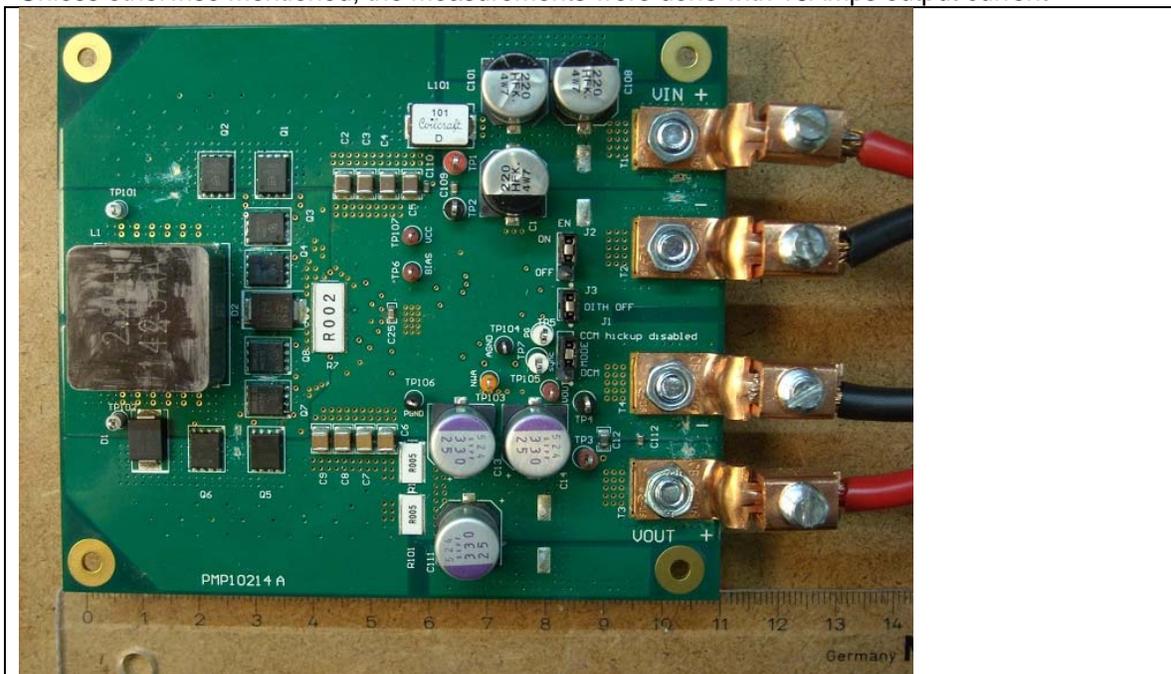


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2	Shutdown	4
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Topology: 4 Switch BuckBoost >300W

Device: LM5175

Unless otherwise mentioned, the measurements were done with 18Amps output current



1 Startup

The startup waveform is shown in the Figure 1. The input voltage was set to 8V and load current was 15A. Power supply (6574A) was switched on.

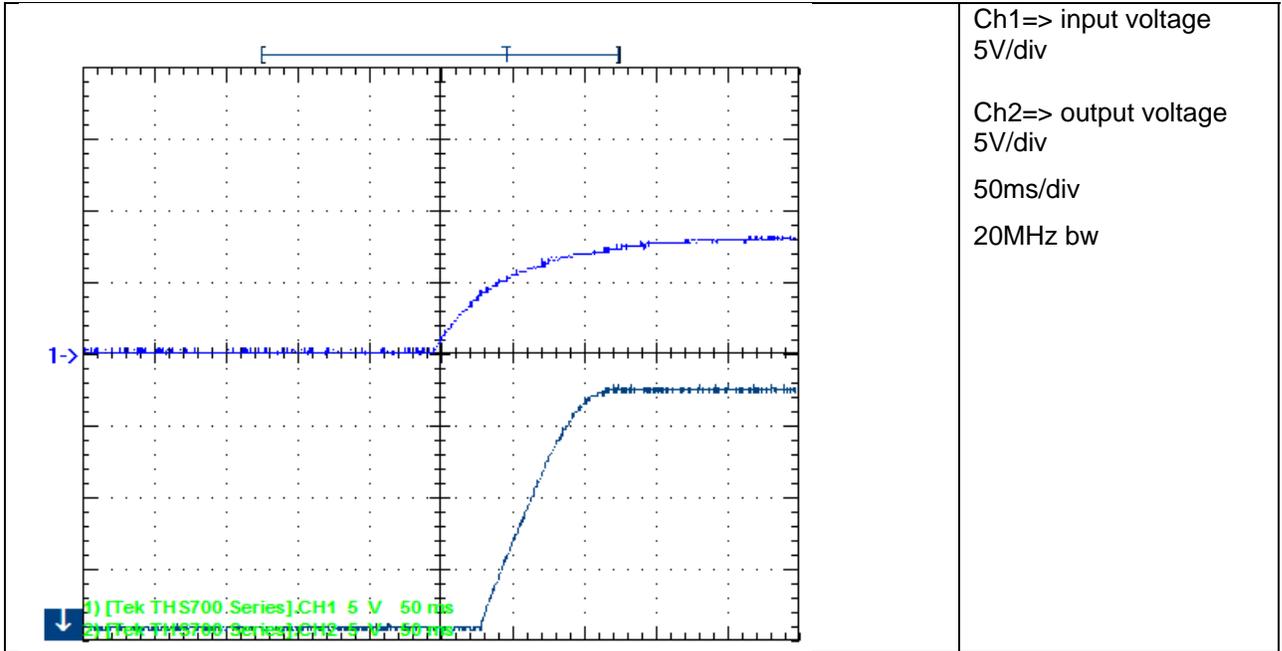


Figure 1

The startup waveform is shown in the Figure 2. The input voltage was set at 12V. Power supply (6574A) was switched on.

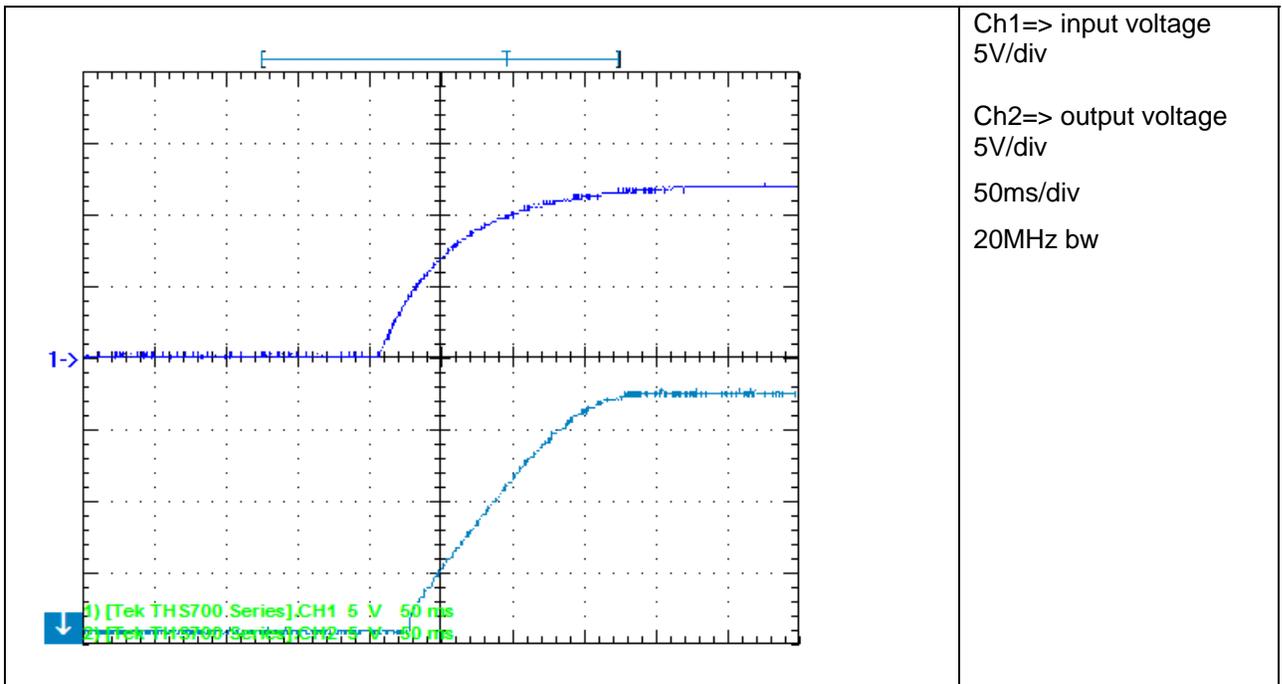


Figure 2

The startup waveform is shown in the Figure 3. The input voltage was set at 16V. Power supply (6574A) was switched on.

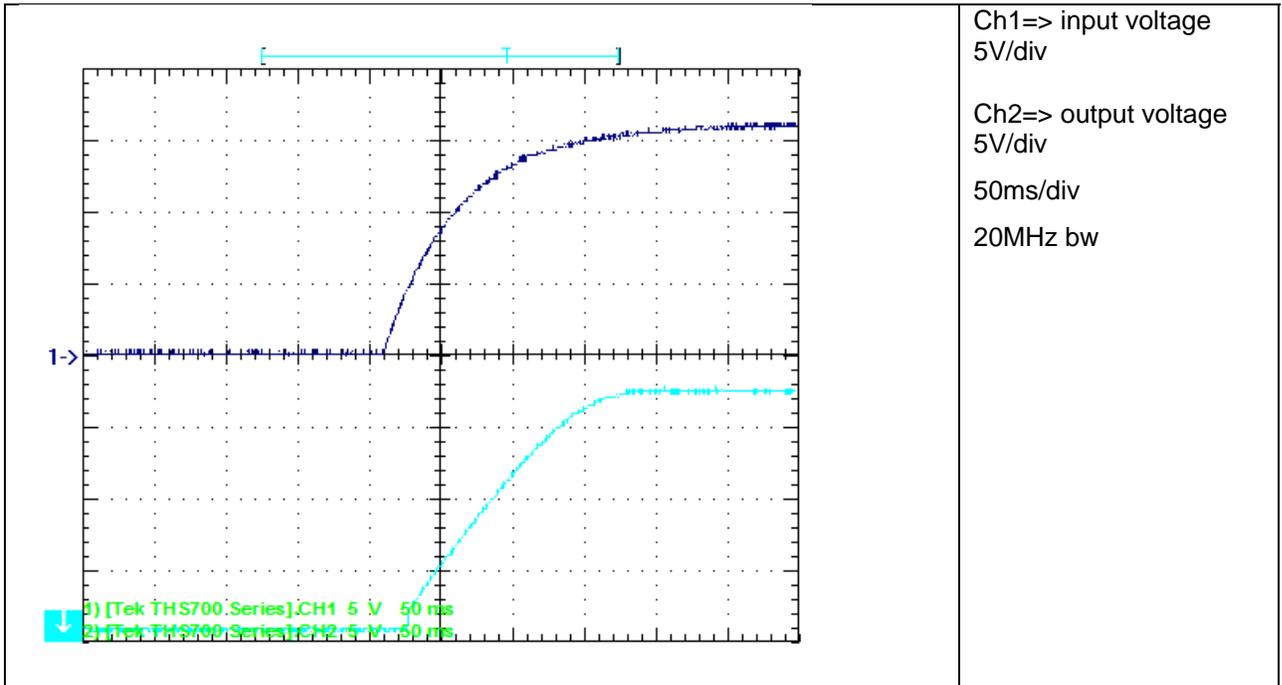


Figure 3

2 Shutdown

The shutdown waveform is shown in the Figure 4. The input voltage was set to 8V with 15A load current. The power supply was switched off.

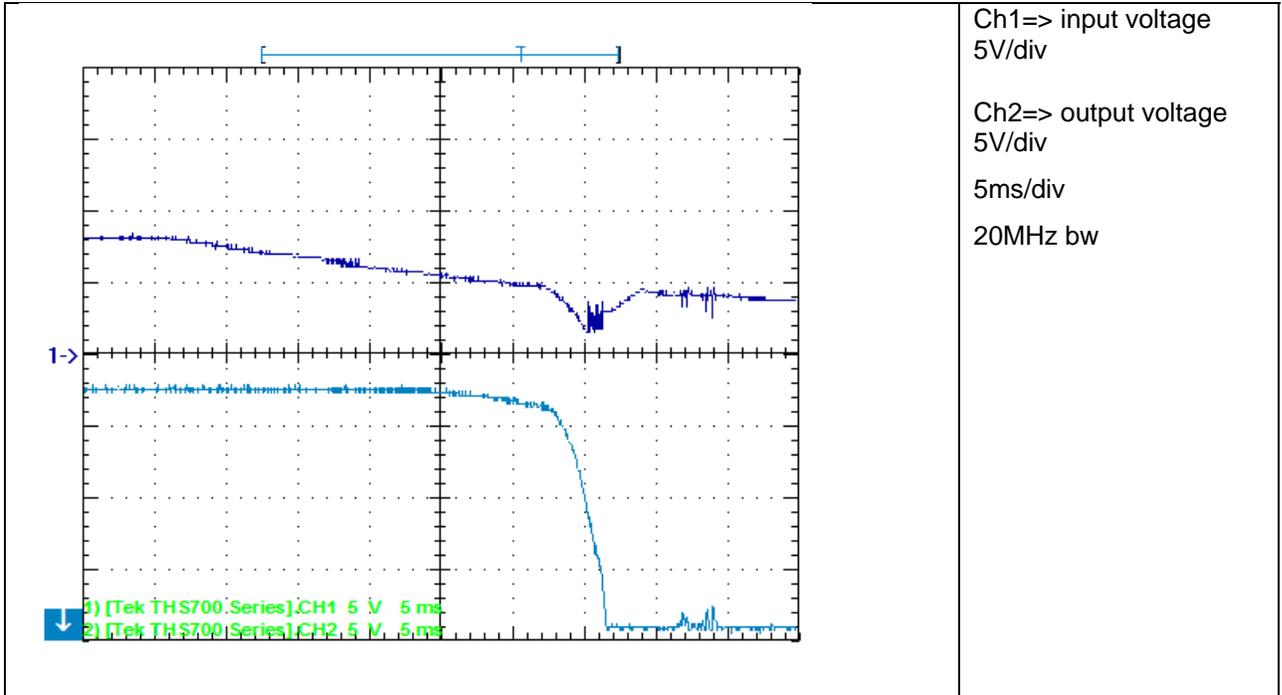


Figure 4

The shutdown waveform is shown in the Figure 5. The input voltage was set at 12V. The power supply was switched off.

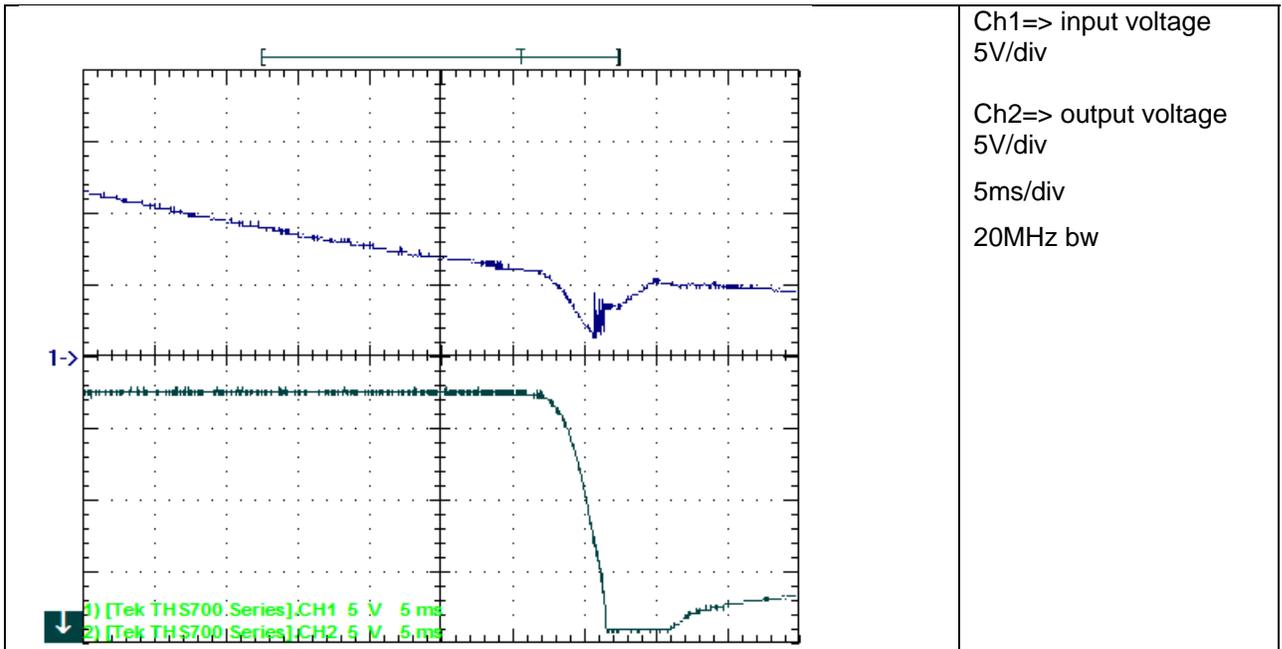


Figure 5

The shutdown waveform is shown in the Figure 6. The input voltage was set at 16V. The power supply was switched off.

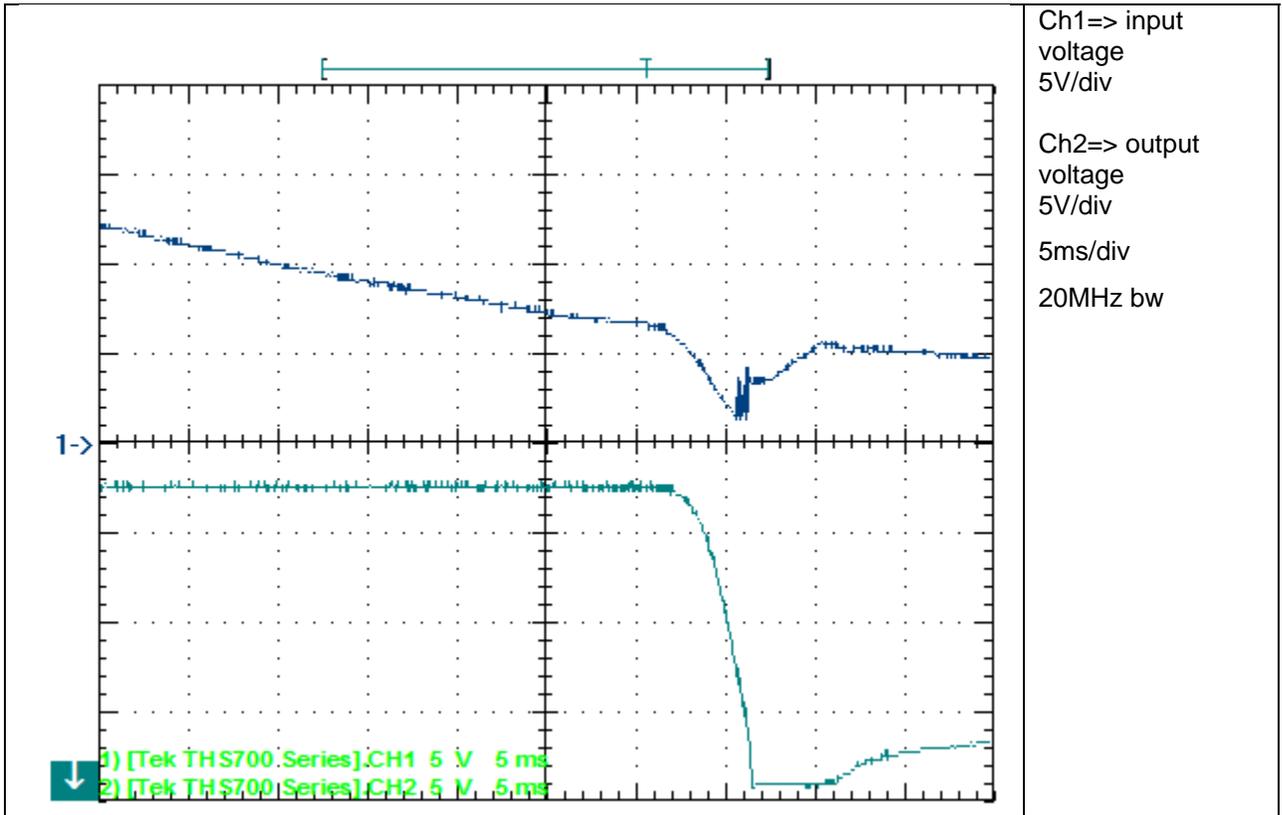


Figure 6

3 Efficiency

The efficiency is shown in the Figure 7 below. The input voltage was set to 9V, 12V and 16V.

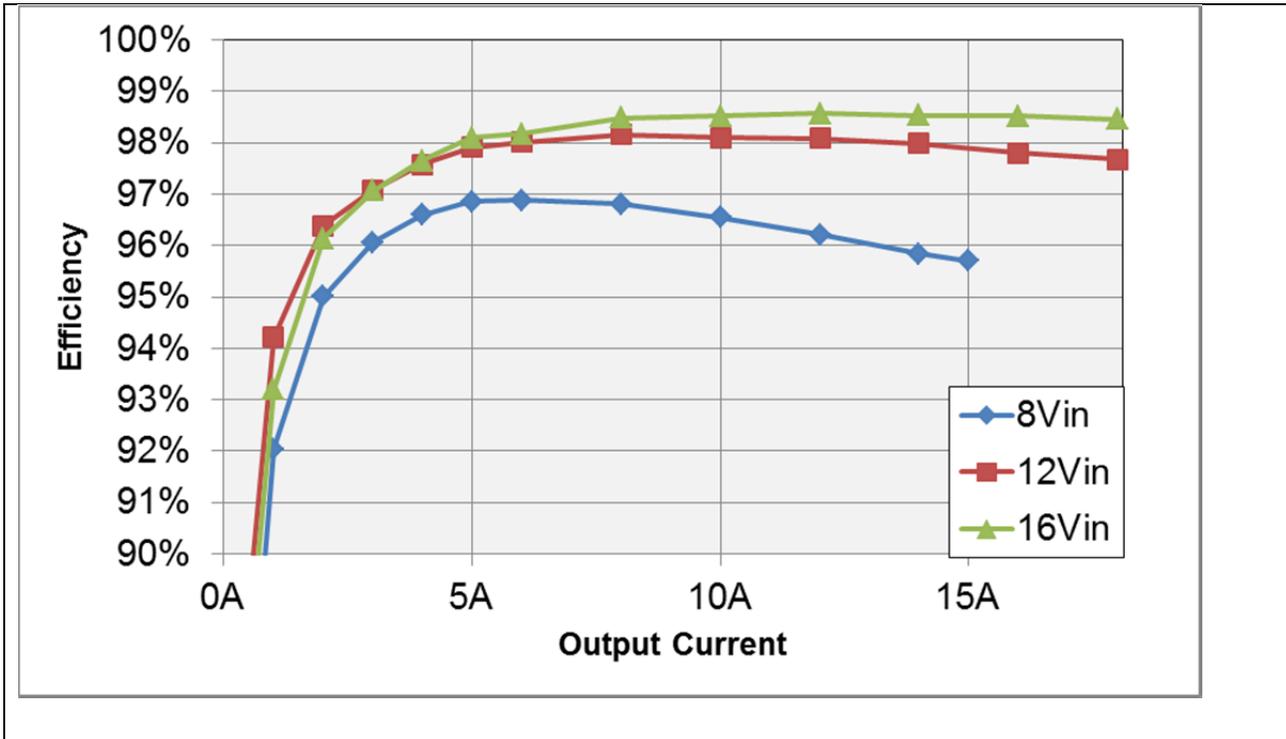


Figure 7

VIN	IIN	VOUT	IOUT	PIN	POUT	Eff
12.01	25.944	16.908	18	311.5874	304.344	0.976753
12.002	23.059	16.916	16	276.7541	270.656	0.977966
12.011	20.121	16.914	14	241.6733	236.796	0.979818
12.003	17.237	16.911	12	206.8957	202.932	0.980842
12.011	14.352	16.91	10	172.3819	169.1	0.980962
12.004	11.478	16.907	8	137.7819	135.256	0.981667
12.012	8.615	16.905	6	103.4834	101.43	0.980157
12.007	7.189	16.904	5	86.31832	84.52	0.979166
12.003	5.773	16.903	4	69.29332	67.612	0.975736
12.015	4.347	16.902	3	52.22921	50.706	0.970836
12.01	2.92	16.901	2	35.0692	33.802	0.963866
12.006	1.494	16.9	1	17.93696	16.9	0.942188
12.012	0.791	16.899	0.5	9.501492	8.4495	0.889281
12.014	0.504	16.899	0.3	6.055056	5.0697	0.837267
12.016	0.217	16.898	0.1	2.607472	1.6898	0.648061
12.017	0.153	16.898	0.05	1.838601	0.8449	0.459534

At typical input range 12V efficiency is >98% in a load range 6Amps to 12 Amps

4 Load Regulation

The load regulation of the output is shown in the Figure 8 below. The input voltage was set to 8V, 12V and 16V.

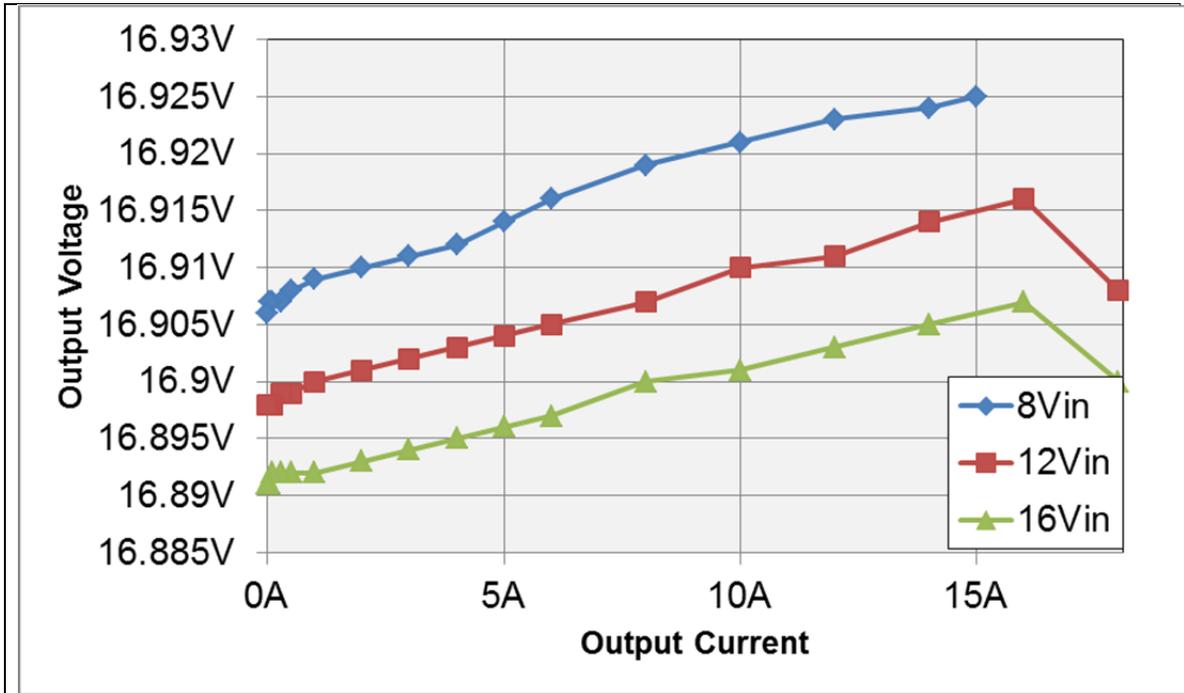


Figure 8

5 Line Regulation

The line regulation is shown in Figure 9. The output current was set to 15A.

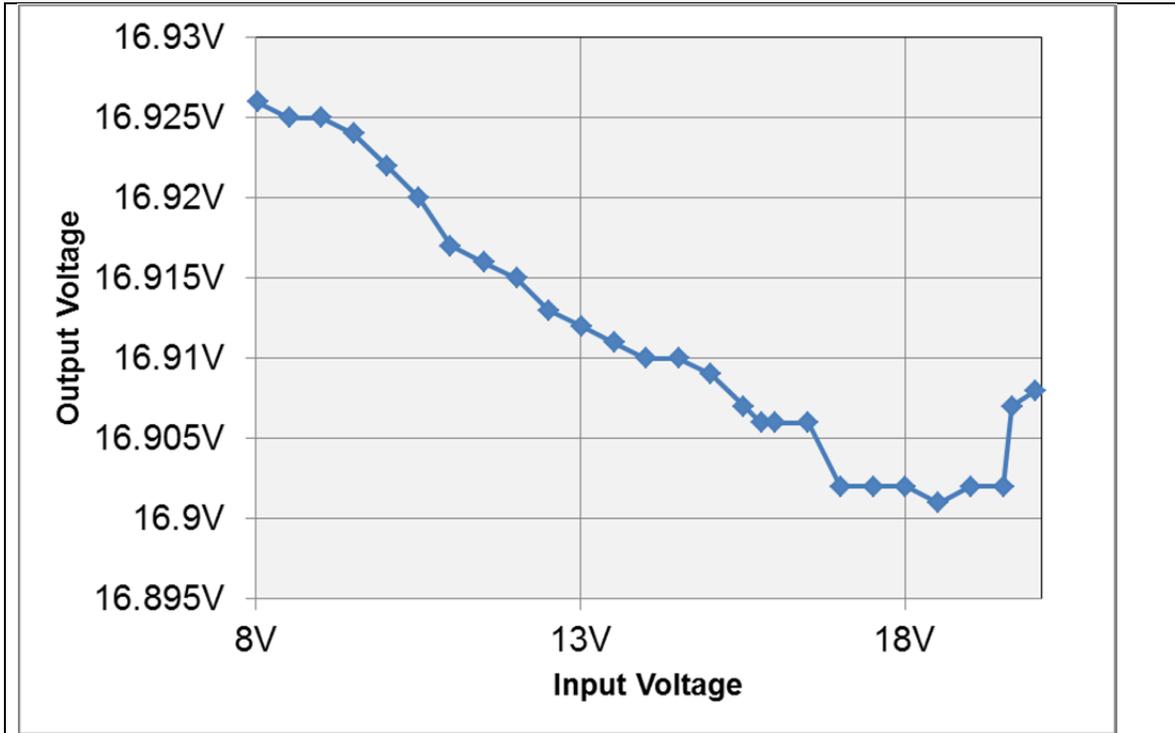


Figure 9

With the same setup the efficiencies are shown in Figure 10.

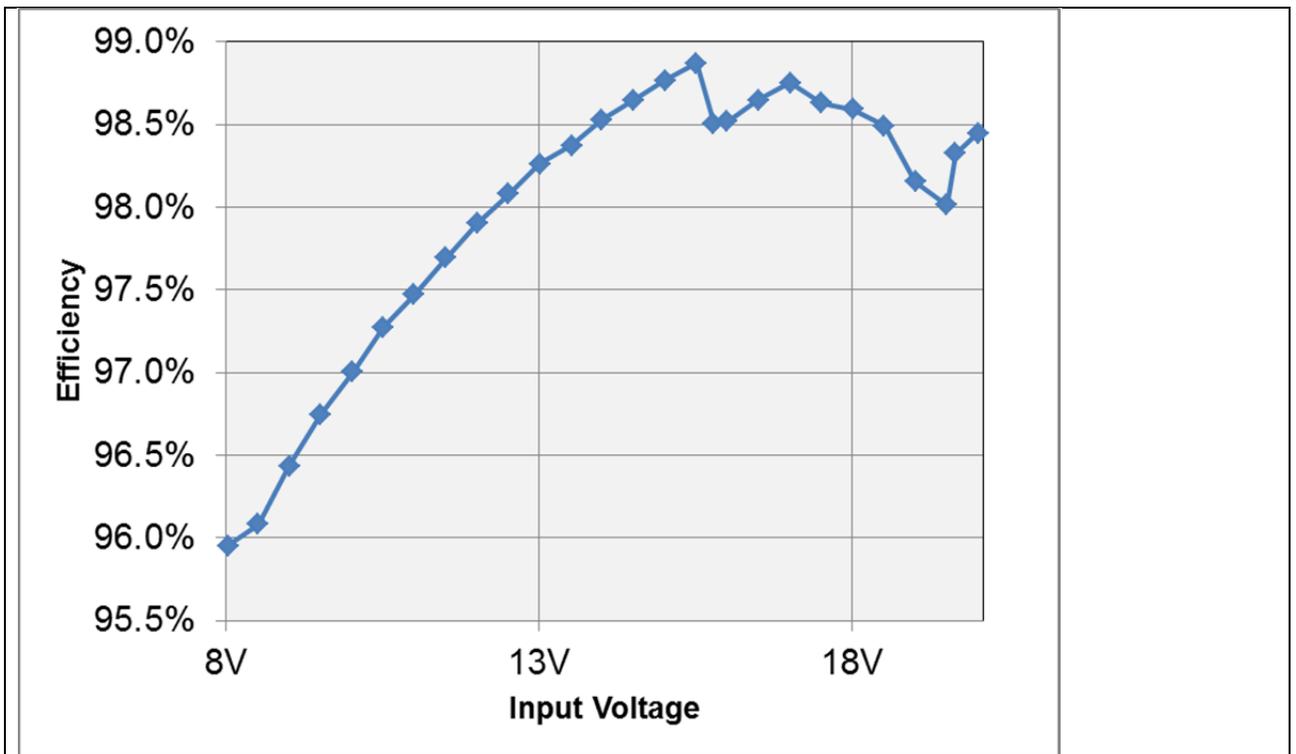


Figure 10

6 Output Ripple Voltage

The output ripple voltage is shown in Figure 11.

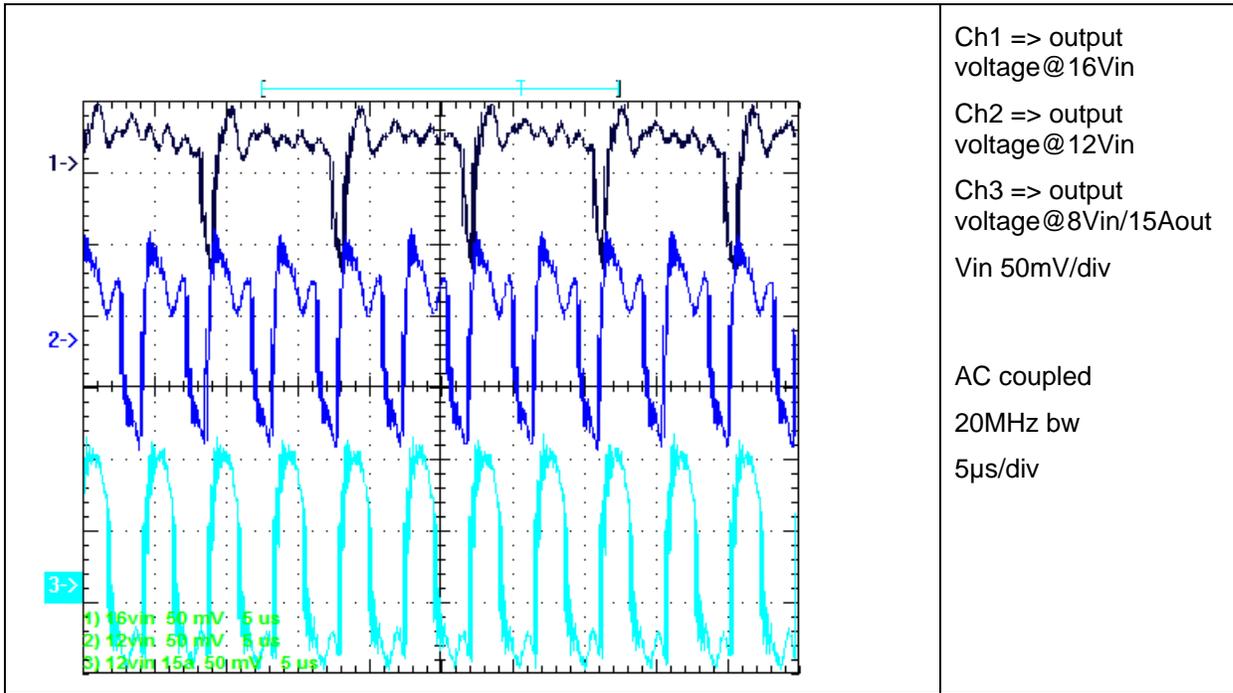


Figure 11

Output voltage ripple is around 150mVpp, so 1% of Vout 16.8V

The output ripple voltage is shown in Figure 12. Input voltage was set to 8V with 15A load. The waveforms were captured separately.

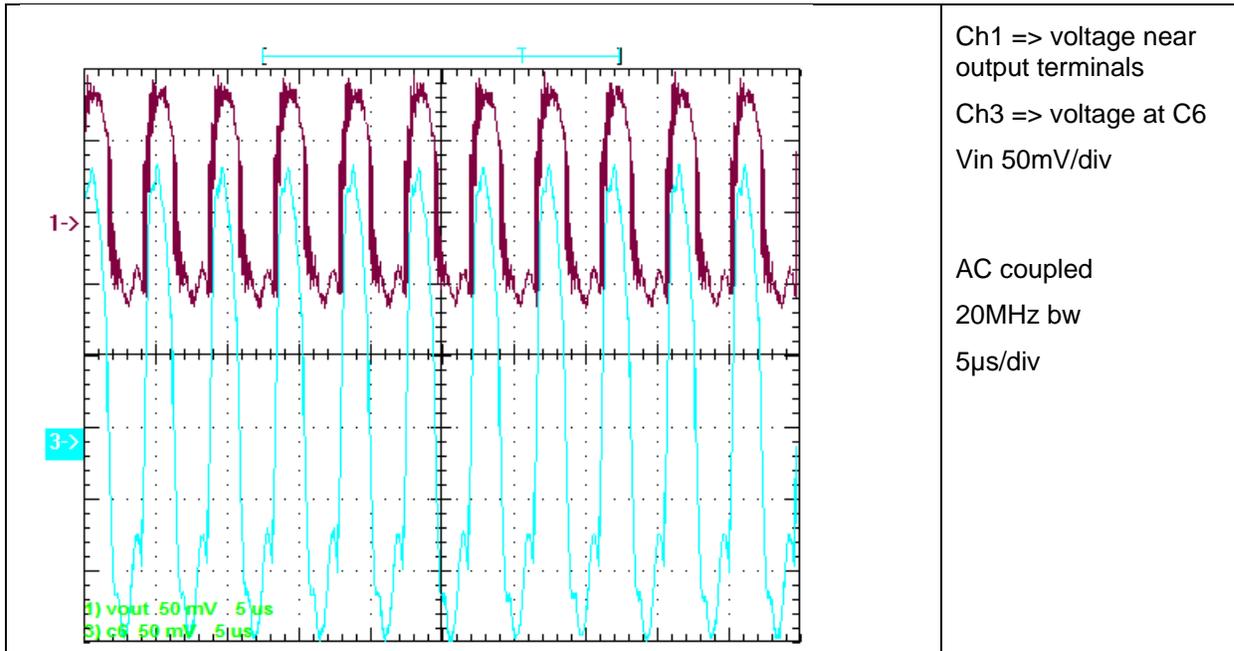


Figure 12

The output ripple voltage is shown in Figure 13. Input voltage was set to 12V. The waveforms were captured separately.

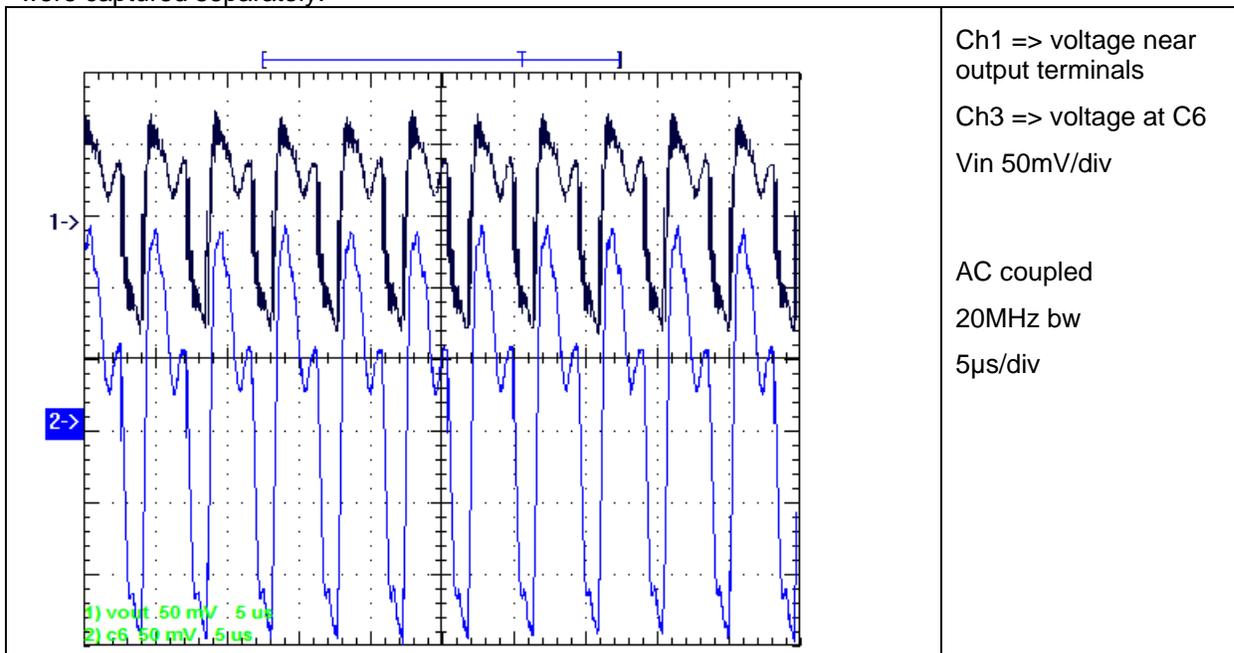


Figure 13

The output ripple voltage is shown in Figure 14. Input voltage was set to 16V. The waveforms were captured separately.

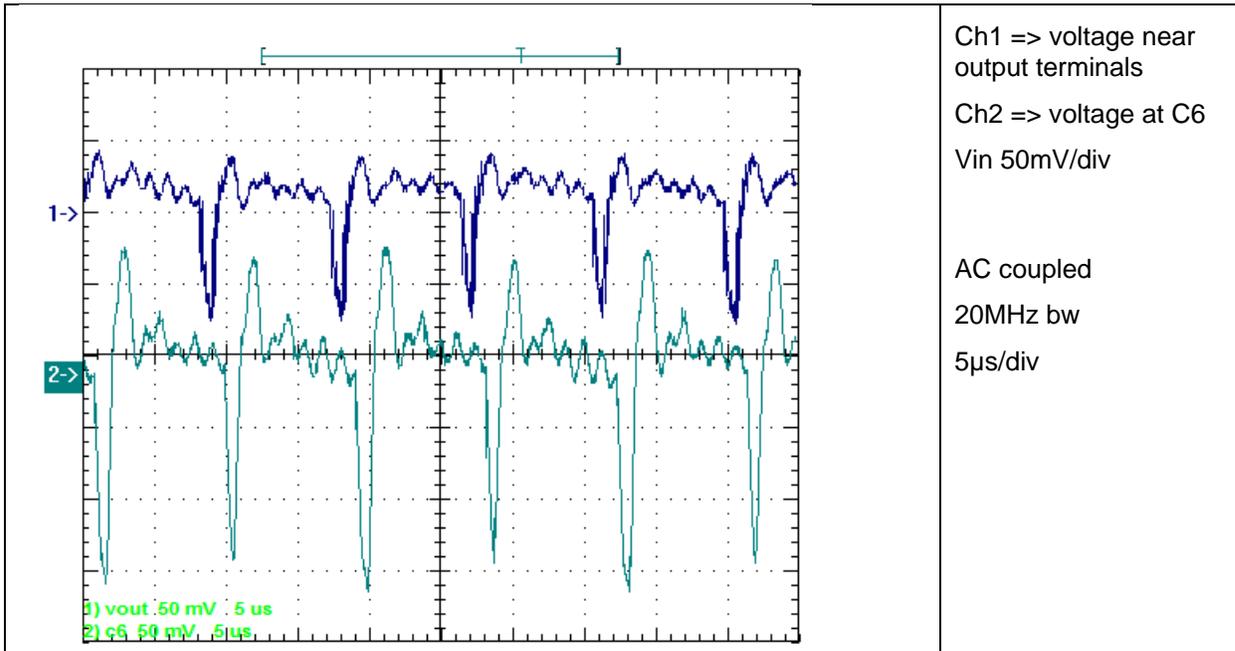


Figure 14

7 Input Ripple Voltage

The input ripple voltage is shown in Figure 15.

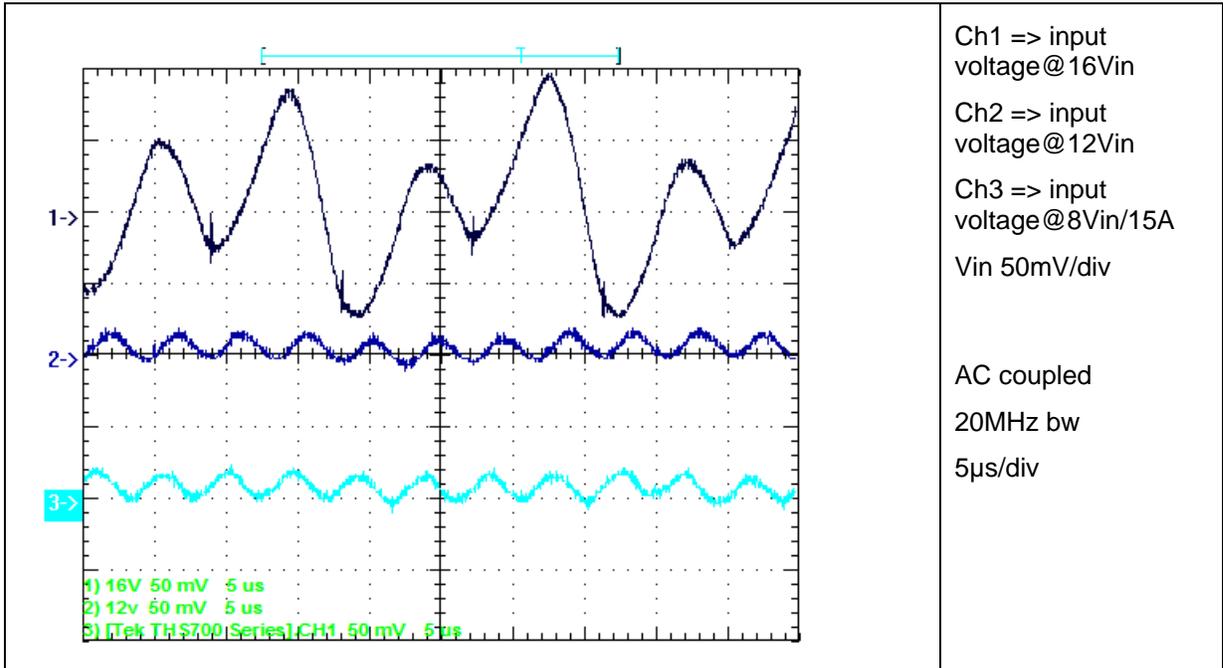


Figure 15

At 16V input voltage the converter is in transfer mode ($V_{in} = V_{out}$); the typical operation for this automotive application could be expected in a range of 11V to 15V input voltage.

The input ripple voltage is shown in Figure 16. Input voltage was set to 8V with 15A load current. The waveforms were captured separately.

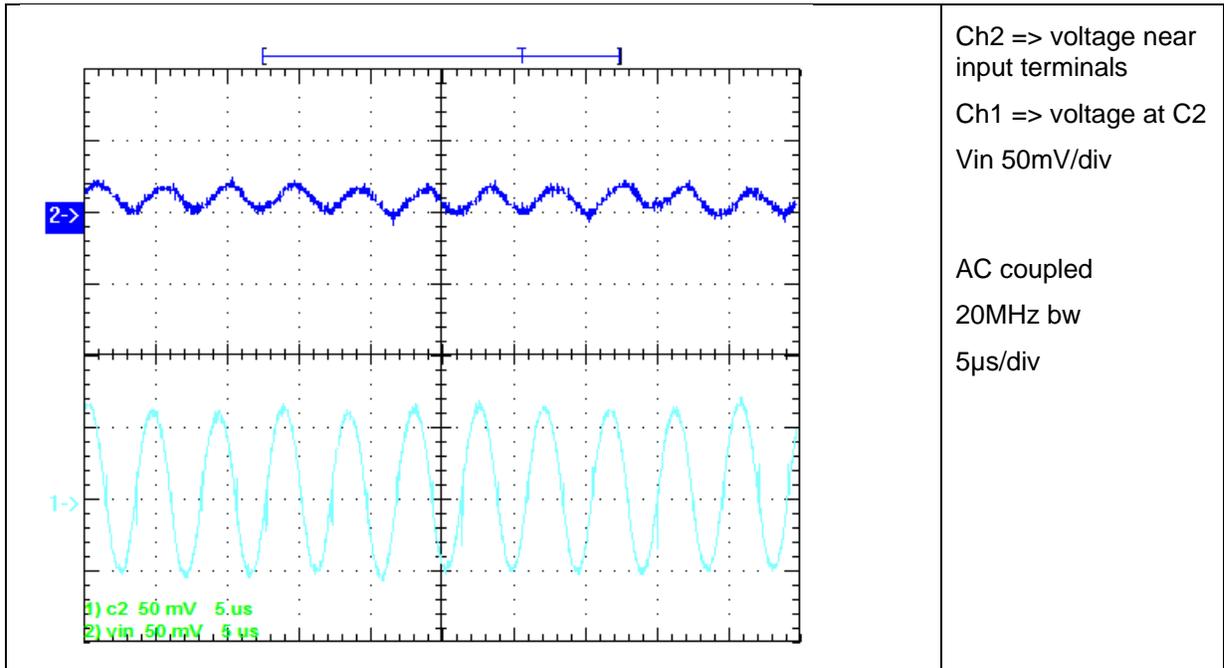


Figure 16

The input ripple voltage is shown in Figure 17. Input voltage was set to 12V. The waveforms were captured separately.

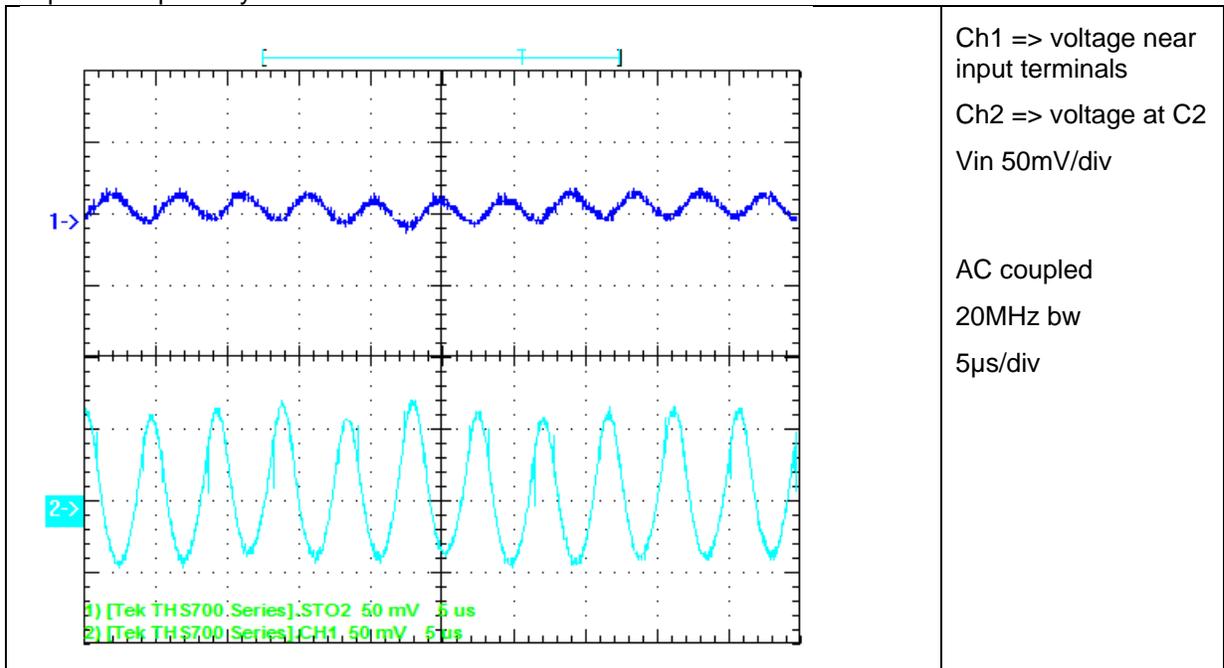


Figure 17

The input ripple voltage is shown in Figure 18. Input voltage was set to 16V. The waveforms were captured separately.

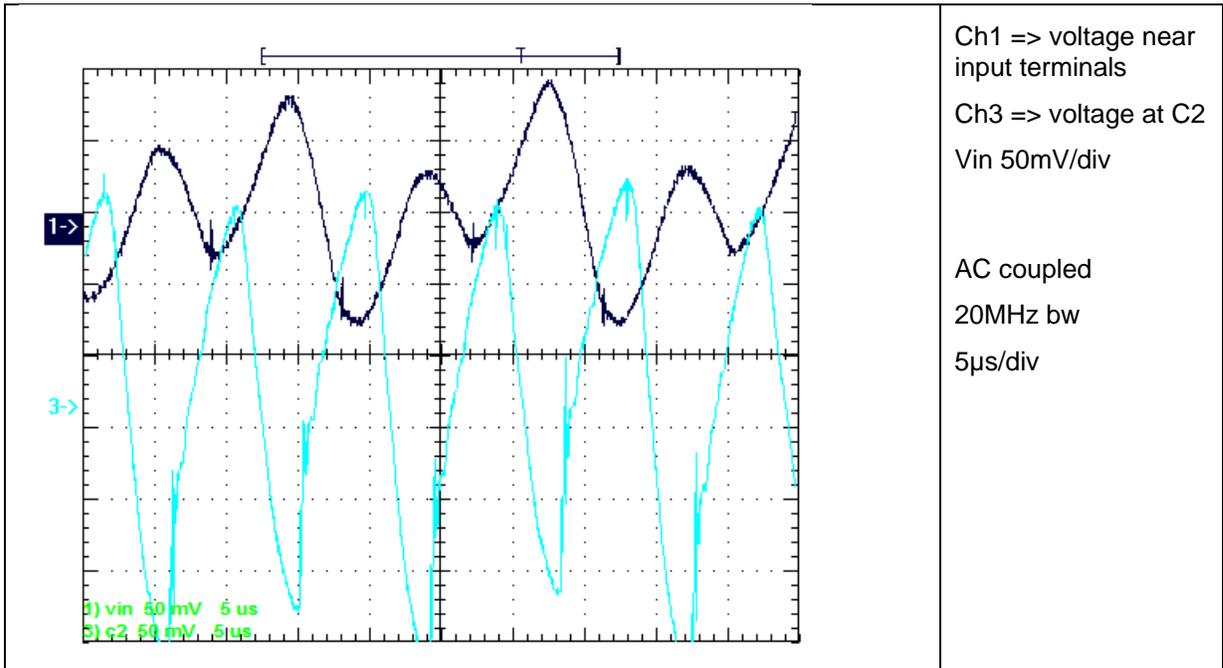


Figure 18

8 Load Transients

The Figure 19 shows the response to load transients. The load is switching from 7.5A to 15A with a frequency of 230Hz. The input voltage was set to 8V

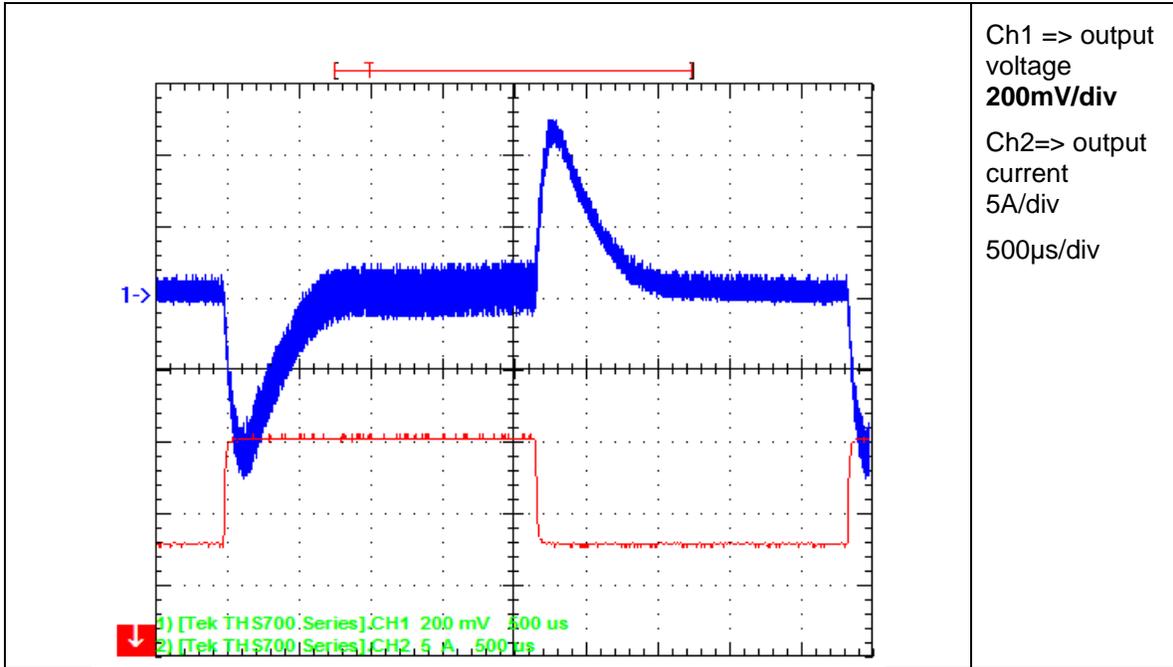


Figure 19

The Figure 20 shows the response to load transients. The load is switching from 9A to 18A with a frequency of 230Hz. The input voltage was set to 12V, deviation is <400mVpk, so less than 2.5%.

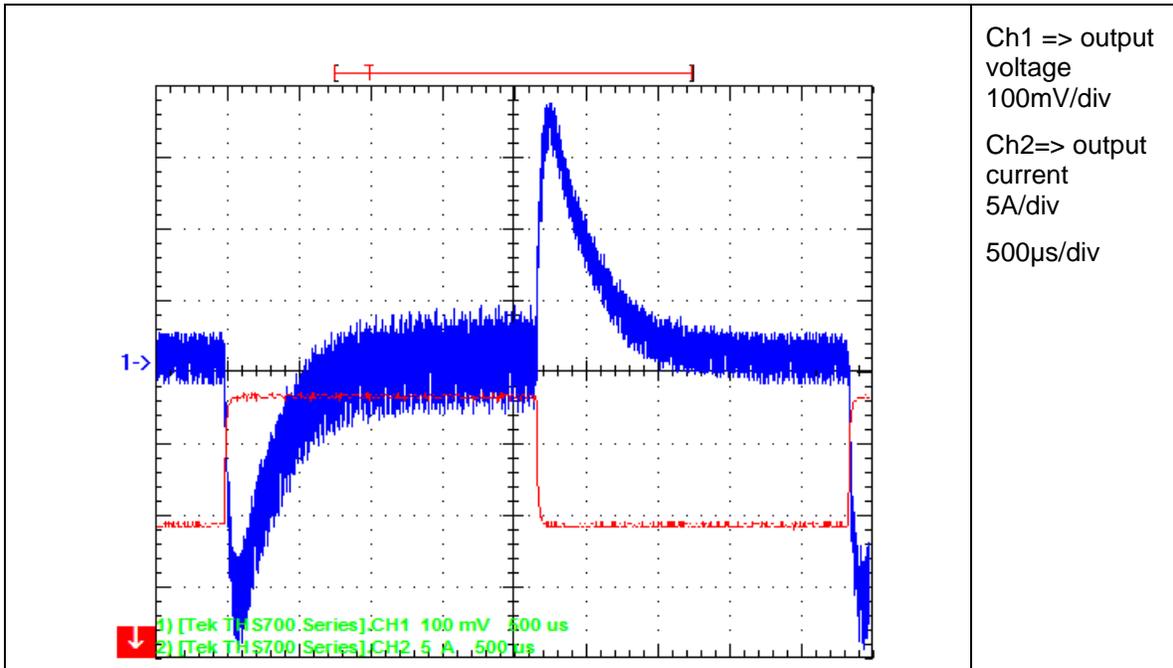


Figure 20

The Figure 21 shows the response to load transients. The load is switching from 9A to 18A with a frequency of 230Hz. The input voltage was set to 16V

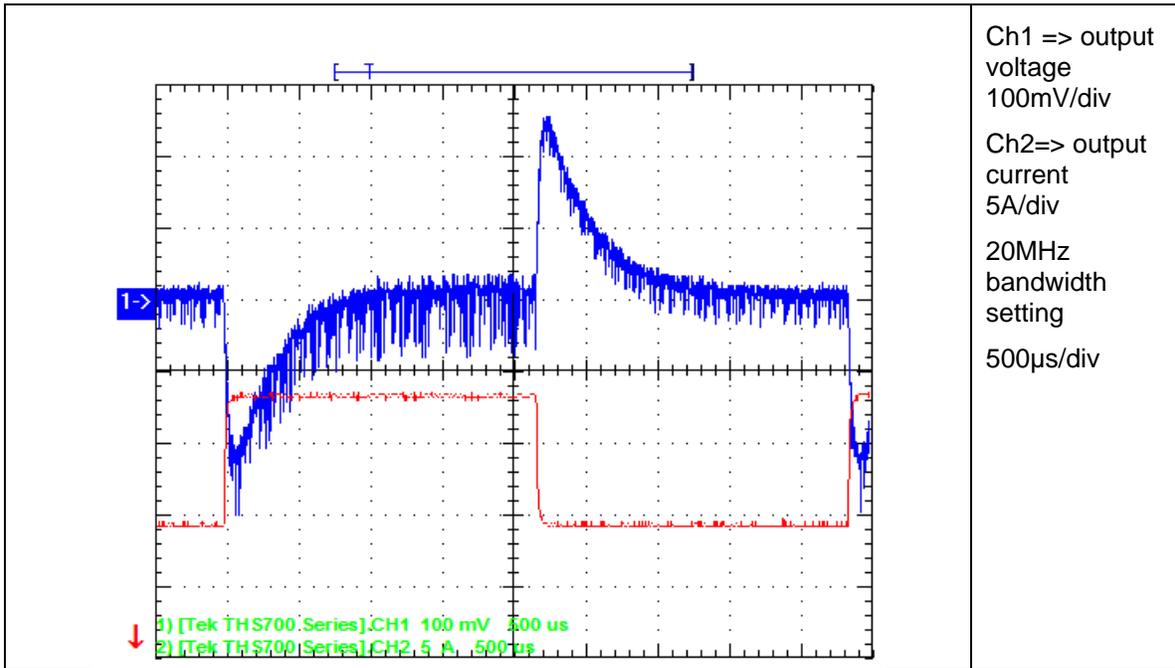


Figure 21

9 Control Loop Frequency Response

Figure 22 shows the loop response. 15A-load applied (electronic load). The input voltage was set to 8V.

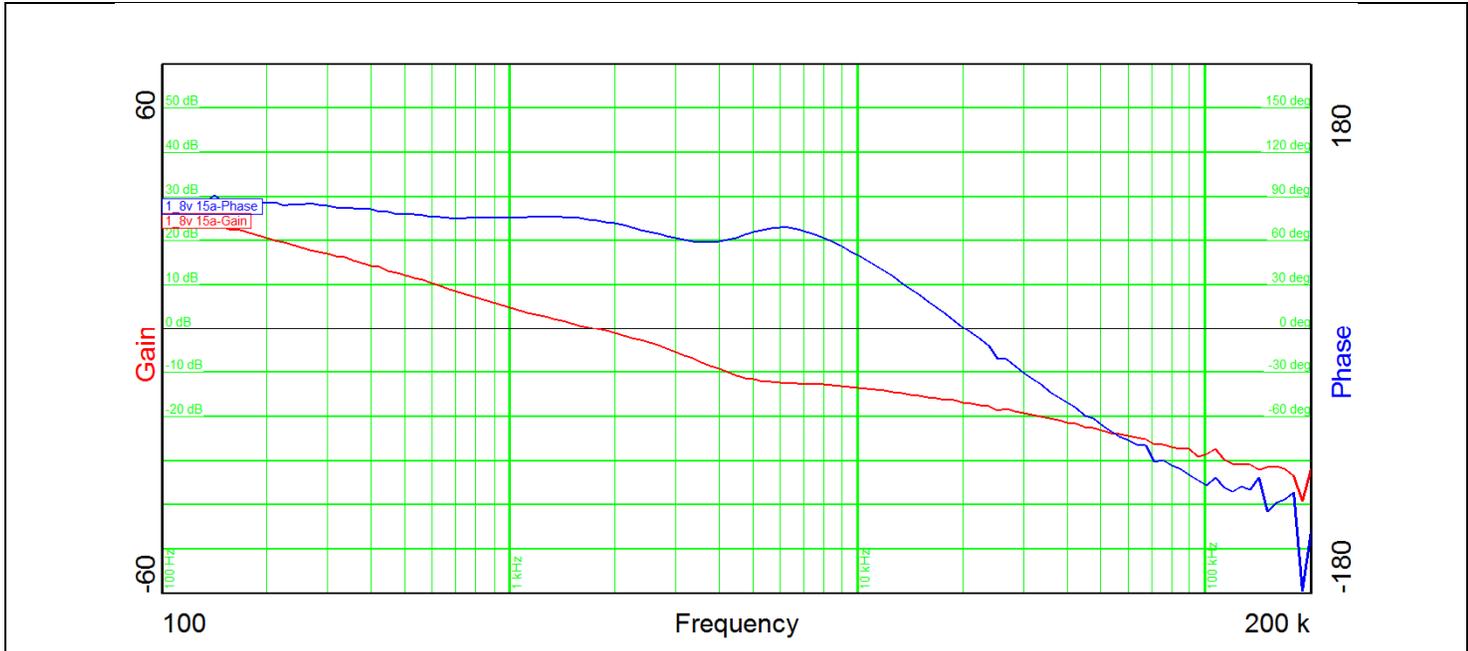


Figure 22

Figure 23 shows the loop response. 18A-load applied (Electronic load). The input voltage was set to 12V.

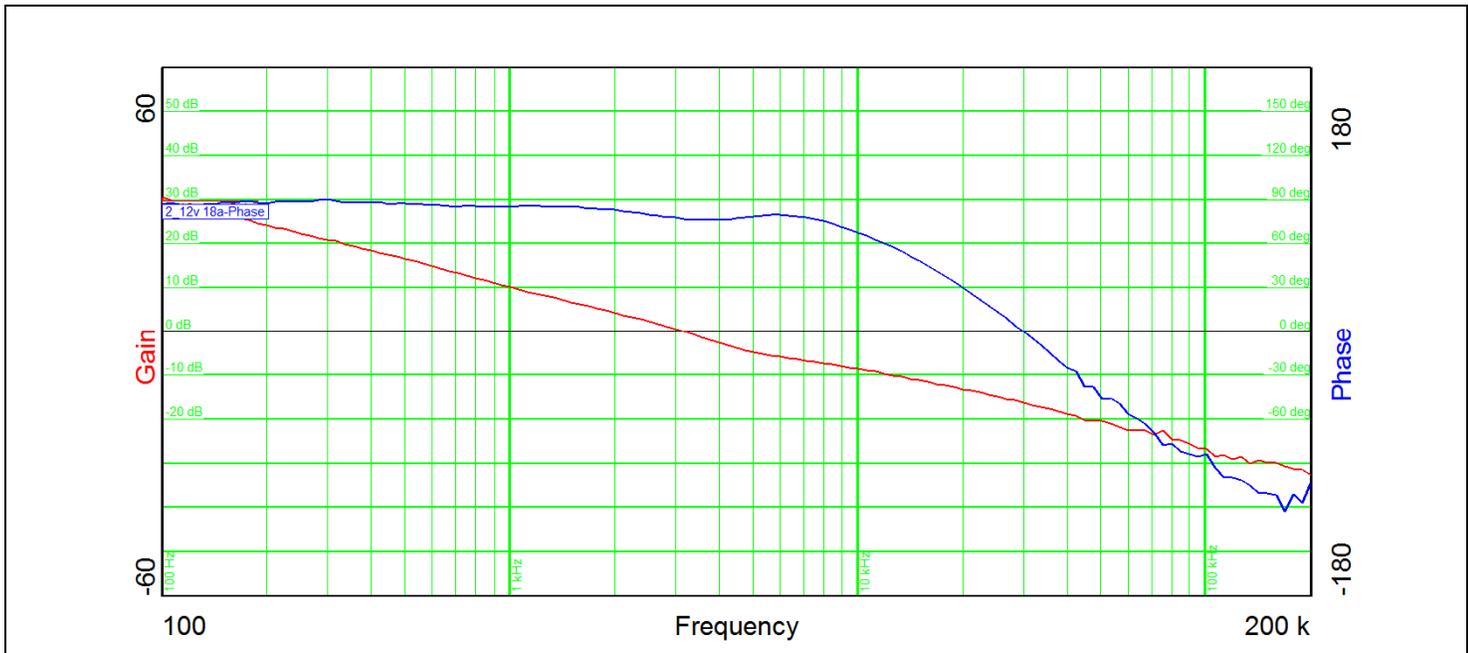


Figure 23

Figure 24 shows the loop response. 18A-load applied (electronic load). The input voltage was set to 16V.

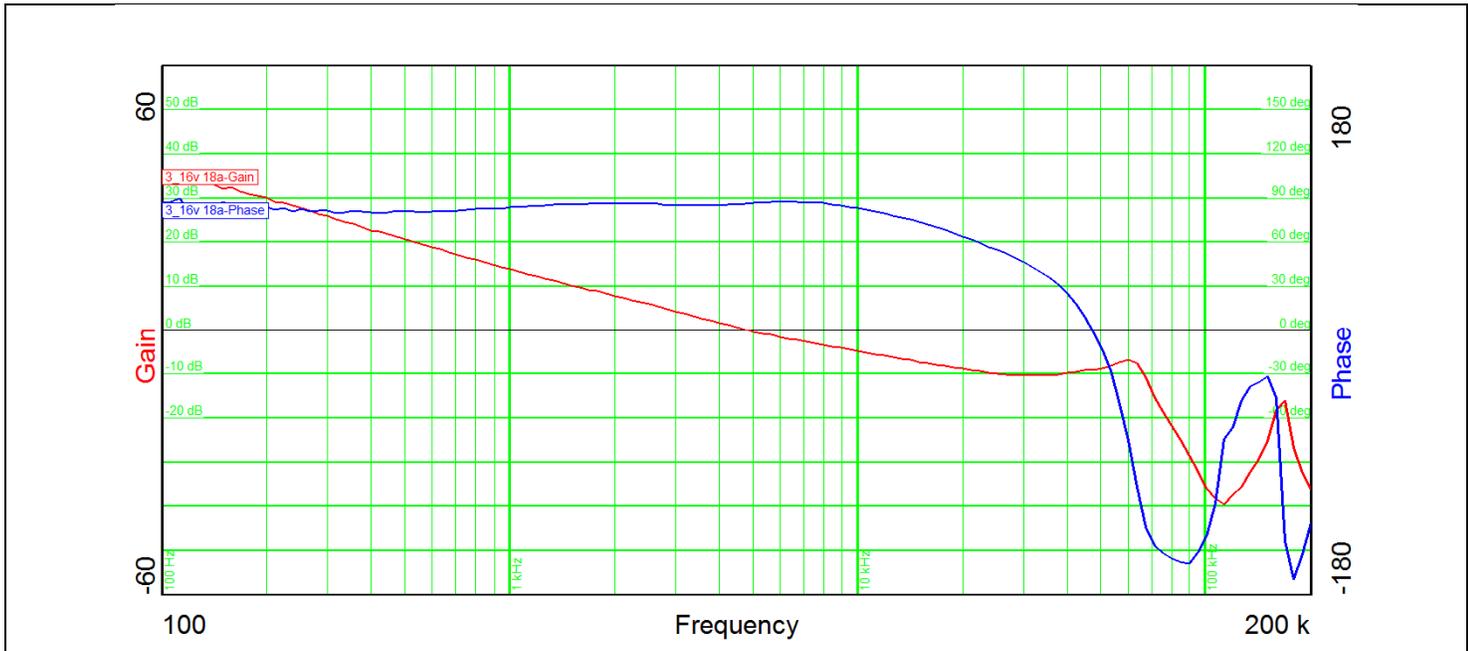


Figure 24

Table 1 summarizes the results from the frequency response.

Vin	8V	12V	16V
Bandwidth (kHz)	1.78	3.15	4.86
Phase margin	74°	77°	86°
slope (20dB/decade)	-0.97	-1.24	-0.93
gain margin (dB)	-16.8	-16.3	-9
slope (20dB/decade)	-0.56	-1.04	+0.49
freq (kHz)	20.4	29.9	47.2

Table 1

10 Miscellaneous Waveforms

10.1 8V Input Voltage (15A Load Current)

10.1.1 Boost High Side (SW2)

10.1.1.1 Source Drain

The waveform measured on source drain is shown Figure 25. (referenced to VOUT')

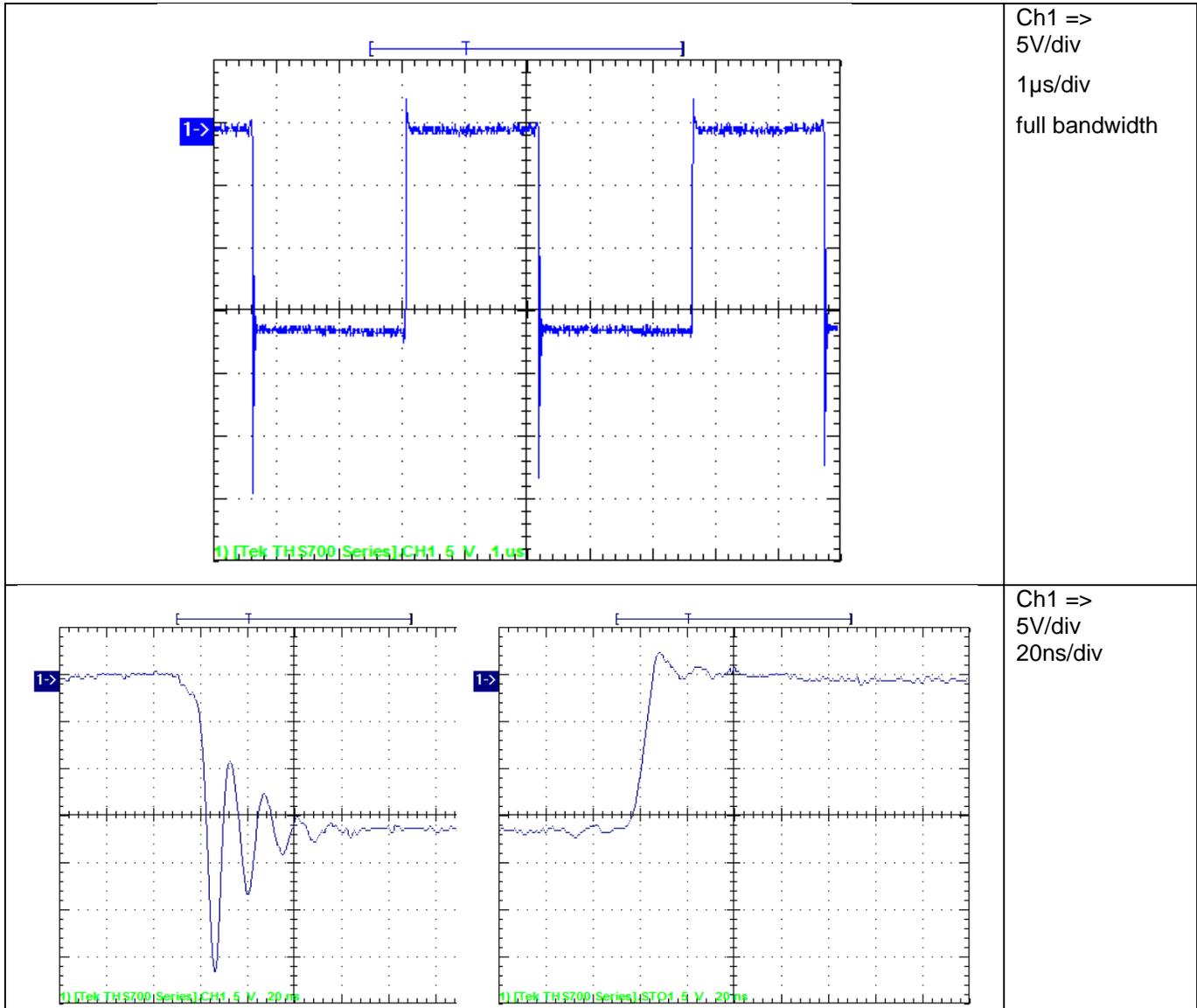


Figure 25

A 30V FET or a RC snubber is recommended for the synchronous rectifier !

10.1.1.2 Gate-Source

The waveform of the **gate-source** voltage is shown in Figure 26 (boost HS).

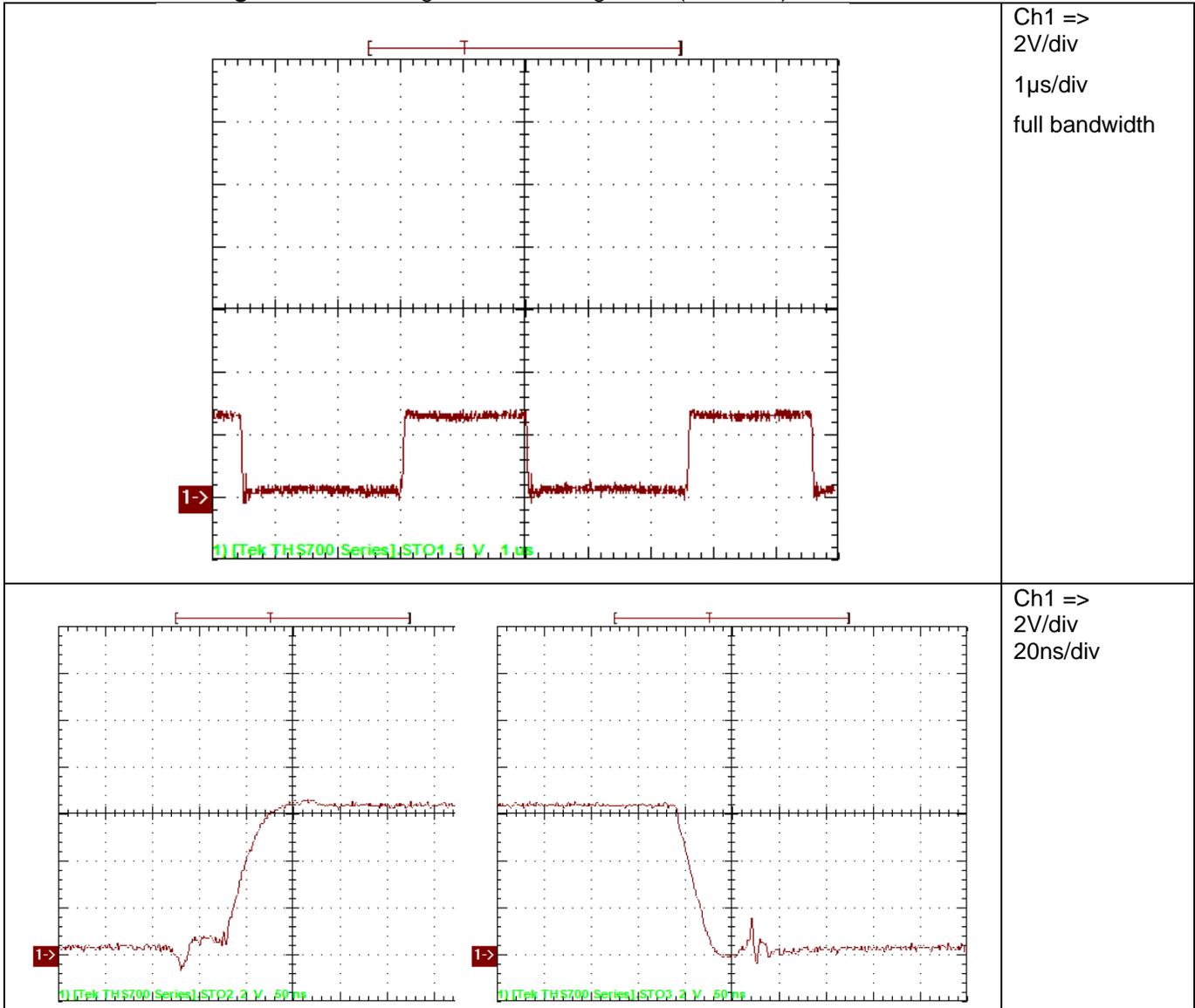


Figure 26

10.1.2 Boost Low Side (SW2)

10.1.2.1 Drain-Source

The waveform of the drain-source voltage on is shown in Figure 27.

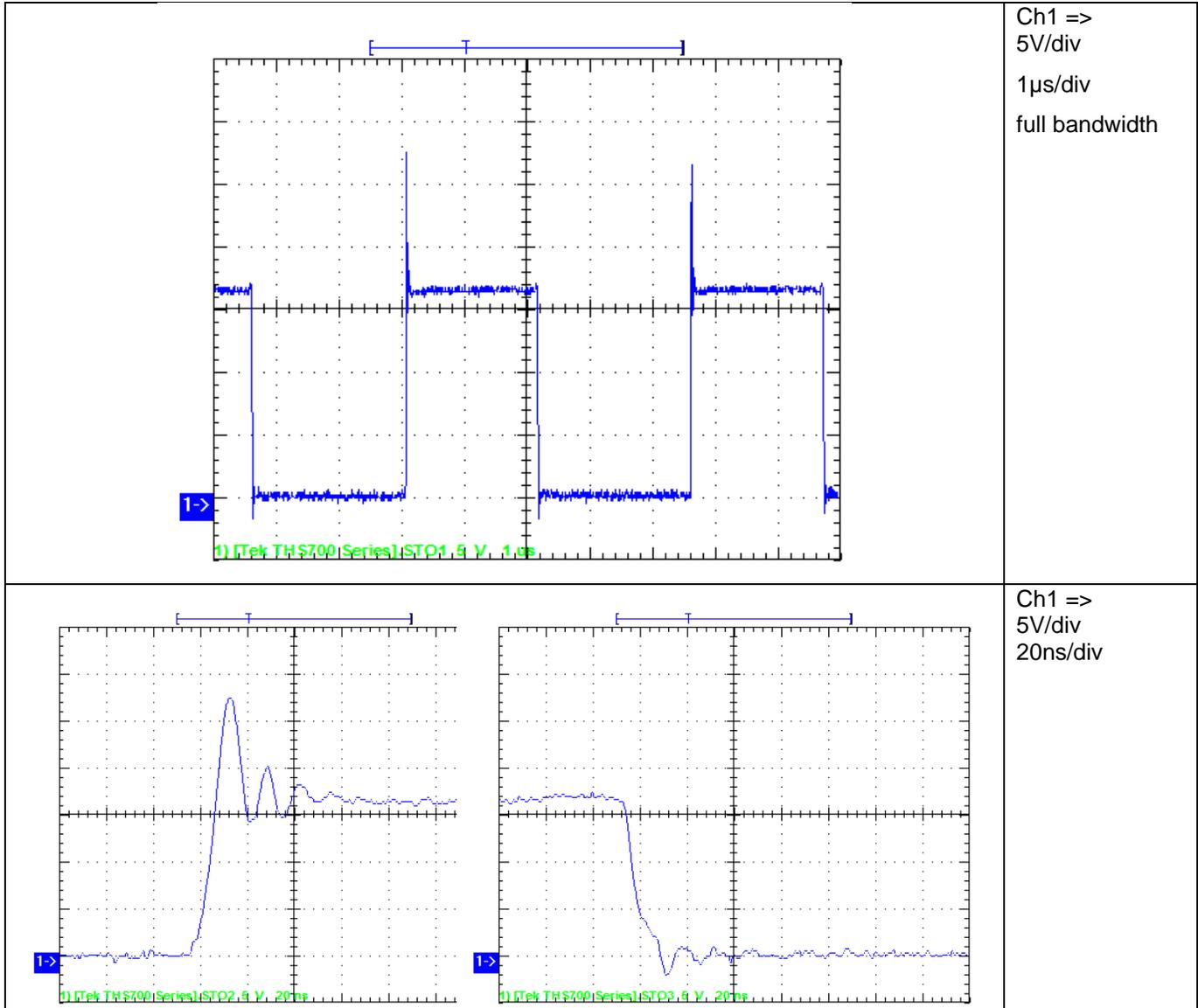


Figure 27

10.1.2.2 Gate Source

The waveform of the **gate-source** voltage is shown in Figure 28 (boost LS).

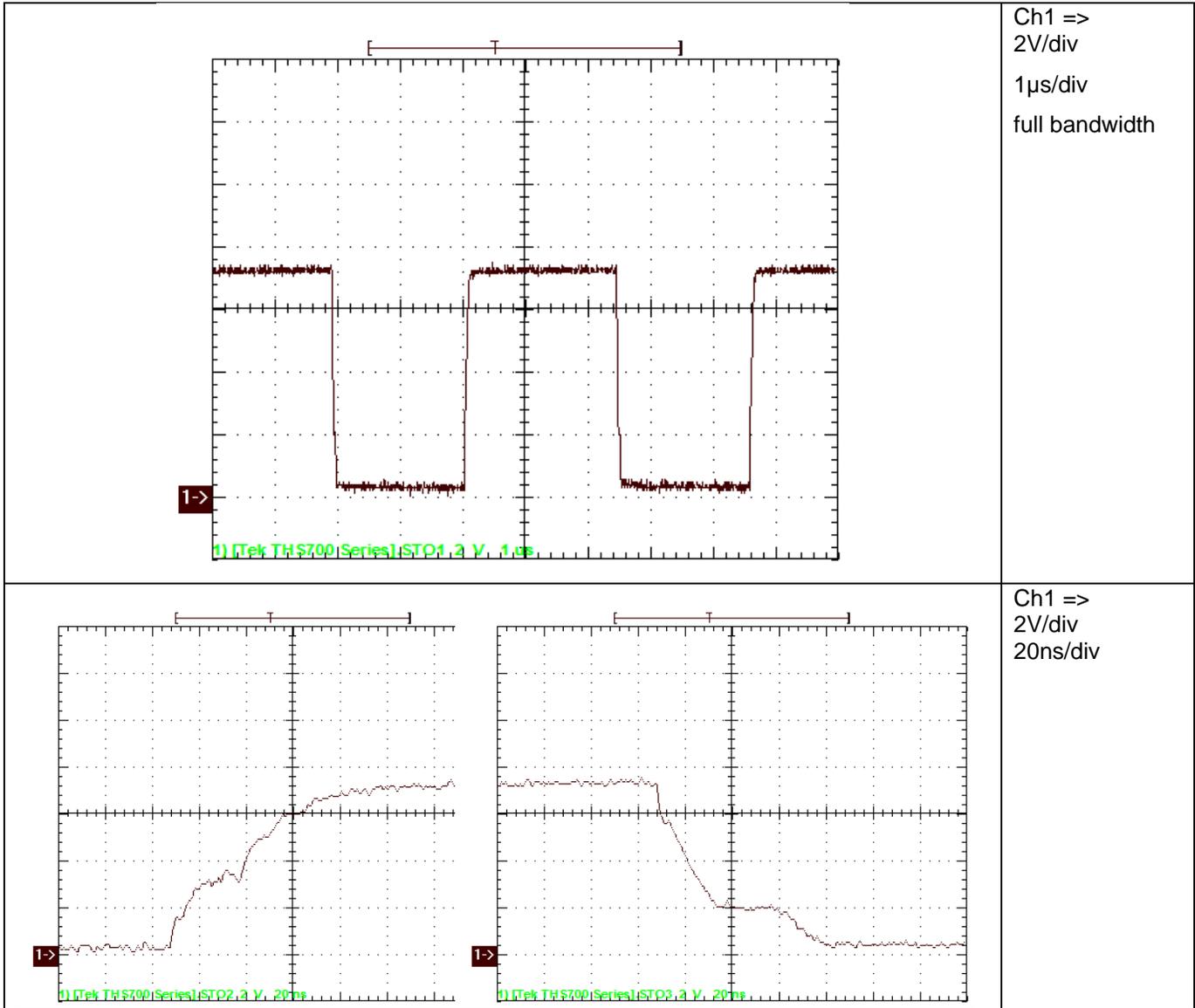


Figure 28

10.2 12V Input Voltage

10.2.1 Boost High Side (SW2)

10.2.1.1 Source Drain

The waveform of the source-drain voltage is shown in Figure 29. (referenced to VOUT')

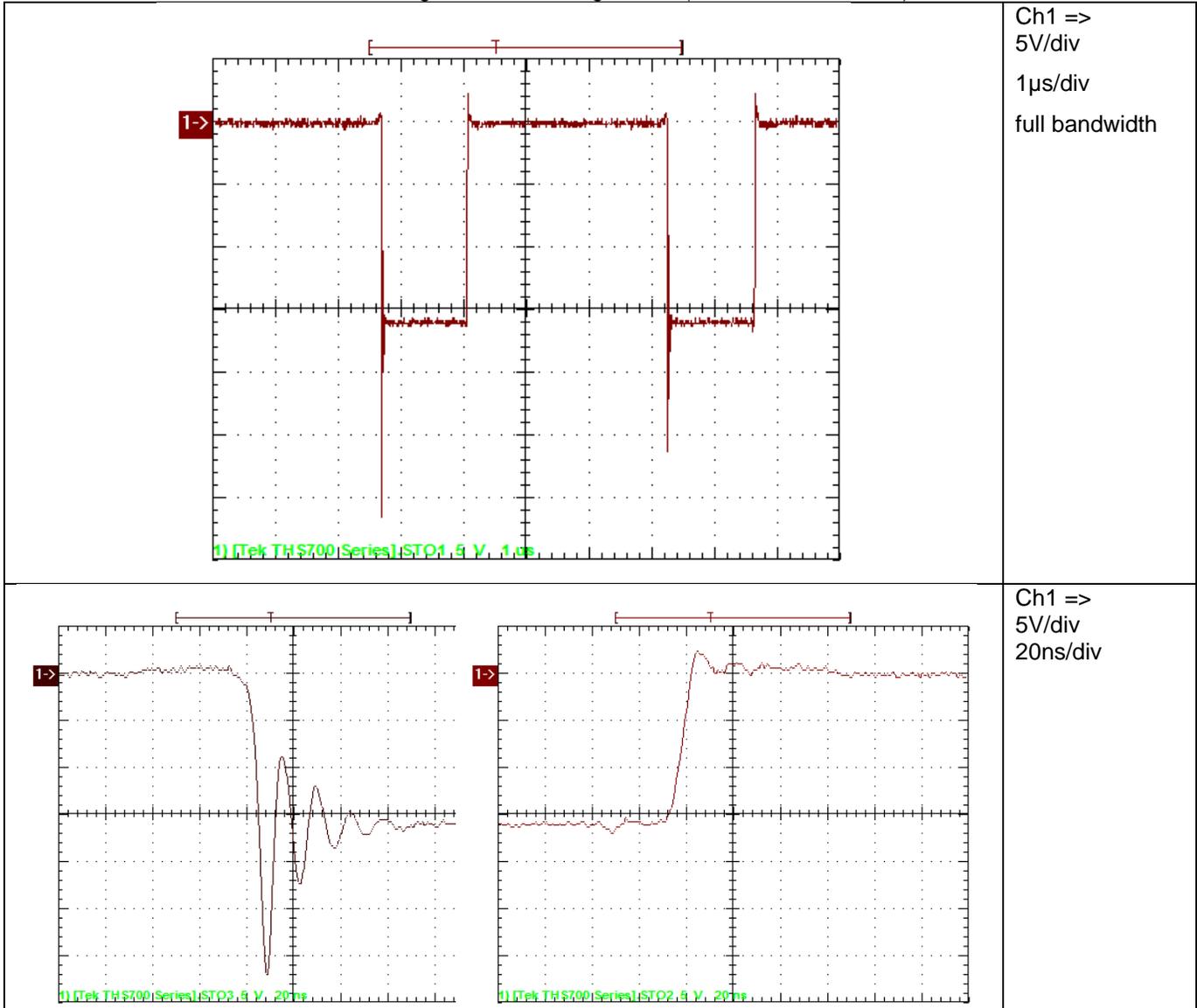


Figure 29

10.2.1.2 Gate-Source

The waveform of the gate-source voltage is shown in Figure 30 (boost HS).

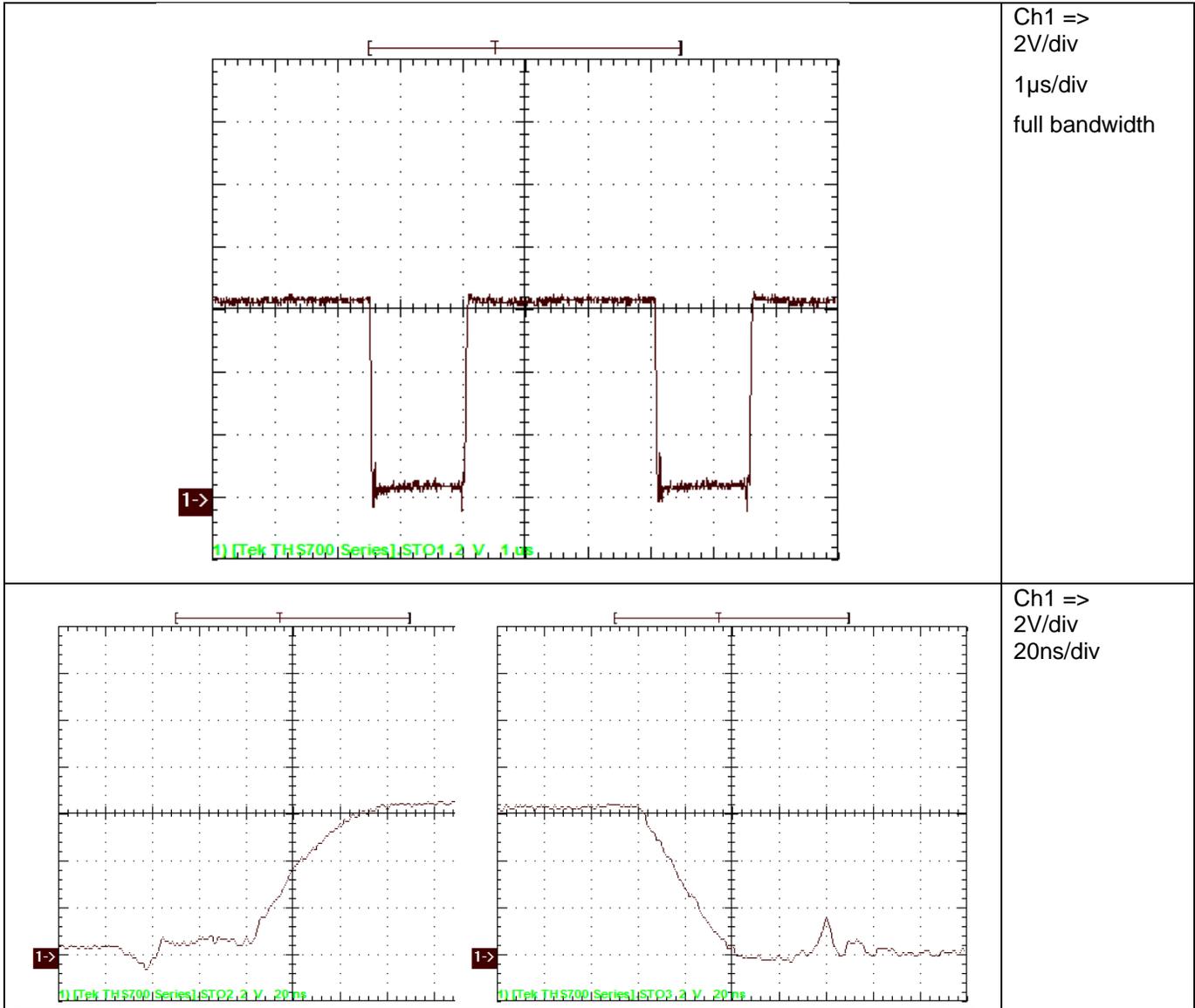


Figure 30

10.2.2 Boost Low Side (SW2)

10.2.2.1 Drain-Source

The waveform of the **drain-source** voltage is shown in Figure 31.

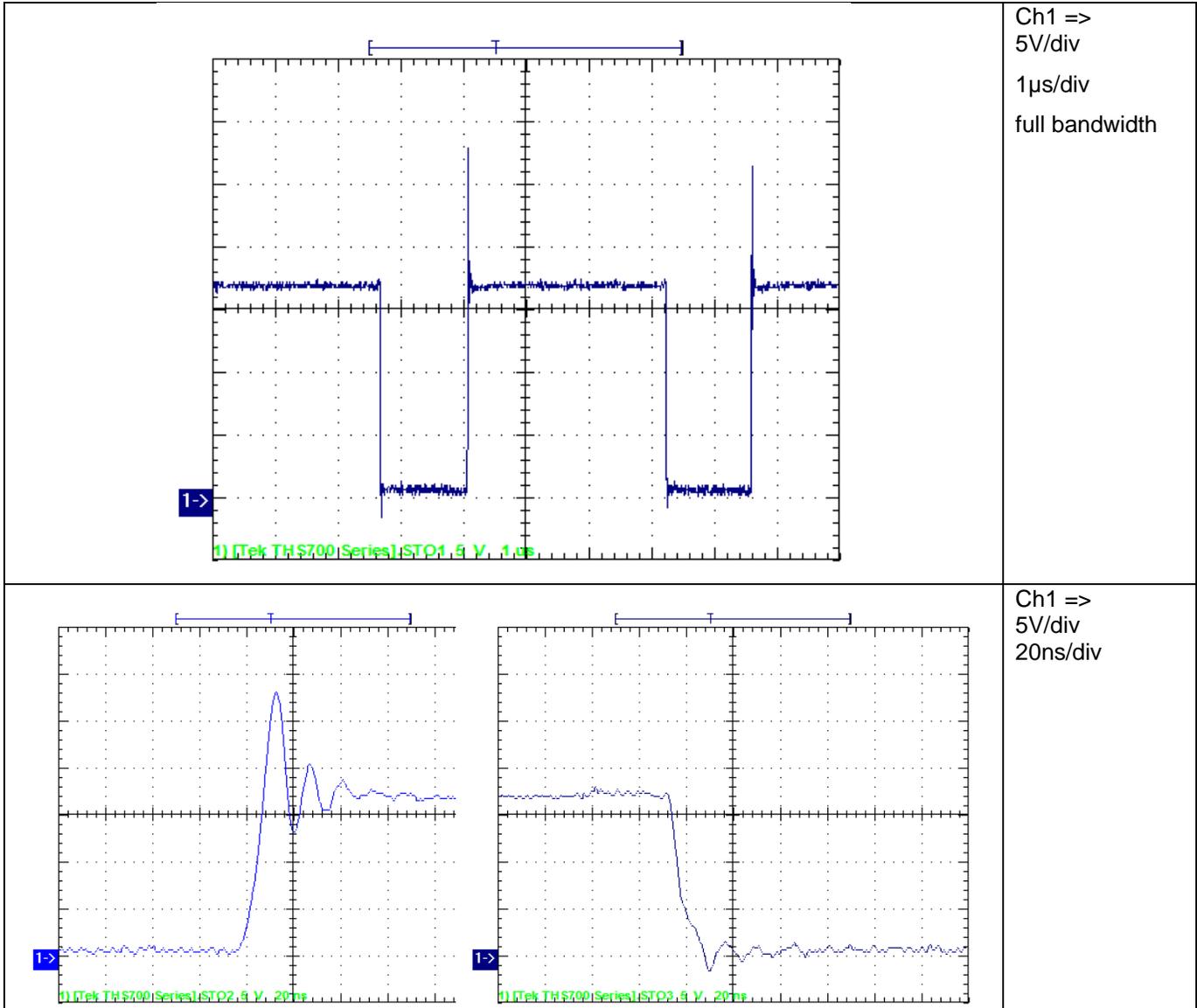


Figure 31

10.2.2.2 Gate Source

The waveform of the **gate-source** voltage on is shown in Figure 32 (boost LS).

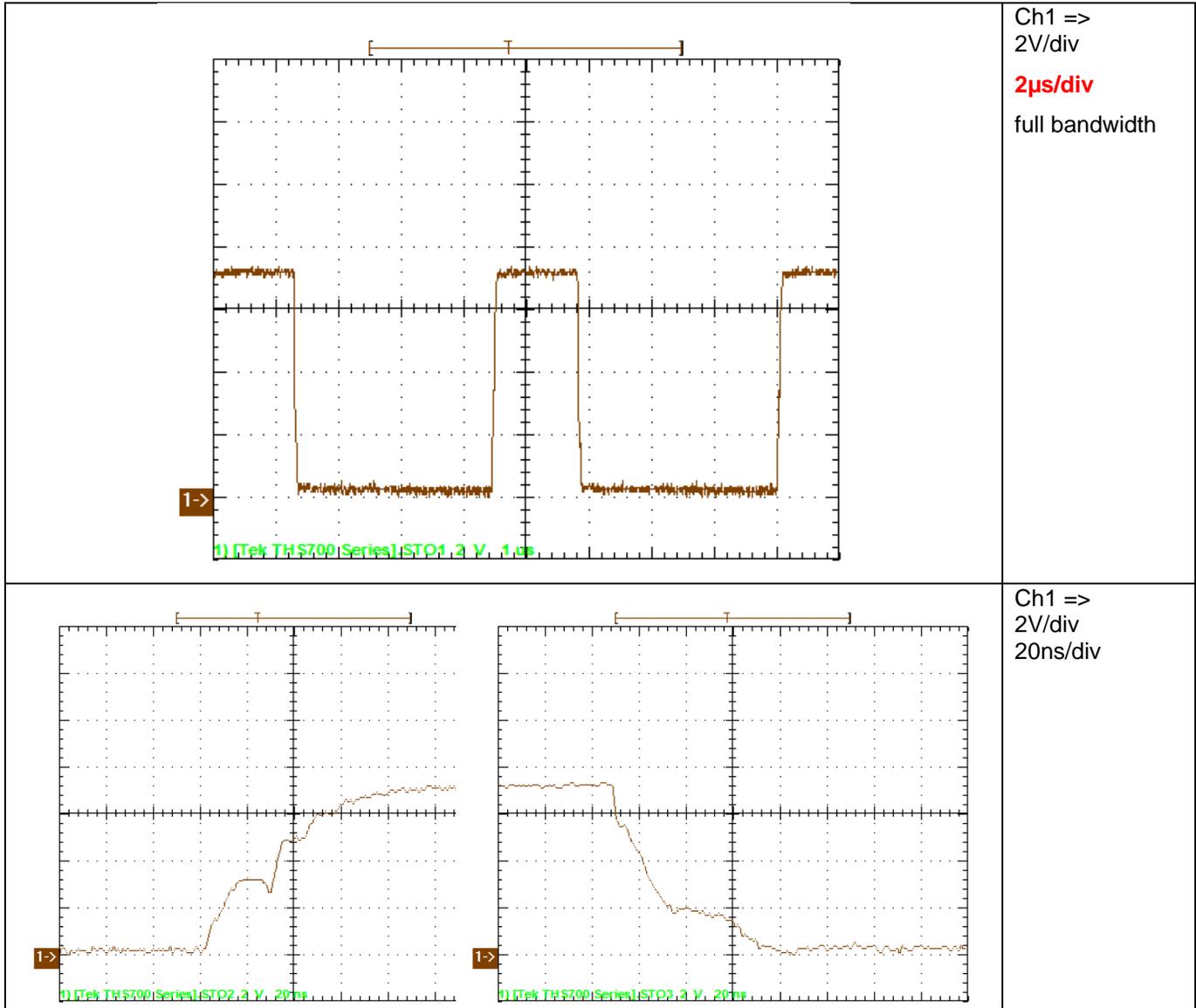


Figure 32

10.3 16V Input Voltage

10.3.1 Boost High Side

10.3.1.1 Source Drain

The waveform of the source-drain voltage is shown in Figure 33 (referenced to VOUT').

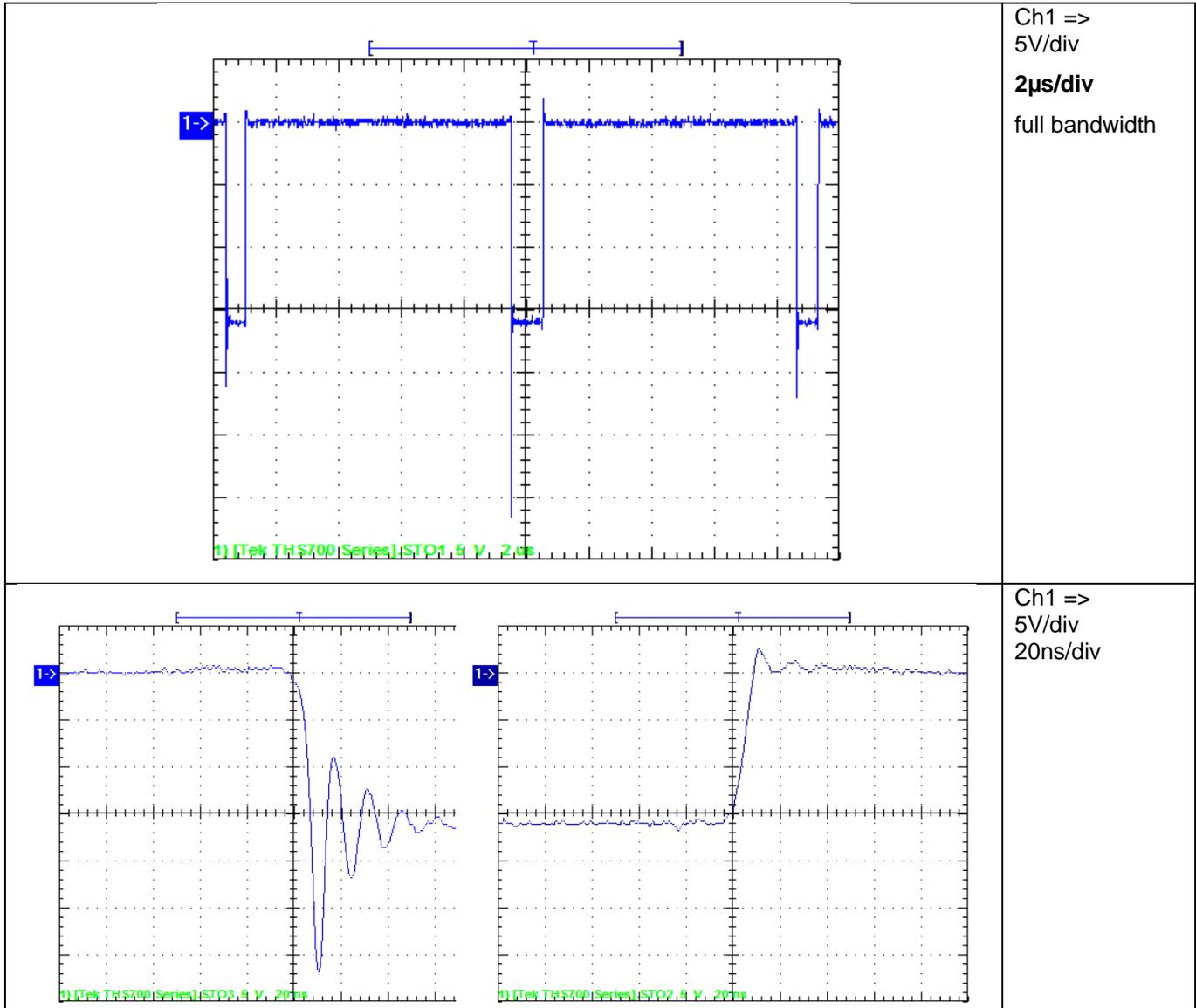


Figure 33

10.3.1.2 Gate Source

The waveform of the **gate-source** voltage is shown in Figure 34 (boost HS).

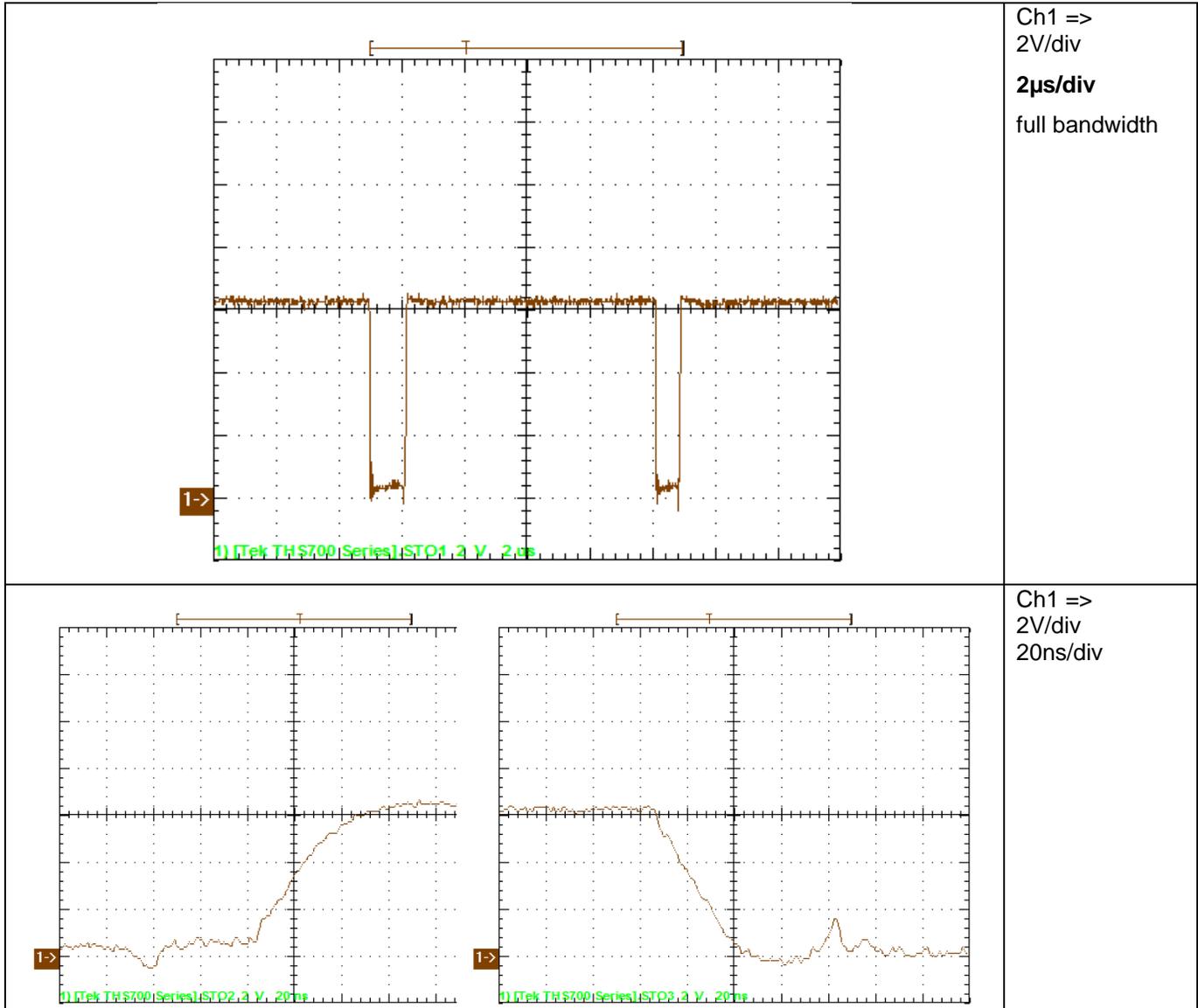


Figure 34

10.3.2 Boost Low Side (SW1)

10.3.2.1 Drain Source

The waveform of the drain-source voltage is shown in Figure 35.

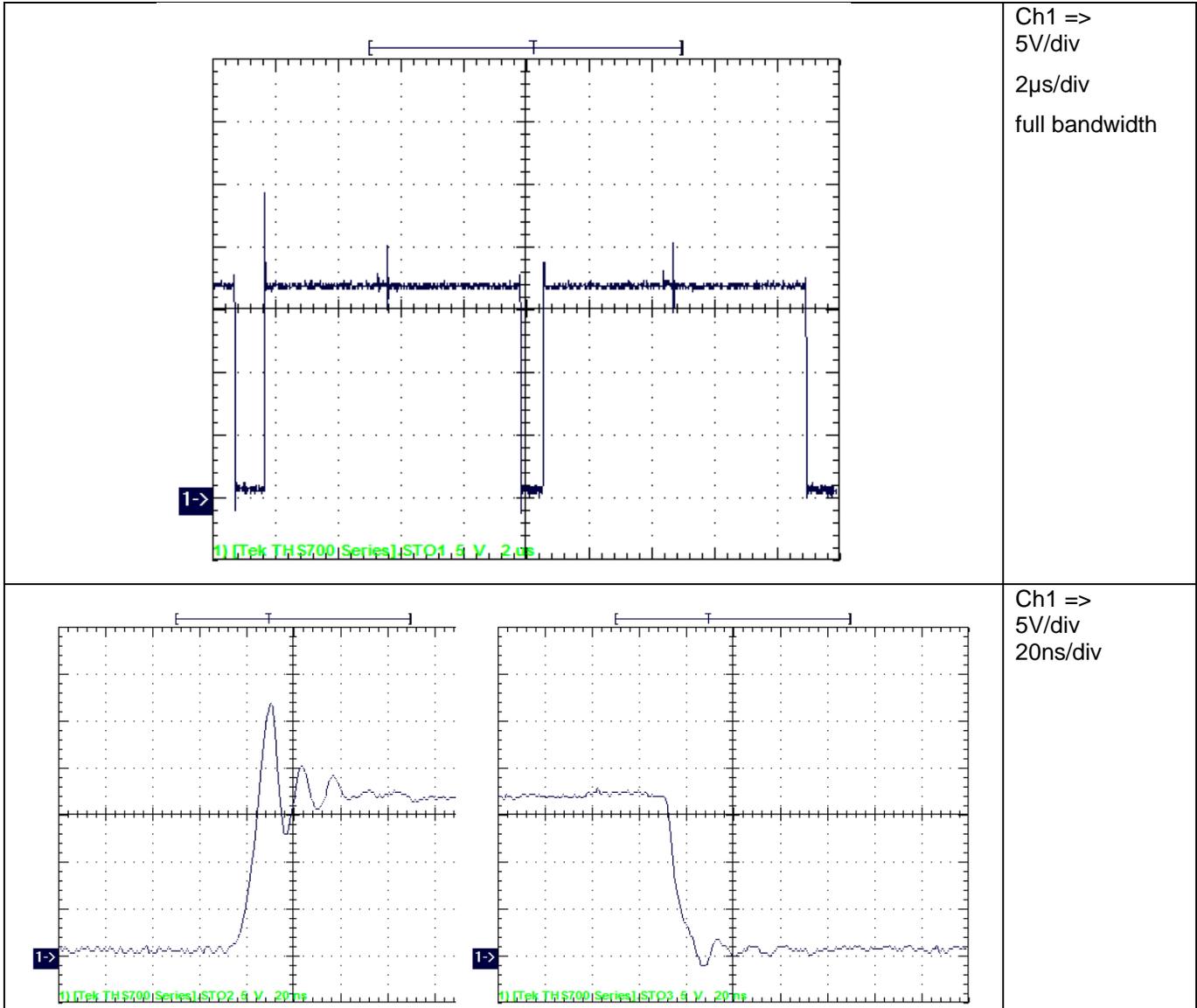


Figure 35

10.3.2.2 Gate Source

The waveform of the gate source voltage is shown in Figure 36 (boost LS).

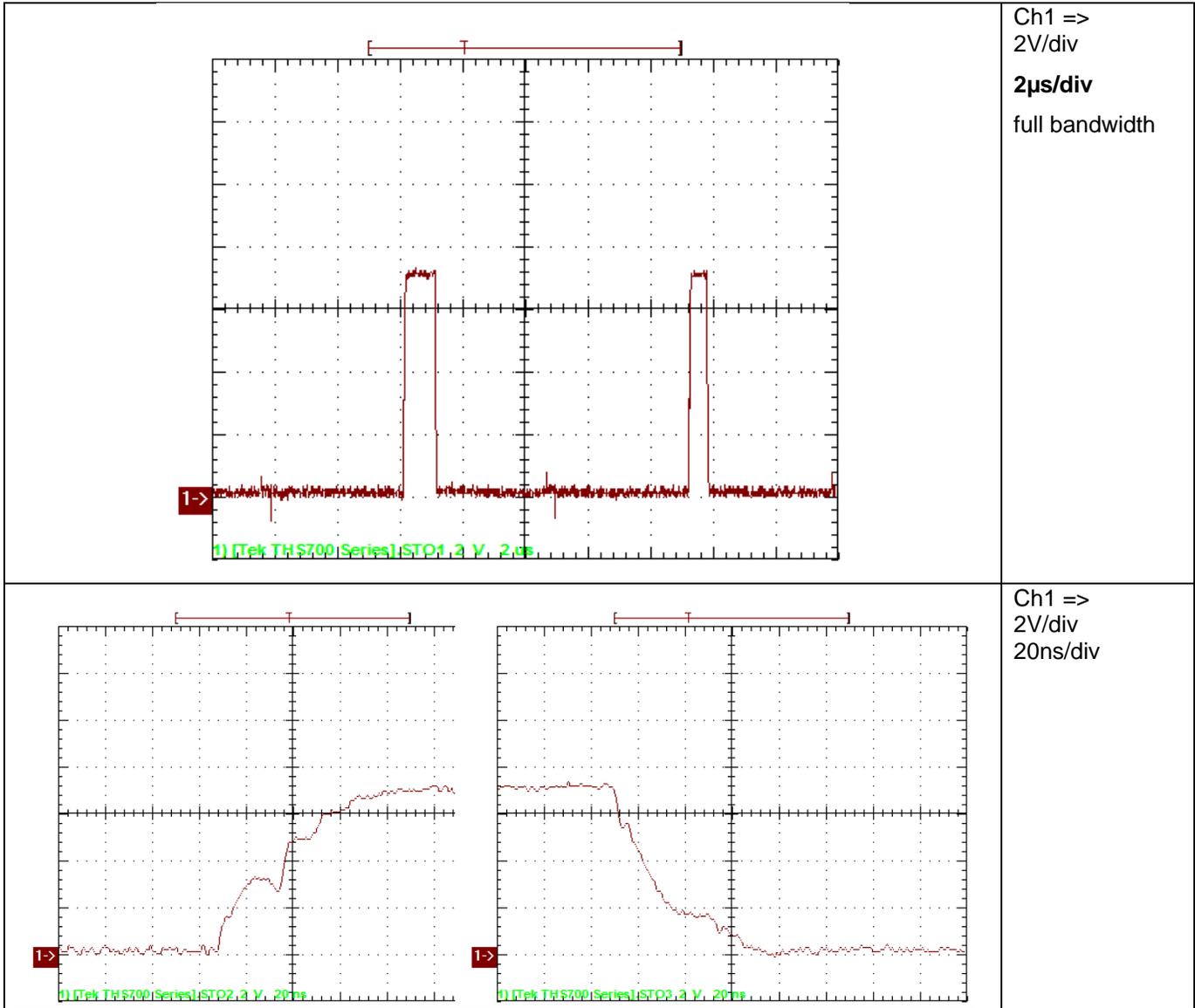


Figure 36

10.3.3 Buck High Side (SW1) at 16V input = transfer region

10.3.3.1 Drain-Source

The waveform of the drain-source voltage is shown in Figure 37.

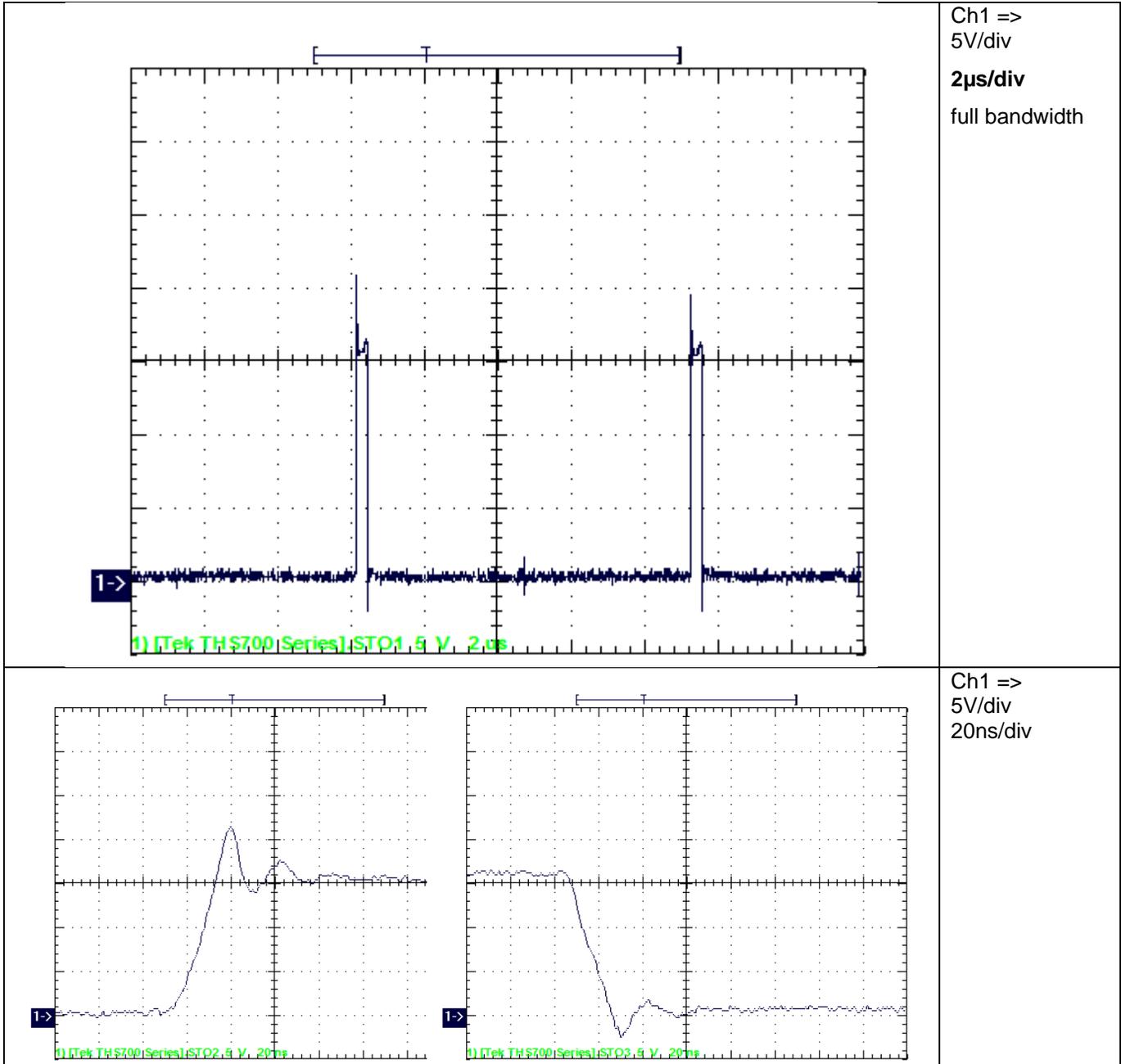


Figure 37

10.3.3.2 Gate Source

The waveform of the **gate-source** voltage is shown in Figure 38 (buck HS)

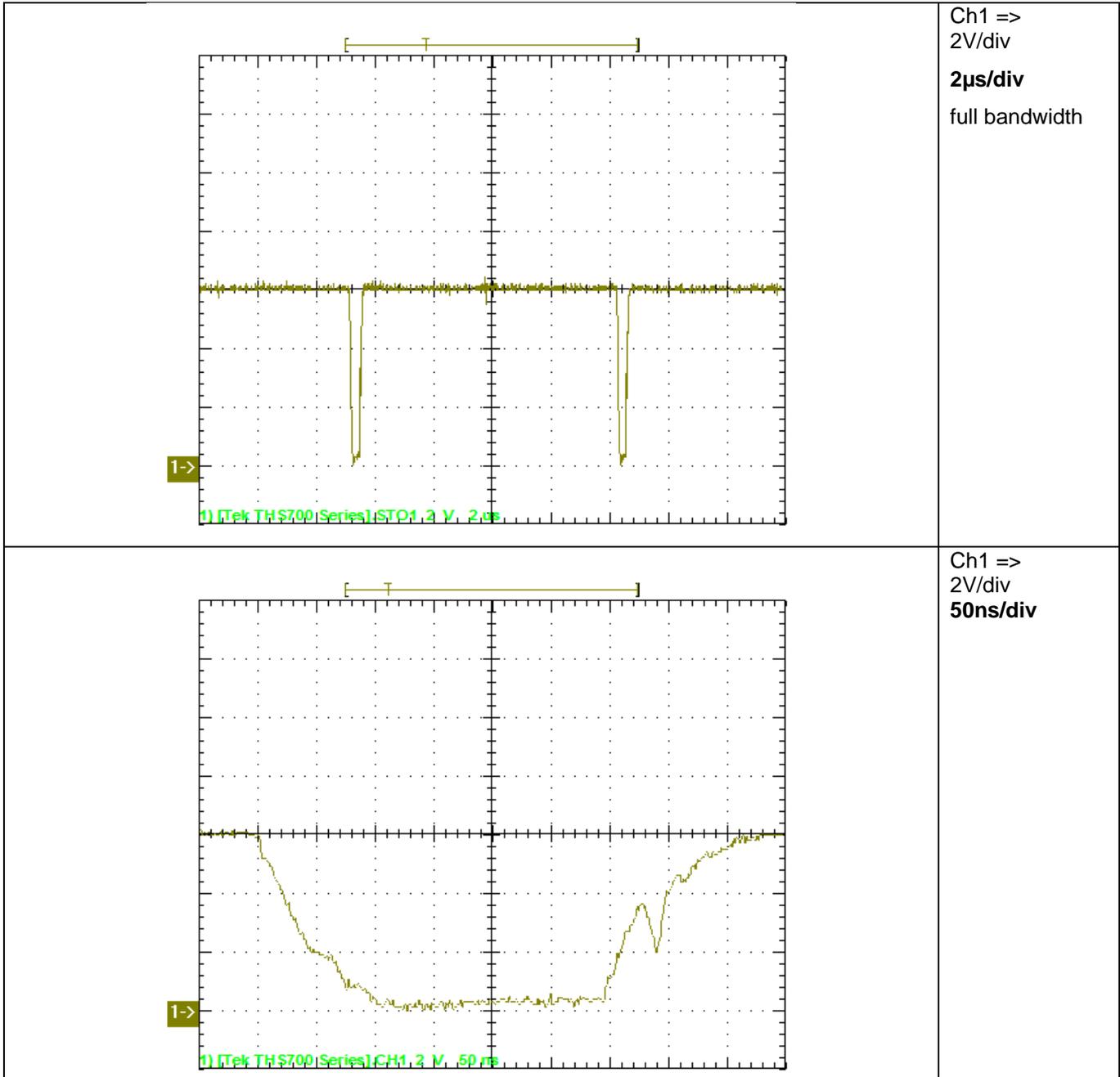


Figure 38

10.3.4 Buck Low Side (SW1)

10.3.4.1 Drain-Source

The waveform of the drain-source voltage is shown in Figure 39.

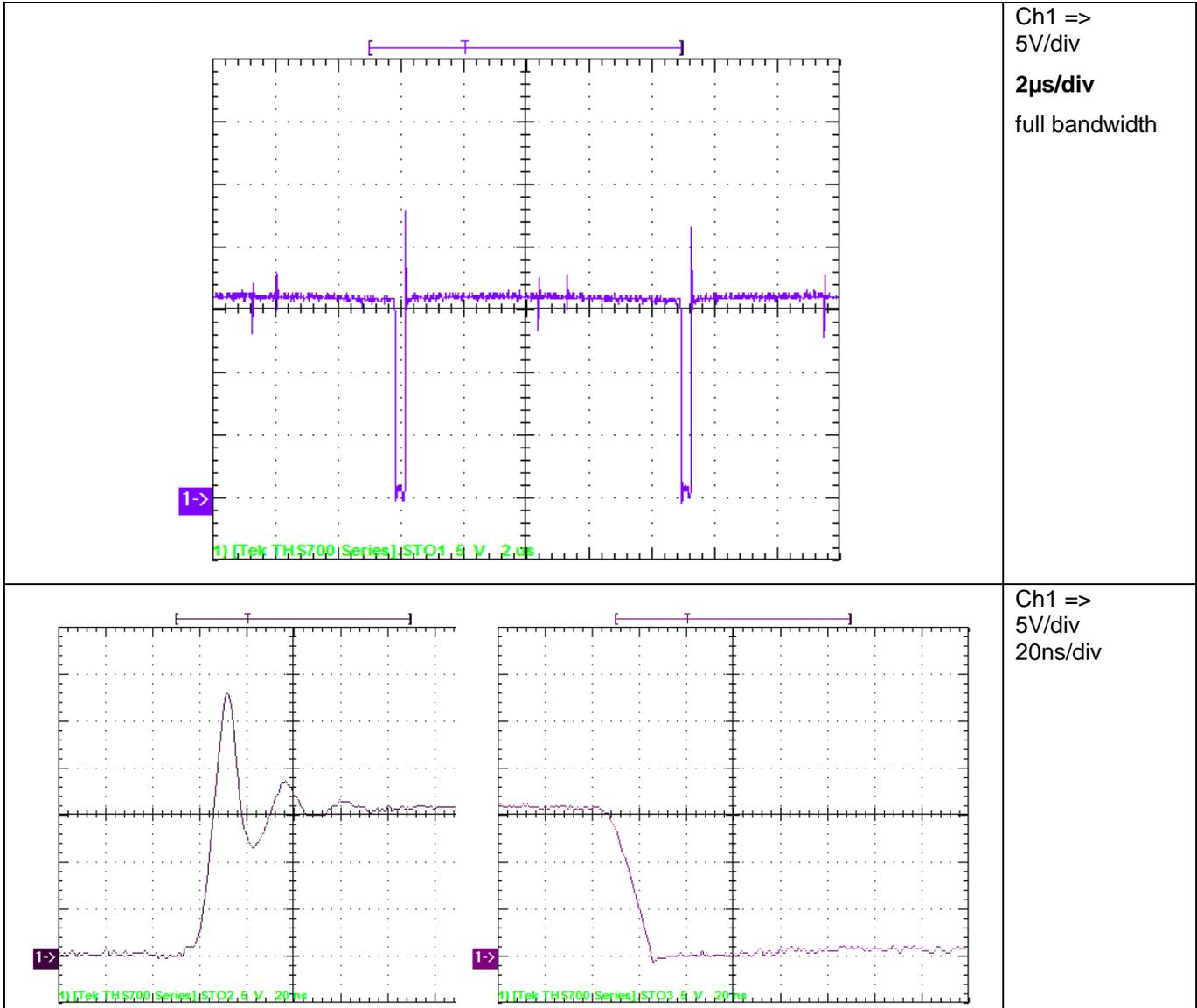


Figure 39

10.3.4.2 Gate Source

The waveform of the **gate-source** voltage is shown in Figure 40 (buck LS)

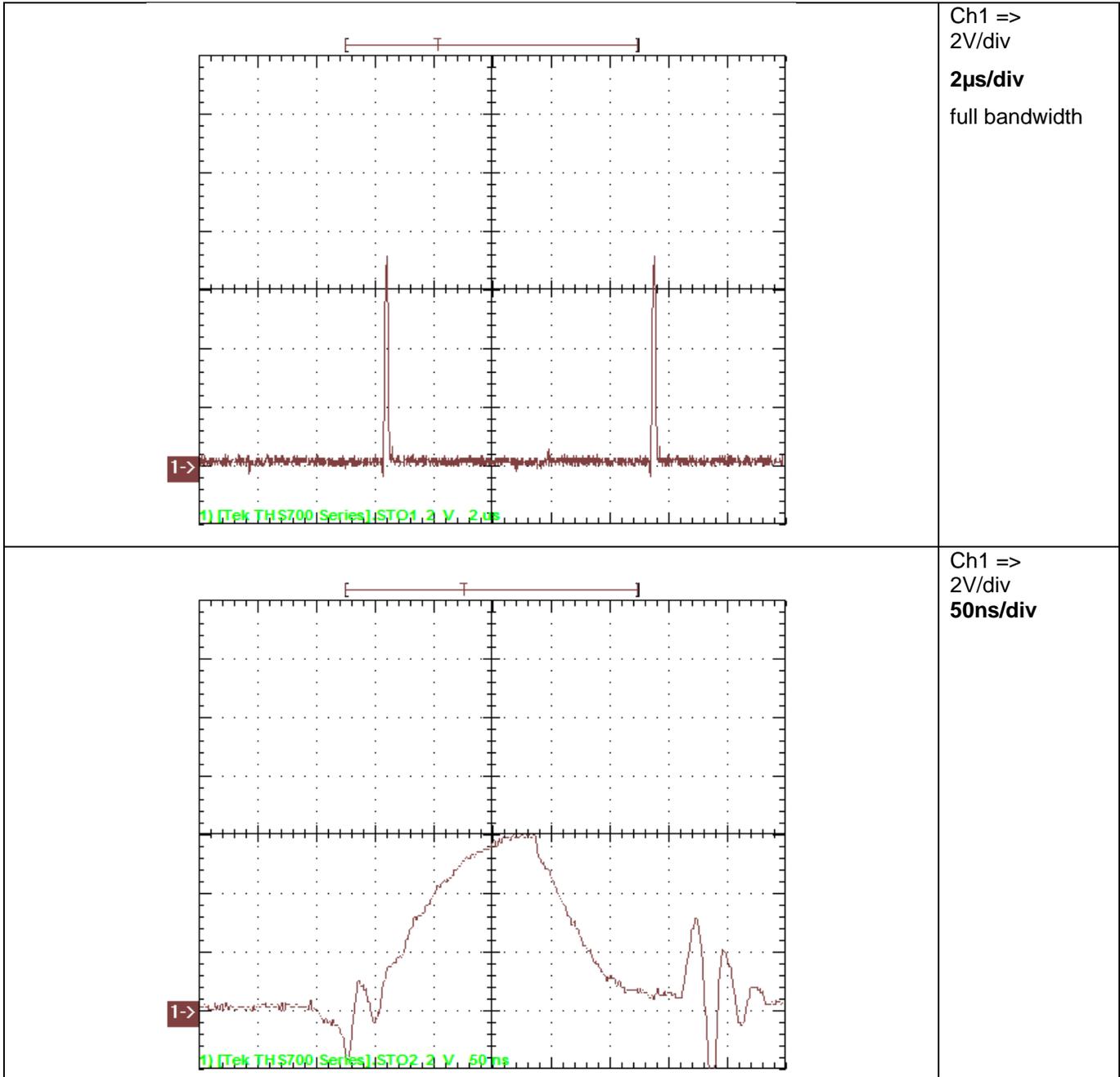


Figure 40

11 Thermal Image

Figure 41 shows the thermal image at 12V input voltage and 18A output current.

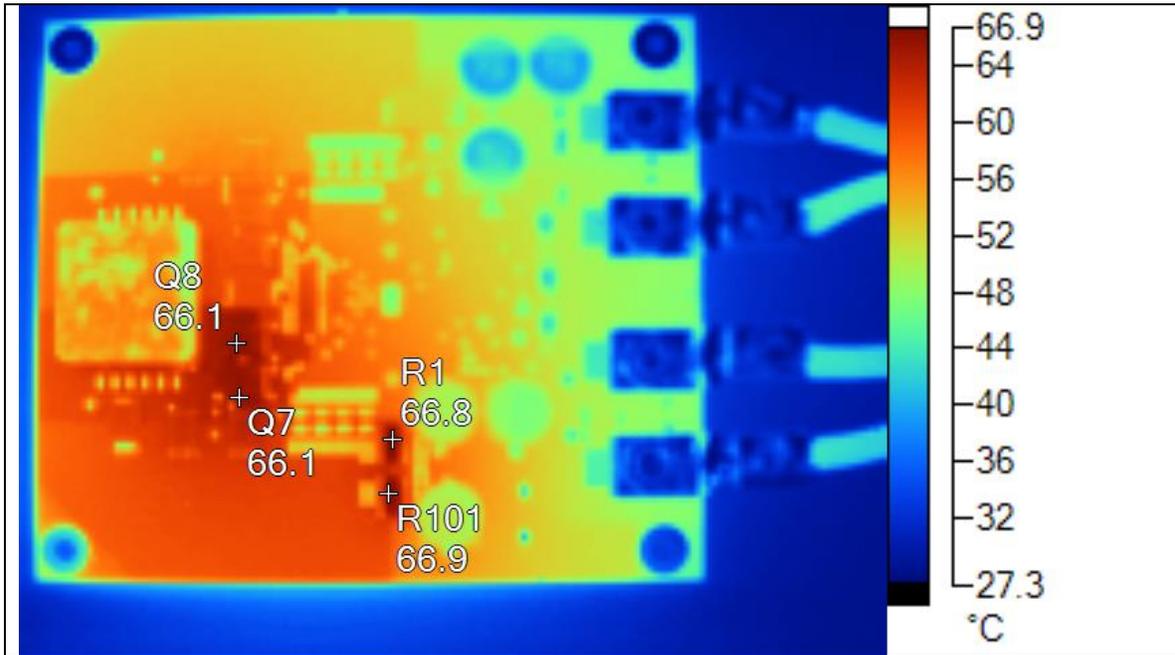


Figure 41

Name	Temperature
R101	66.9°C
Q8	66.1°C
R1	66.8°C
Q7	66.1°C

Figure 43 shows the thermal image at 14V input voltage and 18A output current.

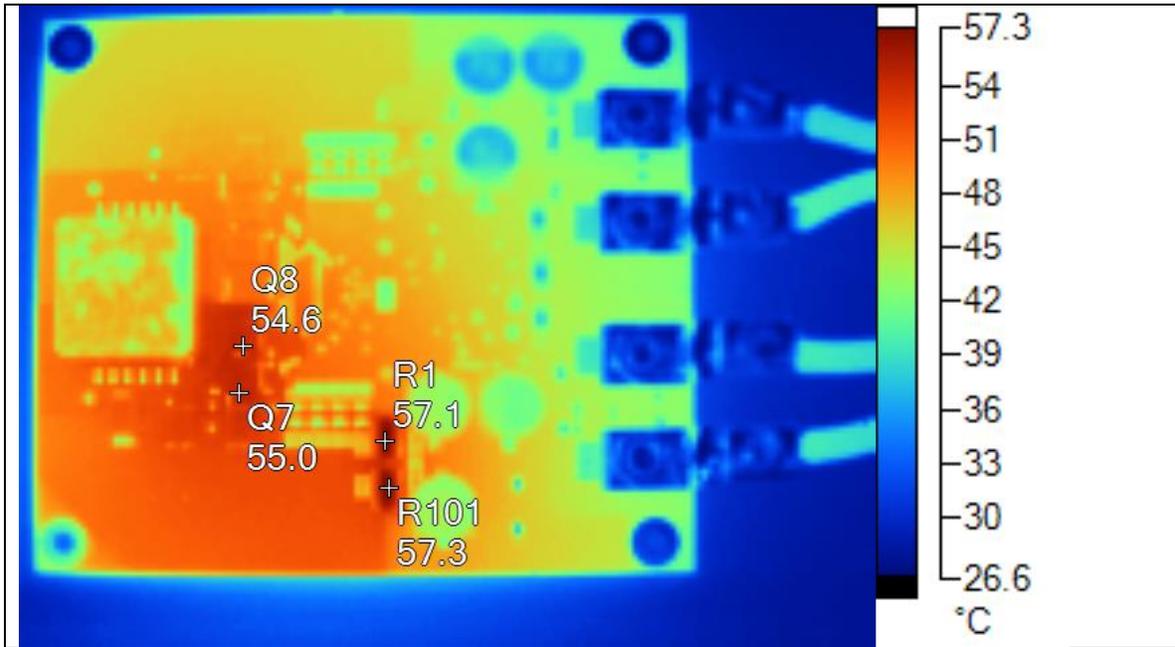


Figure 42

Name	Temperature
R101	57.3°C
Q8	54.6°C
Q7	55.0°C
R1	57.1°C

12 Addendum

12.1 Example of the switching behavior during the buck-boost transition

Figure 43 shows the waveforms of the 2 switchnodes at 16V input voltage

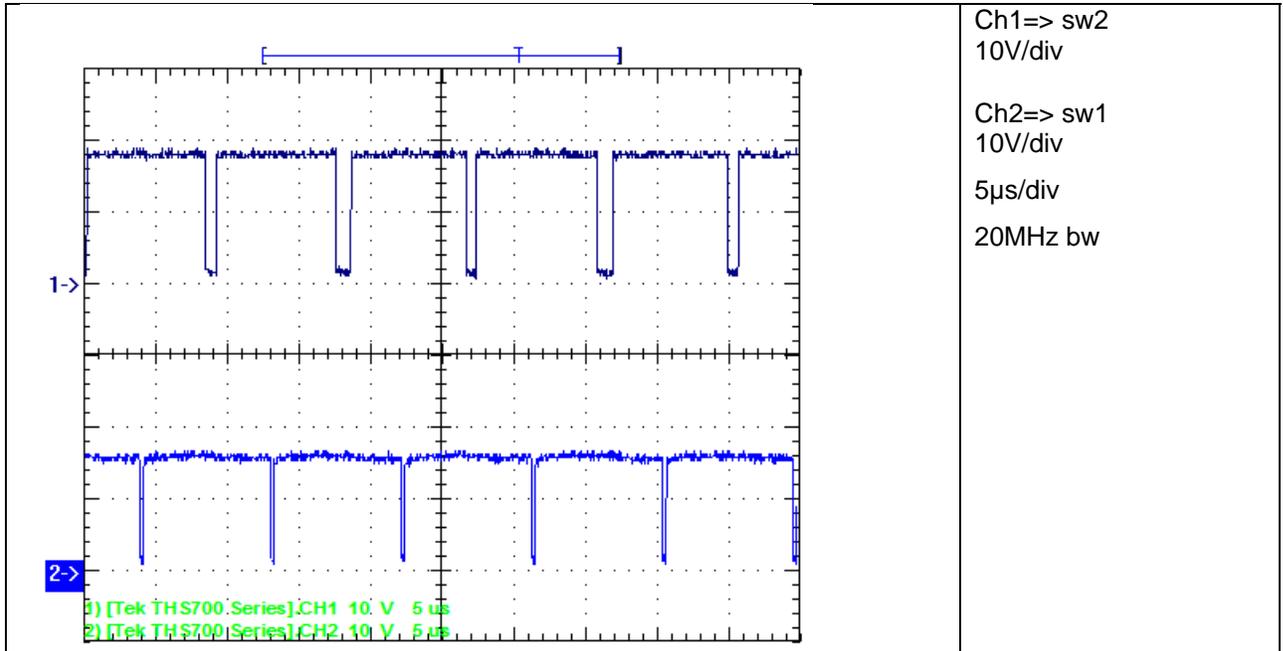


Figure 43

Figure 44 shows the waveforms of the 2 switchnodes at 19.3V input voltage

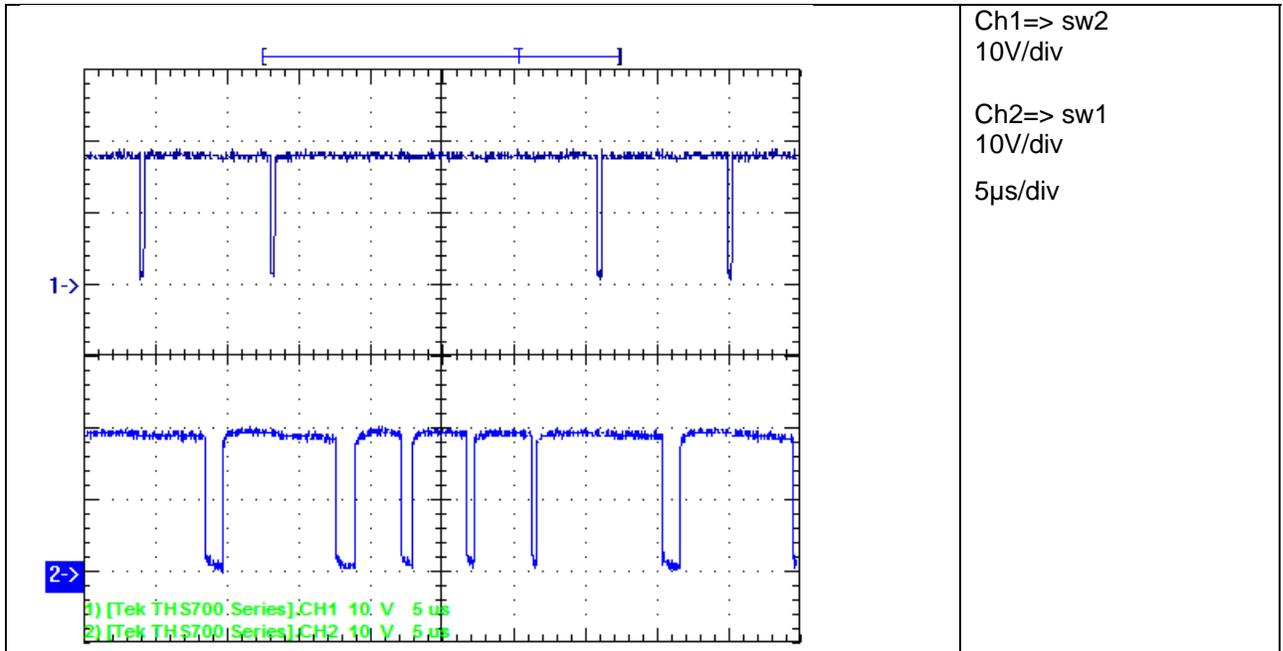


Figure 44

Figure 45 shows the waveforms of the 2 switchnodes at 19.79V input voltage

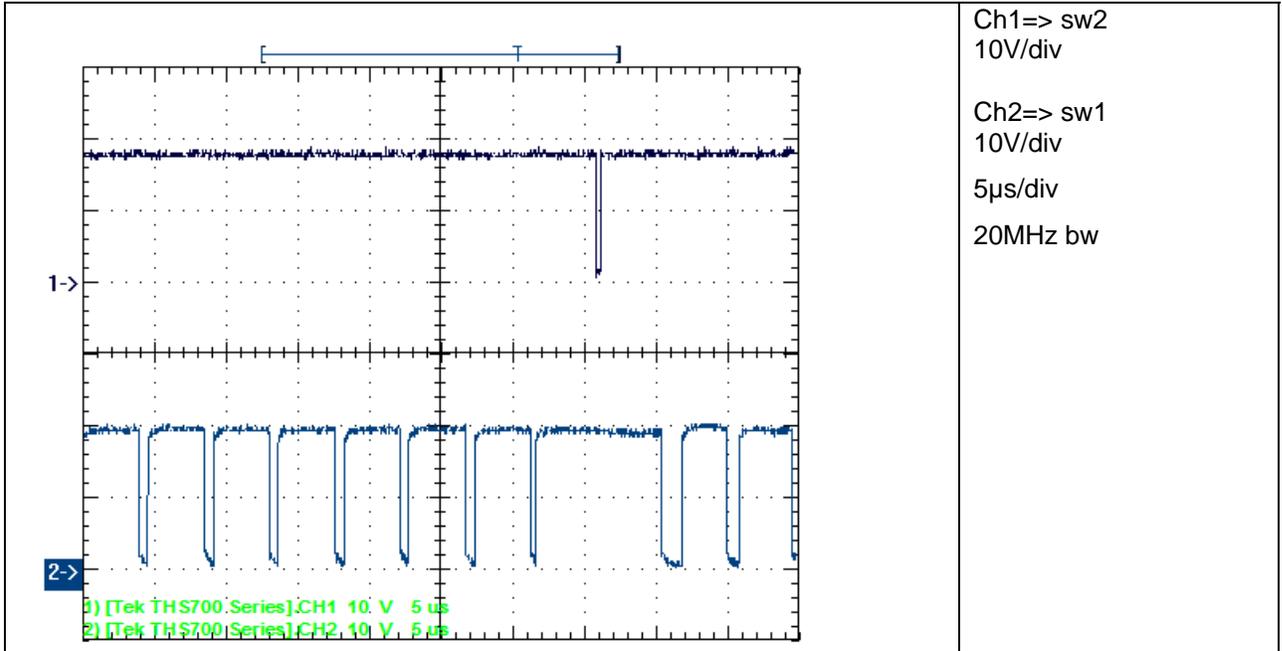


Figure 45

PMP10214RevB Test Results

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