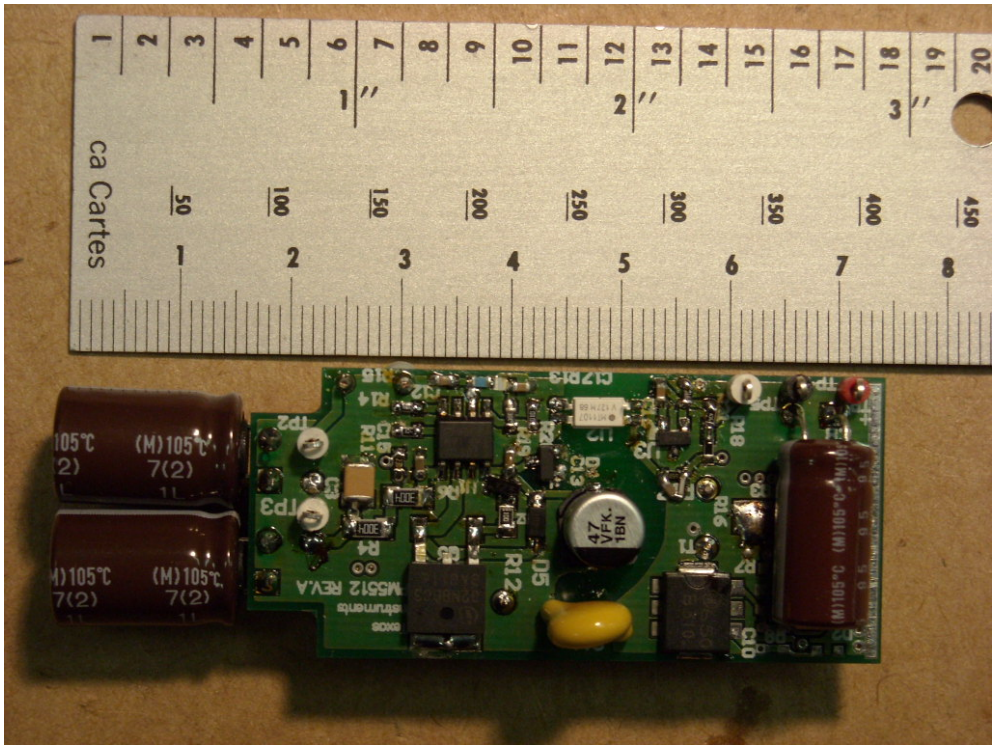
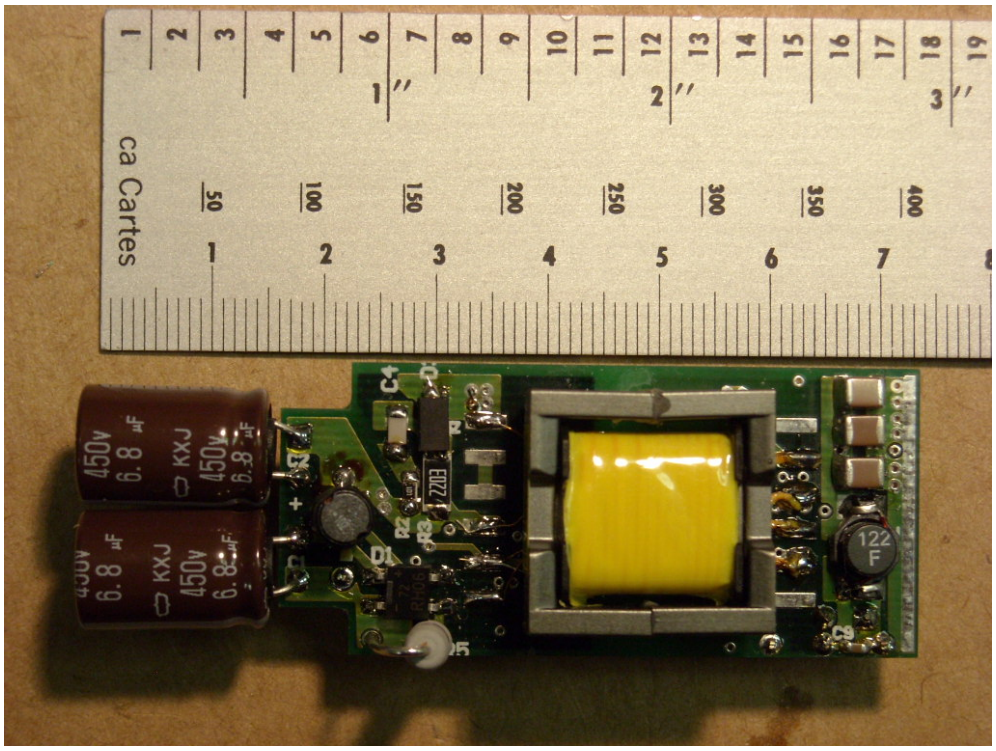
Photo of the prototype

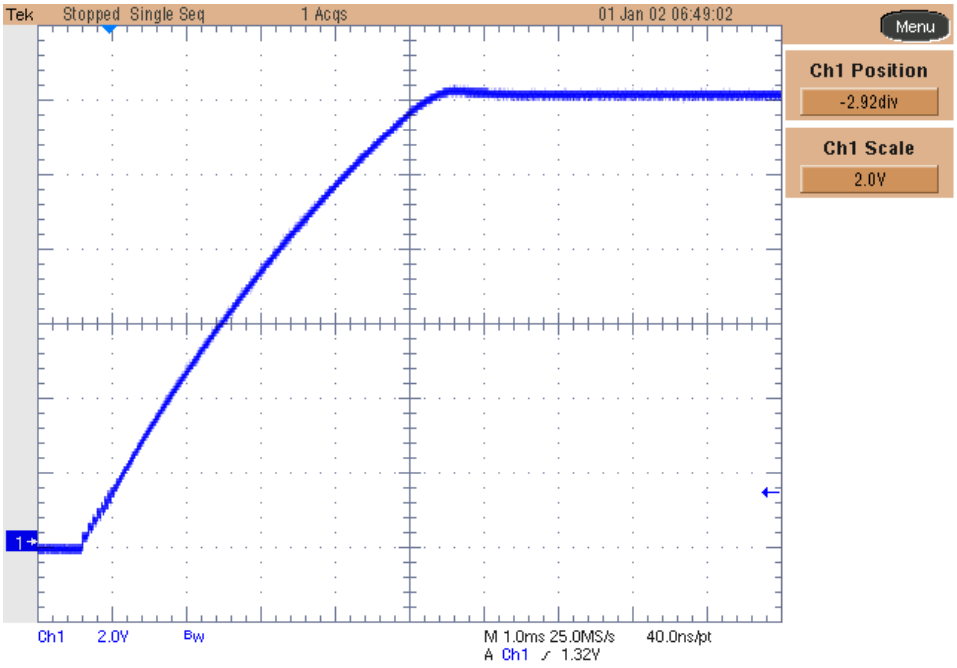


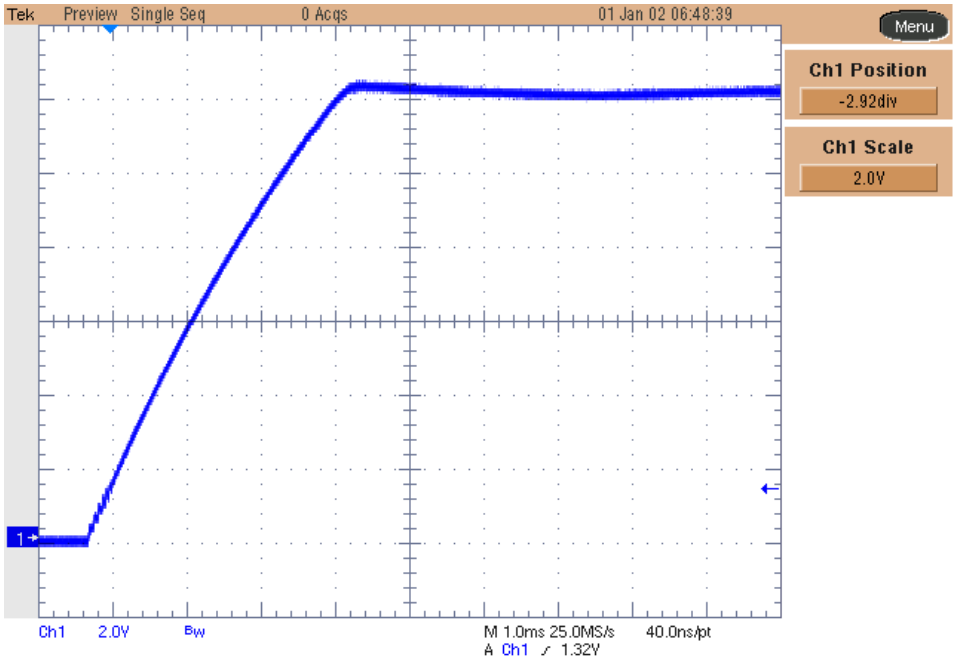


1. Startup

The output voltage waveforms at startup are shown in the images below. The input voltage has been set at 230Vac, 50Hz. The output was loaded with 800mA constant current for the upper picture and with no load for the bottom one.

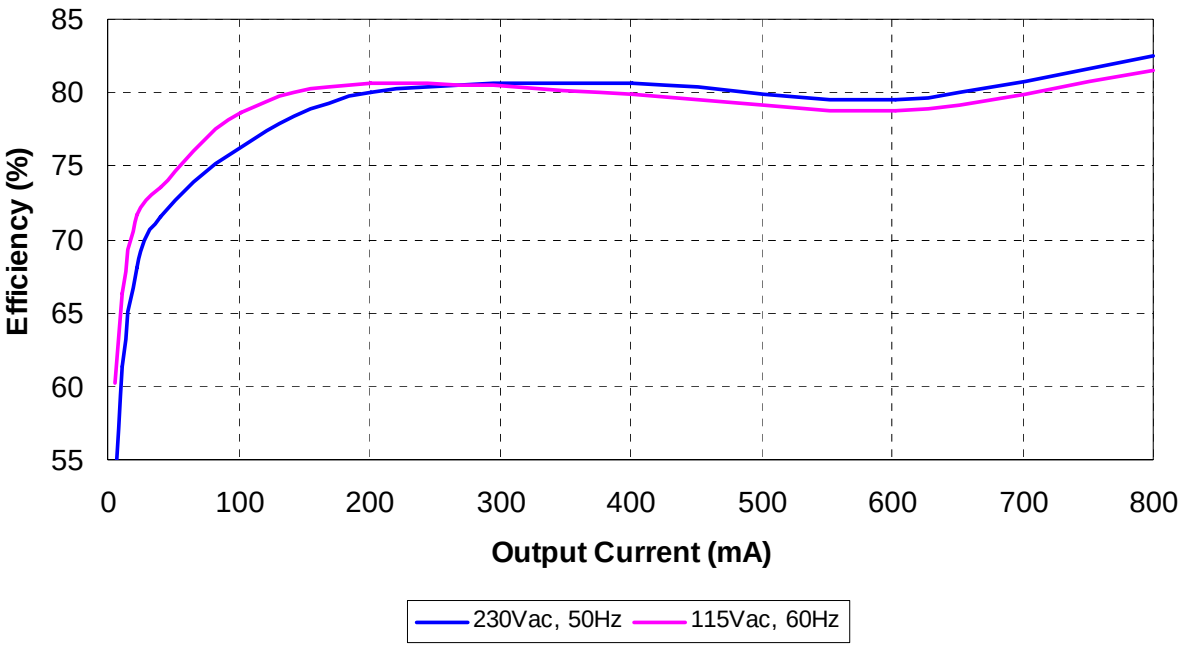
Channel 1: Output Voltage (2V/div, 1msec/div, DC coupling, 20MHz BWL).





2. Efficiency

The efficiency data versus output current is shown in the tables and graph below. The converter has been supplied with 230V, 50Hz and 115V, 60Hz AC source.

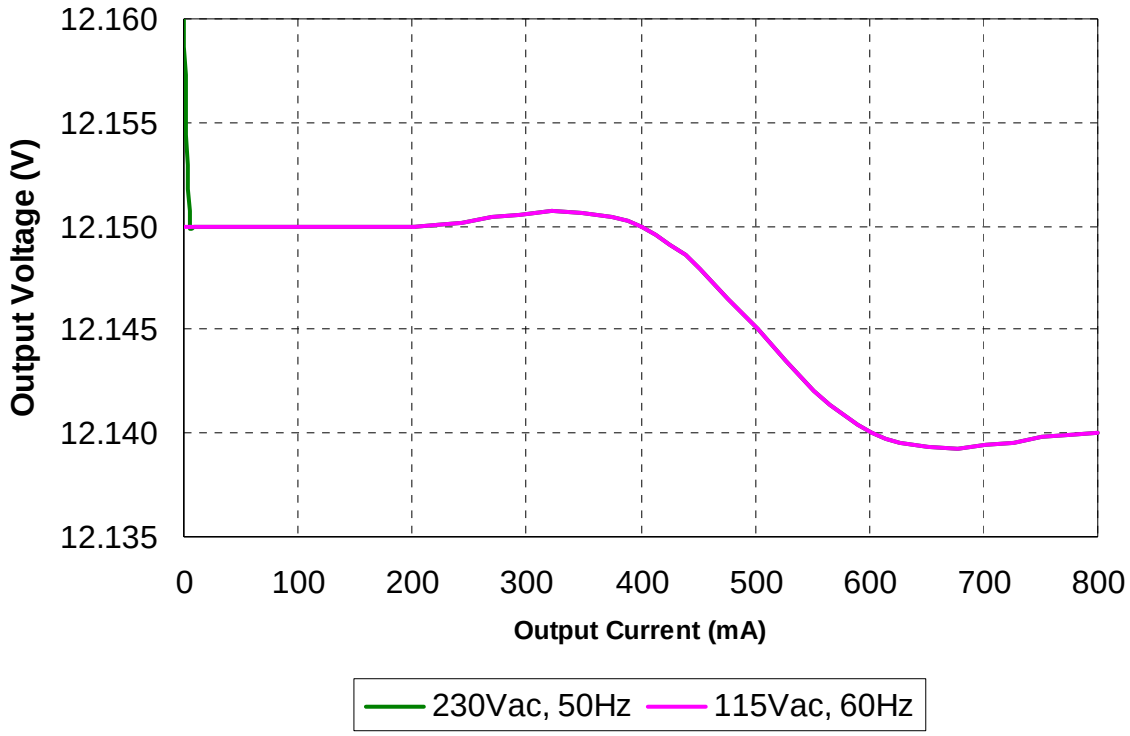


Iout (mA)	Vout (Vdc)	Pout (W)	Vin (Vac)	Pin (W)	Ploss (W)	Eff (%)
0.0	12.16	0.00	230	0.082	0.082	0.0
5.9	12.15	0.072	230	0.136	0.064	52.7
11.2	12.15	0.14	230	0.222	0.086	61.3
22.0	12.15	0.27	230	0.393	0.126	68.0
40.7	12.15	0.49	230	0.691	0.196	71.6
102.1	12.15	1.24	230	1.626	0.385	76.3
201.0	12.15	2.44	230	3.051	0.609	80.0
401.5	12.15	4.88	230	6.049	1.171	80.6
602.5	12.14	7.31	230	9.196	1.882	79.5
800.4	12.14	9.72	230	11.776	2.059	82.5

Iout (mA)	Vout (Vdc)	Pout (W)	Vin (Vac)	Pin (W)	Ploss (W)	Eff (%)
0.0	12.15	0.00	115	0.044	0.044	0.0
5.9	12.15	0.072	115	0.119	0.047	60.2
11.2	12.15	0.14	115	0.205	0.069	66.4
22.0	12.15	0.27	115	0.373	0.106	71.7
40.7	12.15	0.49	115	0.672	0.177	73.6
102.2	12.15	1.24	115	1.579	0.337	78.6
200.9	12.15	2.44	115	3.026	0.585	80.7
401.5	12.15	4.88	115	6.110	1.232	79.8
602.5	12.14	7.31	115	9.287	1.973	78.8
800.3	12.14	9.72	115	11.918	2.202	81.5

3. Output voltage regulation

The output voltage versus output current is plotted below.
The two curves are almost coincident except for the no-load condition.

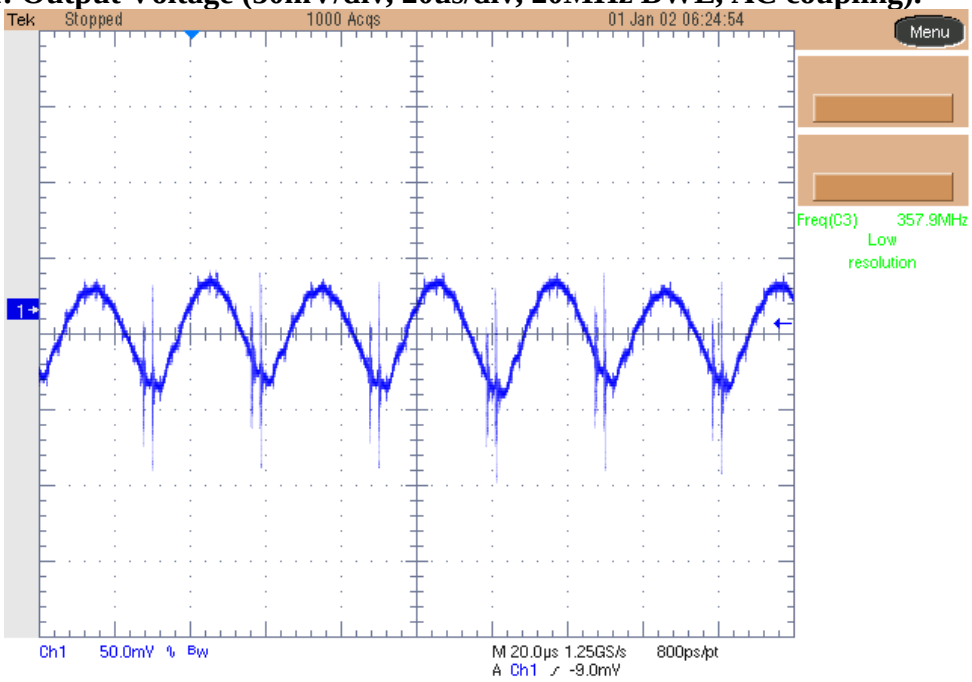


4. Output ripple voltage

The output ripple voltage plots are shown below. A sinusoidal electronic source (California Instruments 2100) has been used as AC source, set to 230Vac, 50Hz and 115Vac, 60Hz.

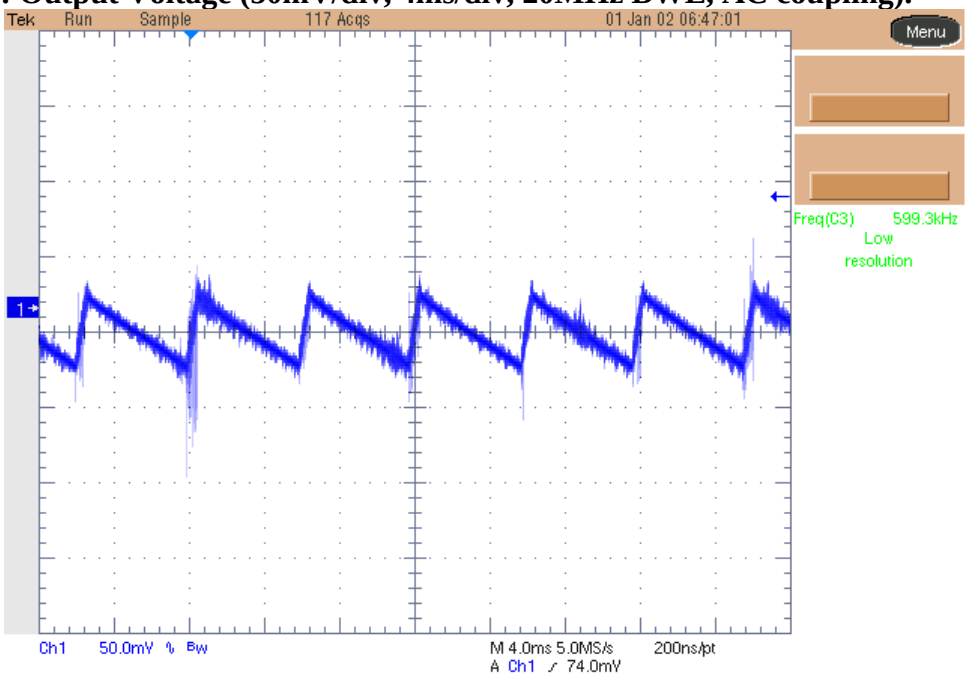
Output current: 800mA

Channel 1: Output Voltage (50mV/div, 20us/div, 20MHz BWL, AC coupling).



Output current: 5mA

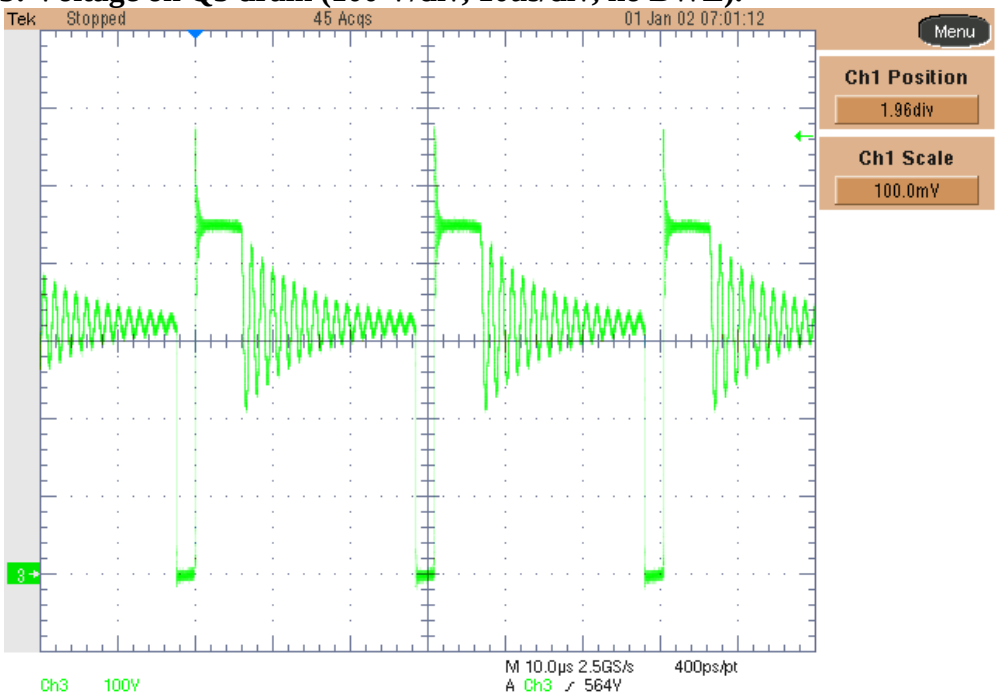
Channel 1: Output Voltage (50mV/div, 4ms/div, 20MHz BWL, AC coupling).



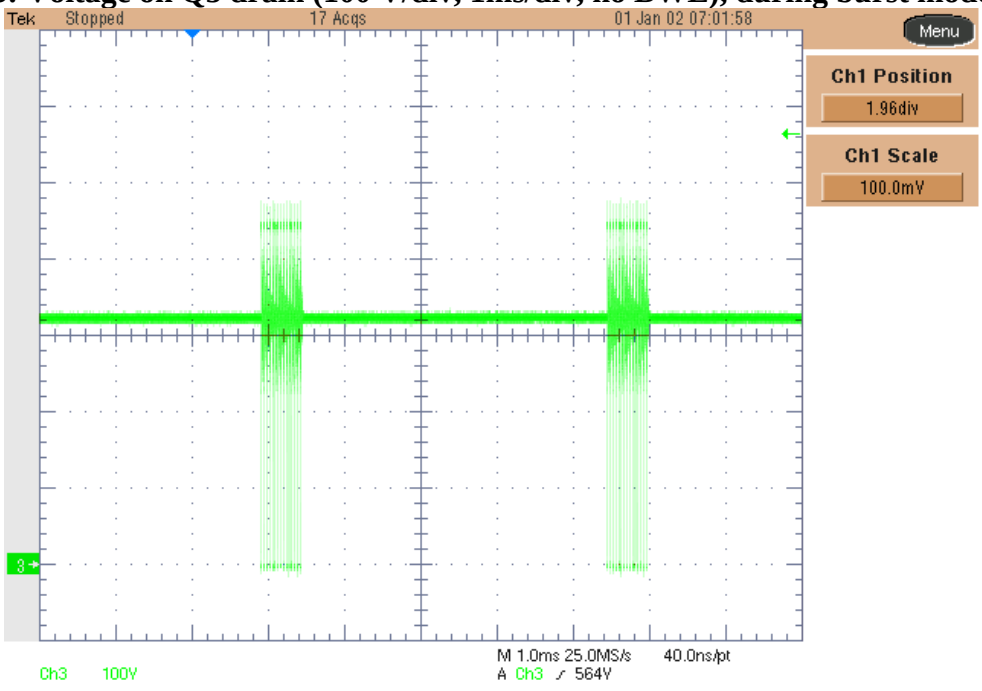
5. Switching Node Waveforms

The images below show the voltage on the drain of Q5 with a 230Vac input, and 800mA load (top picture) and 10mA load (bottom one), showing the burst mode operation.

Channel 3: Voltage on Q5 drain (100 V/div, 10us/div, no BWL).



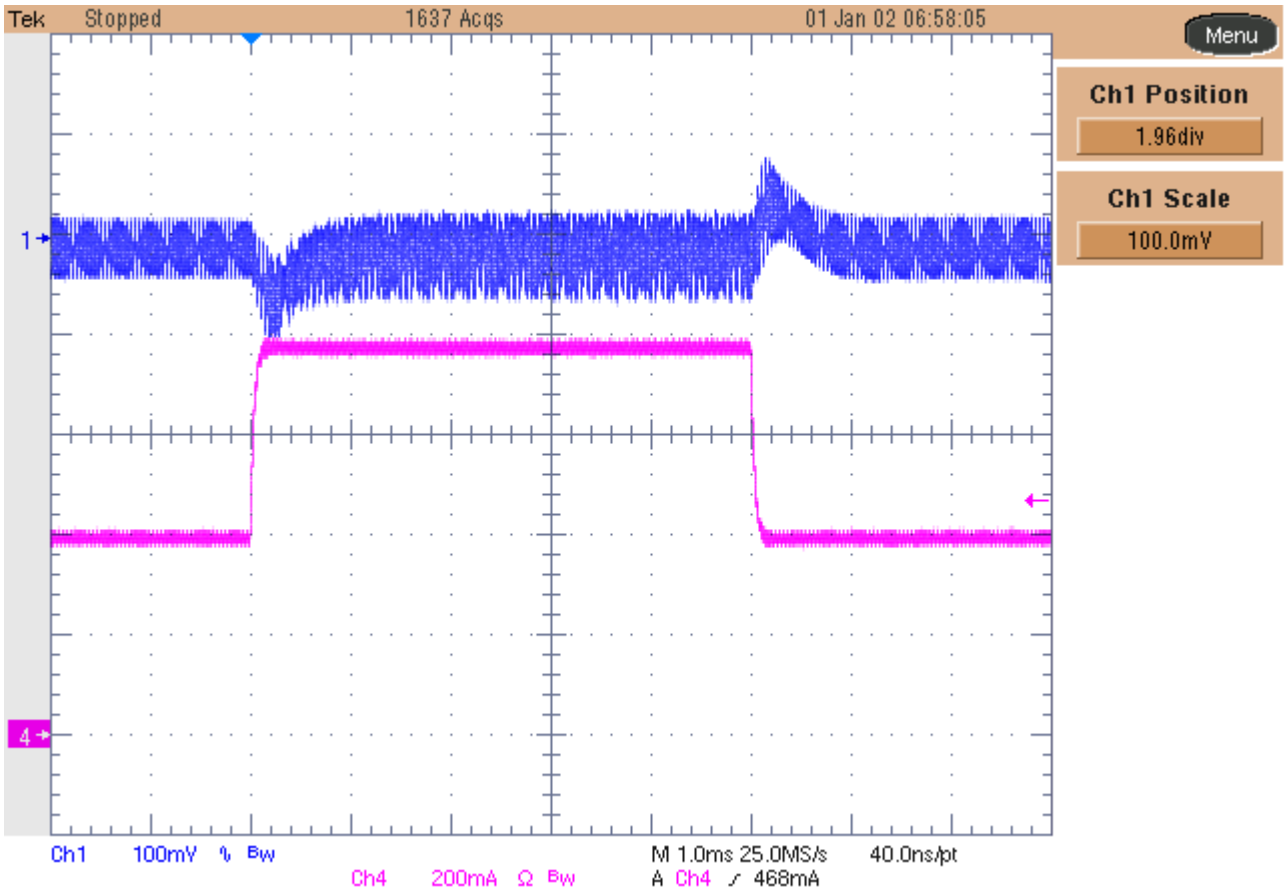
Channel 3: Voltage on Q5 drain (100 V/div, 1ms/div, no BWL), during burst mode.



6. Transient Response

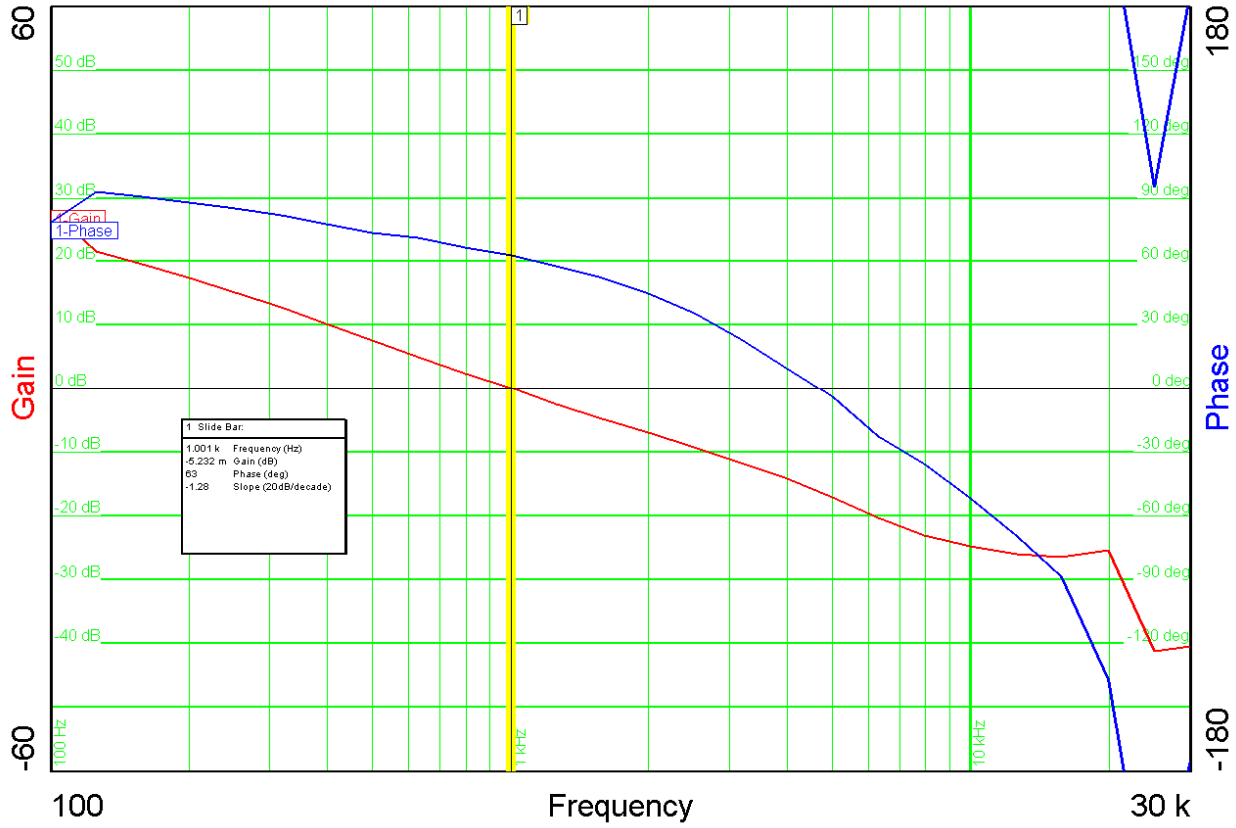
The image below shows the transient response of the output voltage while the load has been switched from 400mA to 800mA (50% to 100% of nominal load), @ 230Vac.

Channel 1: Output Voltage (100mV/div, 1ms/div, 20MHz BWL, AC coupling).
Channel 4: Output Current (200mA/div, 20MHz BWL, DC coupling).



7. Feedback loop

The graph below shows the bode-plot measurement taken on the prototype while the input voltage has been set to 320Vdc and the output load to 800mA.
The crossover frequency was 1 KHz, the phase margin 63 deg. and the gain margin 16.27dB.



8. Thermal analysis

The images below show the thermal images of the prototype (top and bottom side) during a full load condition and 230Vac input. The air temperature (still air condition) was 23C; the board was horizontal on the bench.

BOTTOM SIDE:

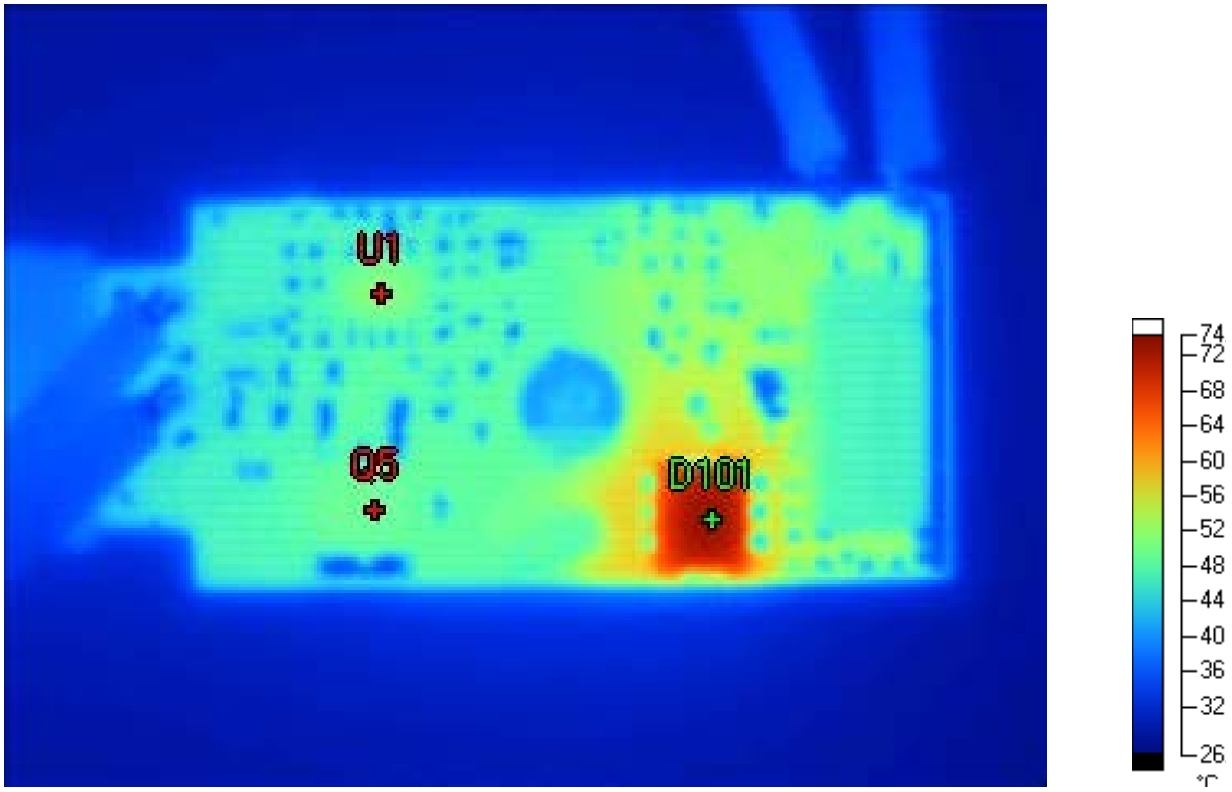


Image Info

Average Temperature	37.3 °C
Calibration Range	-20.0 °C to 350.0 °C
Camera Model	Ti40FT
Image Range	27.3 °C to 73.6 °C
Manufacturer	Fluke
Camera Serial Number	Ti40FT-070263

Markers

Label	Temperature	Emissivity	Background
D101	73.5 °C	0.95	23.0 °C
Q5	49.4 °C	0.95	23.0 °C
U1	51.6 °C	0.95	23.0 °C

TOP SIDE:

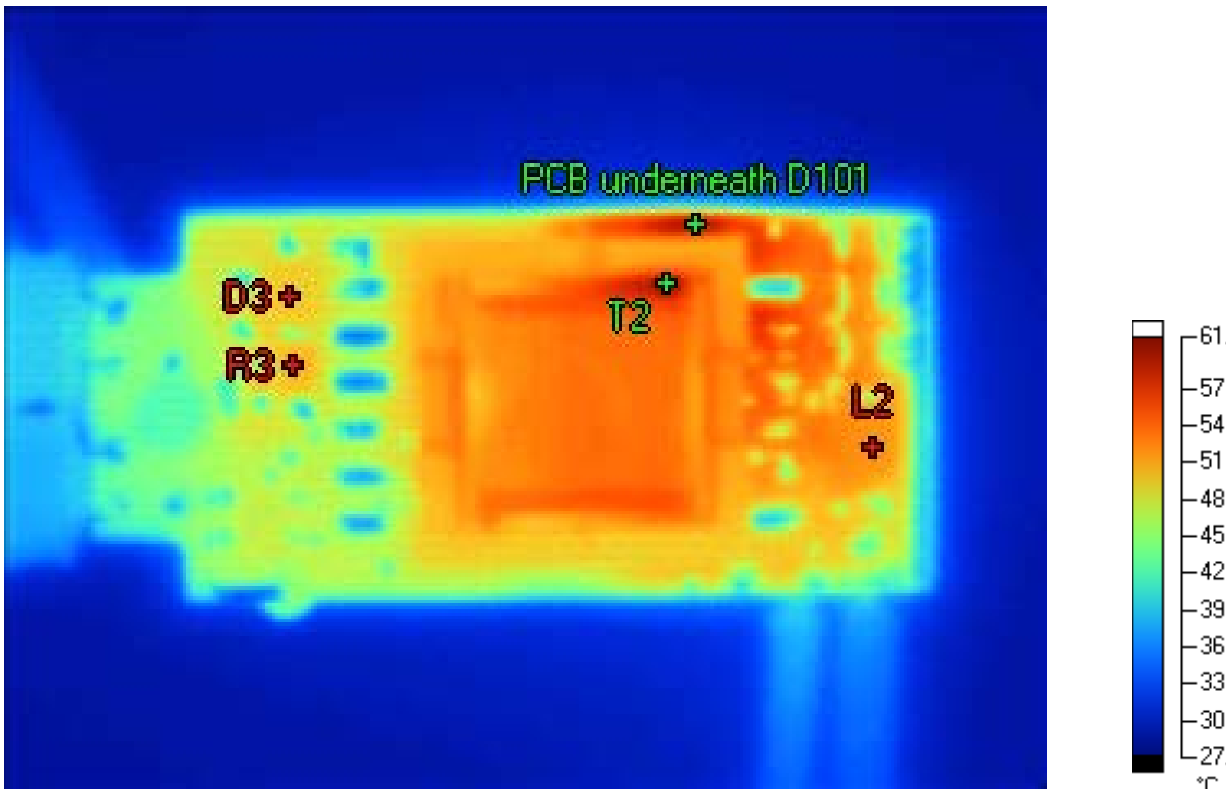


Image Info

Average Temperature	37.5 °C
Calibration Range	-20.0 °C to 350.0 °C
Camera Model	Ti40FT
Image Range	28.0 °C to 60.4 °C
Manufacturer	Fluke
Camera Serial Number	Ti40FT-070263

Markers

Label	Temperature	Emissivity	Background
T2	60.3 °C	0.95	23.0 °C
PCB underneath D101	59.5 °C	0.95	23.0 °C
R3	50.6 °C	0.95	23.0 °C
D3	49.5 °C	0.95	23.0 °C
L2	52.0 °C	0.95	23.0 °C

EVALUATION BOARD/KIT/MODULE (EVM) WARNINGS, RESTRICTIONS AND DISCLAIMER

For Feasibility Evaluation Only, in Laboratory/Development Environments. The EVM is not a complete product. It is intended solely for use for preliminary feasibility evaluation in laboratory / development environments by technically qualified electronics experts who are familiar with the dangers and application risks associated with handling electrical / mechanical components, systems and subsystems. It should not be used as all or part of a production unit.

Your Sole Responsibility and Risk. You acknowledge, represent and agree that:

1. You have unique knowledge concerning Federal, State and local regulatory requirements (including but not limited to Food and Drug Administration regulations, if applicable) which relate to your products and which relate to your use (and/or that of your employees, affiliates, contractors or designees) of the EVM for evaluation, testing and other purposes.
2. You have full and exclusive responsibility to assure the safety and compliance of your products with all such laws and other applicable regulatory requirements, and also to assure the safety of any activities to be conducted by you and/or your employees, affiliates, contractors or designees, using the EVM. Further, you are responsible to assure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard.
3. Since the EVM is not a completed product, it may not meet all applicable regulatory and safety compliance standards (such as UL, CSA, VDE, CE, RoHS and WEEE) which may normally be associated with similar items. You assume full responsibility to determine and/or assure compliance with any such standards and related certifications as may be applicable. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.

Certain Instructions. Exceeding the specified EVM ratings (including but not limited to input and output voltage, current, power, and environmental ranges) may cause property damage, personal injury or death. If there are questions concerning these ratings please contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, some circuit components may have case temperatures greater than 60°C as long as the input and output ranges are maintained at nominal ambient operating temperature. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors which can be indentified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during normal operation, please be aware that these devices may be very warm to the touch.

Agreement to Defend, Indemnify and Hold Harmless. You agree to defend, indemnify and hold TI, its licensors and their representatives harmless from and against any and all claims, damages, losses, expenses, costs and liabilities (collectively, "Claims") arising out of or in connection with any use of the EVM that is not in accordance with the terms of this agreement. This obligation shall apply whether Claims arise under the law of tort or contract or any other legal theory, and even if the EVM fails to perform as described or expected.

Safety-Critical or Life-Critical Applications. If you intend to evaluate TI components for possible use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, such as devices which are classified as FDA Class III or similar classification, then you must specifically notify TI of such intent and enter into a separate Assurance and Indemnity Agreement.

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), 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, regulatory 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 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.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265