

# PMP10081RevC Test Results

---

1	Startup	3
2	Shutdown	5
3	Efficiency	7
4	Load Regulation	8
5	Line Regulation	9
6	Output Ripple Voltage	10
7	Input Ripple Voltage	10
8	Load Transients	11
9	Control Loop Frequency Response	13
9.1	Resistive Load	13
9.2	5Ah Battery Load	14
10	Miscellaneous Waveforms	17
10.1	Switchnode (drain-source)	17
10.2	Gate to Source	20
10.3	Voltage D3 (referenced to VOUT)	23
11	Thermal Image	26

**Topology:** SEPIC, added CC charging by additional current ctr ( via TLC272)  
**Device:** TPS40210 and CSD18563Q5A

*Unless otherwise indicated, resistive load was applied, load current was set to 1.5A;  
 For charger verification battery YUASA NP 5-12 (= 12V, 5Ah, AGM) was used;  
 here load current has been set to 1.0A (5Ah @ 20%).*

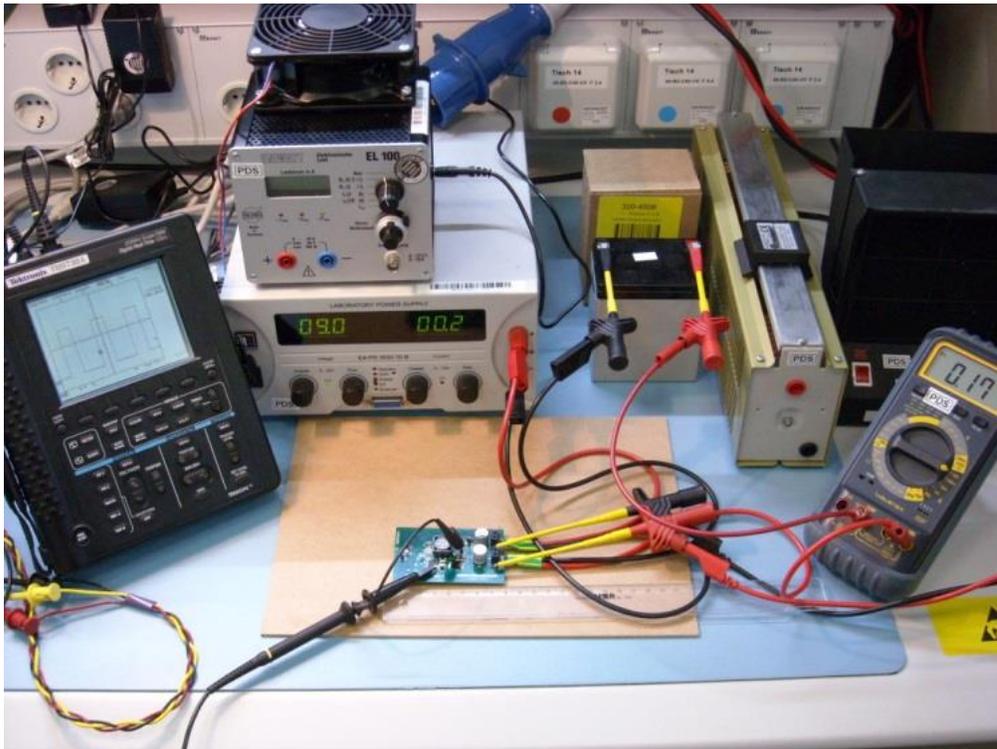
Static measurements:

Fsw	302kHz	OK
ON	8.8V	OK
OFF	7.6V	OK

Picture A shows the 20W SEPIC power stage controlled by TPS40210 and driven by CSD18563:



Picture B shows the test setup electronic load, resistive load and – here - lead acid battery 5Ah:



## 1 Startup

The CV startup waveform is shown in the Figure 1. The input voltage was set to 9V,  $C_{ss}$  220nF.

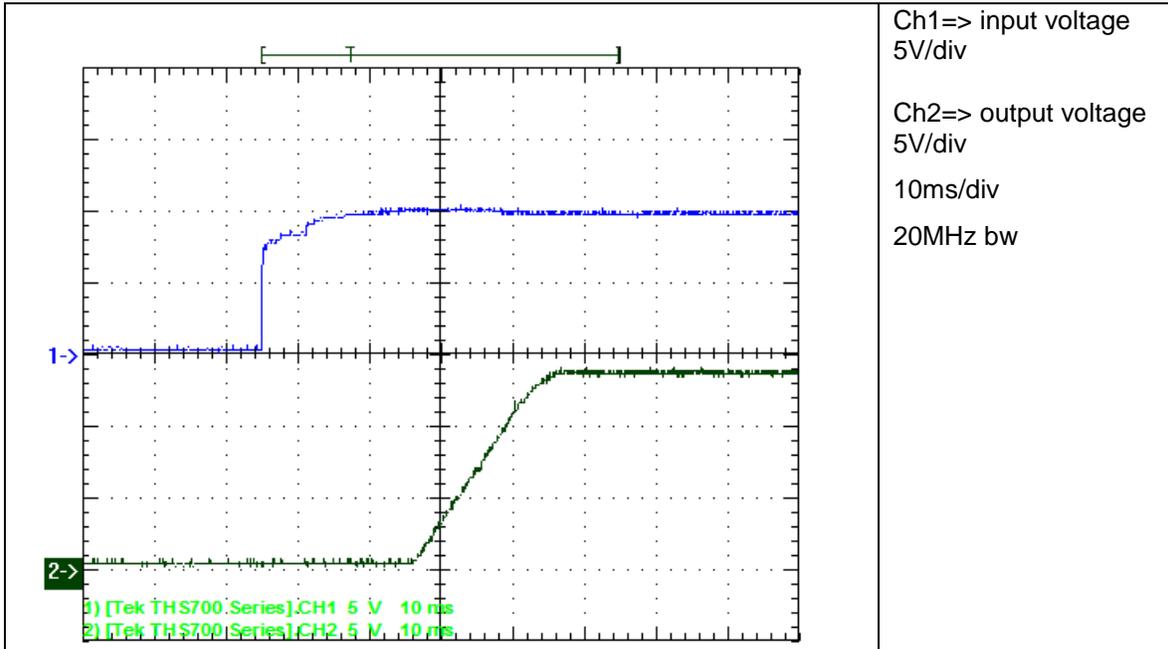


Figure 1

The CV startup waveform is shown in the Figure 2. The input voltage was set to 24V.

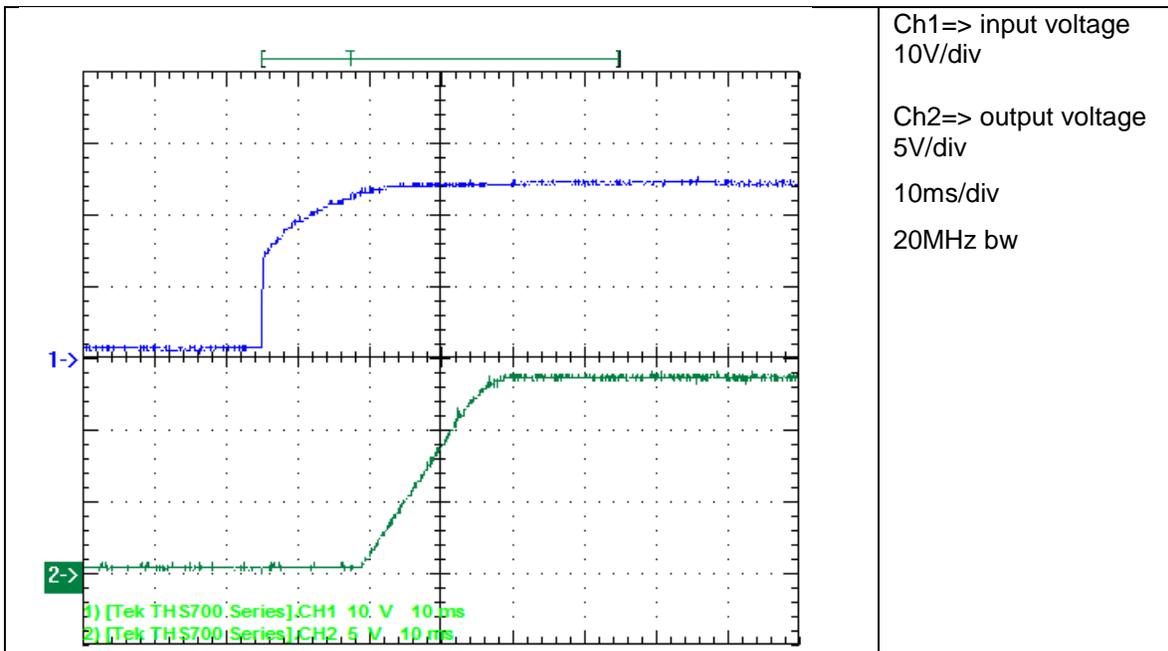


Figure 2

The CV startup waveform is shown in the Figure 3. The input voltage was set to 36V.

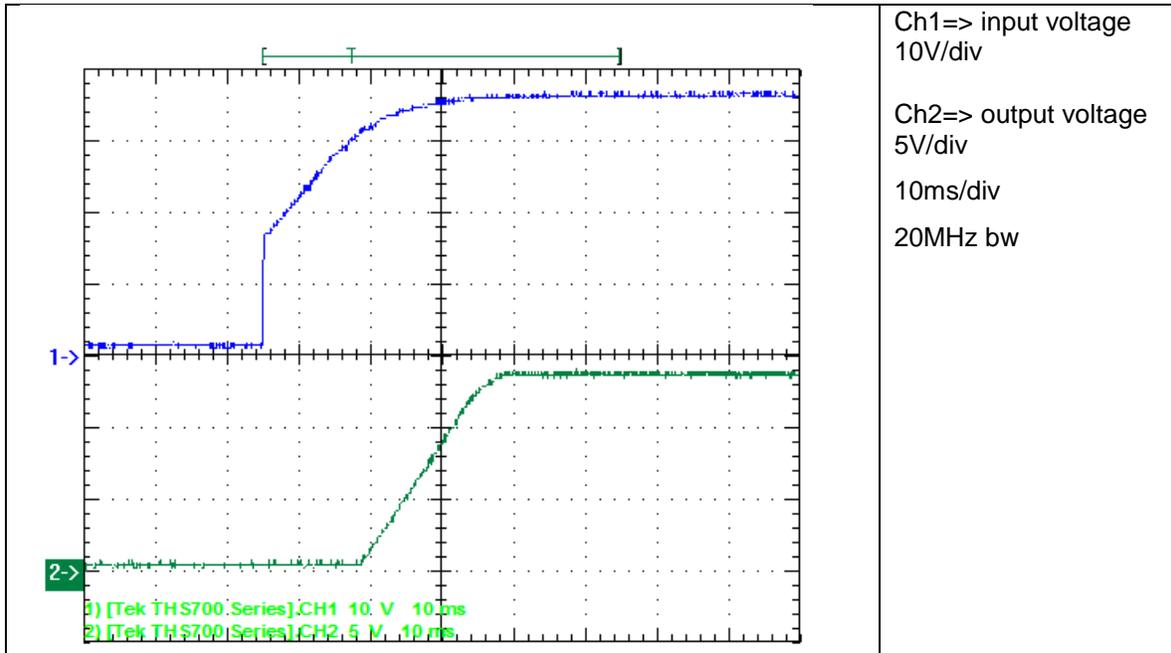


Figure 3

## 2 Shutdown

The CV shutdown waveform is shown in the Figure 4. The input voltage was set to 9V. The power supply was disconnected.

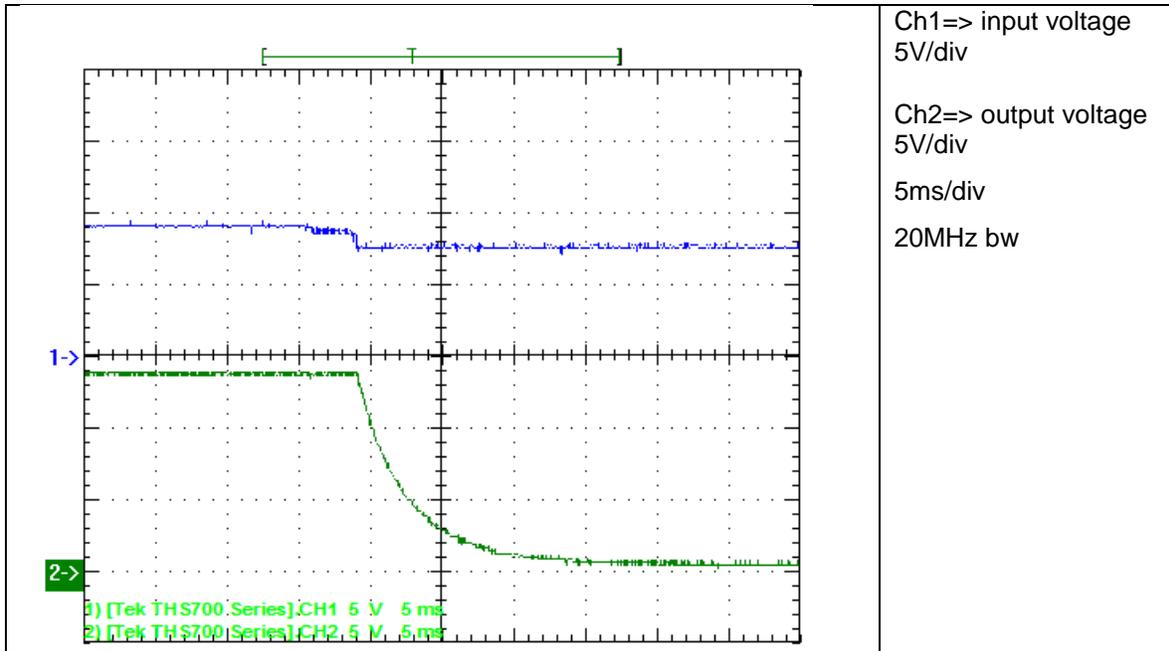


Figure 4

The CV shutdown waveform is shown in the Figure 5. The input voltage was set to 24V. The power supply was disconnected.

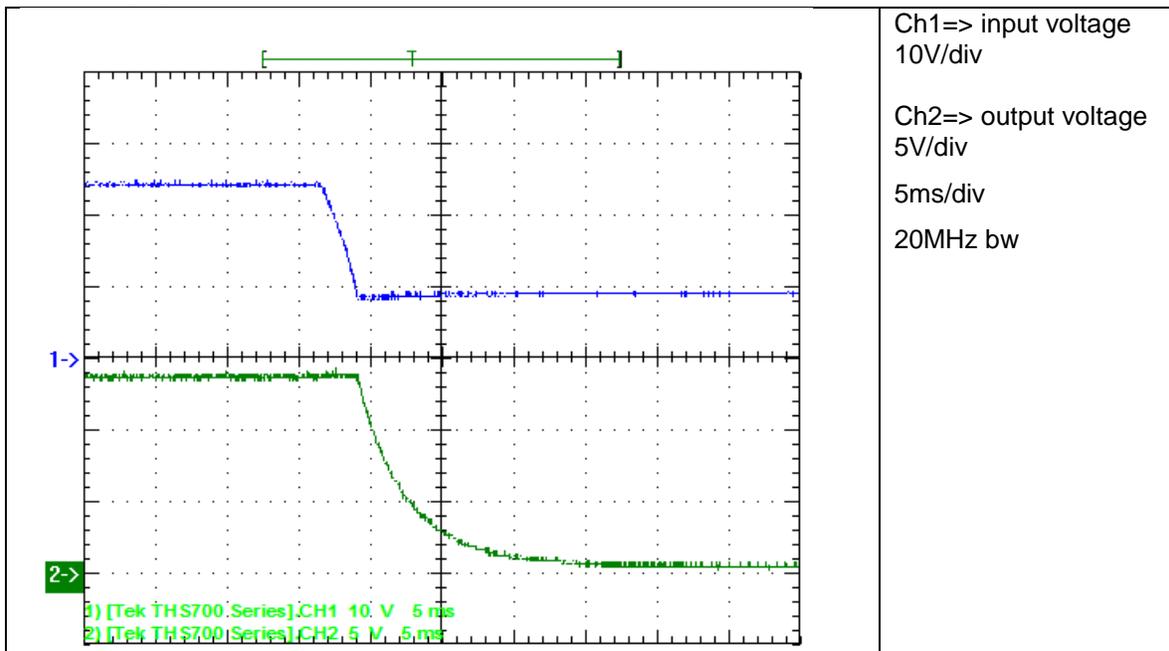


Figure 5

The CV shutdown waveform is shown in the Figure 6. The input voltage was set to 36V. The power supply was disconnected.

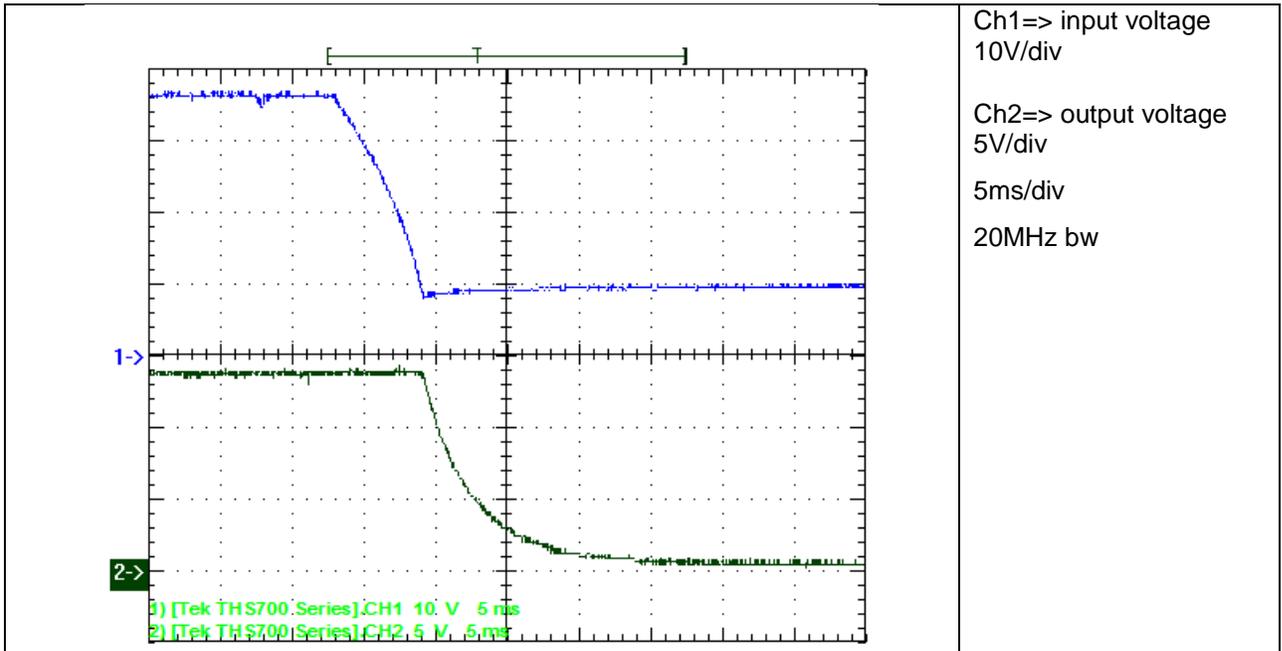


Figure 6

## 3 Efficiency

The CV efficiency is shown in the Figure 7 below. The input voltage was set to 9V, 24V and 36V (resistive load).

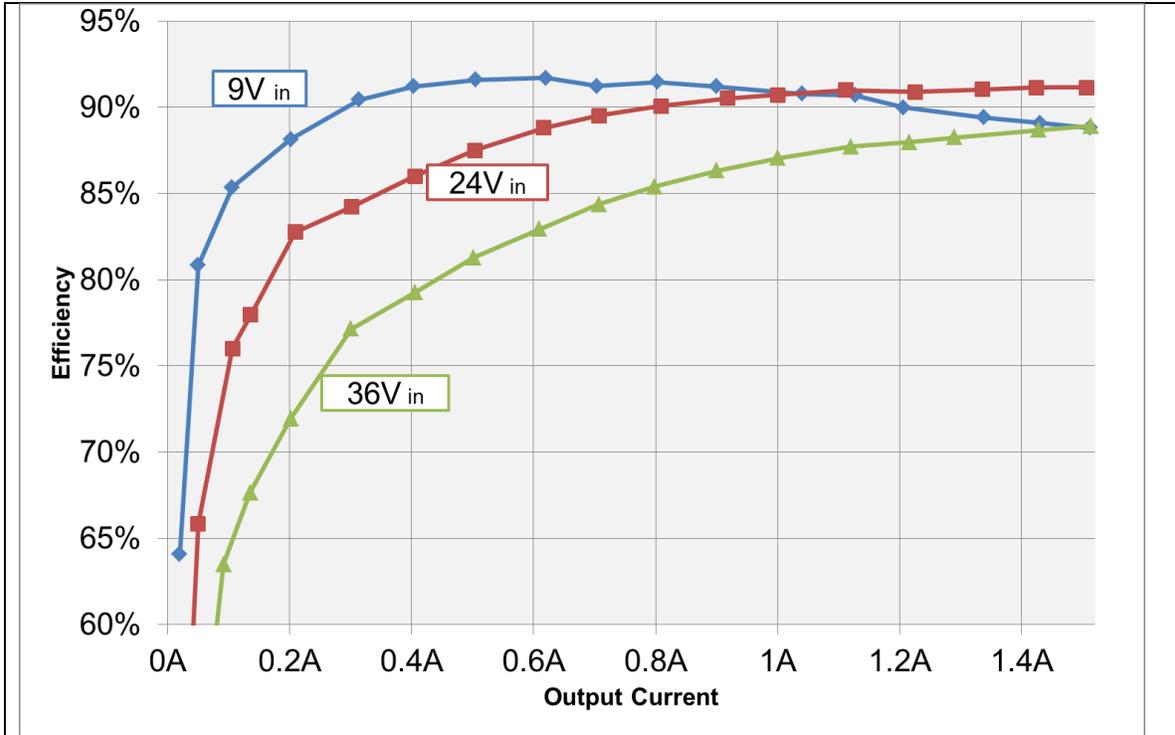


Figure 7

## 4 Load Regulation

The CV load regulation of the output is shown in the Figure 8 below. The input voltage was set to 9V, 24V and 36V (resistive load).

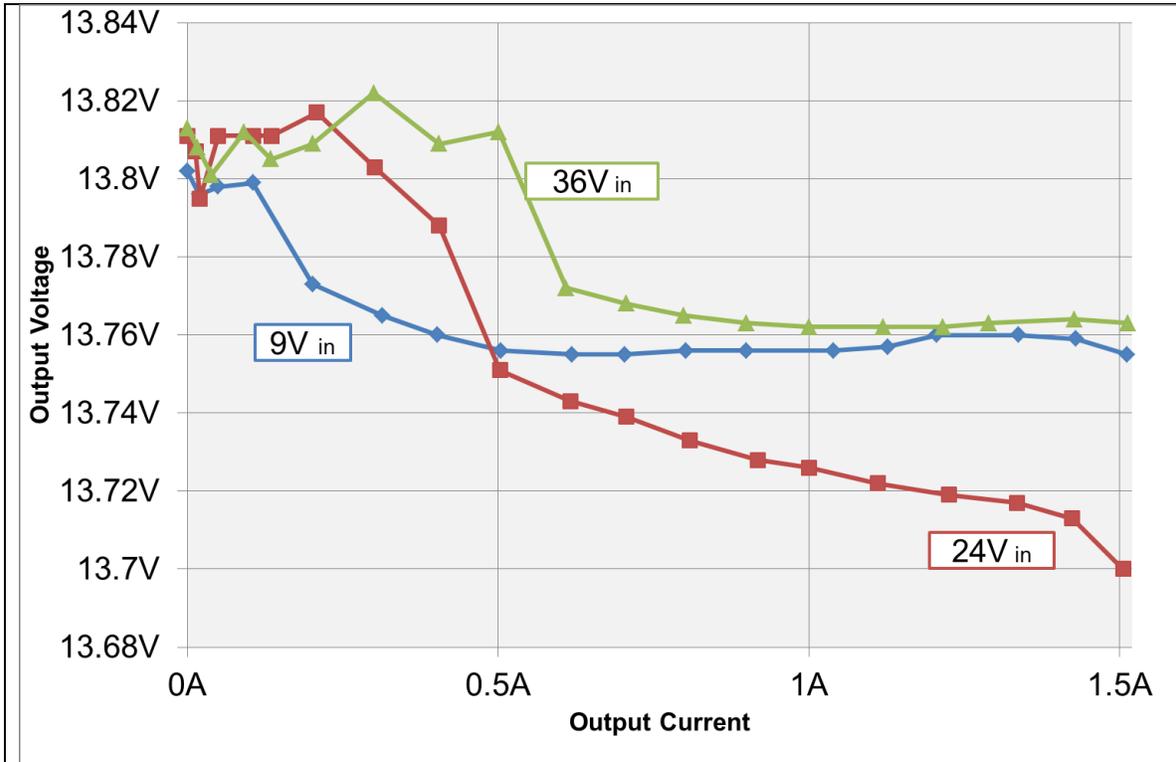


Figure 8

## 5 Line Regulation

The CV line regulation is shown in Figure 9. The output current was set about 1.5A.

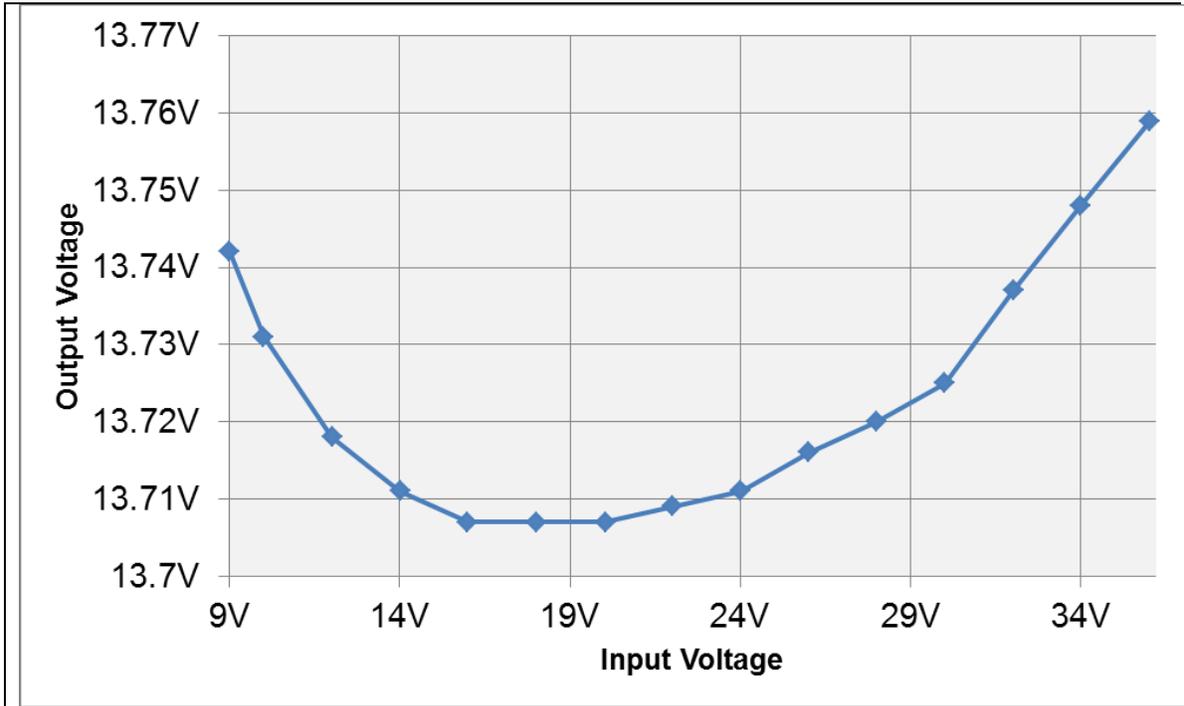


Figure 9

With the same setup efficiencies were calculated. This is shown in Figure 10

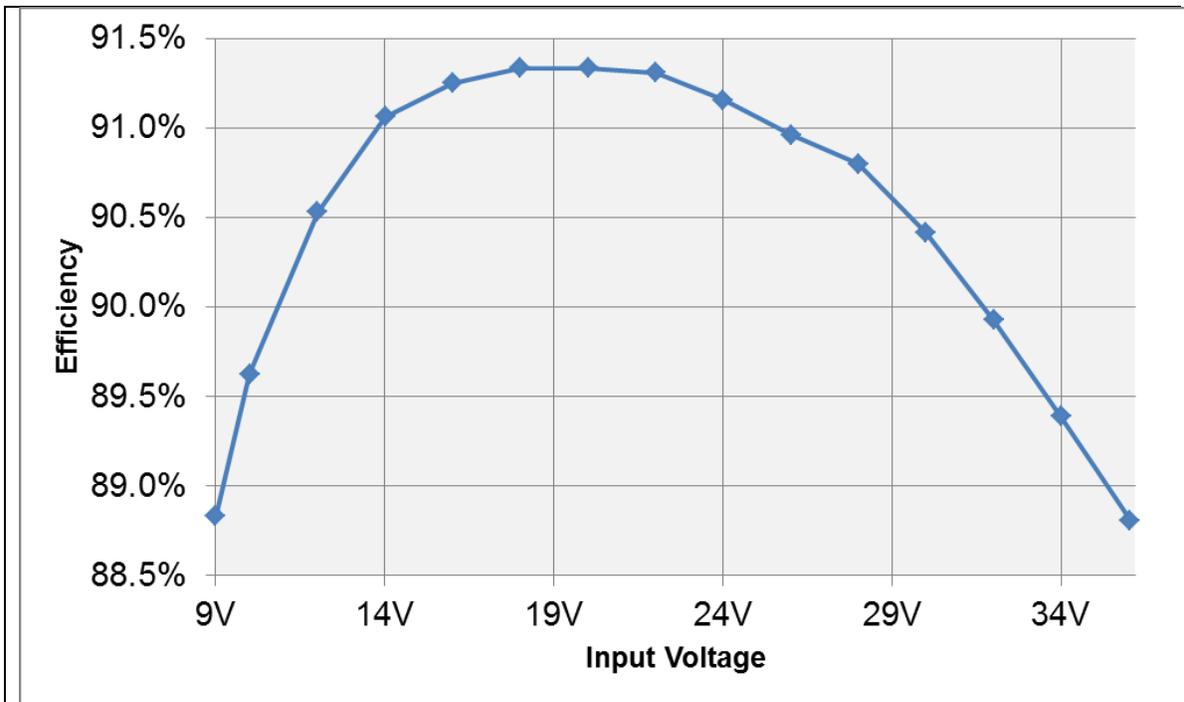


Figure 10

## 6 Output Ripple Voltage

The CV output ripple voltage at full load 1.5A is shown in Figure 11.

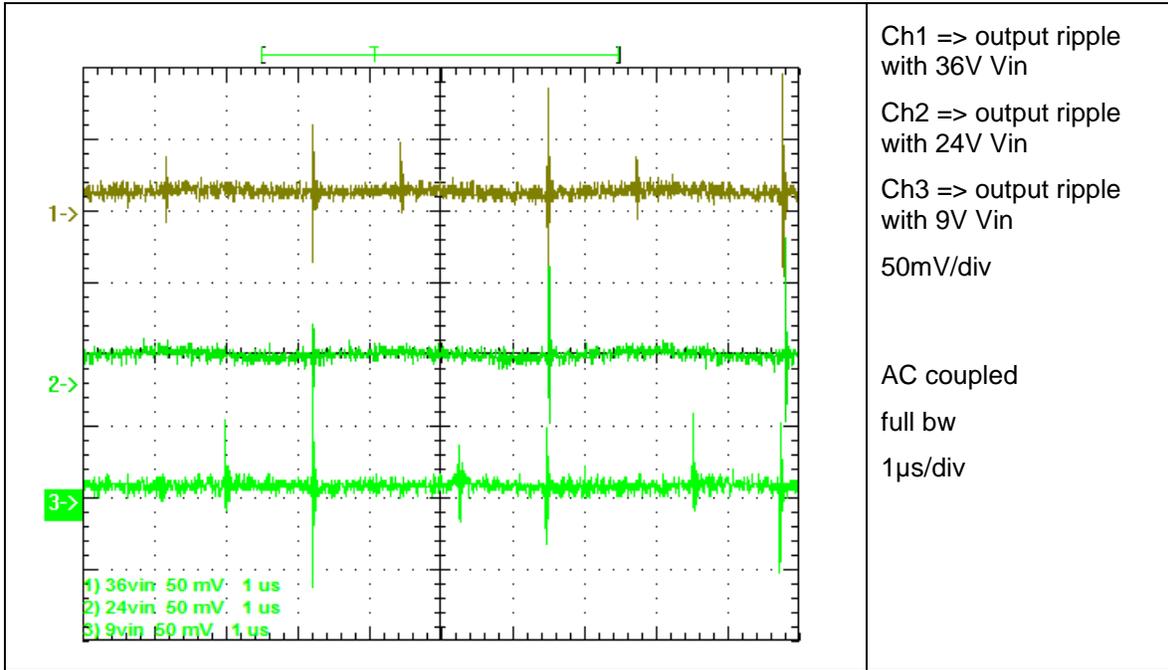


Figure 11

## 7 Input Ripple Voltage

The input ripple voltage is shown in Figure 12.

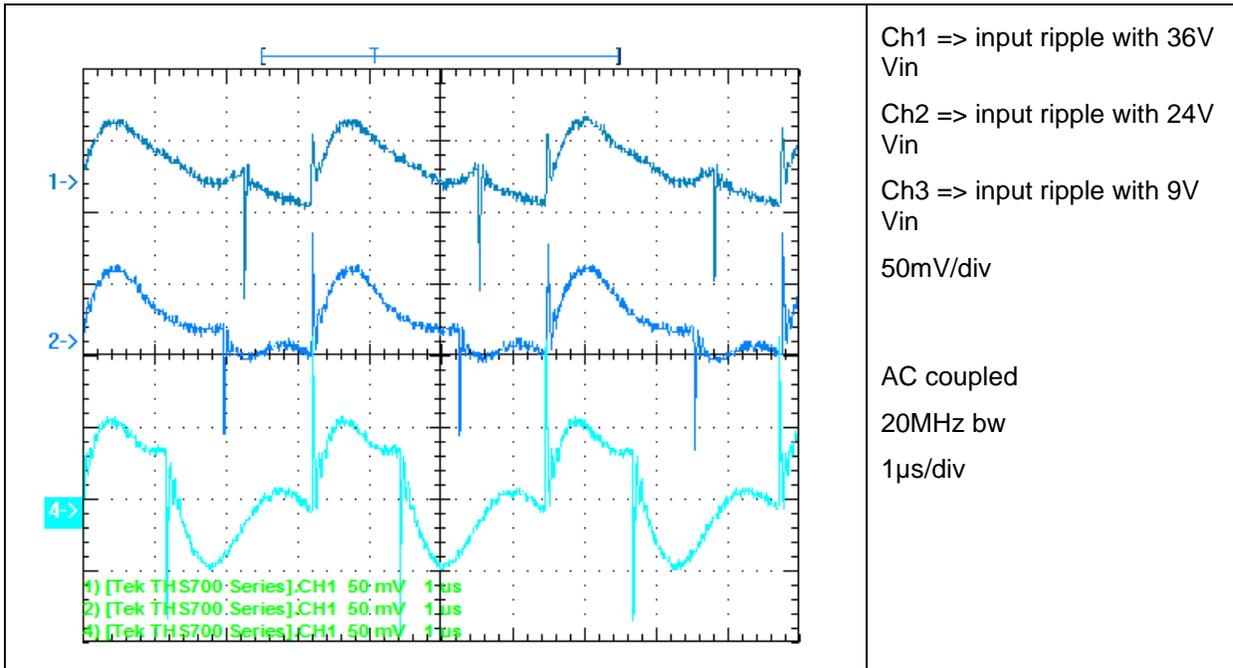


Figure 12

## 8 Load Transients

The Figure 13 shows the response to load transients with 9V input voltage. The load is switching from 0.75A to 1.5A with 30Hz. N3305 load was used.

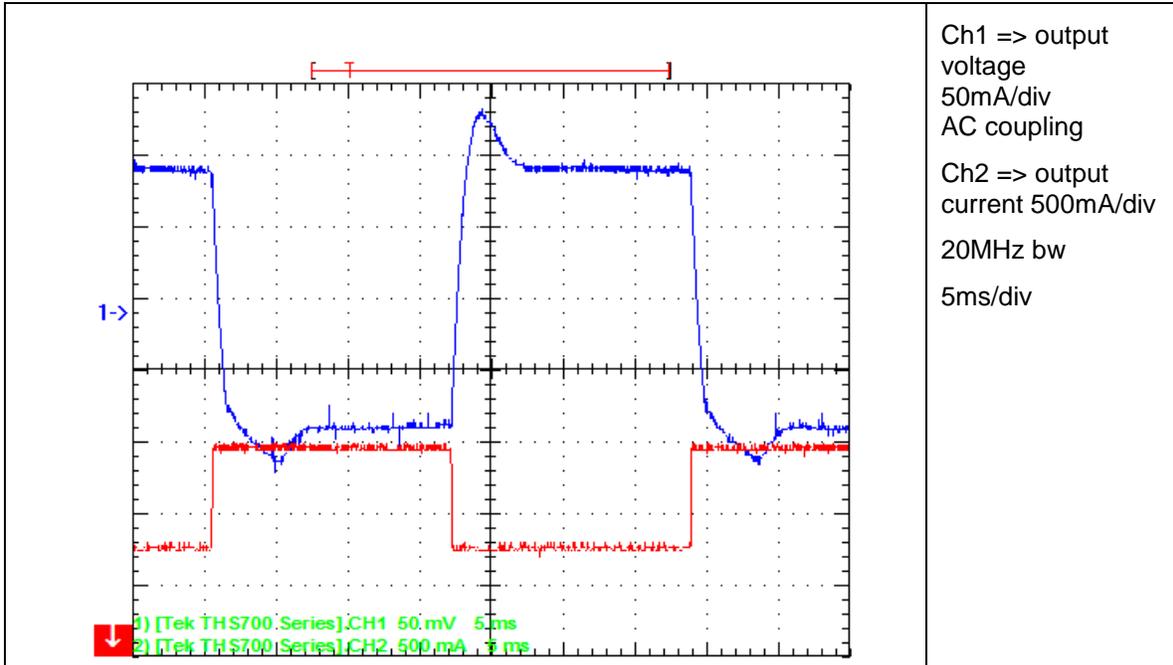


Figure 13

The Figure 14 shows the response to load transients with 24V input voltage. The load is switching from 0.75A to 1.5A with a frequency of 30Hz (load N3305A).

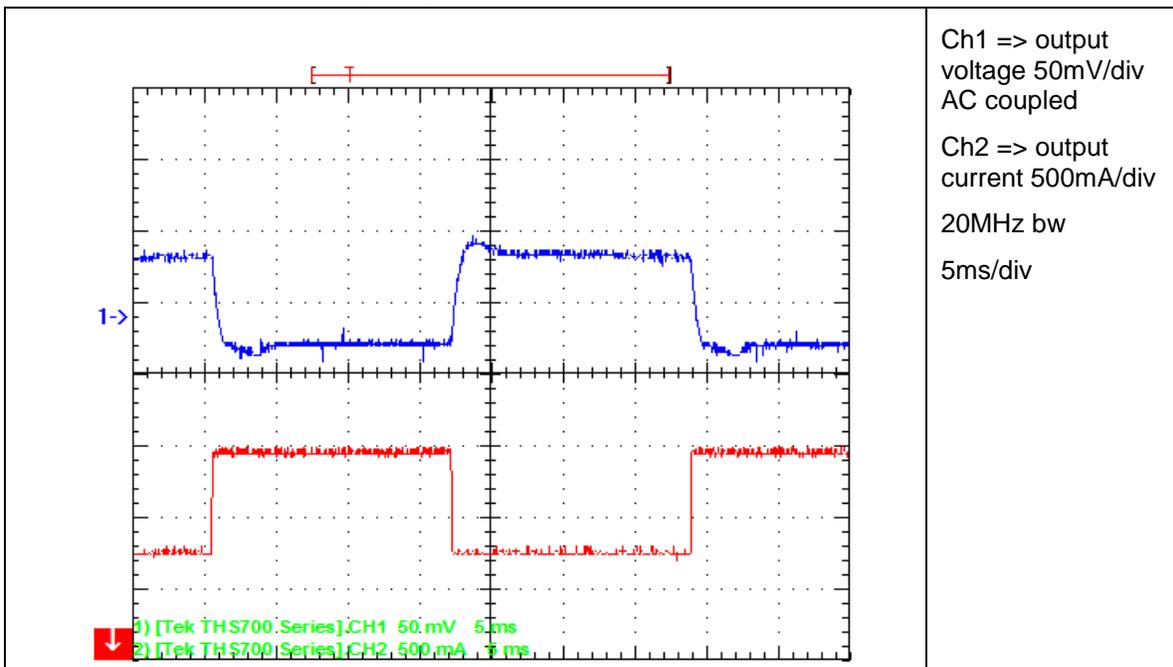


Figure 14

The Figure 15 shows the response to load transients with 36V input voltage. The load is switching from 0.75A to 1.5A with a frequency of 30Hz. (N3305 load)

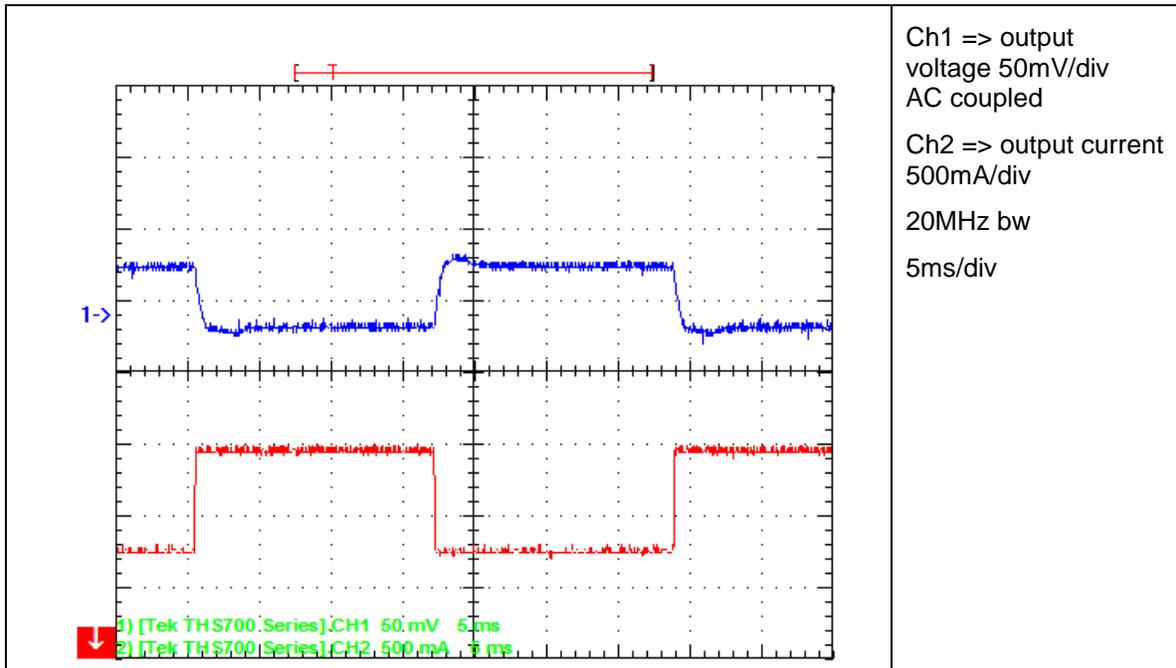


Figure 15

## 9 Control Loop Frequency Response

Input voltage was set worst case to 9V input, so at maximum duty cycle RHPZ is lowest.

### 9.1 Resistive Load

Figure 16 shows the closed loop **voltage controlled** = CV at a load current of 500mA.

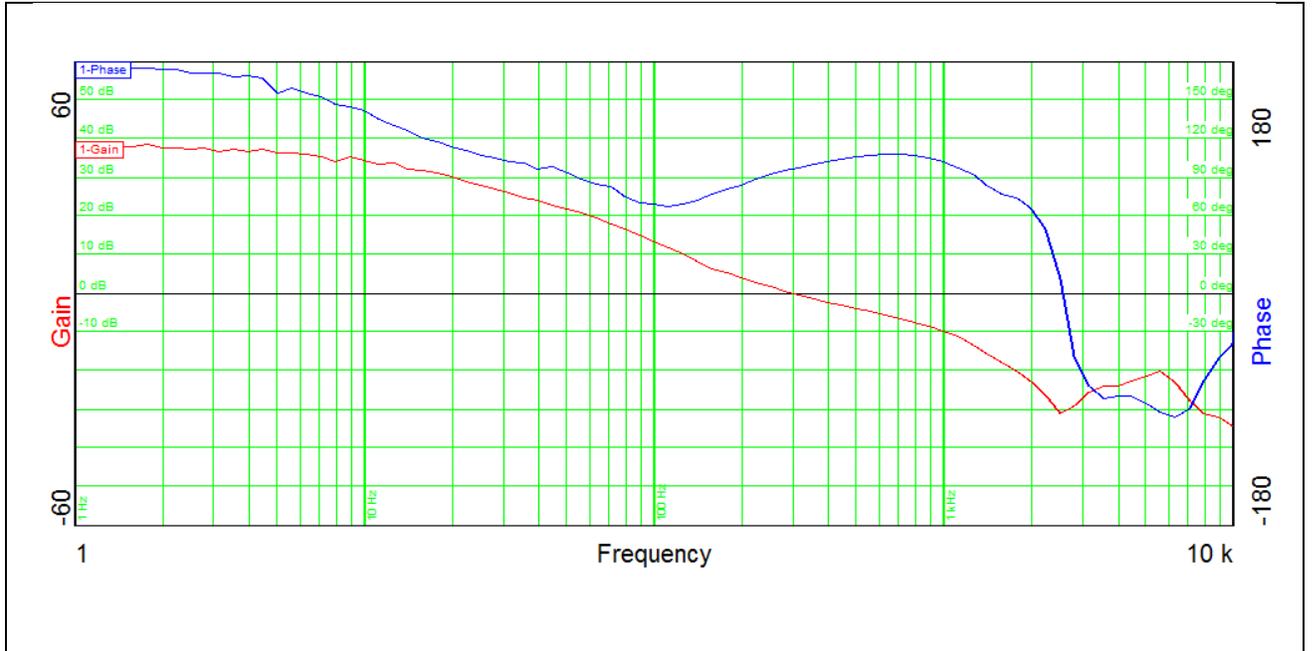


Figure 16

Figure 17 shows the closed loop **current controlled** = CC at a load current of 1A.

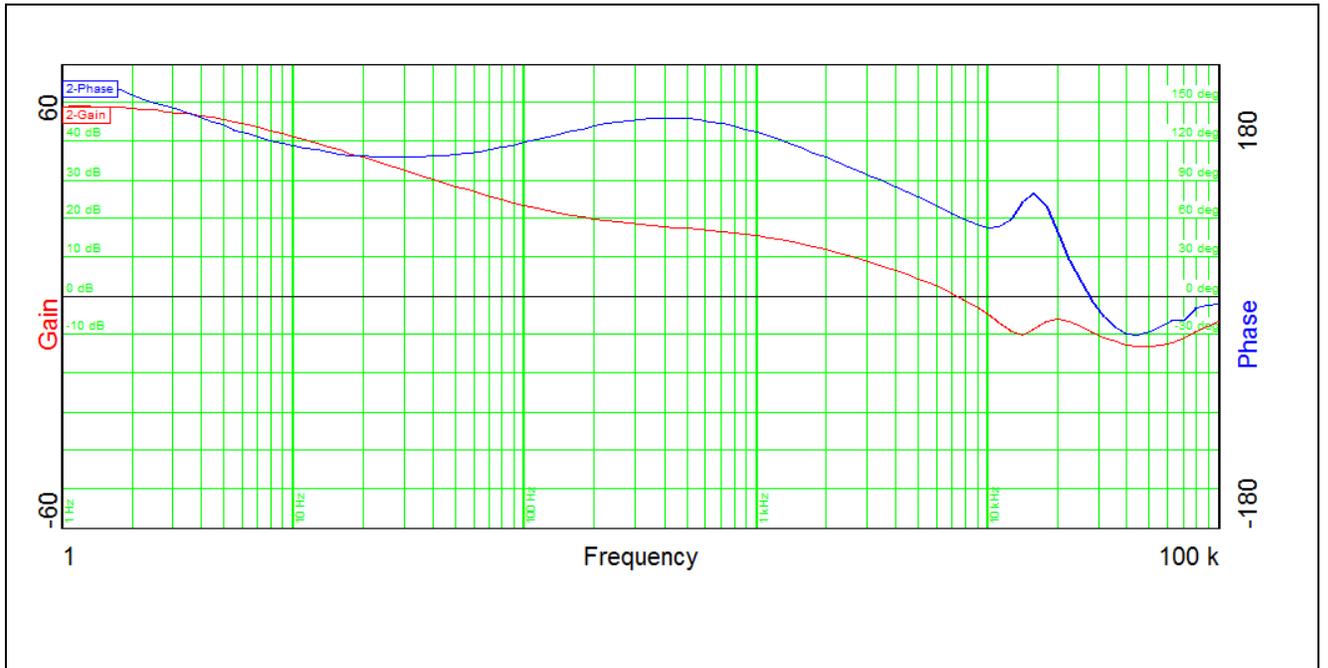


Figure 17

## 9.2 True C/V Battery Loading @ 12V 5Ah

Figure 18, first - **current controlled** loading at 1A constant current, voltage rises:

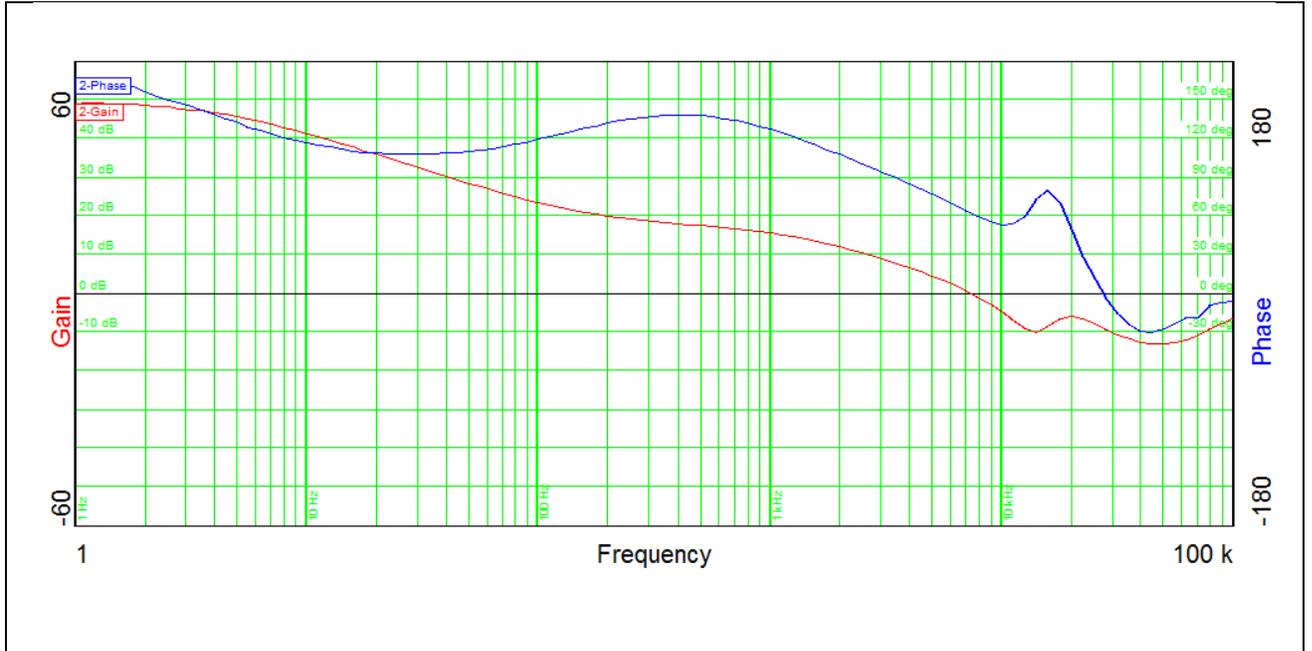


Figure 18

Figure 19, second – transfer current control to **voltage control**, loading now at 13.8V/700mA

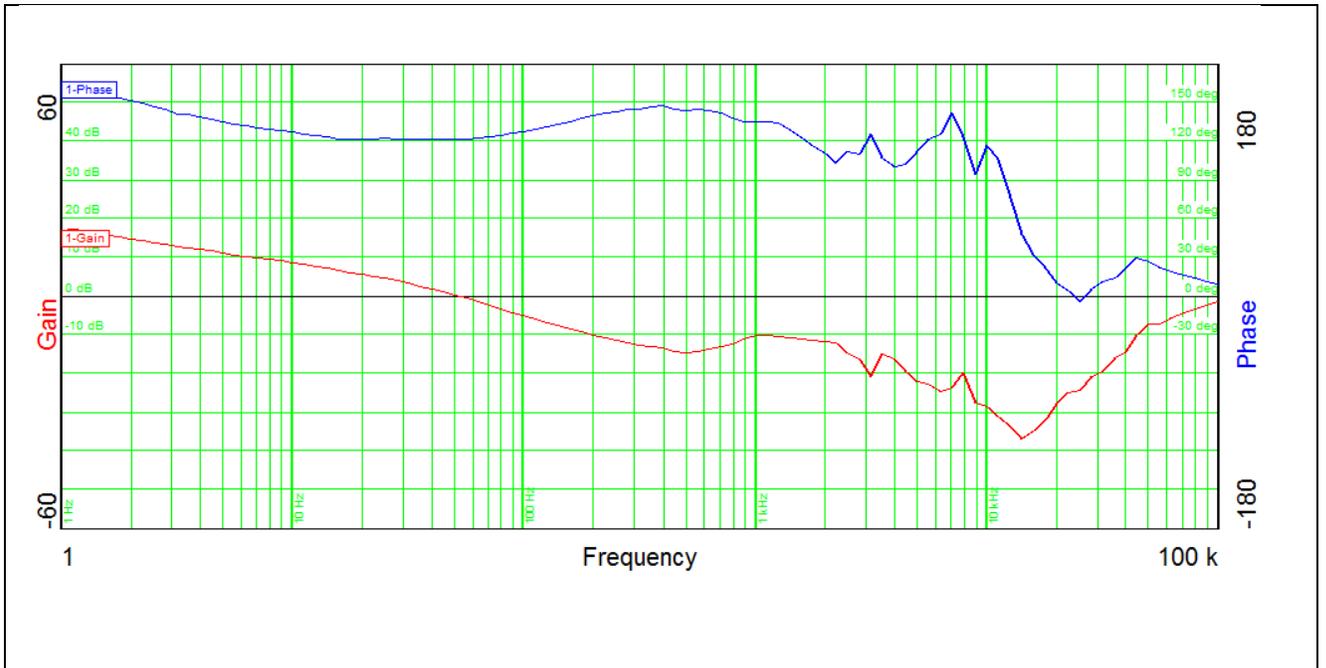


Figure 19

Figure 20, further **voltage control**, charging current drops, shown 700mA – 200mA – 70mA

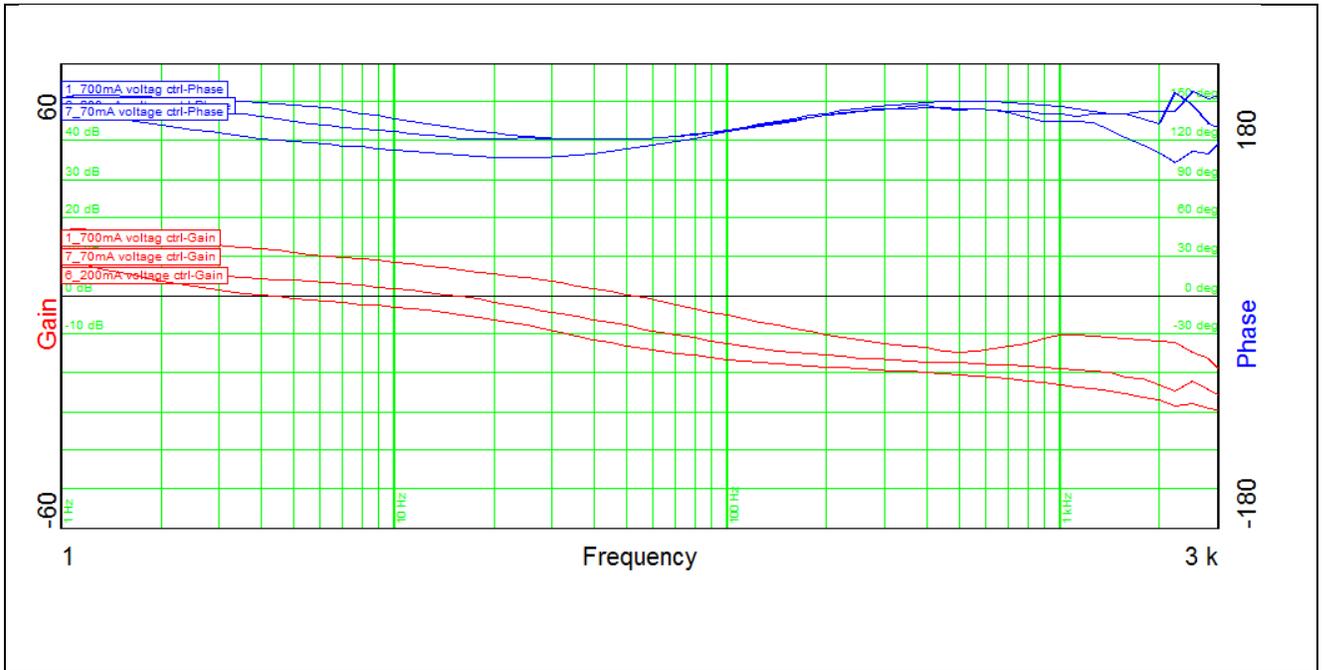


Figure 20

Figure 21 shows comparison voltage control (ye/or) and current control 900mA (rd/bl)

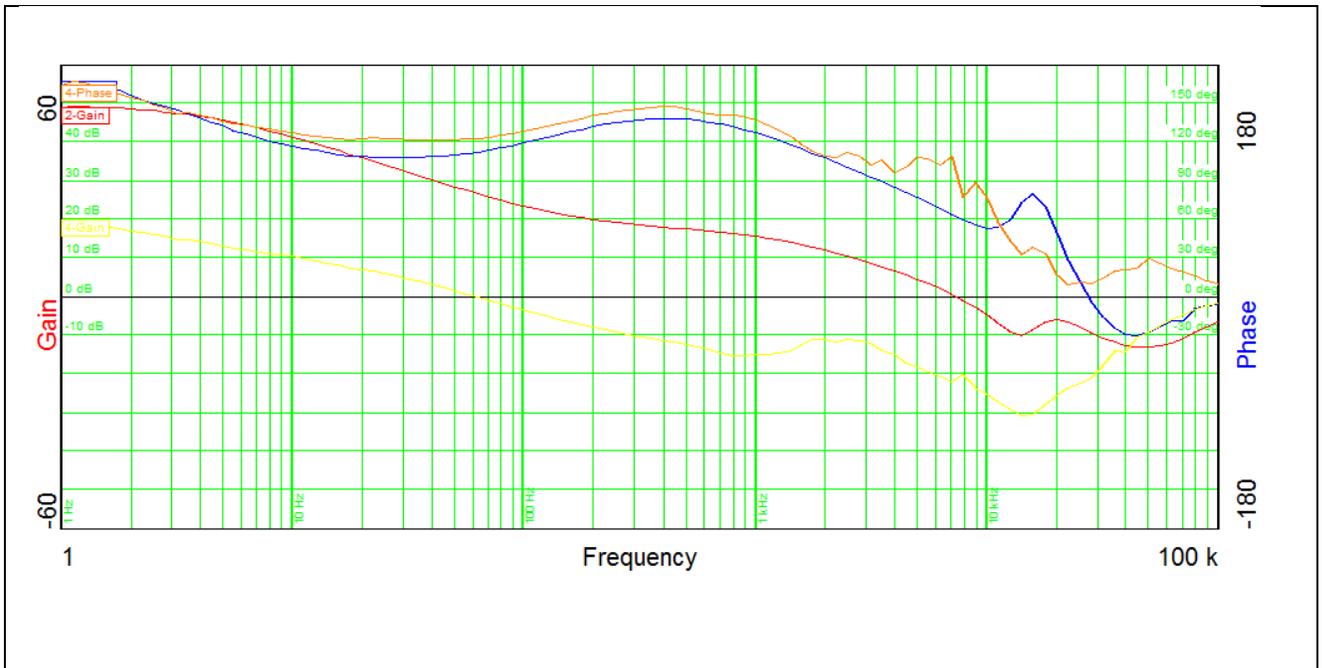


Figure 21

Table 1 + 2 summarizes the results of the Bode measurements:

Vin	R Load		5Ah Battery		
	V ctrl	I ctr	I ctr	Vctrl	V ctr
<b>Bandwidth (Hz)</b>	296.8	7306	7306	60.86	52.06
<b>Phase margin</b>	95.78°	62.54°	62.54°	122.5°	121.2°
<b>slope (20dB/decade)</b>	-0.955	-1.57	-1.57	-0.860	-0.853
			(1000mA)	(900mA)	(700mA)
<b>gain margin (dB)</b>	-30.76	-9.078	-9.078		
<b>slope (20dB/decade)</b>	-1.93	-1.42	-1.42		
<b>freq (Hz)</b>	2565	27230	27230		

Table 1

Vin	5Ah Battery		
	V ctrl 700mA	Vctr 200mA	V ctr 70mA
<b>Bandwidth (Hz)</b>	52	14.7	3.9
<b>Phase margin</b>	121°	130°	122°
<b>slope (20dB/decade)</b>	-0.85	-0.59	-0.41

Table 2

CC/CV loading has been verified at true battery; current control charges battery with **constant current** set point 1000mA and voltage at battery increases = CC loading. Touching the voltage set point at 13.8V voltage control takes over and charges the battery further at **constant voltage** 13.8V while current drops continuously = CV loading. Continuously load current decreases to 5mA holdup current.

## 10 Miscellaneous Waveforms

### 10.1 Switchnode (drain-source)

The waveform of the voltage on switchnode (drain to source) is shown in Figure 22. Input voltage was set to 9V.

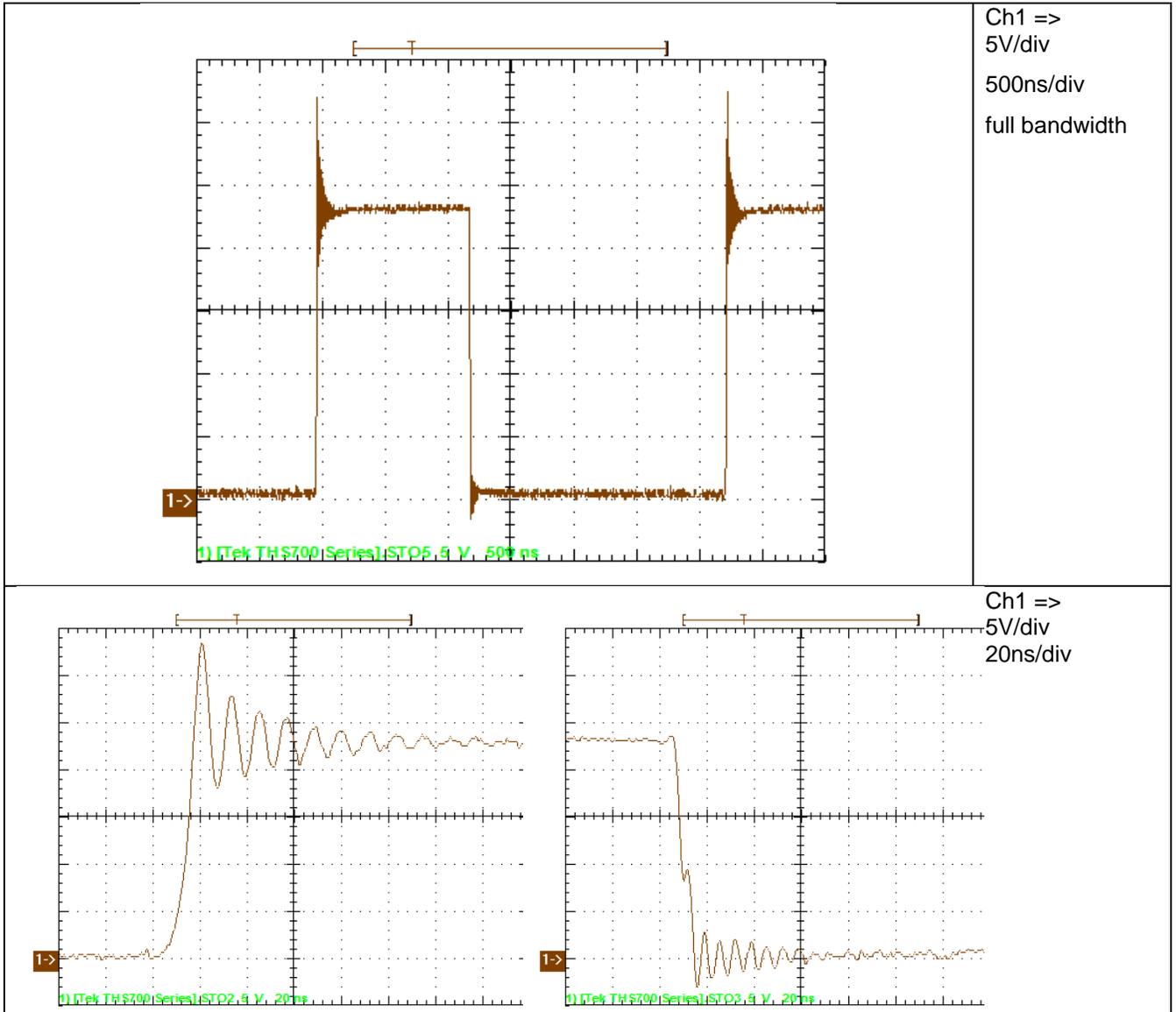


Figure 22

The waveform of the voltage on switchnode (drain to source) is shown in Figure 23. Input voltage was set to 24V.

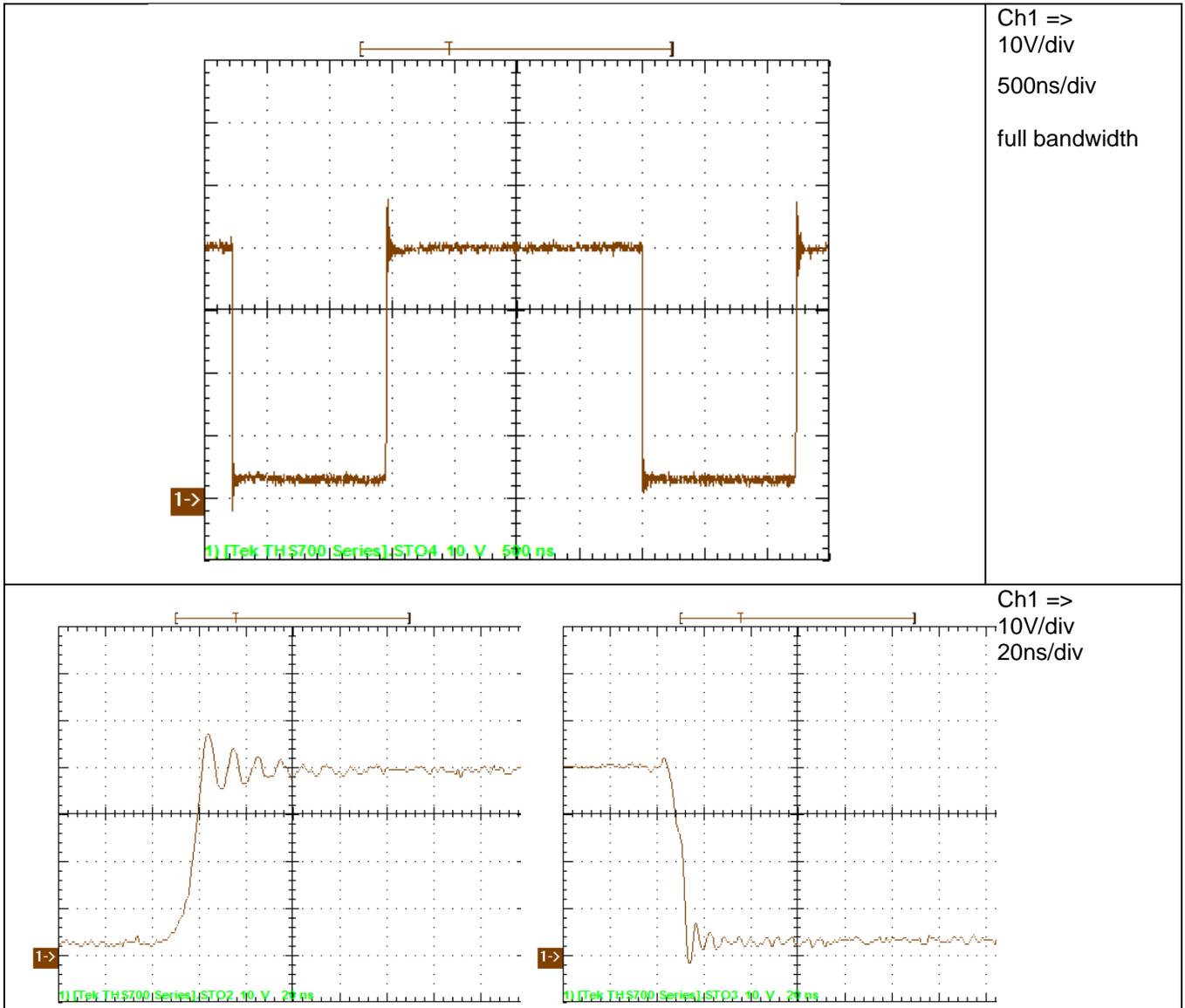


Figure 23

The waveform of the voltage on switchnode (drain to source) is shown in Figure 24. Input voltage was set to 36V.

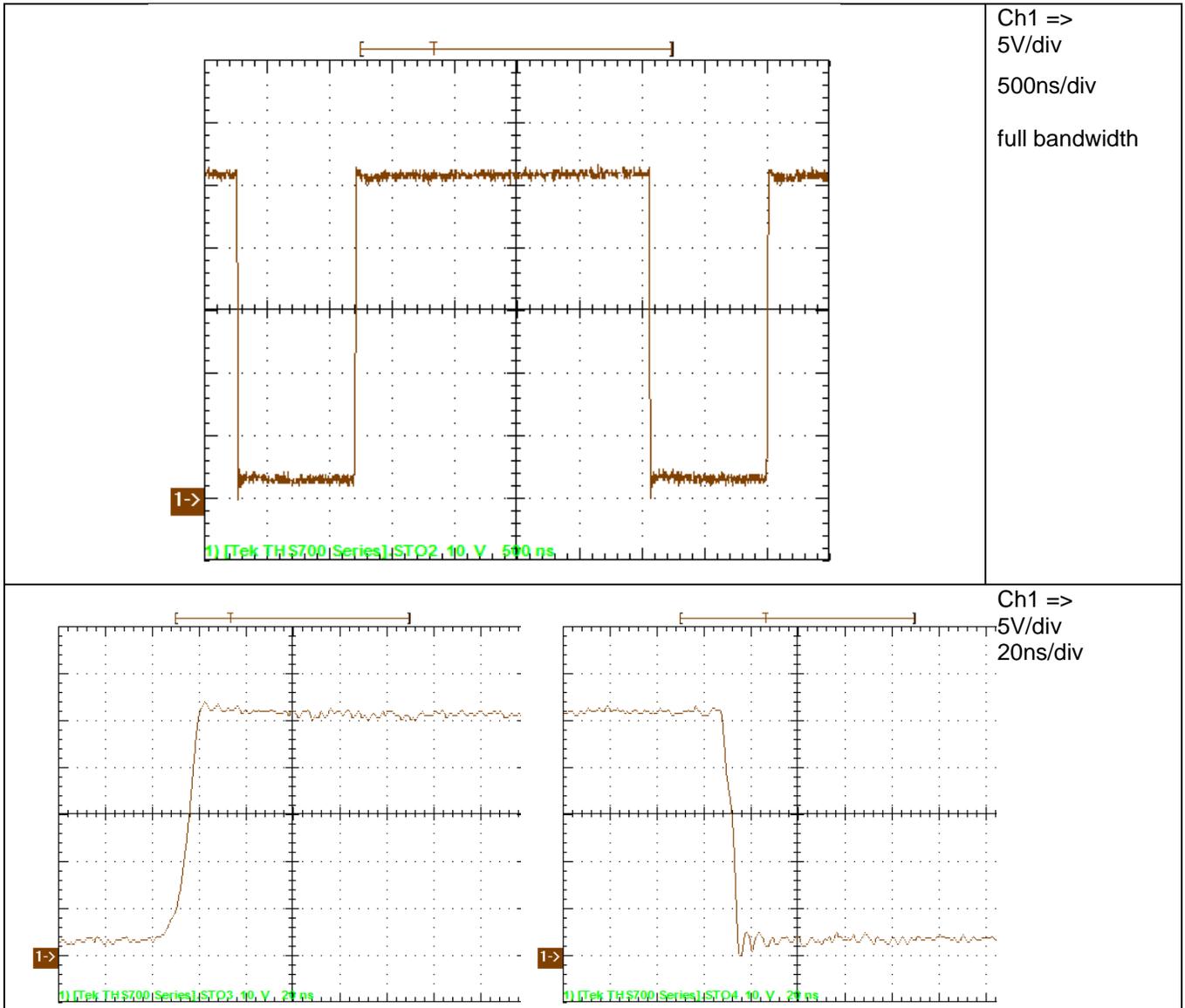


Figure 24

## 10.2 Gate to Source

The waveform of the voltage on the gate to source is shown in Fig. 25. Input voltage was set to 9V.

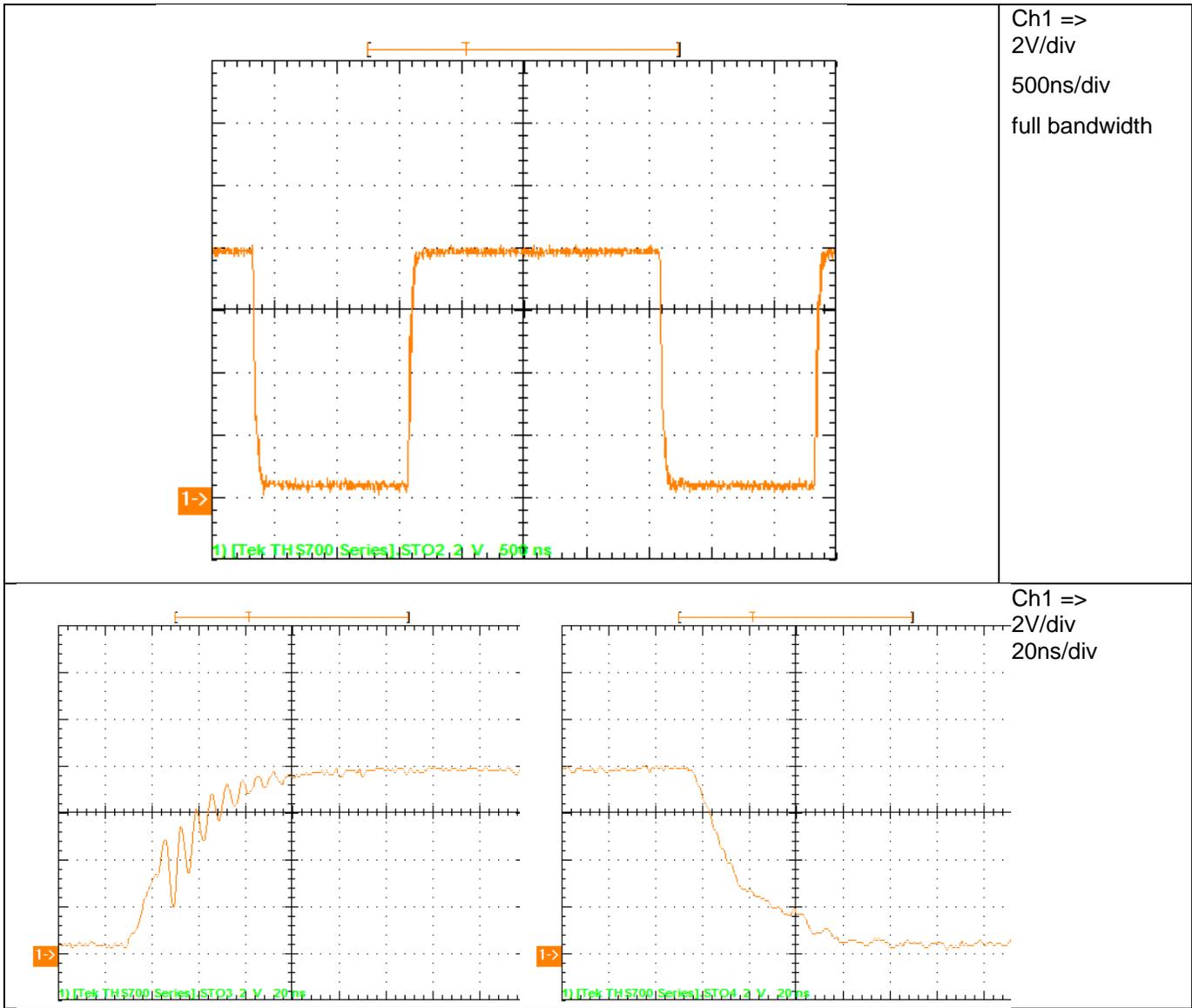


Figure 25

The waveform of the voltage on gate to source is shown in Figure 26. Input voltage was set to 24V.

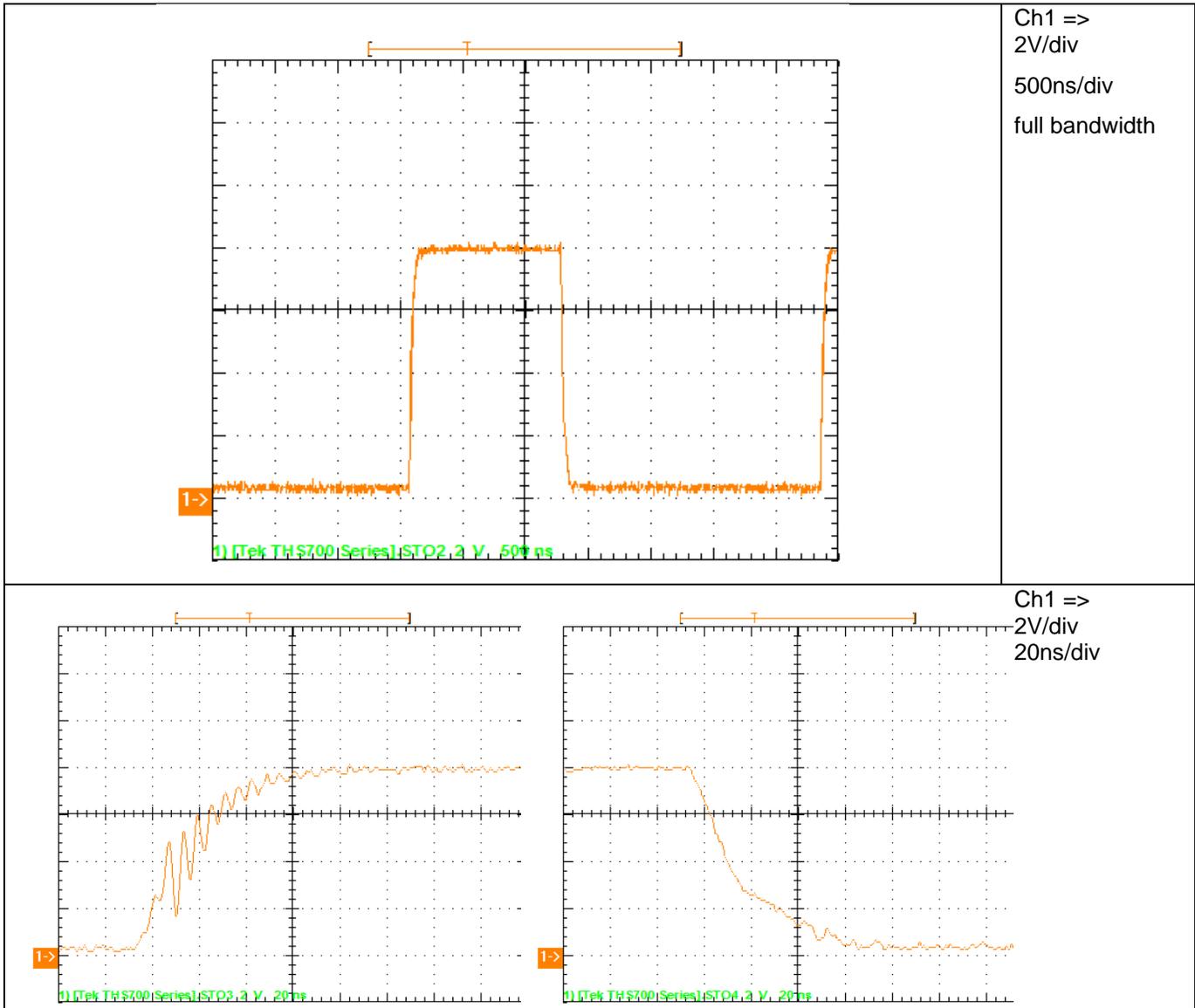


Figure 26

The waveform of the voltage on gate to source is shown in Figure 27. Input voltage was set to 36V.

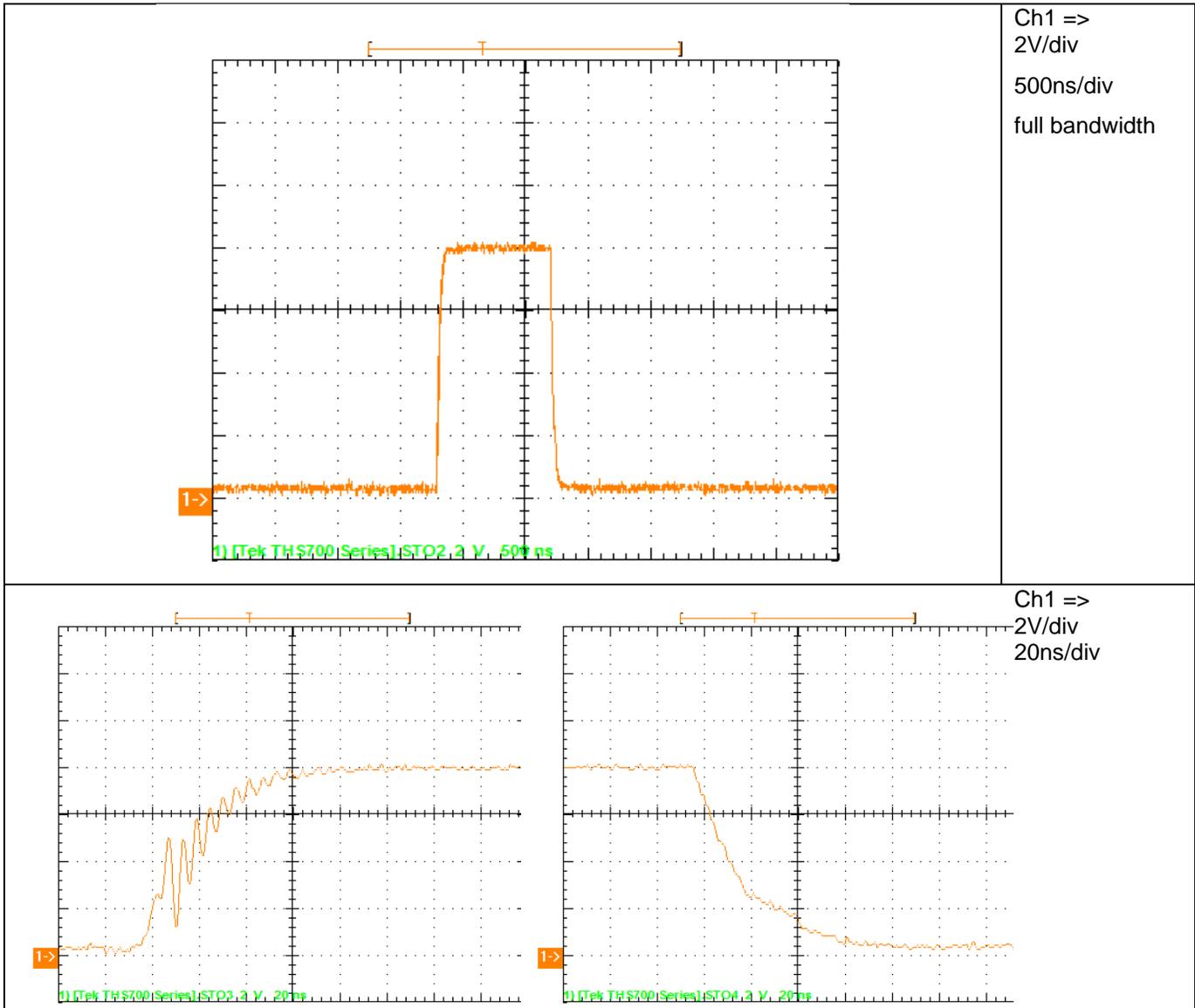


Figure 27

## 10.3 Voltage D3 (referenced to VOUT)

The waveform of the voltage is shown in Figure 28. Input voltage was set to 9V.

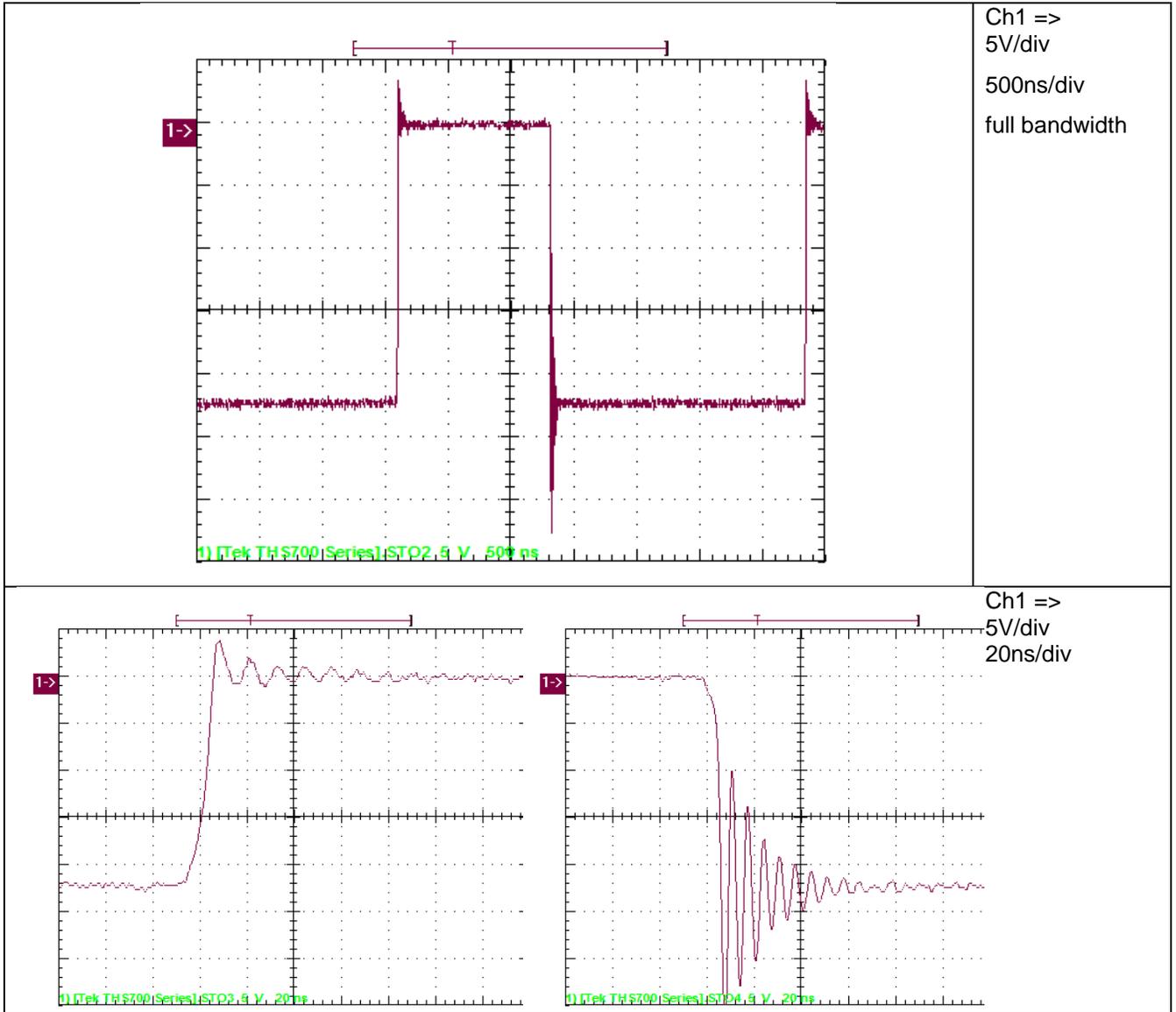


Figure 28

The waveform of the voltage is shown in Figure 29. Input voltage was set to 24V.

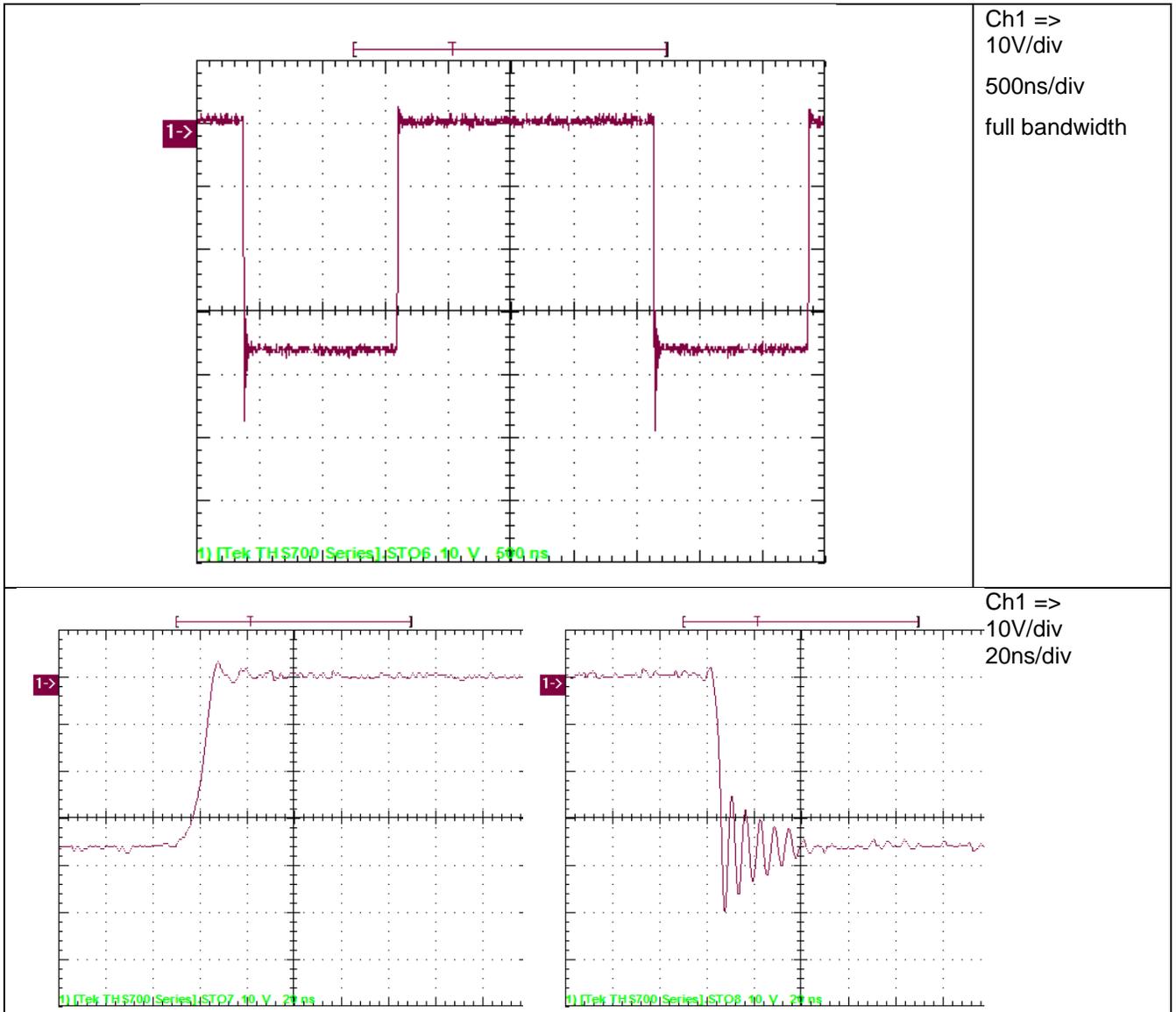


Figure 29

The waveform of the voltage is shown in Figure 30. Input voltage was set to 36V.

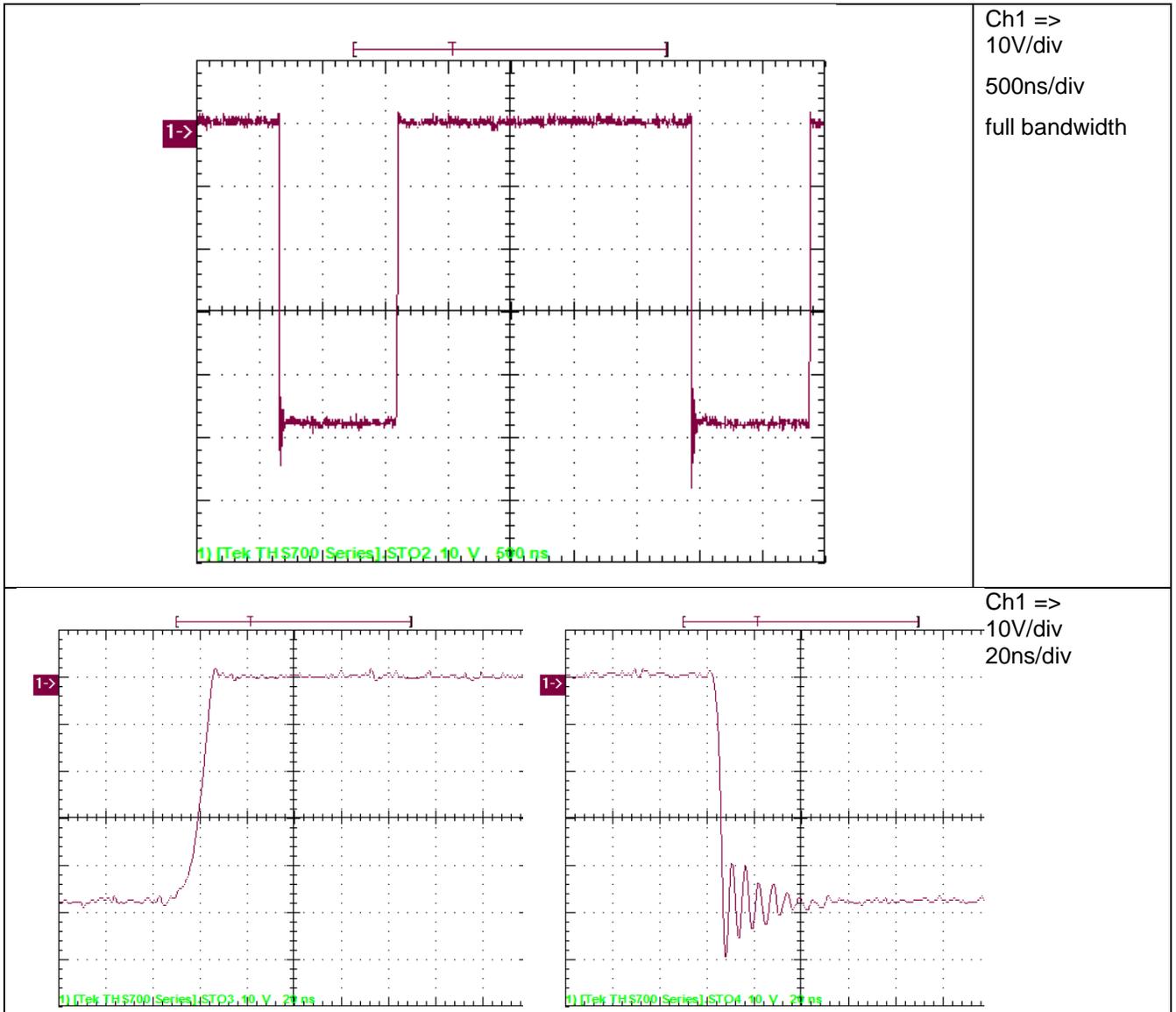


Figure 30

## 11 Thermal Image

Figure 31 shows the thermal image at 24V input voltage and full load 1.5A for >1hr.

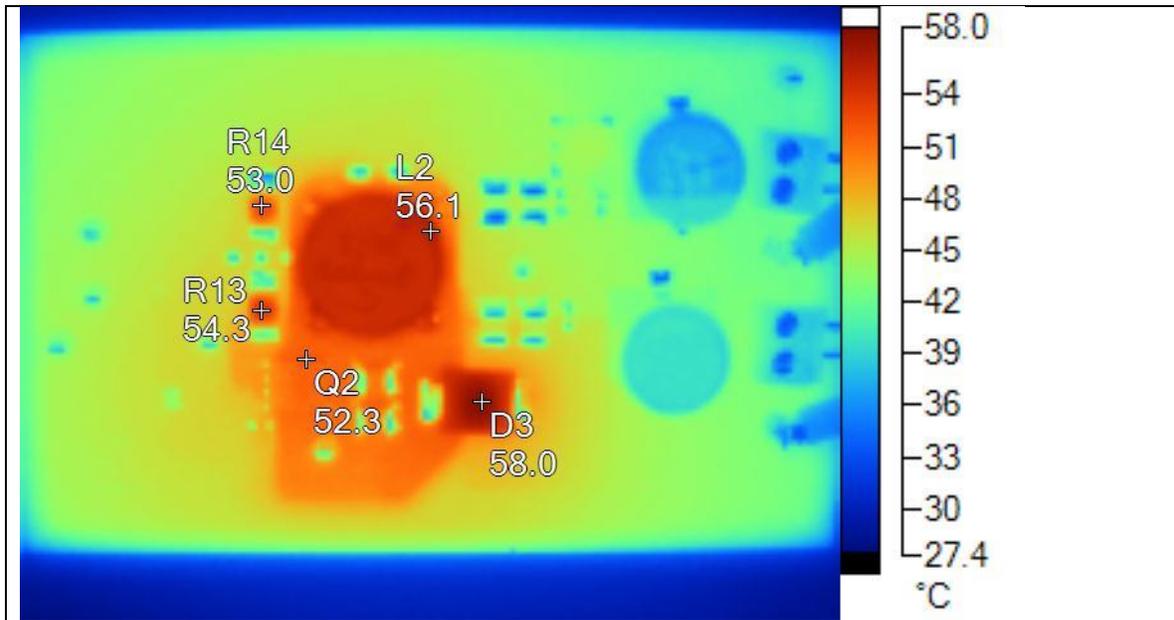


Figure 31

Name	Temperature
D3	58.0°C
L2	56.1°C
R14	53.0°C
R13	54.3°C
Q2	52.3°C

## 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