

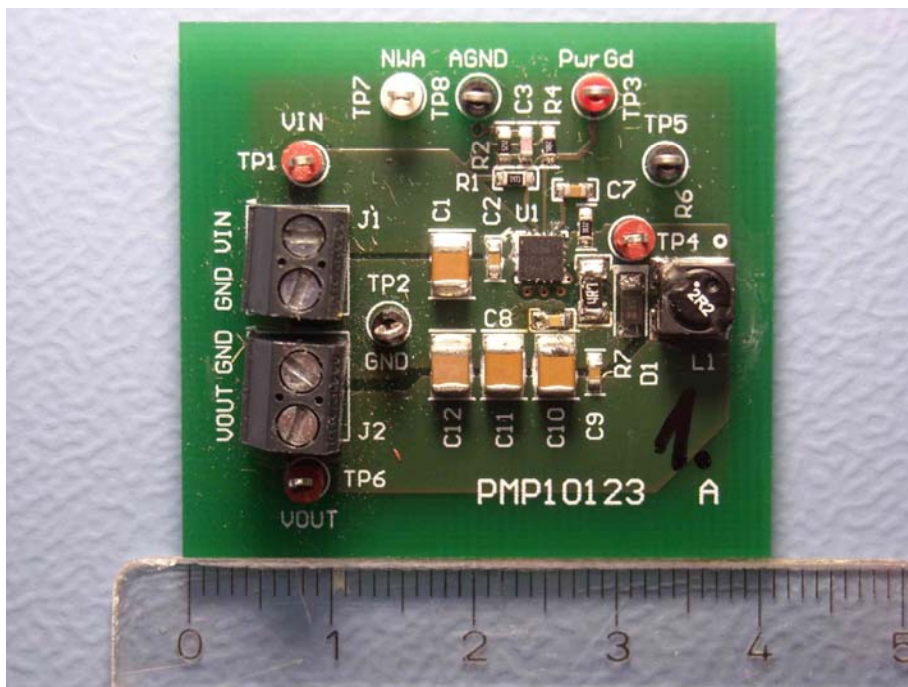
# PMP10123 – Rev. B – Test Report

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Topology:       synchronous step down SWIFT converter  
 Device:        TPS57112, tested board #1 at Fsw 2.19MHz (RT 82.5kOhm)

## Revision B:

- RC snubber:
  - R7 changed to 4.7 Ohm
  - C8 changed to 330 pF
- Loop compensation
  - C6 changed to 22 nF
  - R5 changed to 4.99 kOhm



## 1 Startup

Startup sequence is shown in Figure 1.

Power Setup		Oscilloscope Setup					
			Description	Time	Scale	BW	Coupling
$V_{in}$	5.0V	C1	Input Voltage	2ms / div	2V / div	Full	DC 1M $\Omega$ m
$V_{out}$	3.3V	C2	Output Voltage	2ms / div	2V / div	Full	DC 1M $\Omega$ m
$I_{in}$							
$I_{out}$	2.0A						

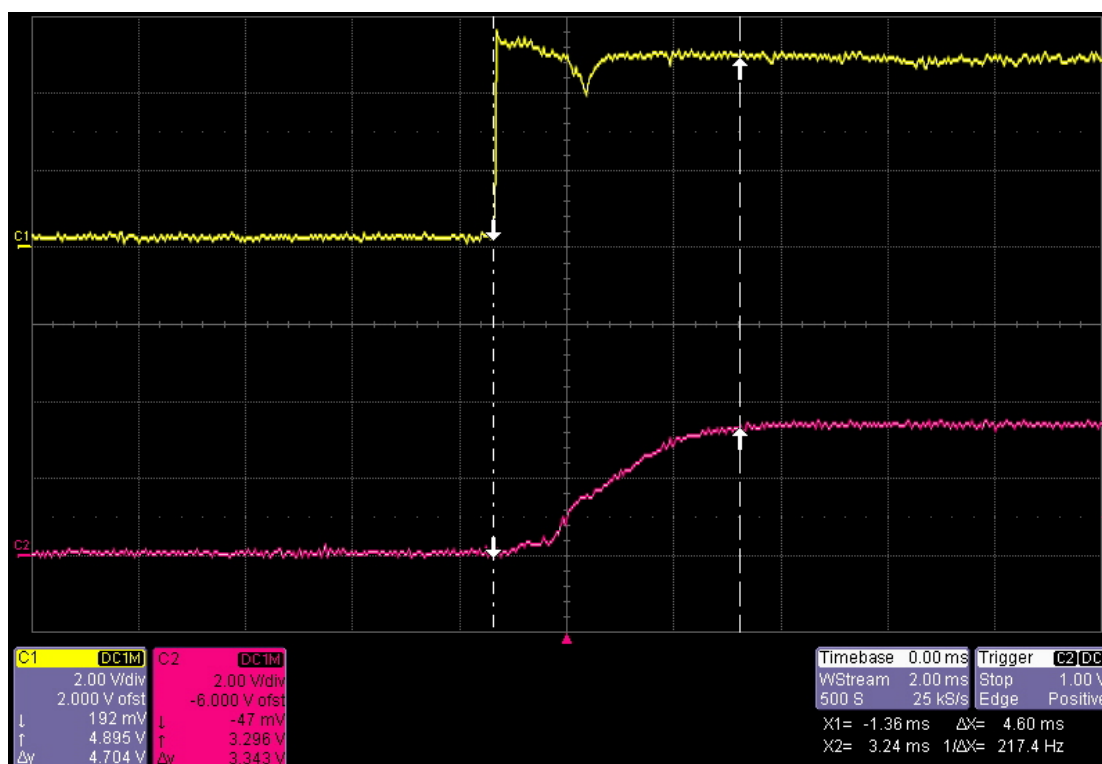


Figure 1: Startup sequence

Startup time is about 4.60 ms.

## 2 Shutdown

Shutdown sequence is shown in Figure 2.

Power Setup		Oscilloscope Setup					
		Description	Time	Scale	BW	Coupling	
$V_{in}$	5.0V	C1 Input Voltage	2ms / div	2V / div	Full	DC 1MOhm	
$V_{out}$	3.3V	C2 Output Voltage	2ms / div	2V / div	Full	DC 1MOhm	
$I_{in}$							
$I_{out}$	2.0A						

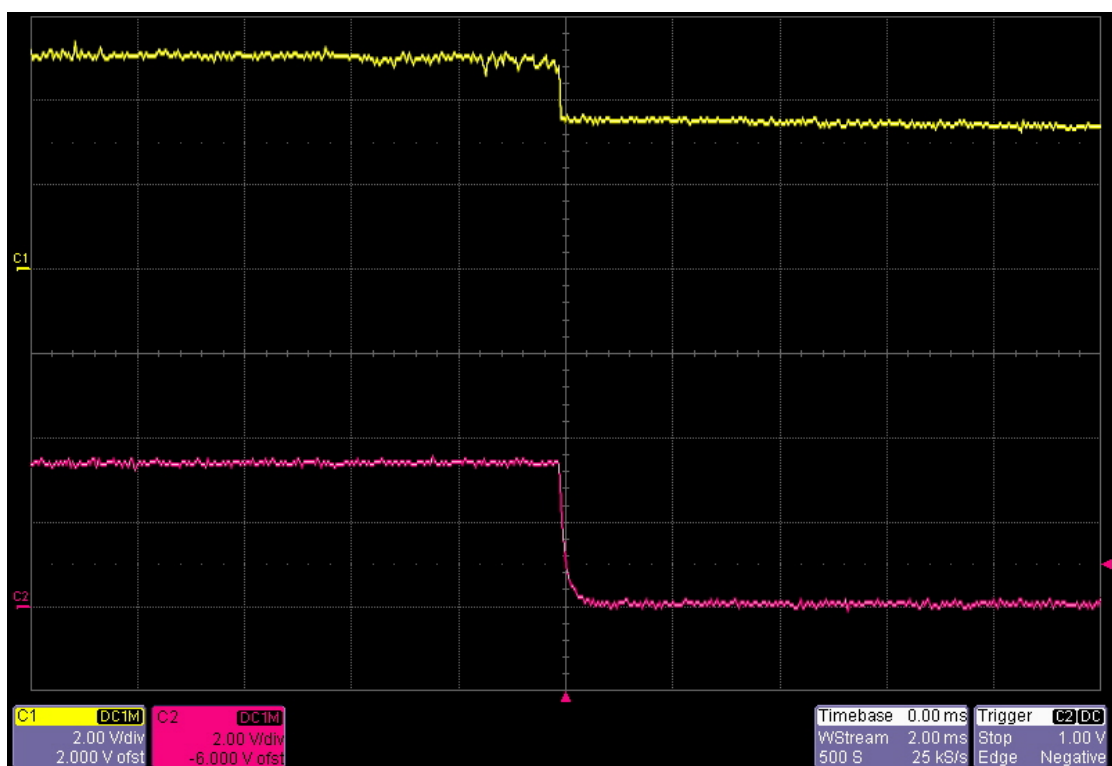


Figure 2: Shutdown sequence

### 3 Efficiency

The data in Table 1 were recorded. Efficiency curve is shown in Figure 3.

Table 1				
$V_{in}$	$I_{in}$	$V_{out}$	$I_{out}$	Eff.
5.000 V	0.1086 A	3.3240 V	0.1293 A	79.15 %
5.000 V	0.1746 A	3.3241 V	0.2200 A	83.77 %
5.000 V	0.3827 A	3.3240 V	0.5313 A	92.29 %
4.999 V	0.5954 A	3.3236 V	0.8387 A	93.65 %
4.998 V	0.7972 A	3.3228 V	1.1275 A	94.03 %
5.002 V	1.0109 A	3.3225 V	1.4290 A	93.90 %
5.002 V	1.2260 A	3.3224 V	1.7360 A	94.05 %
4.999 V	1.4350 A	3.3221 V	2.0260 A	93.82 %
5.000 V	1.6560 A	3.3215 V	2.3300 A	93.47 %

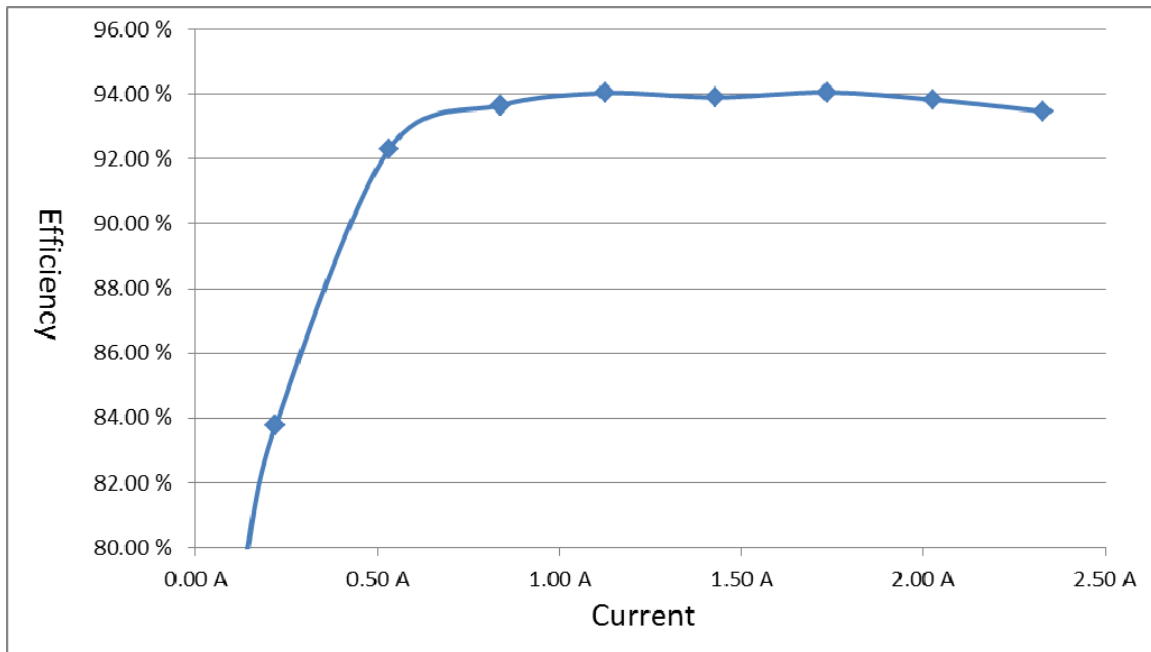
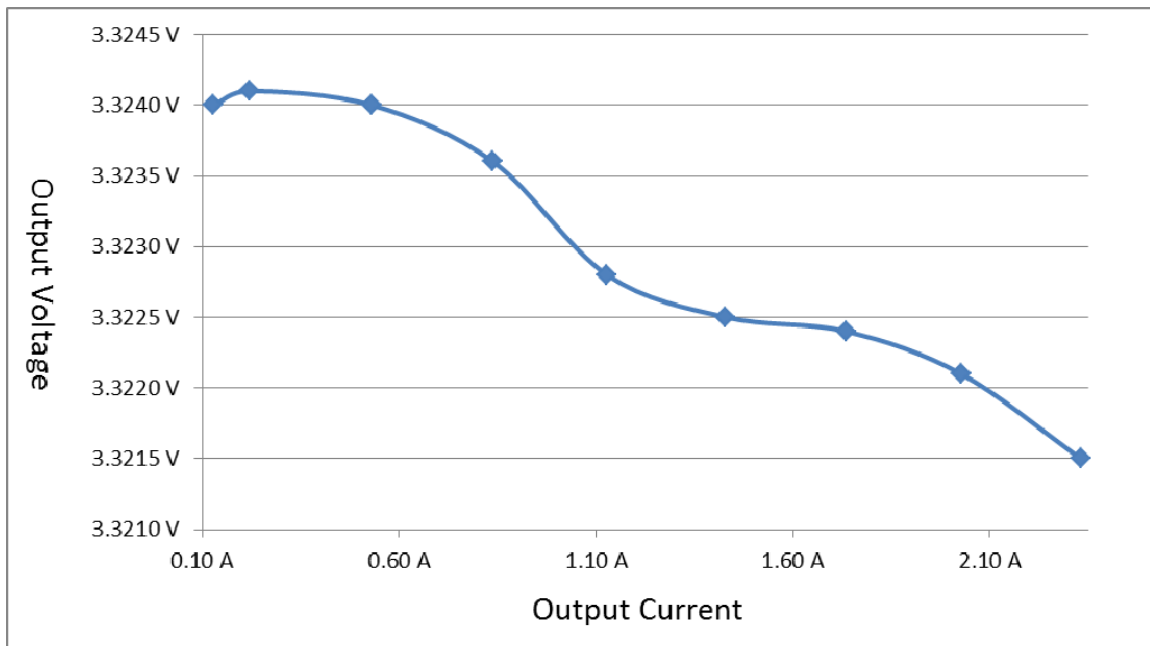


Figure 3: Efficiency over output current

Maximum efficiency 94% at 1A to 2A output current.

## 4 Load Regulation

Load regulation of the output is shown in **Figure 4**.



**Figure 4: Load regulation**

Min.  $V_{out}$ : 3.3215V  
Max  $V_{out}$ : 3.3241V

$V_{out}$  Variation: 2.6mV

## 5 Ripple Voltage

Input and output ripple voltage are shown in Figure 5 and Figure 6.

Power Setup		Oscilloscope Setup					
			Description	Time	Scale	BW	Coupling
$V_{in}$	5.0V	C1	Input Ripple V.	100ns / div	100mV / div	Full	AC 1MOhm
$V_{out}$	3.3V	C2	Output Ripple V.	100ns / div	100mV / div	Full	AC 1MOhm
$I_{in}$							
$I_{out}$	2.0A						

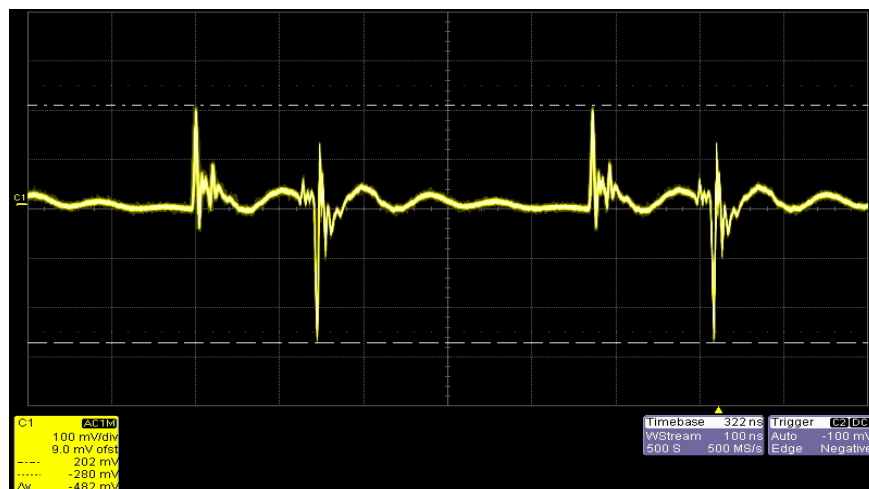


Figure 5: Input ripple voltage

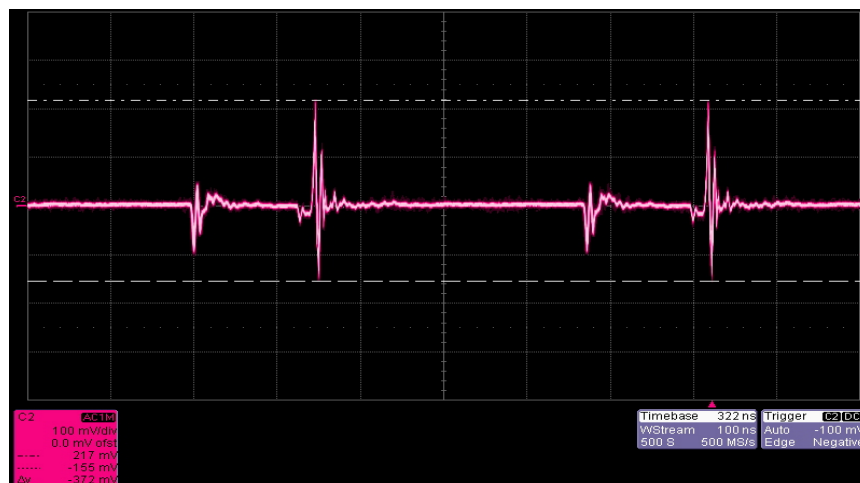


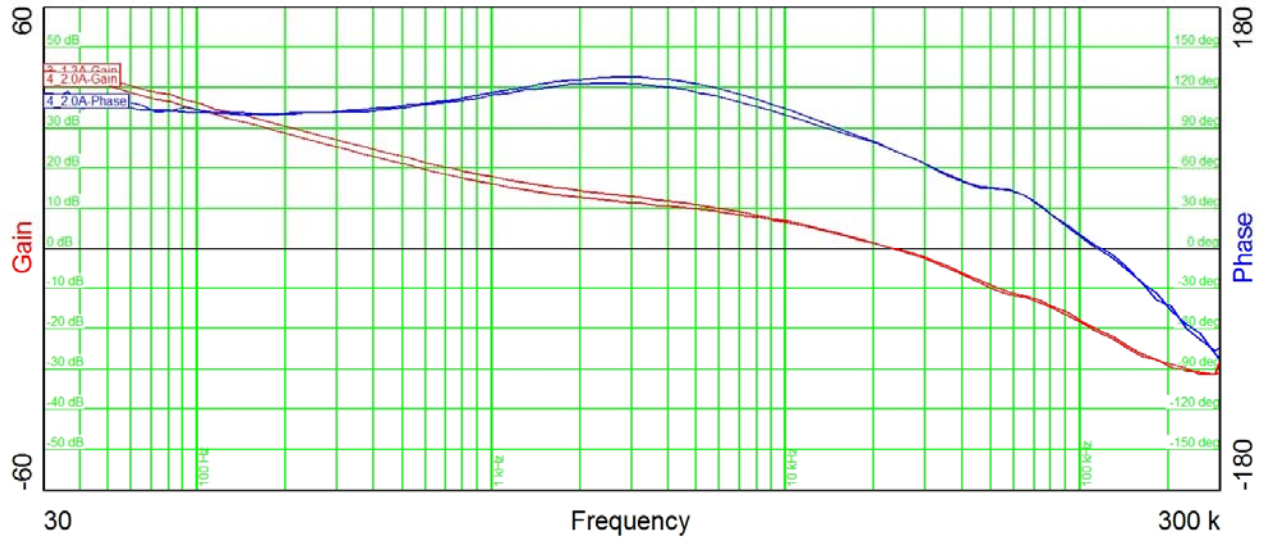
Figure 6: Output ripple voltage

Input ripple voltage is 482mV peak peak. Output ripple voltage is 372mV peak peak.

**For EMI analysis these msrmts have been taken w/ FULL BANDWIDTH !** (standard procedure bw 20MHz)

## 6 Control Loop Frequency Response

Figure 7 shows the loop response for 1.3A and 2.0A load.



**Figure 7: Control Loop Frequency Response**

1.3A load:

Crossover frequency $f_{co}$ :	23.7 kHz
Phase margin at $f_{co}$ :	72.7 deg
Gain Margin:	-20.6 dB

2.0A load:

Crossover frequency $f_{co}$ :	23.1 kHz
Phase margin at $f_{co}$ :	74.5 deg
Gain Margin:	-21.0 dB

## 7 Load Transients

Figure 8 shows the response to a load transient from 0.7A to 1.4A.  
Alternating frequency is 500Hz.

Power Setup		Oscilloscope Setup					
		Description	Time	Scale	BW	Coupling	
$V_{in}$	5.0V	C1 Output Voltage	500us / div	100mV / div	20MHz	AC 1MOhm	
$V_{out}$	3.3V	C2 Output Current	500us / div	10mV / div	20MHz	DC 1MOhm	
$I_{in}$				10mV $\hat{=}$ 1A			
$I_{out}$							

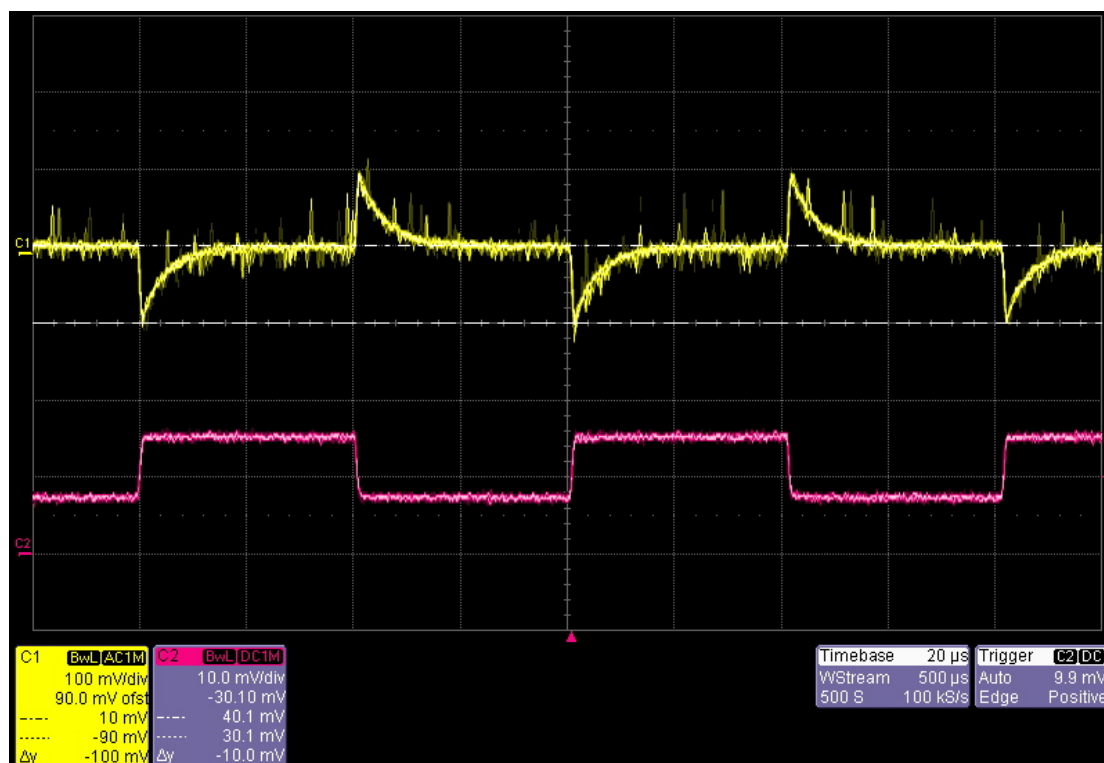


Figure 8: Load transient from 0.7A to 1.4A

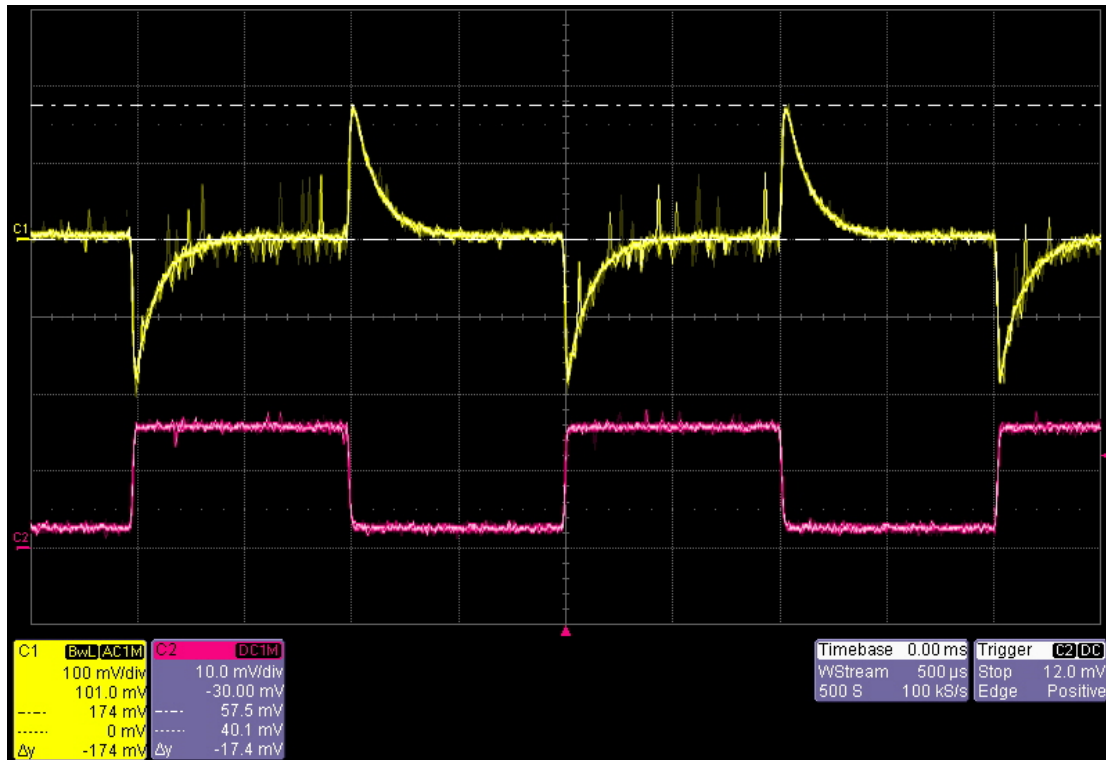
The voltage drop caused by  $\Delta I = 700\text{mA}$  is 100mV, this reflects  $\Delta U = 3\%$ .  
Standard msrmt for customer application w/ 1.3A maximum load current.



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Figure 9 shows the response to a load transient from 0.15A to 1.5A. Switching frequency is 500Hz.

Power Setup		Oscilloscope Setup					
		Description	Time	Scale	BW	Coupling	
$V_{in}$	5.0V	C1	Output Voltage	500us / div	100mV / div	20MHz	AC 1MOhm
$V_{out}$	3.3V	C2	Output Current	500us / div	10mV / div	Full	DC 1MOhm
$I_{in}$					10mV $\hat{=}$ 1A		
$I_{out}$							



**Figure 9 Load transient from 0.15A to 1.5A**

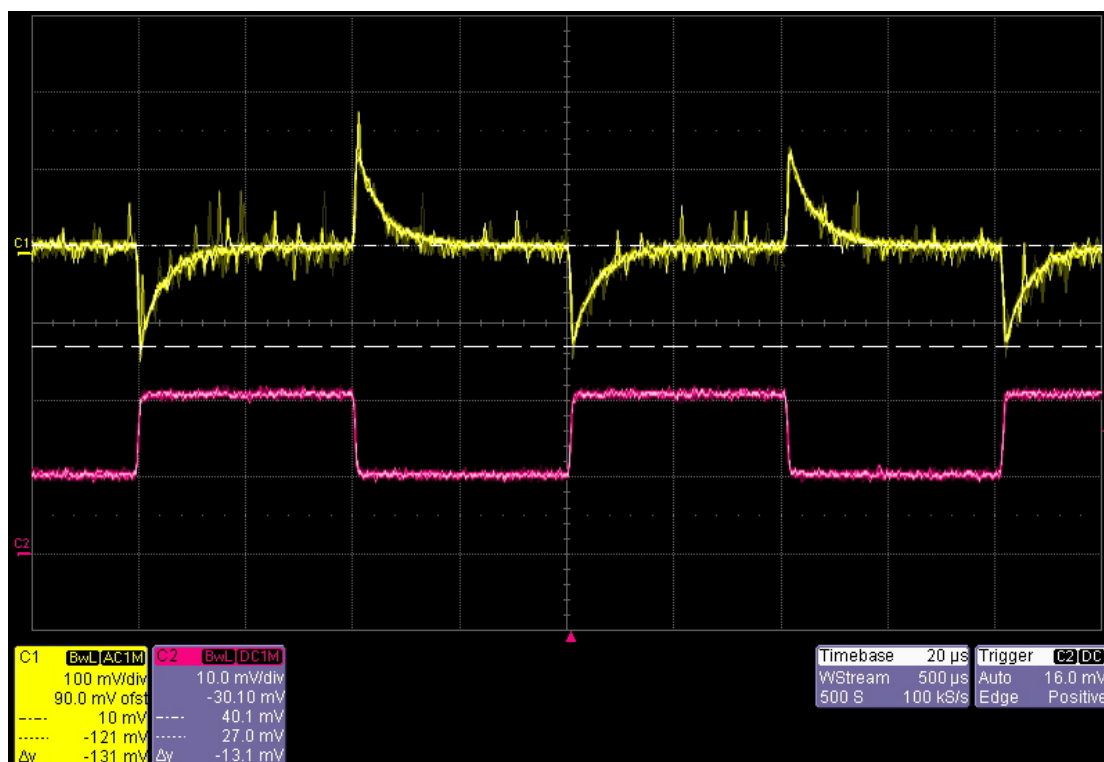
The voltage drop caused by  $di = 1.35A$  is 174mV, this reflects  $du = 5.3\%$  for **90% transient**.

(standard procedure 50% transient, see before)

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Figure 10 shows the response to a load transient from 1.0A to 2.0A. Switching frequency is 500Hz.

Power Setup		Oscilloscope Setup					
		Description	Time	Scale	BW	Coupling	
$V_{in}$	5.0V	C1 Output Voltage	500us / div	100mV / div	20MHz	AC 1MOhm	
$V_{out}$	3.3V	C2 Output Current	500us / div	10mV / div	20MHz	DC 1MOhm	
$I_{in}$				10mV $\hat{=}$ 1A			
$I_{out}$							



**Figure 10: Load transient from 1.0A to 2.0A**

The voltage drop caused by  $di = 1A$  is 131mV, this reflects  $du = 4\%$ ; Typical msrmt for the 2Amps device.

## 8 Switch node

Figure 11 shows the voltage characteristic at the switch node.

Power Setup		Oscilloscope Setup					
			Description	Time	Scale	BW	Coupling
$V_{in}$	5.0V	C1	SW Node Voltage	100ns / div	2V / div	Full	DC 1M $\Omega$ m
$V_{out}$	3.3V	C2					
$I_{in}$							
$I_{out}$	2.0A						

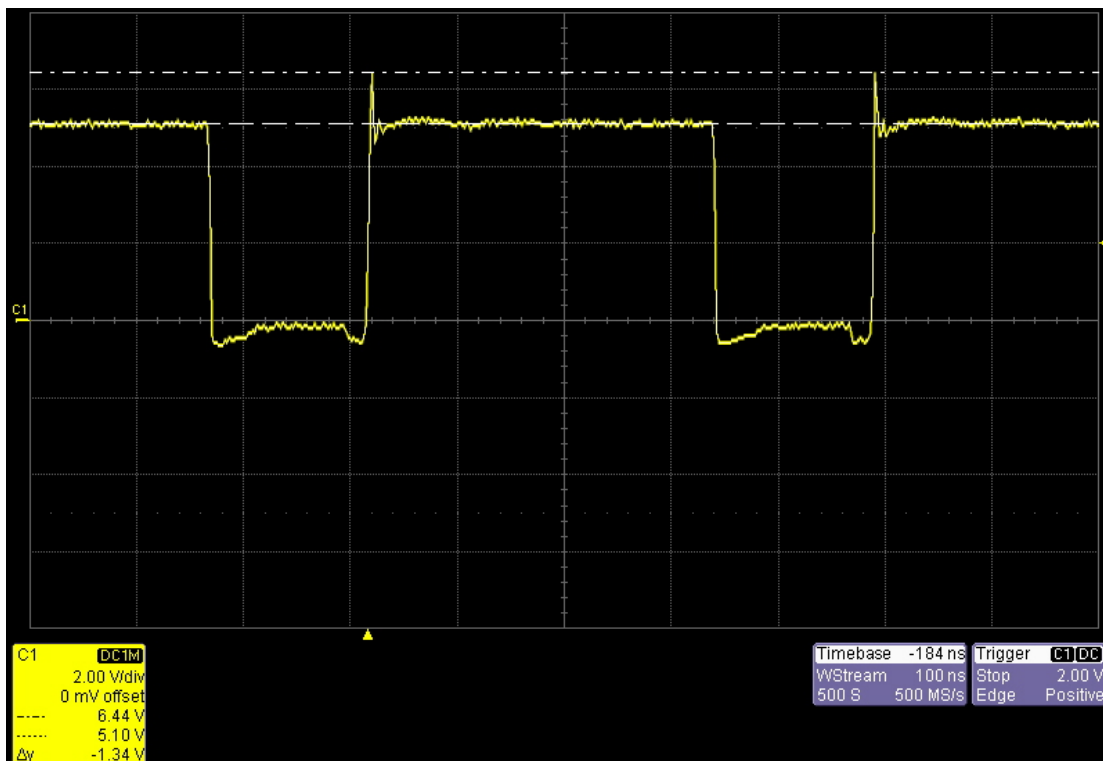


Figure 11: Switch Node

Voltage overshoot is 1.34V.

The design has been evaluated with:

- RC snubber at switch node to attenuate overshoot and RF ringing
- Bootstrap resistor to reduce rising slope slightly (effcy still 94%)
- Additional LS Schottky to prevent from  $Q_{rr}$  of LS FET body diody, causing GND noise

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Figure 12 and Figure 13 also show the ringing of the switch node, but more detailed (10ns/div). The snubber circuit consists of 4.7Ohm and 330pF in serial.

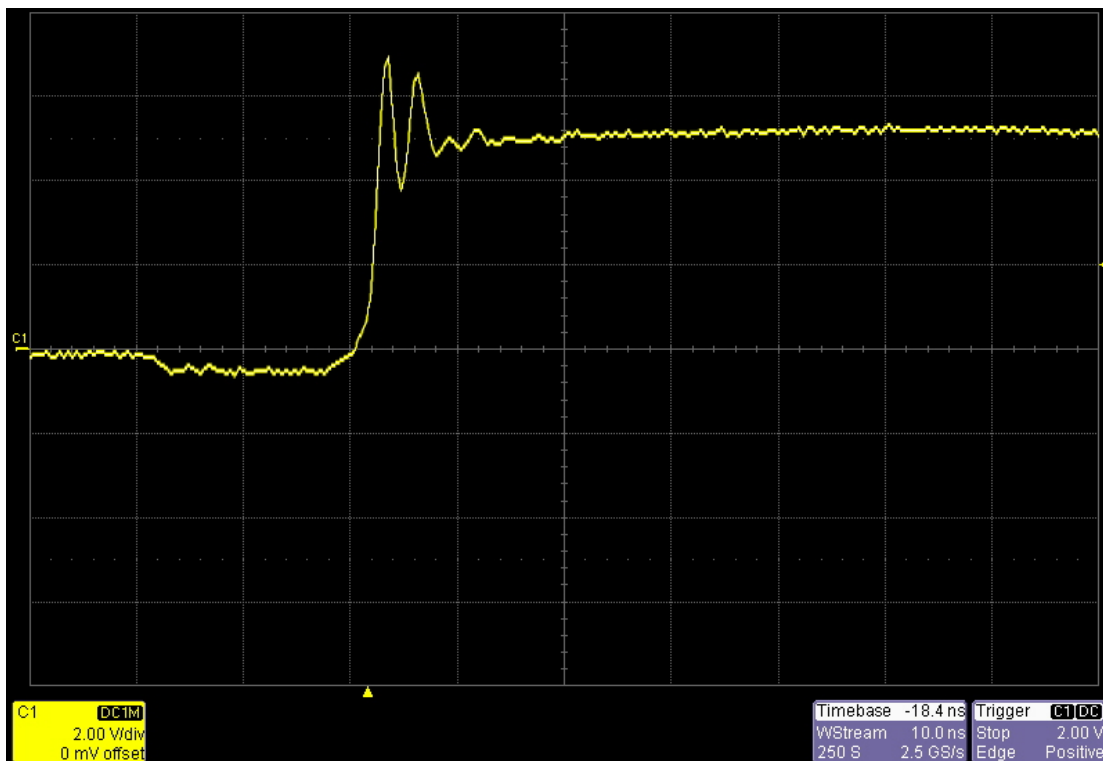


Figure 12: Voltage rise at switch node

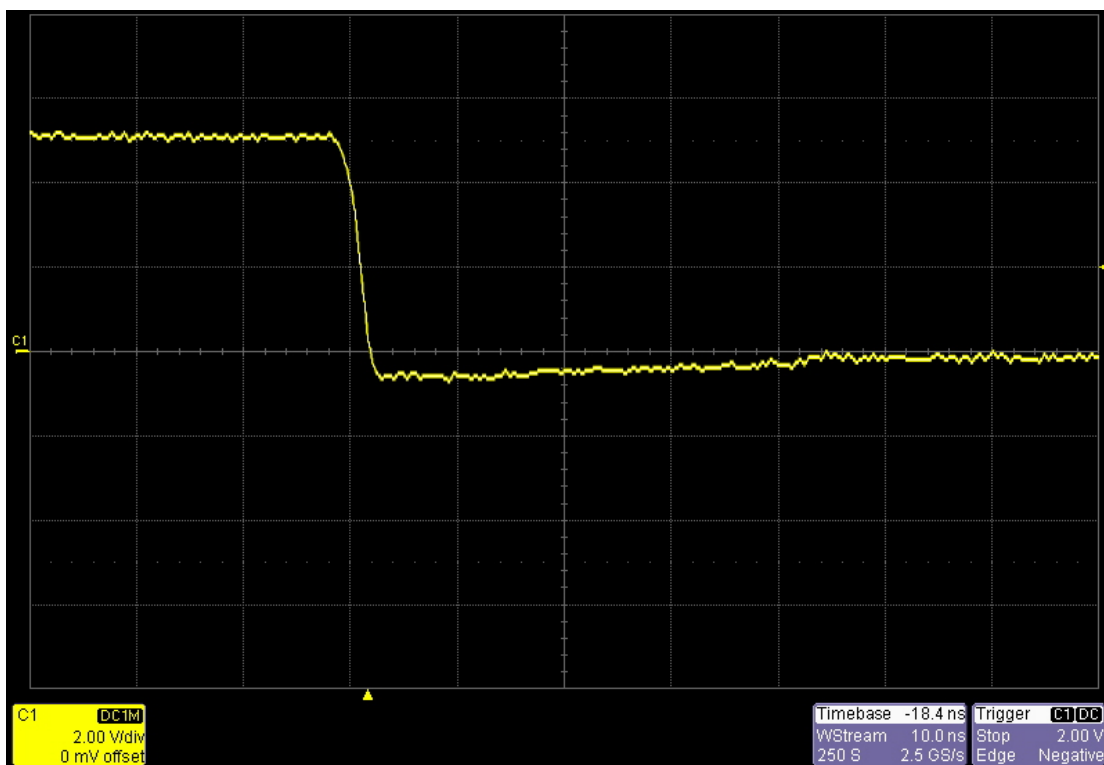


Figure 13: Voltage drop at switch node

## 9 Thermal image

Figure 14 and Figure 15 show the thermal image at 1.4A and 2.0A at room temperature (23 °C).

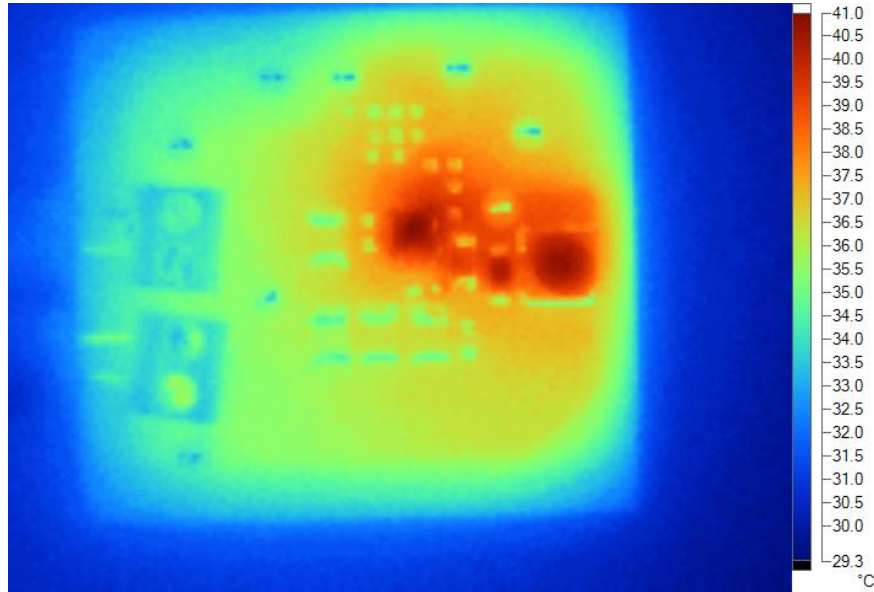


Figure 14: Thermal image at 1.4A load

Balanced temperature at device – Schottky – Inductor, no hotspot;  
Temperature rise  $\Delta T$  below +20K (!) - minor energy at snubber resistor.

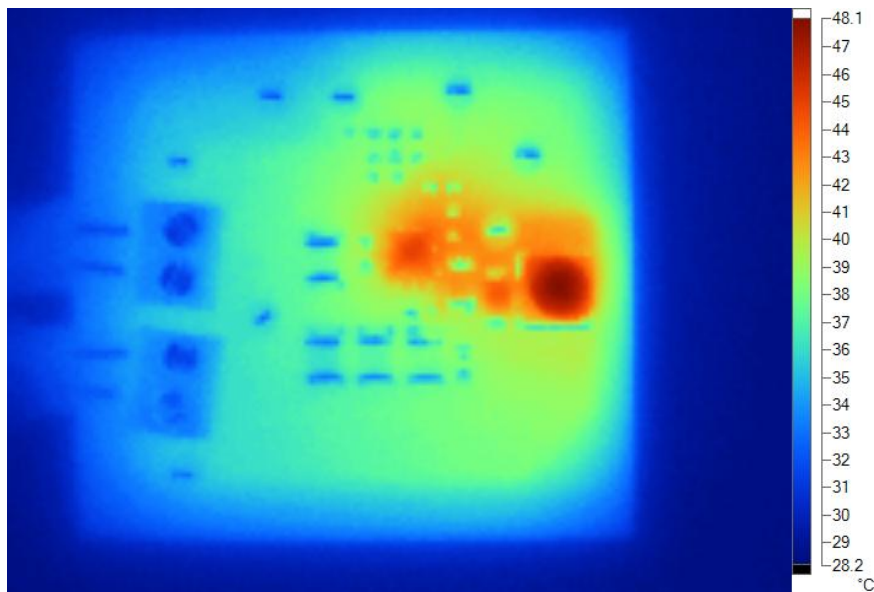


Figure 15: Thermal image at 2.0A load

Maximum temperature at 2.0A is 48.1 °C at inductor, so temperature rise  $\Delta T$  below +25K.

## Appendix: functional verification Board #2

### Efficiency Board #2:

$$V_{in} = 5.000V \quad I_{in} = 1.418A$$

$$V_{out} = 3.327V \quad I_{out} = 2.000A$$

⇒ Efficiency = 93.85 % (similar to board #1 at 93.82%, **power stage OK**)

### Closed loop, small signal analysis in frequency domain:

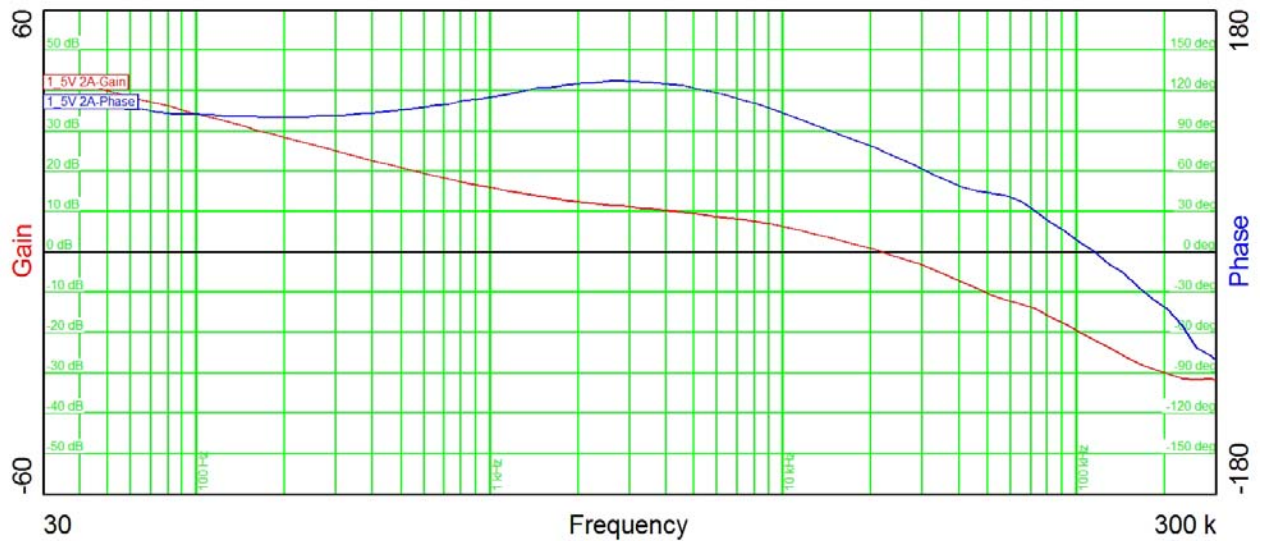


Figure 16: Control Loop Frequency Response Board #2

Measurement at load current 2.0A:

Crossover frequency $f_{co}$ :	23.8 kHz
Phase margin at $f_{co}$ :	75.2 deg
Gain Margin:	-21.8 dB

(similar to board #1, **loop OK**)

## Switch Node Board #2:

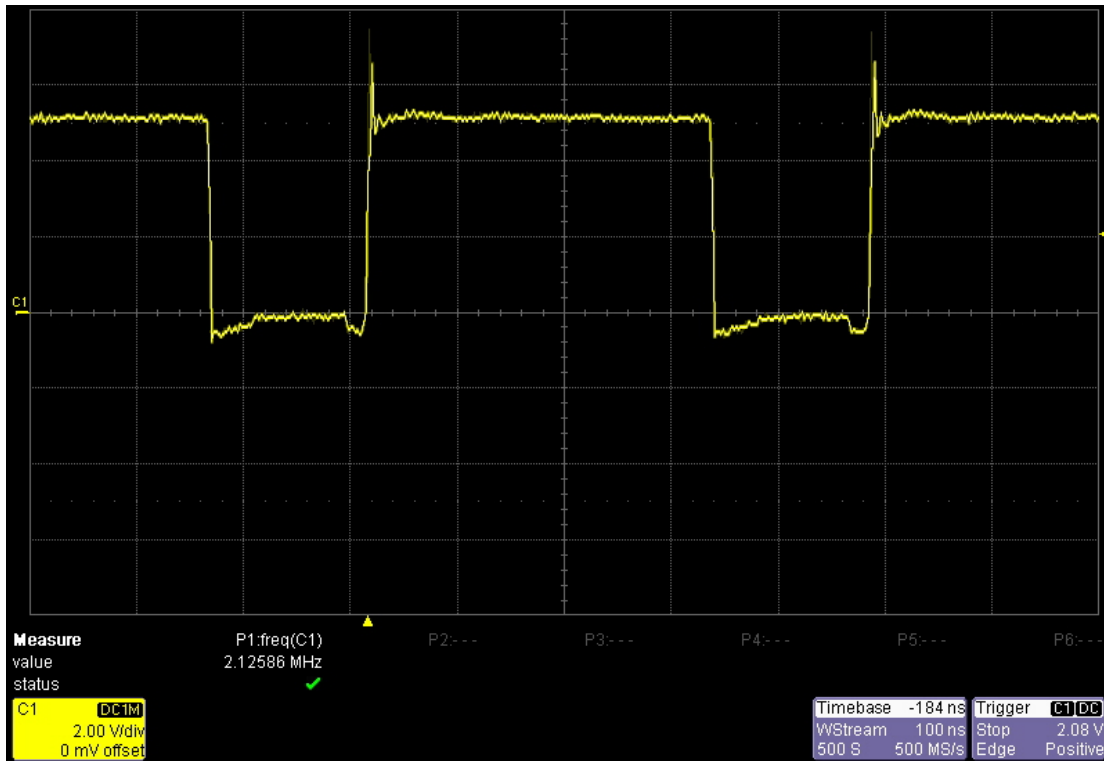


Figure 17: Switch node Board 2

$$F_{sw} = 2.13 \text{ MHz}$$

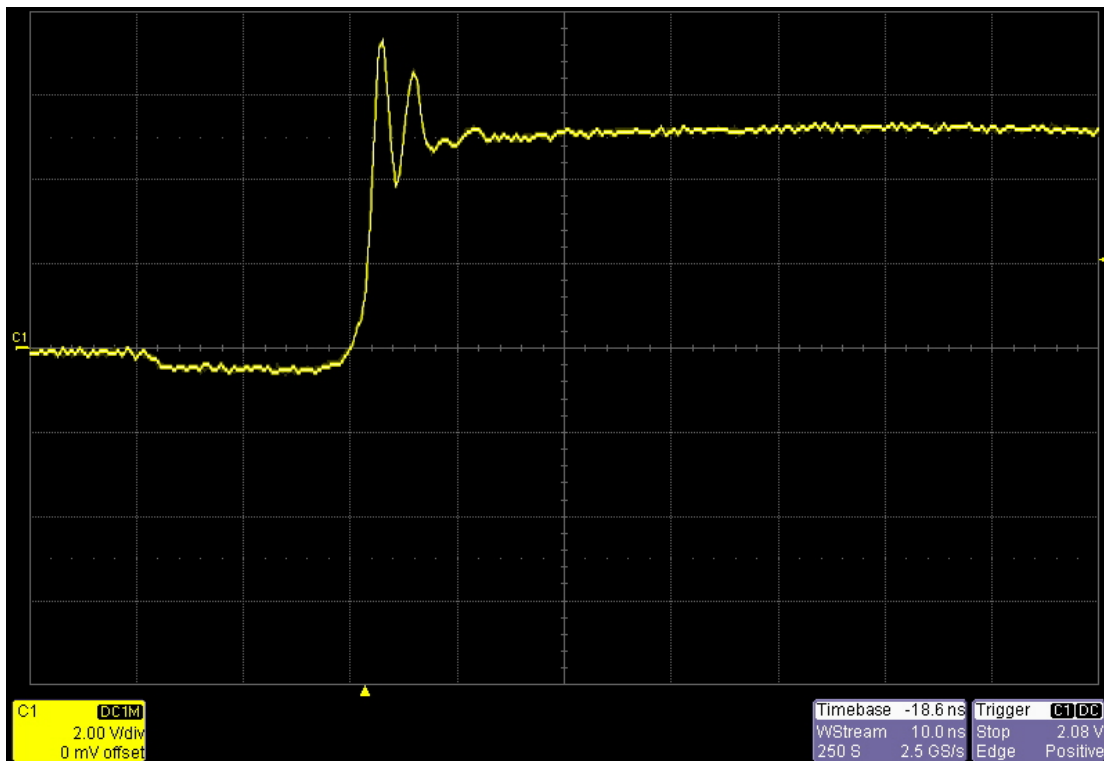
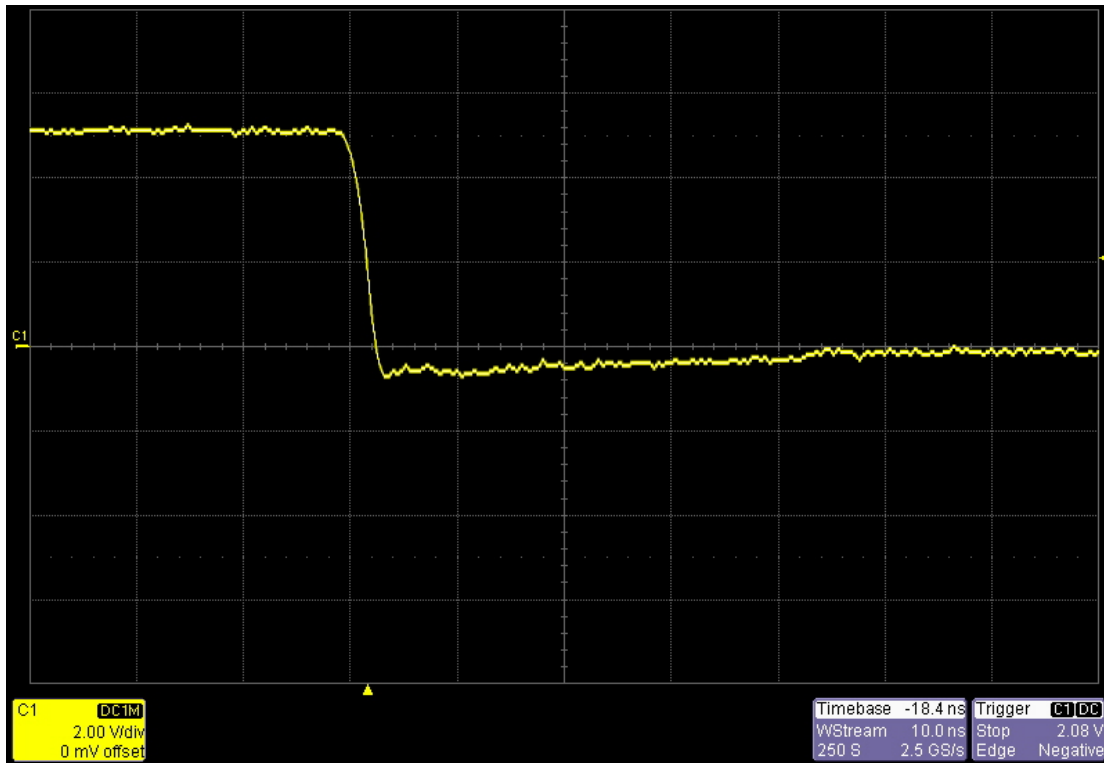


Figure 18: Voltage rise at switch node Board 2



**Figure 19: Voltage drop at switch node Board 2**

measurements at switch node in time domain similar to board #1, same switching behavior



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