

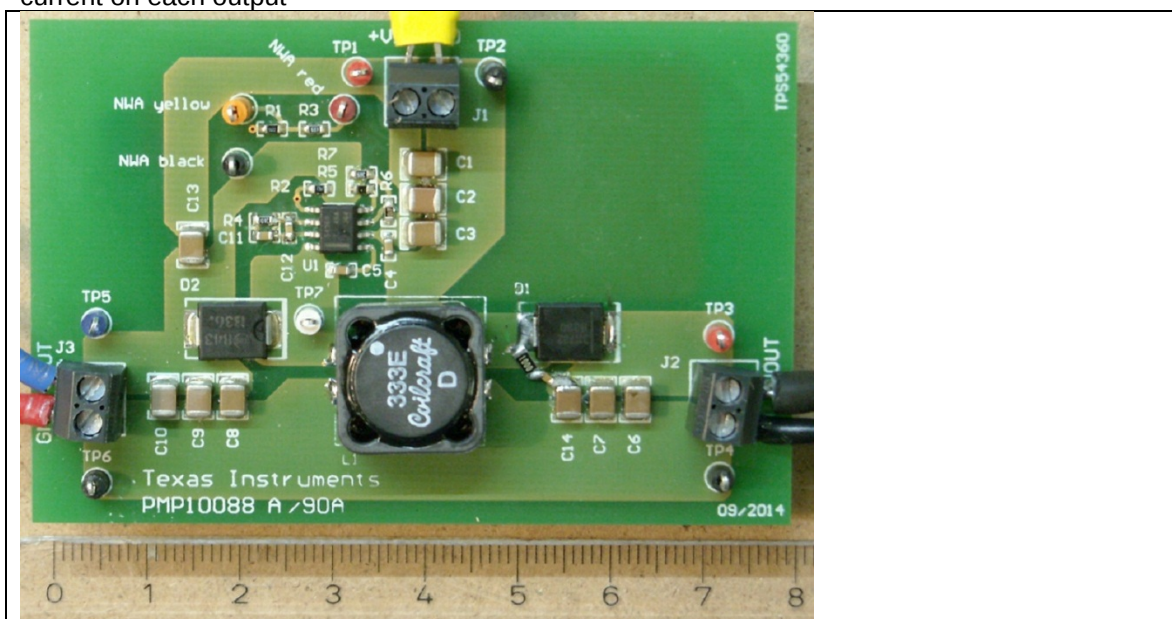
PMP10088RevB Test Results

1	Startup	2
2	Shutdown	3
3	Efficiency	4
4	Load Regulation	5
5	Line Regulation	6
6	Cross Regulation	8
7	Ripple Voltage	9
7.1	Positive Output	9
7.2	Negative Output	10
7.3	Input Voltage	11
8	Control Loop Frequency Response	12
9	Load Transients	13
9.1	Transient applied at negative VOUT (-VOUT)	13
9.2	Transient applied at positive VOUT (+VOUT)	14
10	Miscellaneous Waveforms	15
11	Thermal Image	19

Topology: Dual Inverting Buck-Boost (negative and positive output on second winding).

Device: TPS54360

Unless otherwise mentioned all measurements were done with 24V input voltage and 0.7A output current on each output



PMP10088RevB Test Results

1 Startup

The startup waveform is shown in the Figure 1. The input voltage was set at 24V, with 0.7A load at the output on each output. Power supply was connected.

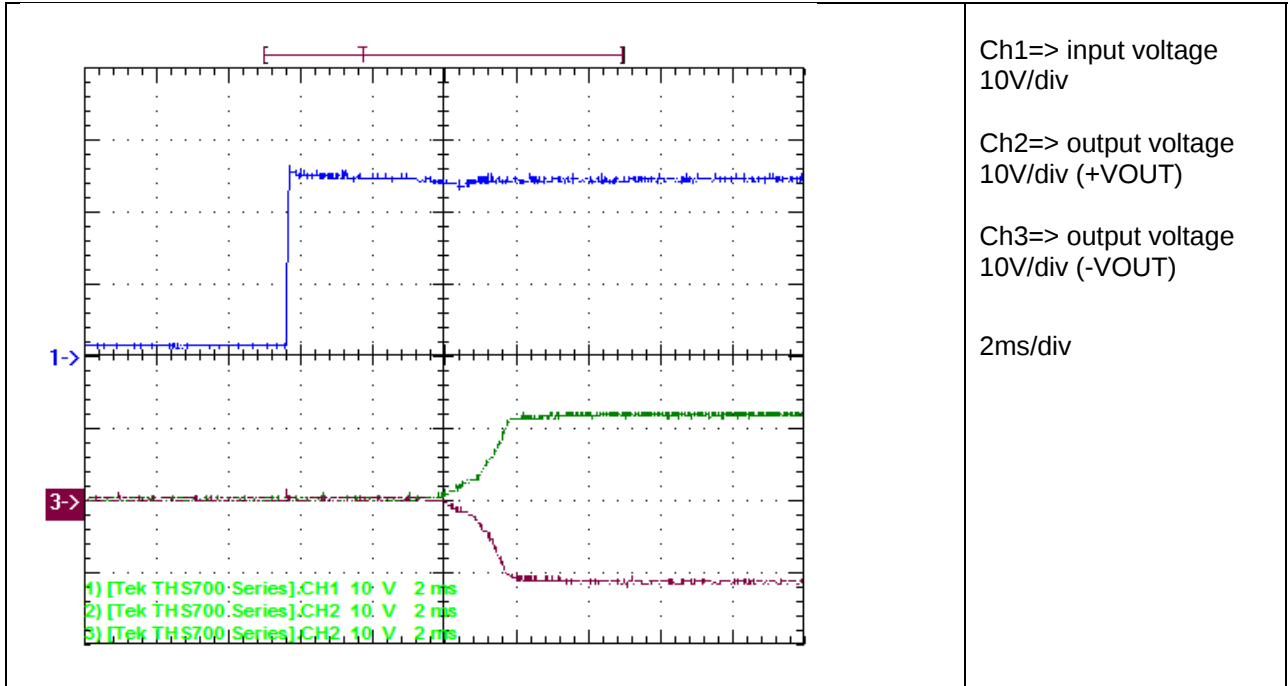


Figure 1

PMP10088RevB Test Results

2 Shutdown

The shutdown waveform is shown in the Figure 2. The input voltage was set at 24V, with 0.7A load on each output. Power supply was disconnected.

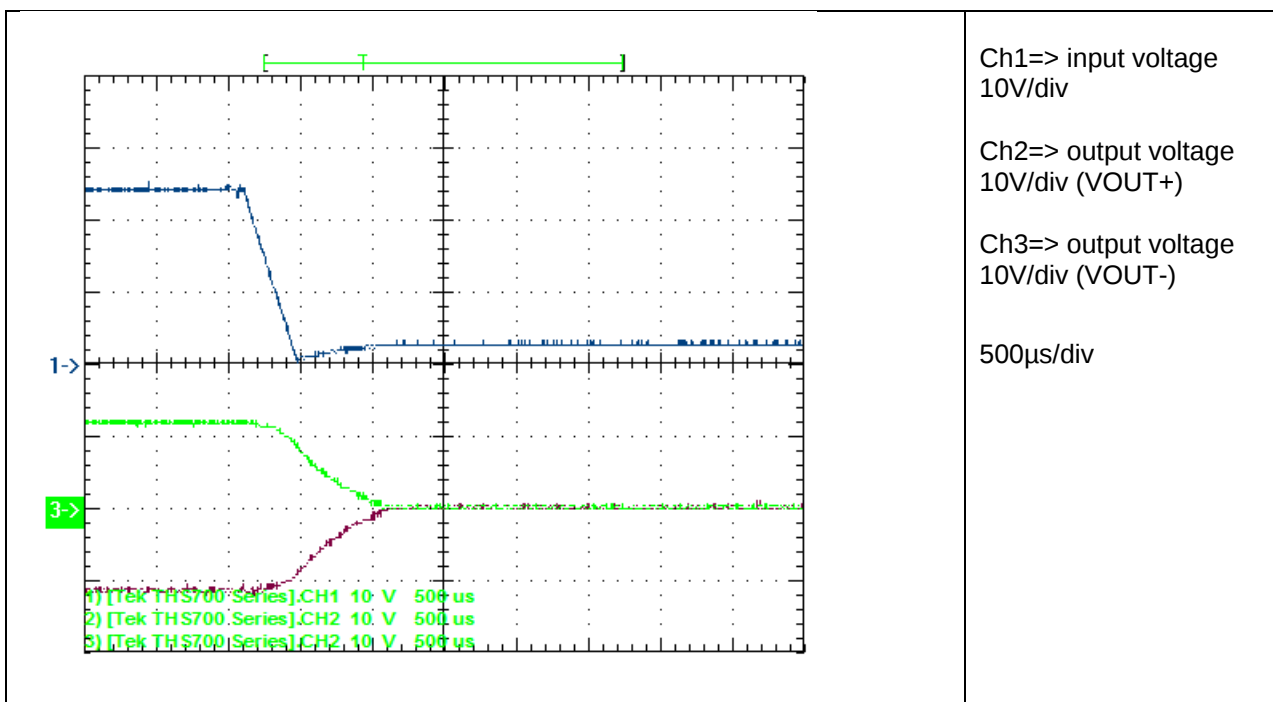


Figure 2

PMP10088RevB Test Results

3 Efficiency

The efficiency is shown in the Figure 3 below. The input voltage was set to 24V. The output currents were modified simultaneous ($-I_{OUT} = +I_{OUT}$). The discontinuity in the curve reflects the transition from discontinuous to continuous mode.

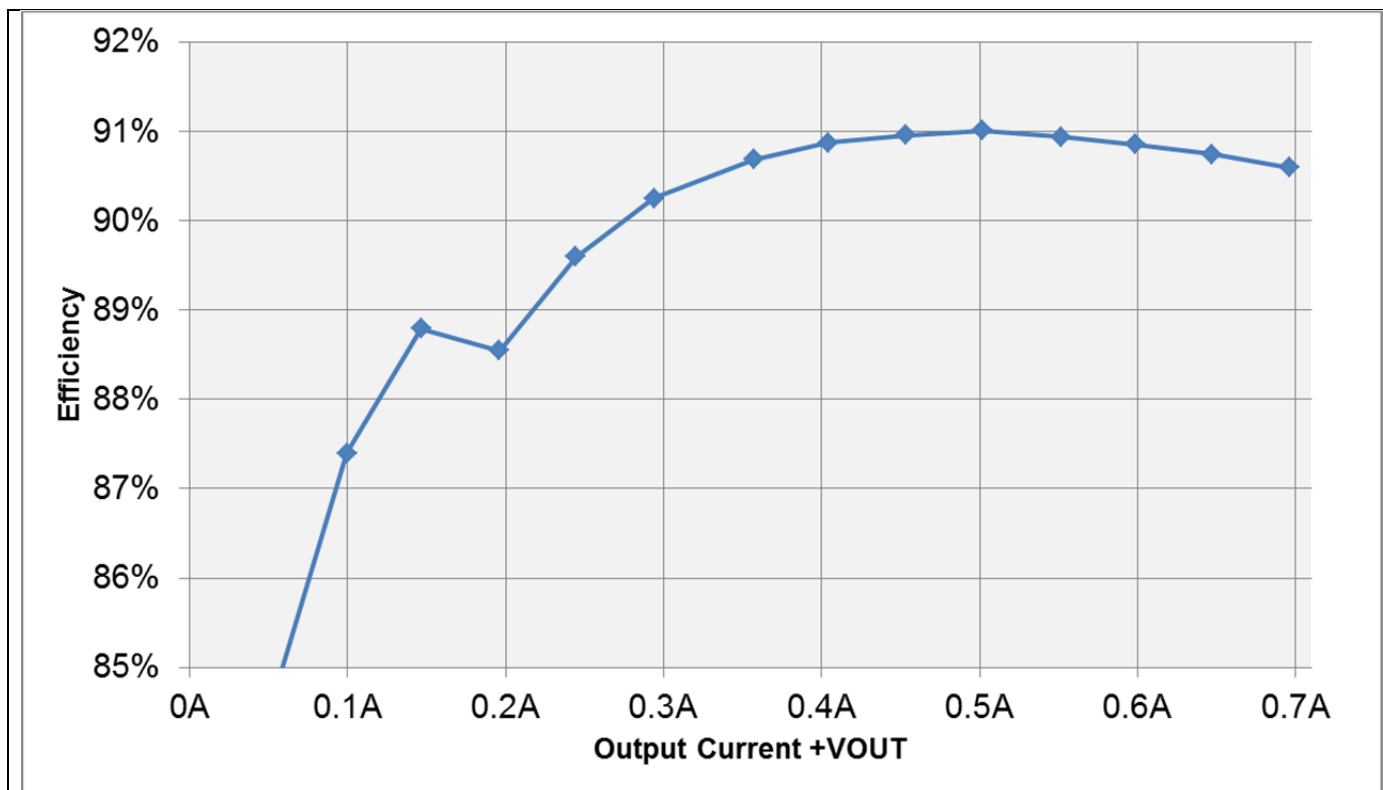


Figure 3

4 Load Regulation

The load regulation of the output is shown in the Figure 4 below.

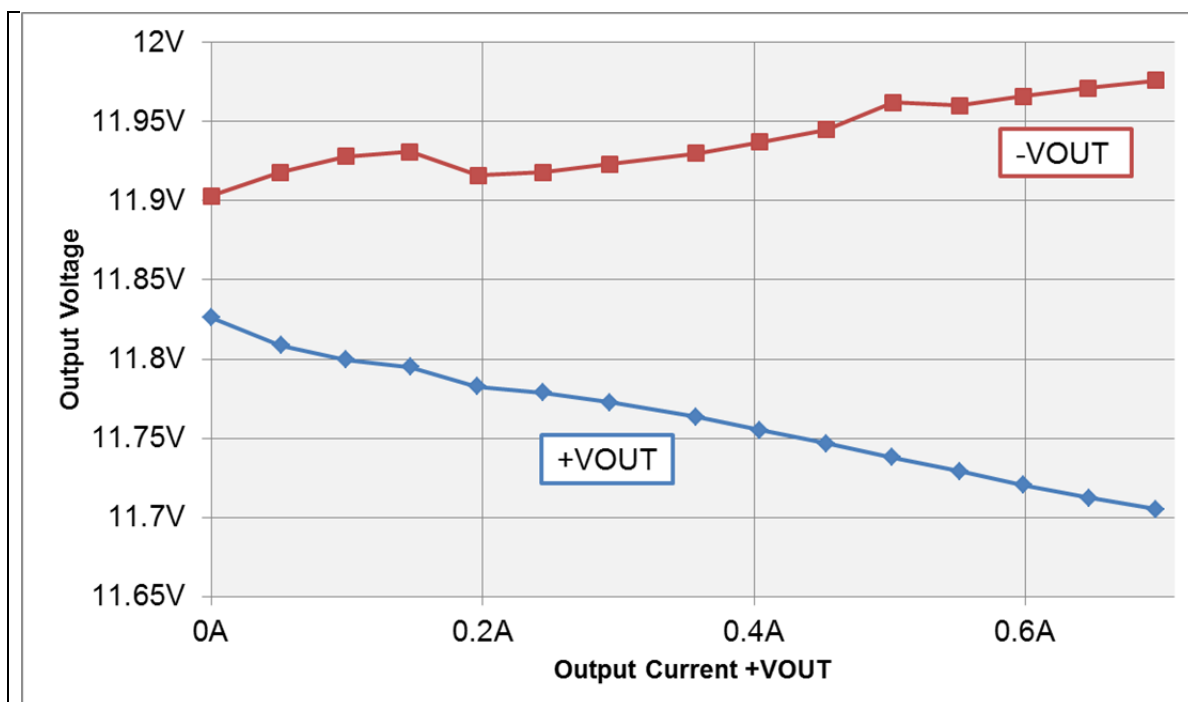


Figure 4

Deviation on load of negative rail <100mV, less than 1%

Deviation of positive rail around 120mV, roughly 1%

5 Line Regulation

Line regulation at 0.7A output current is shown in Figure 5

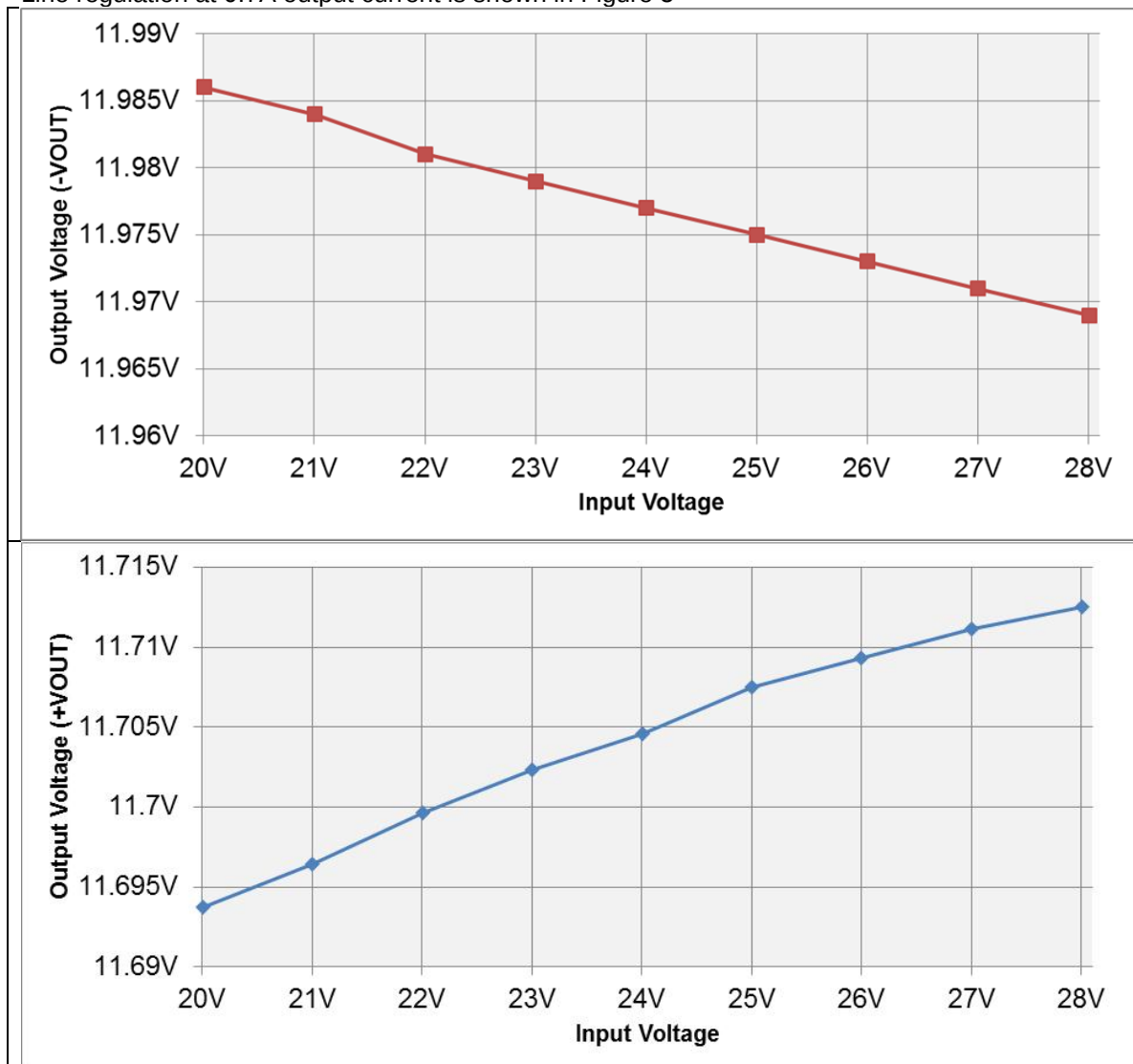


Figure 5

Deviation on input voltage is around 20mV, insignificant low.

PMP10088RevB Test Results

With the same measurement the full load efficiencies across input voltage were calculated

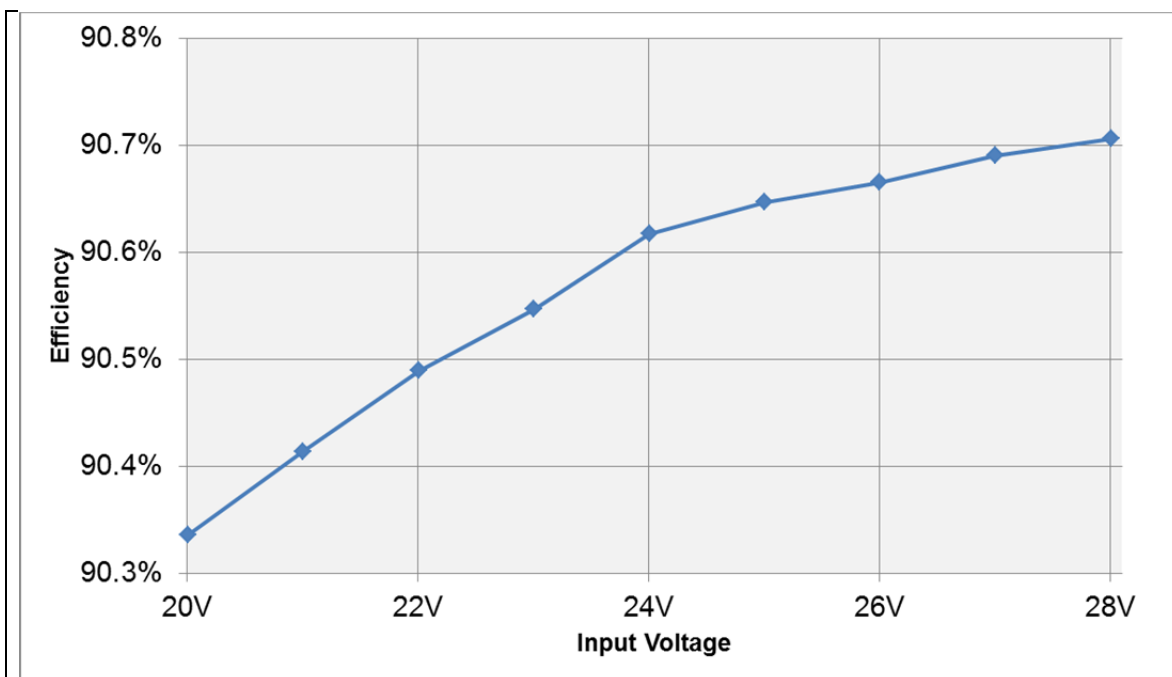


Figure 6

Full load efficiency across input voltage range +90%.

PMP10088RevB Test Results

6 Cross Regulation

The output currents were changed separately (0A, 0.2A, 0.4A, 0.7A)

Figure 7 shows the effects on the positive output voltage, if the negative output current is varied. The different curves represent the positive output current settings

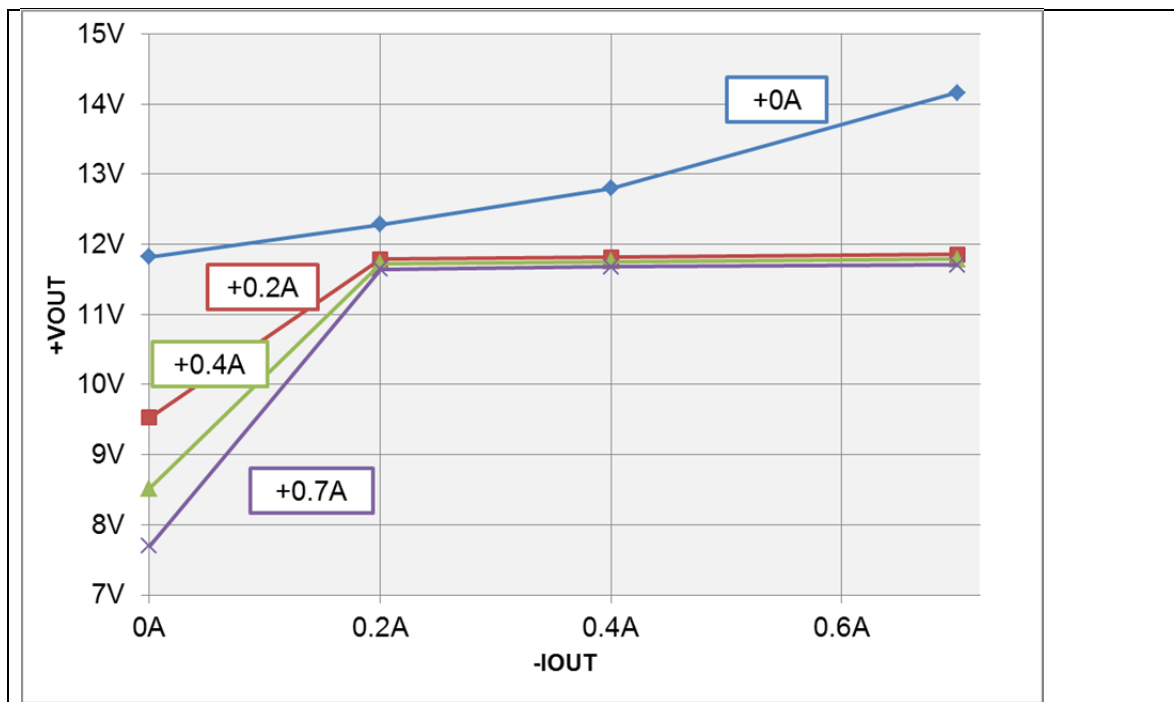


Figure 7

Figure 8 shows the effects on the negative output voltage, if the positive output current is varied. The different curves represent the negative output current settings.

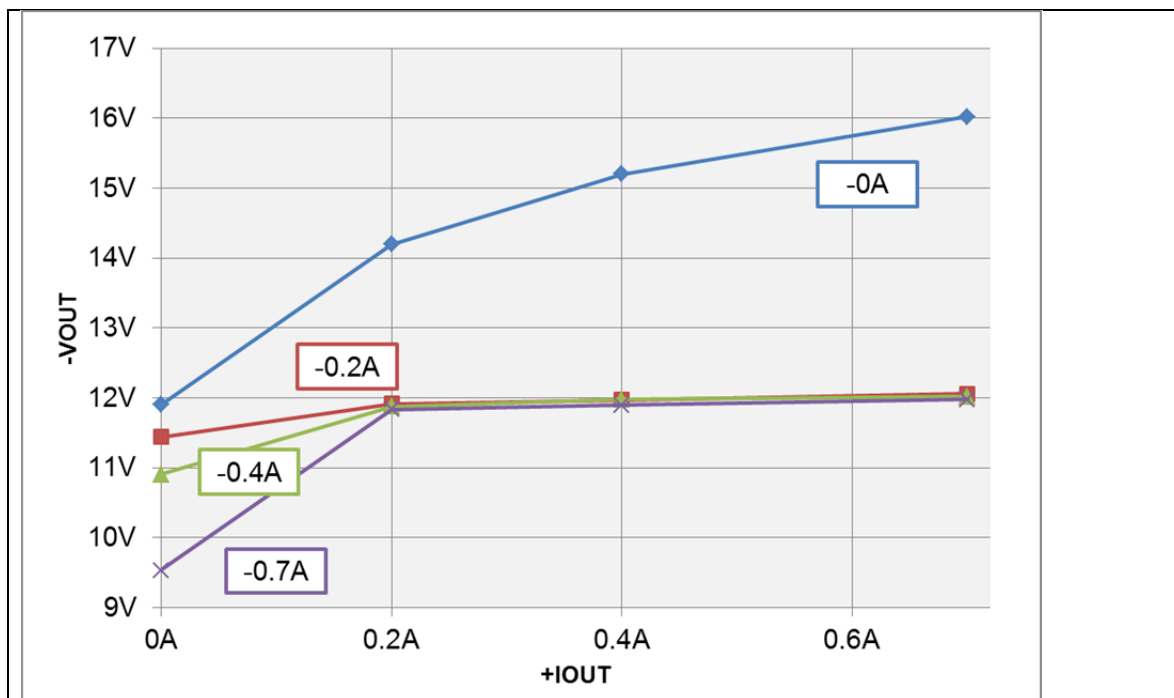


Figure 8

7 Ripple Voltage

7.1 Positive Output

The output ripple voltage is shown in Figure 9. The image was taken with a 0.7A and 24V at the input.

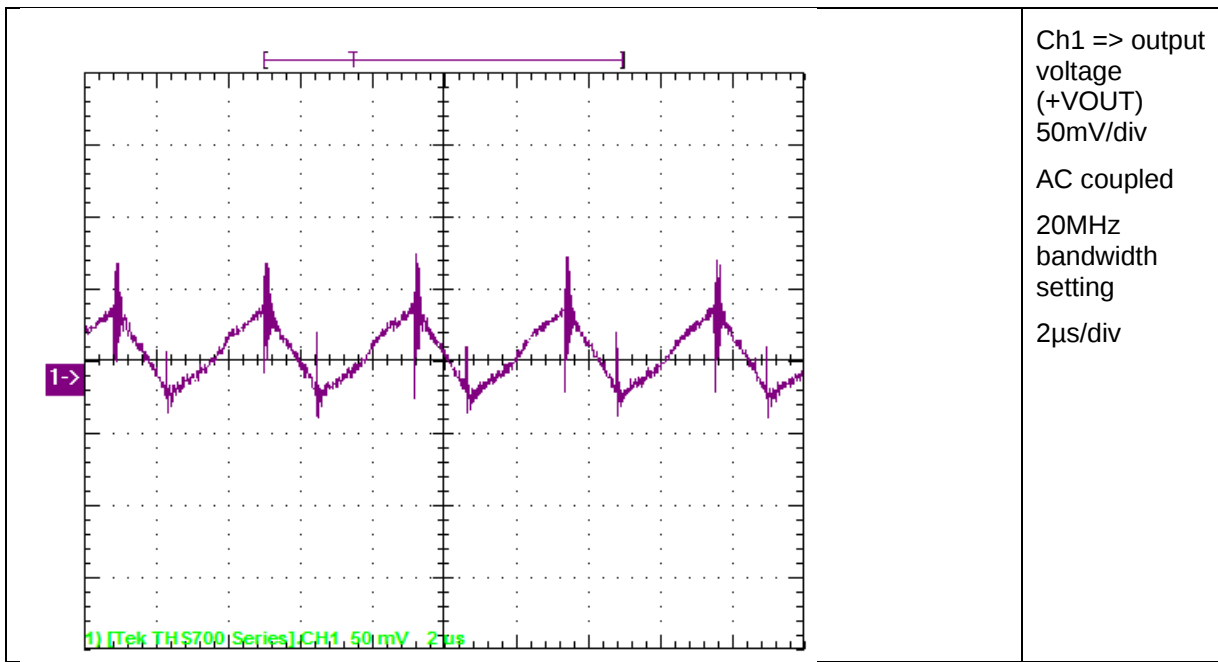


Figure 9

Output ripple around 100mVpp, so less than 1% of output voltage.

7.2 Negative Output

The negative output ripple voltage is shown in Figure 10. The image was taken with a 0.7A load 24V at the input.

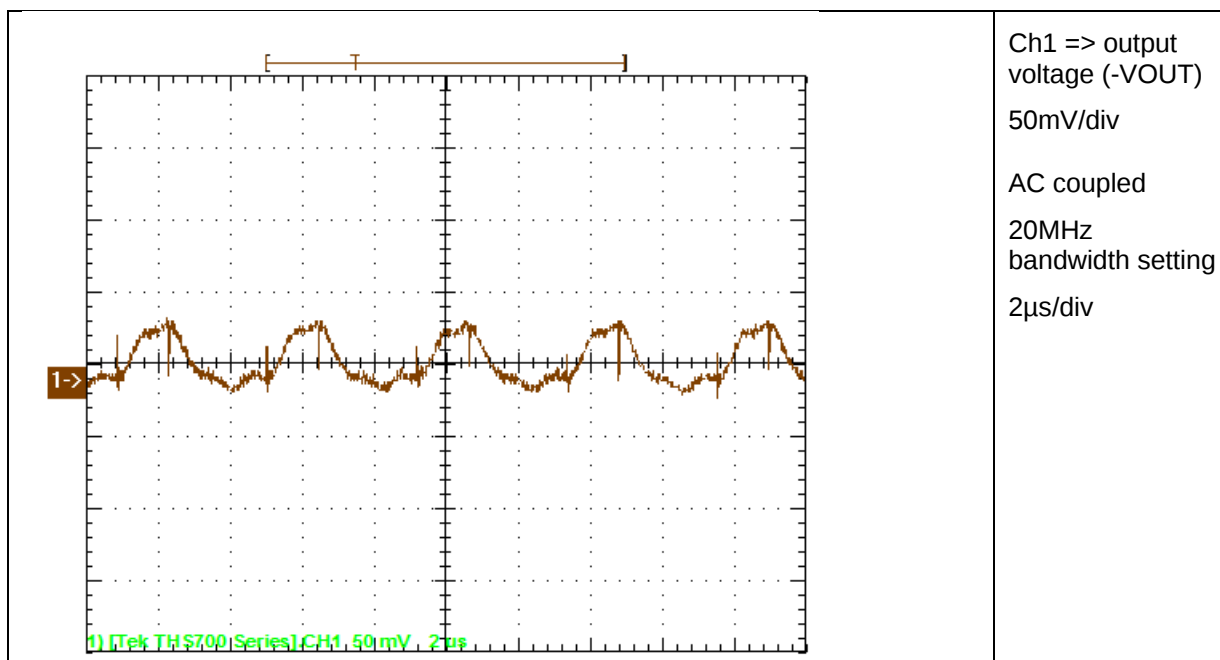


Figure 10

Output ripple around 50mVpp, so less than 1% of output voltage.

7.3 Input Voltage

The input ripple voltage is shown in Figure 11.

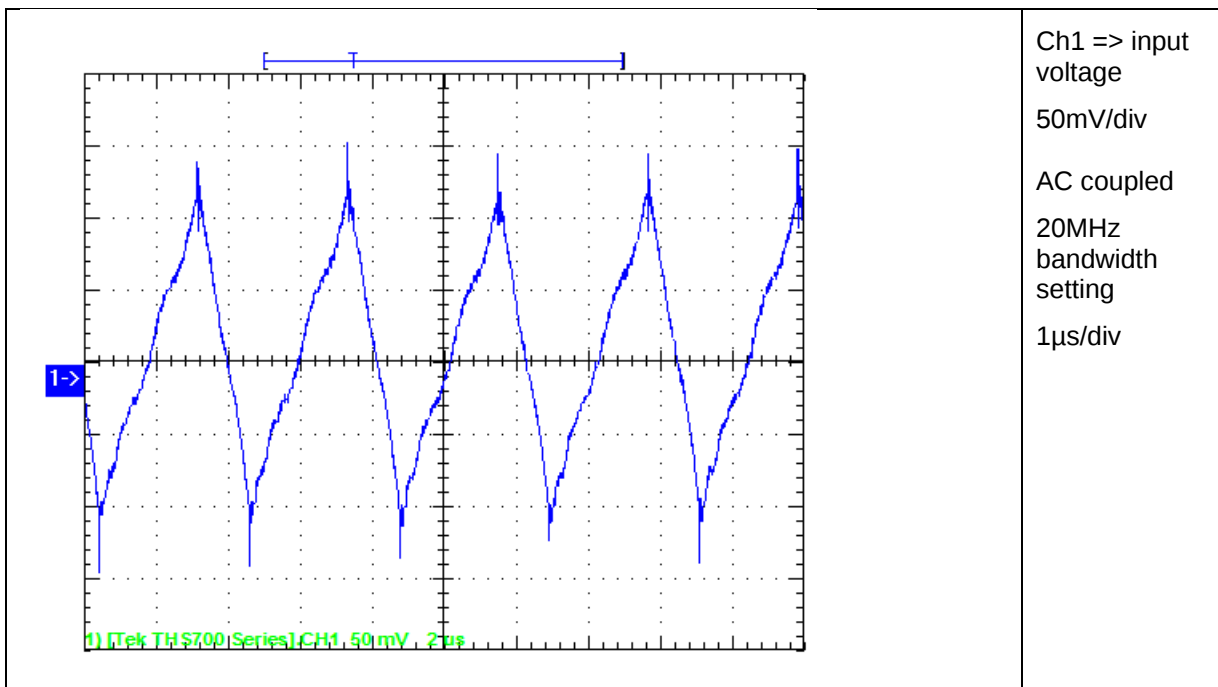


Figure 11

8 Control Loop Frequency Response

Figure 12 shows the loop response with 0.7A load and 20V, 24V and 28V input.

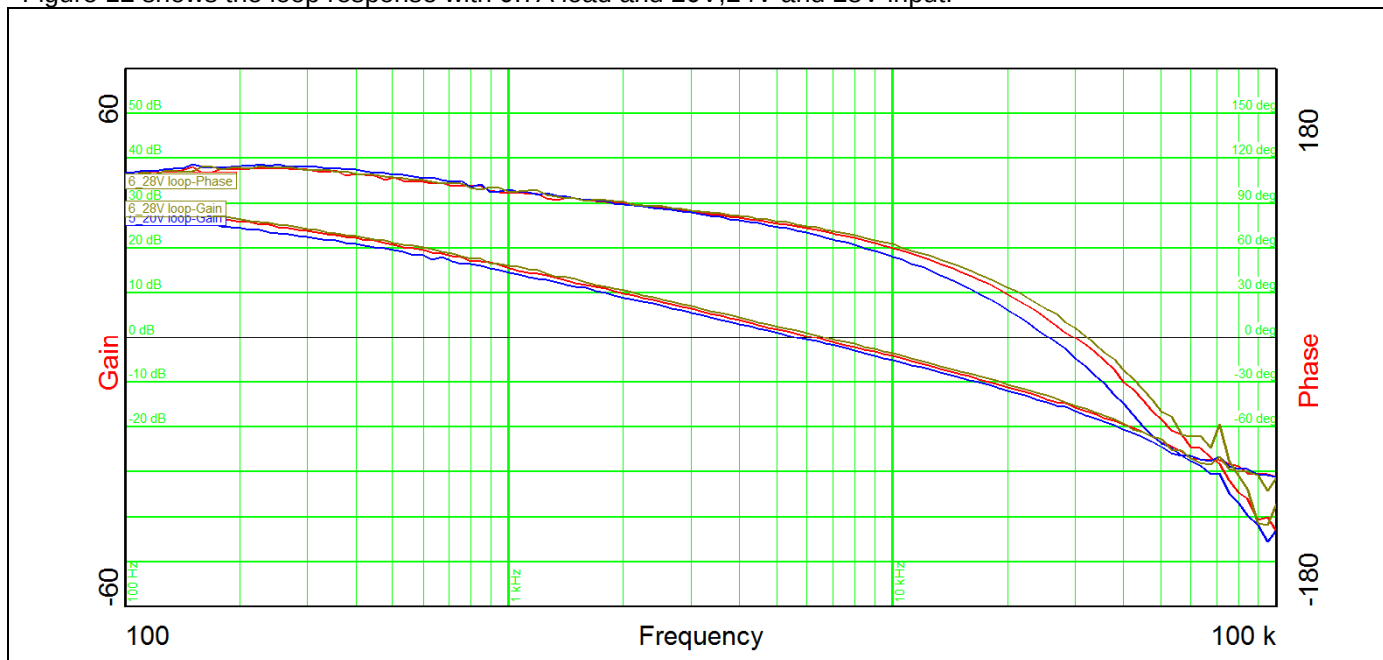


Figure 12

Table 1 summarizes the results

	20V	24V	28V
Bandwidth (kHz)	5.65	6.2	6.65
Phasemargin	71°	72.4°	72.5°
slope (20dB/decade)	-1.2	-1	-1.1
gain margin (dB)	-14.67	-15.7	-16.1
slope (20dB/decade)	-1.44	-2.15	-1.5
freq (kHz)	25.5	29.9	32.1

Table 1

The loop was designed for PM>65degs and GM around -15dB;
The bandwidth of 6kHz for the flyback topology is fair, the slope of -1 at Fco is perfect.

9 Load Transients

9.1 Transient applied at negative VOUT (-VOUT)

The Figure 13 shows the response to load transients. The load is switching from 0.35A to 0.7A (50 Hz). Negative VOUT was measured

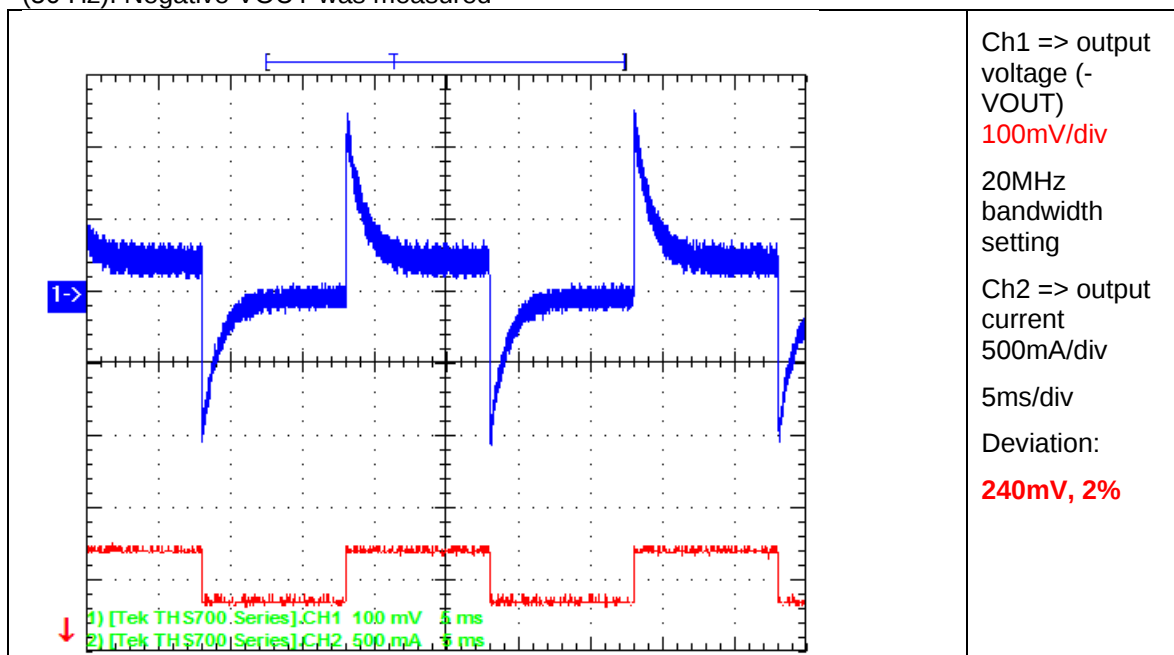


Figure 13

The Figure 14 shows the response to load transients. The load is switching from 0.35A to 0.7A (50 Hz). Positive VOUT was measured

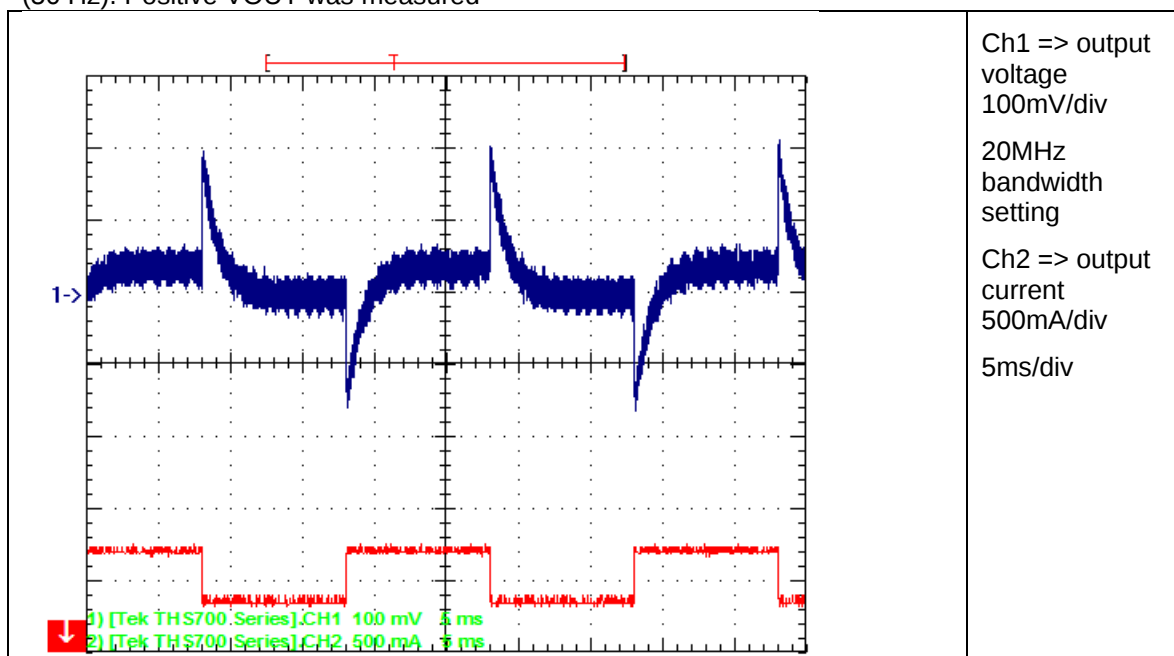


Figure 14

9.2 Transient applied at positive VOUT (+VOUT)

The Figure 13 shows the response to load transients. The load is switching from **0.36A to 0.87A** (load precision !) (50 Hz). Negative VOUT was measured

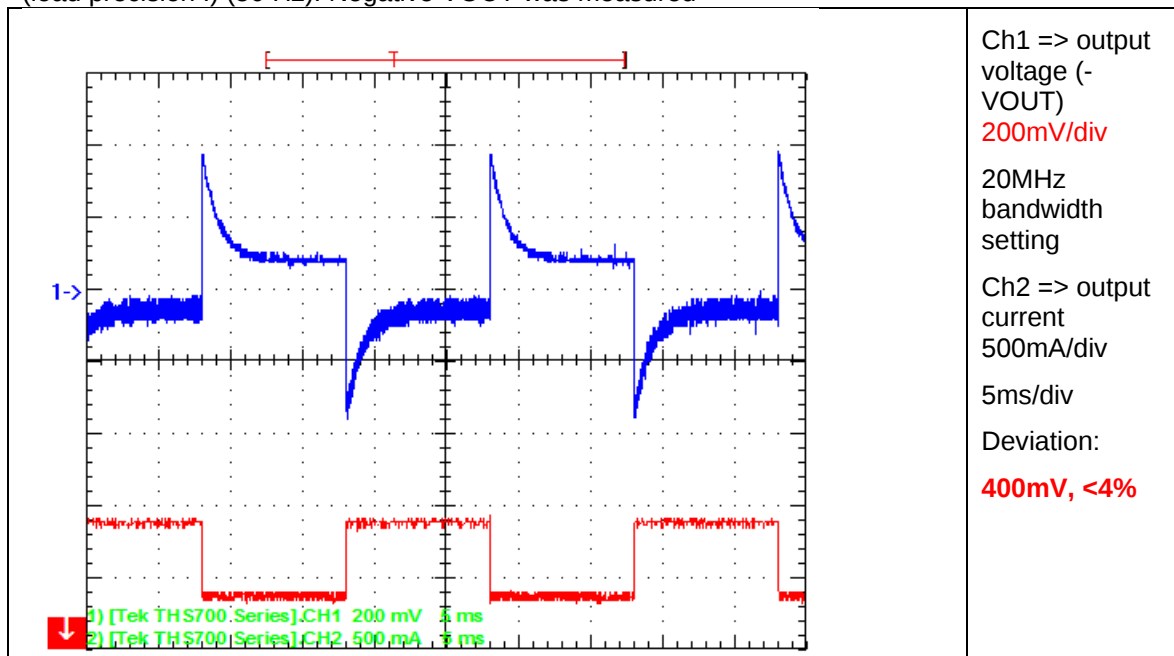


Figure 15

The Figure 14 shows the response to load transients. The load is switching from **0.36A to 0.87A** (50 Hz). Positive VOUT was measured

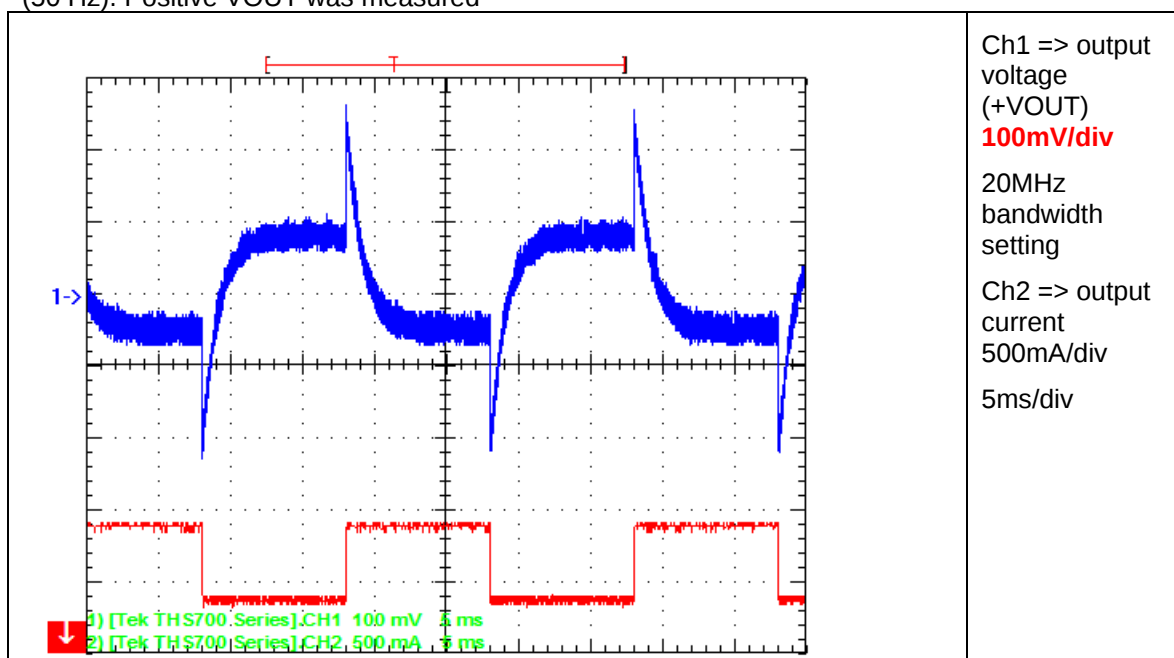


Figure 16

10 Miscellaneous Waveforms

Switch node ("SW" to -VOUT)) waveform shown in Figure 17

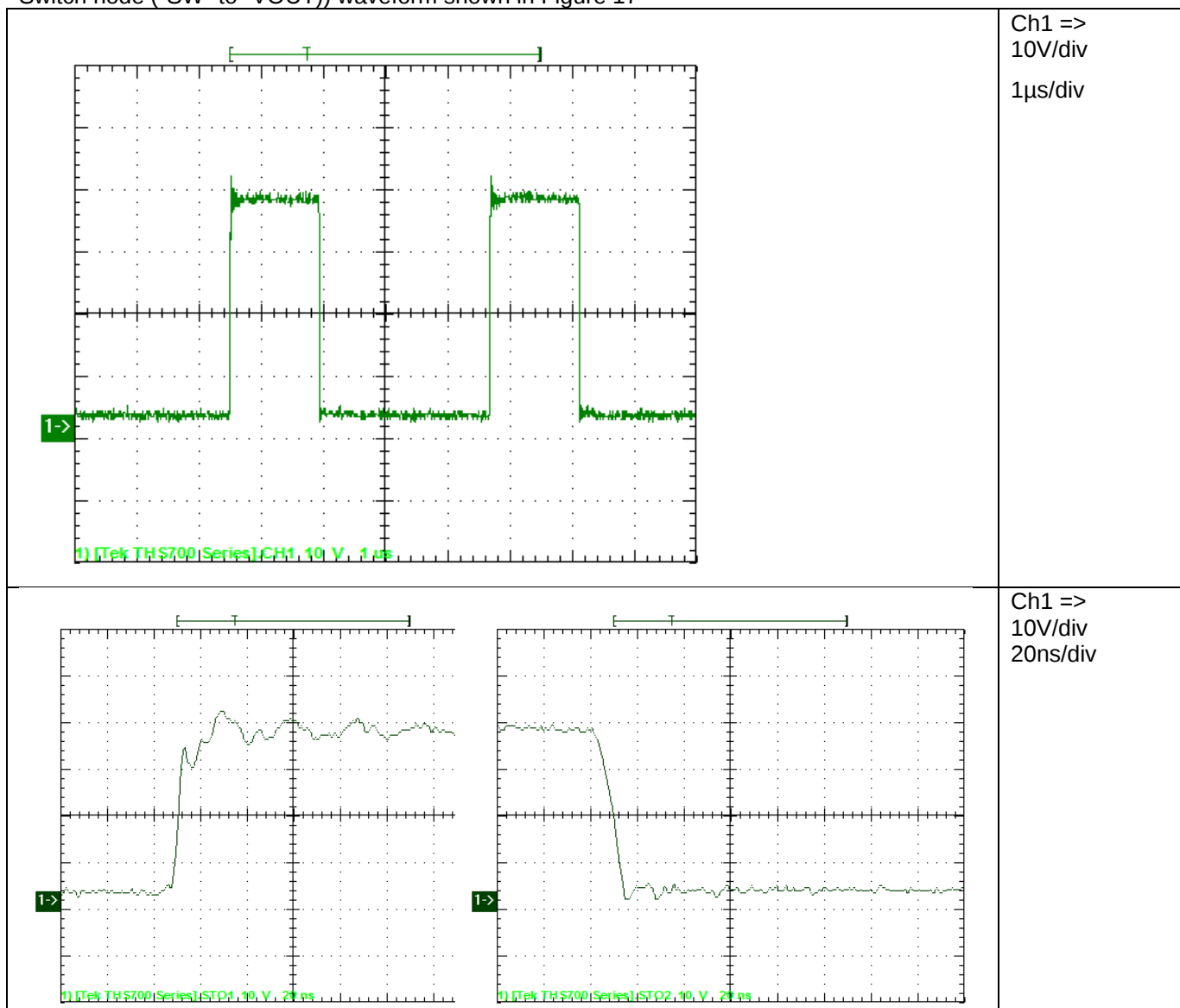


Figure 17

PMP10088RevB Test Results

Switchnode ("SW" to GND measured at the inductor pads) results in the waveform shown in Figure 18.

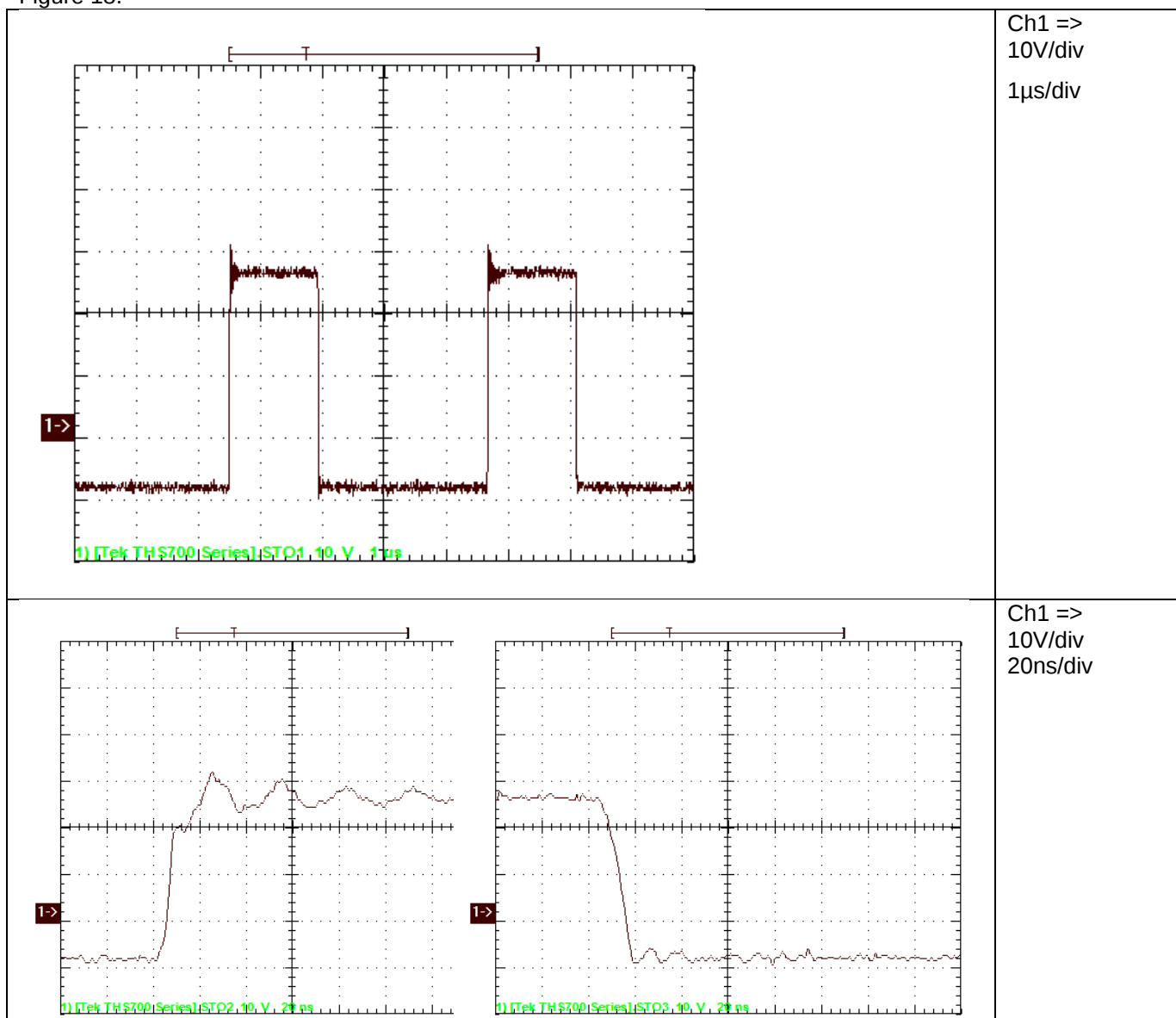


Figure 18

PMP10088RevB Test Results

"Secondary" switchnode (measured at the inductor pads): the waveform is shown in **Figure 19**.
Measured without snubber.

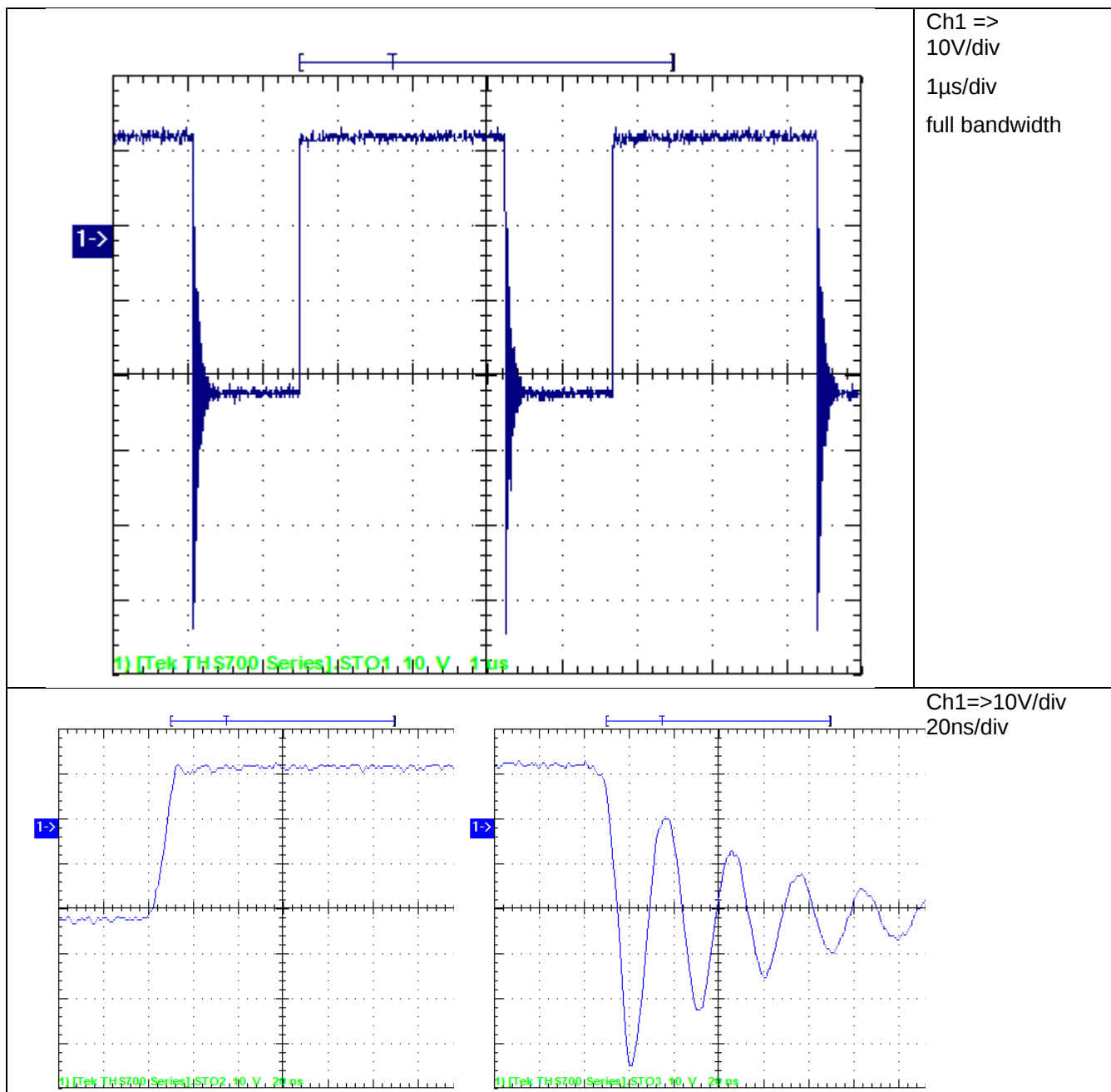


Figure 19

PMP10088RevB Test Results

Secondary switchnode (SW2 to +VOUT) the waveform is shown in Figure 20.
Applied RC snubber across diode D1 (100Ohm + 470pF in series)

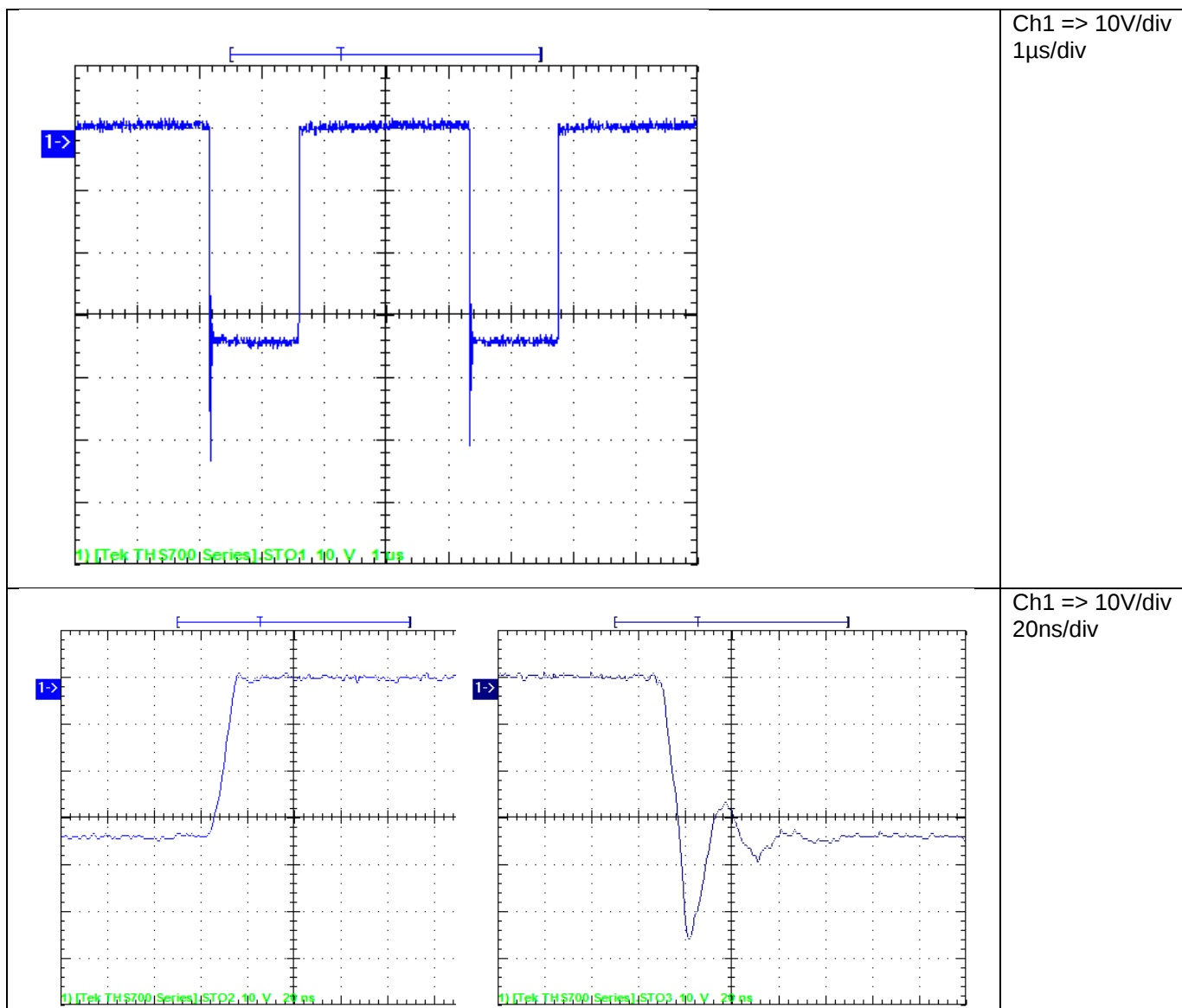


Figure 20

RC snubber deduced voltage stress below 60Vpk

PMP10088RevB Test Results

11 Thermal Image

Thermal image is shown in Figure 21. Input voltage was set to 24V and both output currents at full load 700mA for more than 30minutes:

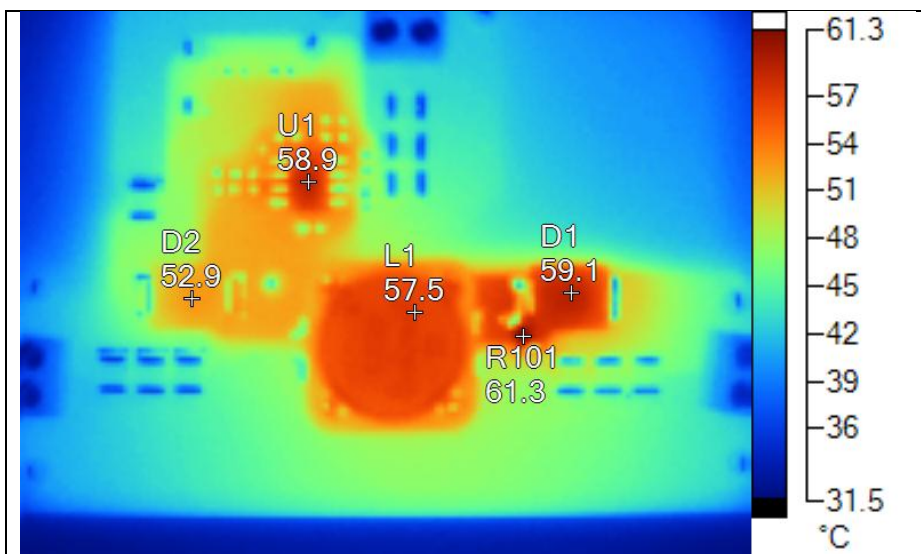


Figure 21

Name	Temperature
R101	61.3°C
U1	58.9°C
D1	59.1°C
L1	57.5°C
D2	52.9°C

Table 2

Thermal stress at the semiconductors is low, $\Delta T < 40K$

IMPORTANT NOTICE FOR TI REFERENCE DESIGNS

Texas Instruments Incorporated ("TI") reference designs are solely intended to assist designers ("Buyers") who are developing systems that incorporate TI semiconductor products (also referred to herein as "components"). Buyer understands and agrees that Buyer remains responsible for using its independent analysis, evaluation and judgment in designing Buyer's systems and products.

TI reference designs have been created using standard laboratory conditions and engineering practices. **TI has not conducted any testing other than that specifically described in the published documentation for a particular reference design.** TI may make corrections, enhancements, improvements and other changes to its reference designs.

Buyers are authorized to use TI reference designs with the TI component(s) identified in each particular reference design and to modify the reference design in the development of their end products. HOWEVER, NO OTHER LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE TO ANY OTHER TI INTELLECTUAL PROPERTY RIGHT, AND NO LICENSE TO ANY THIRD PARTY TECHNOLOGY OR INTELLECTUAL PROPERTY RIGHT, IS GRANTED HEREIN, including but not limited to any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services, or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

TI REFERENCE DESIGNS ARE PROVIDED "AS IS". TI MAKES NO WARRANTIES OR REPRESENTATIONS WITH REGARD TO THE REFERENCE DESIGNS OR USE OF THE REFERENCE DESIGNS, EXPRESS, IMPLIED OR STATUTORY, INCLUDING ACCURACY OR COMPLETENESS. TI DISCLAIMS ANY WARRANTY OF TITLE AND ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, QUIET ENJOYMENT, QUIET POSSESSION, AND NON-INFRINGEMENT OF ANY THIRD PARTY INTELLECTUAL PROPERTY RIGHTS WITH REGARD TO TI REFERENCE DESIGNS OR USE THEREOF. TI SHALL NOT BE LIABLE FOR AND SHALL NOT DEFEND OR INDEMNIFY BUYERS AGAINST ANY THIRD PARTY INFRINGEMENT CLAIM THAT RELATES TO OR IS BASED ON A COMBINATION OF COMPONENTS PROVIDED IN A TI REFERENCE DESIGN. IN NO EVENT SHALL TI BE LIABLE FOR ANY ACTUAL, SPECIAL, INCIDENTAL, CONSEQUENTIAL OR INDIRECT DAMAGES, HOWEVER CAUSED, ON ANY THEORY OF LIABILITY AND WHETHER OR NOT TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES, ARISING IN ANY WAY OUT OF TI REFERENCE DESIGNS OR BUYER'S USE OF TI REFERENCE DESIGNS.

TI reserves the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques for TI components are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

Reproduction of significant portions of TI information in TI data books, data sheets or reference designs is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards that anticipate dangerous failures, monitor failures and their consequences, lessen the likelihood of dangerous failures and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in Buyer's safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed an agreement specifically governing such use.

Only those TI components that TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components that have **not** been so designated is solely at Buyer's risk, and Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.