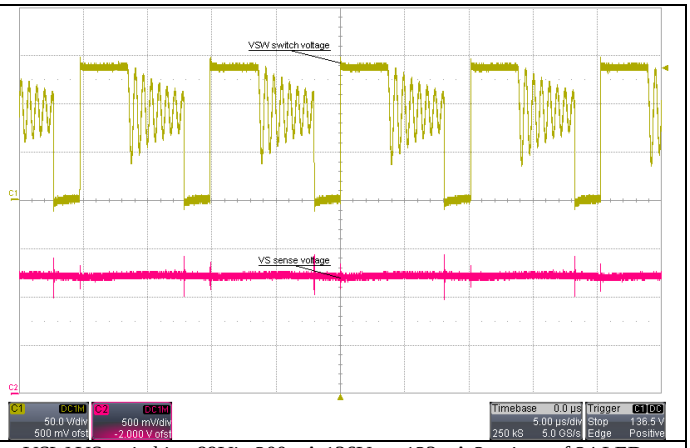
VSW VS startup from ballast using 37µF bridge capacitor and LED load

7 Switch Voltage and Sense Voltage Ripple

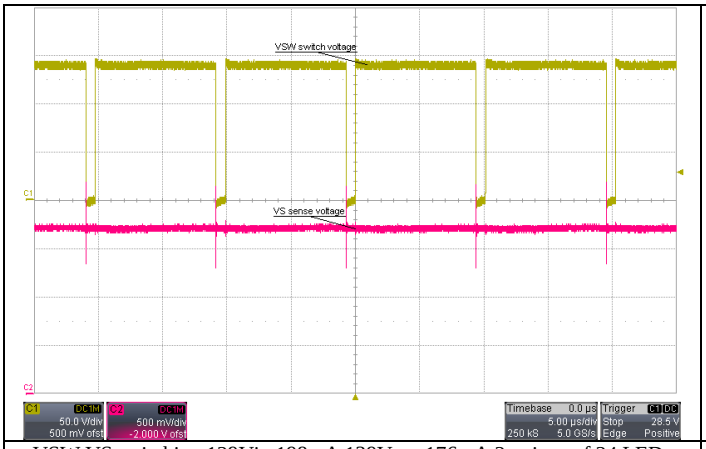
A 20kΩ summing resistor to the LMV431 REF pin and external supply is used to adjust the LED current.



VSW VS switching 62Vin 203mA 133Vout 87mA 2 strings of 24 LEDs

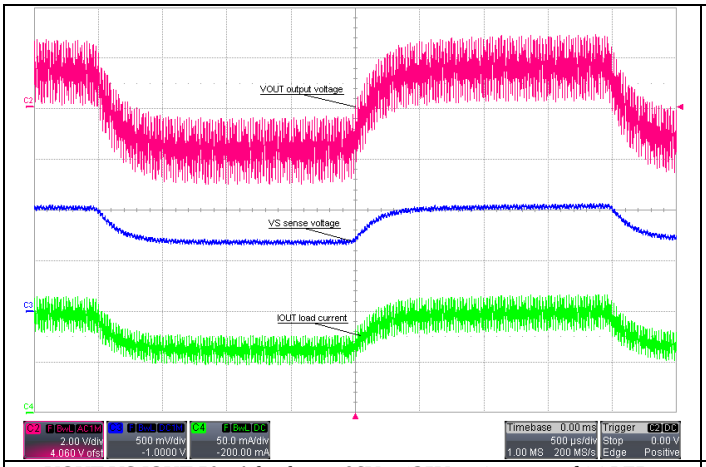
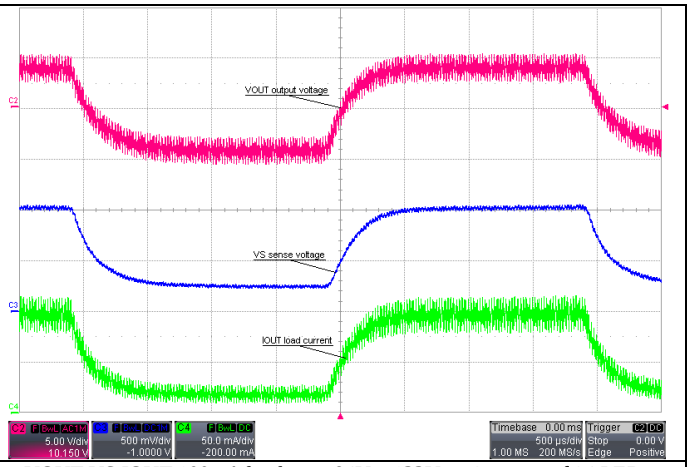


VSW VS switching 89Vin 200mA 136Vout 123mA 2 strings of 24 LEDs



VSW VS switching 129Vin 198mA 139Vout 176mA 2 strings of 24 LEDs

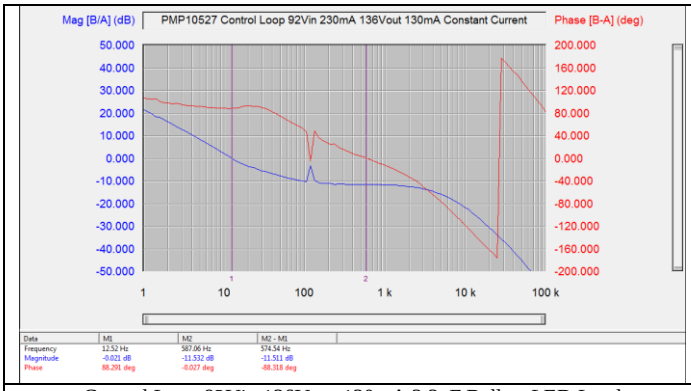
8 Load Transient Response

	
VOUT VS IOUT 50mA load step 96Vin 135Vout 2 strings of 24 LEDs	VOUT VS IOUT 100mA load step 94Vin 133Vout 2 strings of 24 LEDs

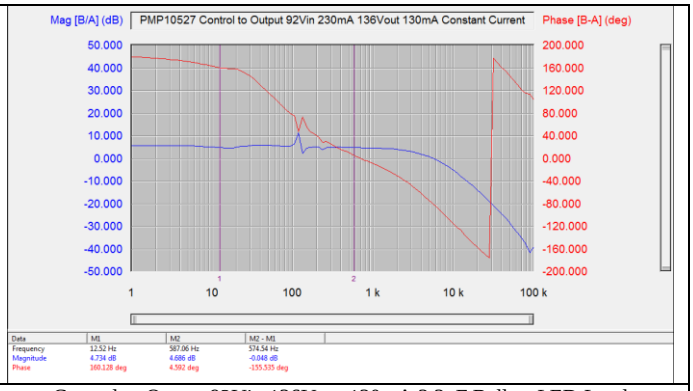
9 Control Loop Frequency Response

9.1 Constant Current Ballast and LED Load

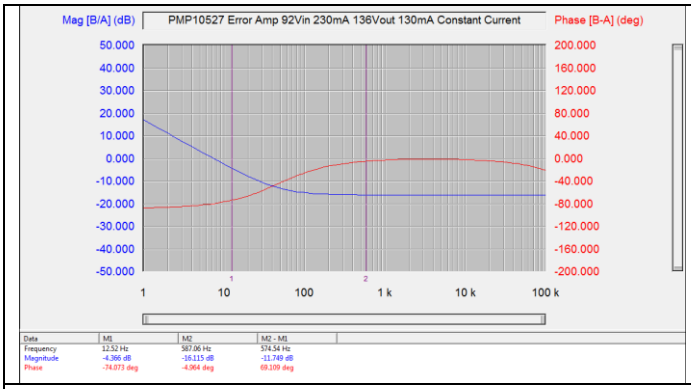
Test using ac ballast, bridge rectifier into 3.3µF 250V film capacitor at input and 2 strings of 24 LEDs.



Control Loop 92Vin 136Vout 130mA 3.3uF Ballast LED Load



Control to Output 92Vin 136Vout 130mA 3.3uF Ballast LED Load



Error Amp 92Vin 136Vout 130mA 3.3uF Ballast LED Load

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 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