Test Report: PMP23249

Compact LMG3522R030-Q1 650-V, 30-mΩ, Half-Bridge Daughter Card Reference Design

Description

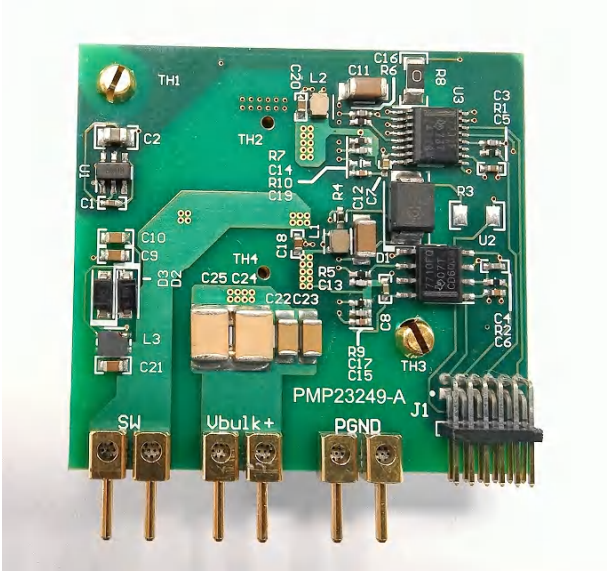
This design configures two LMG3522R030 GaN FETs in a half bridge with the cycle-by-cycle overcurrent protection, latched short-circuit protection function, and all the necessary auxiliary peripheral circuitry. This compact daughter card is designed to work in conjunction with larger systems. The peak efficiency is up to 98% with a smaller PCB size of 37 mm × 40 mm.

Features

- Input voltage operates up to 650 V
- Simple open-loop design to evaluate performance of LMG352xR030
- Cycle-by-cycle overcurrent protection function
- Smaller size allows higher power density

Applications

- Merchant network and server PSU



Top of Board

Bottom of Board

1 Test Prerequisites

The daughter card test results are based on the conjunct mother board PMP23069.

1.1 Voltage and Current Requirements

Table 1-1. Voltage and Current Requirements

Parameter	Specifications
Input Voltage Range	85 VAC to 265 VAC
Output Voltage, Current	380 VDC, 3.6 A

1.2 Required Equipment

- AC Voltage Source
- Electronic load
- Multimeters
- Oscilloscope
- Power meter

1.3 Test Setup

1. Connect the Daughter Card to PMP23069 as Figure 1-1 shows. Figure 1-2 shows the area for connection on the mother board.
2. Place the PMP23069 inside a ventilated HV safety box.
3. Connect the AC power supply to the input connector of the PMP23069 and the **Electronic** load to the output connector.

Figure 1-1. Test Setup (View 1)

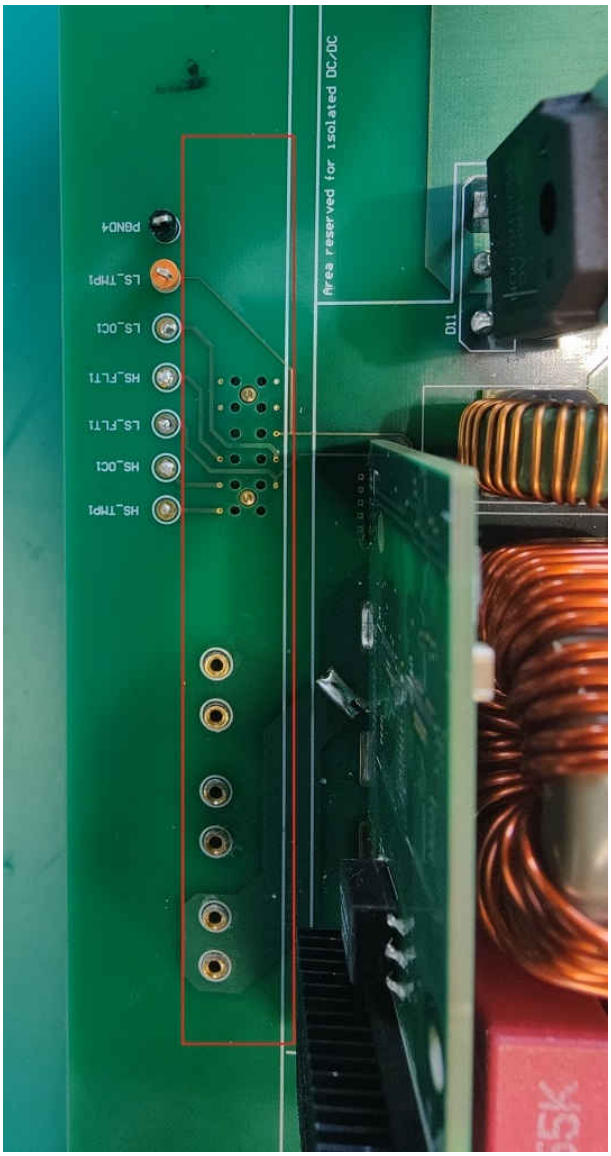


Figure 1-2. Test Setup (View 2)

2 Testing and Results

2.1 Efficiency Graphs

Efficiency is shown in the following figure.

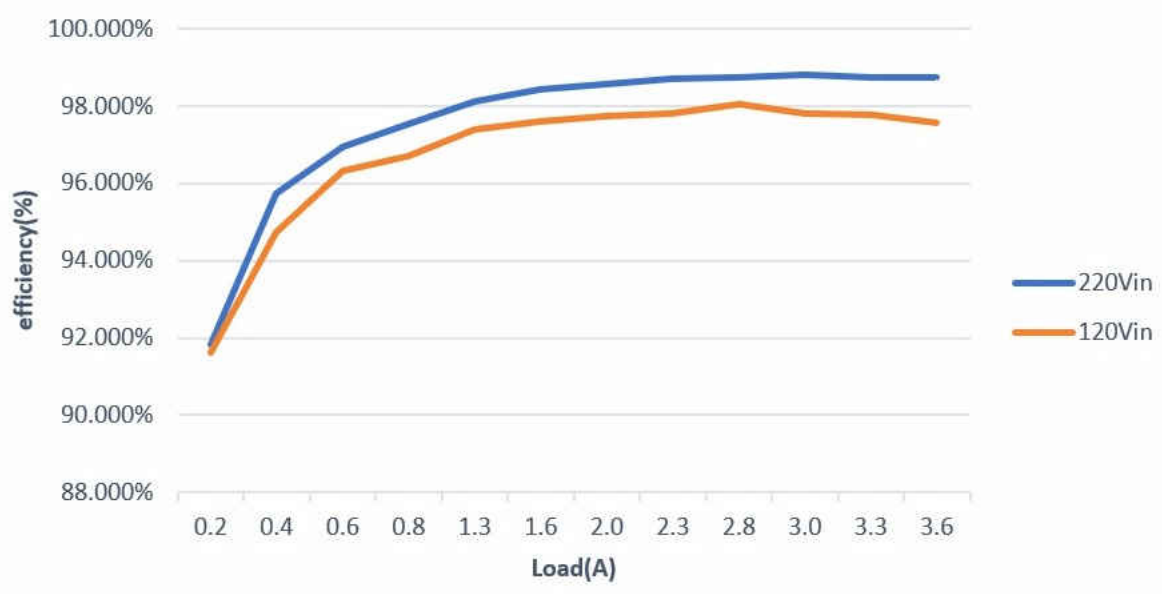


Figure 2-1. Efficiency Graph

2.2 Efficiency Data

Efficiency data for 120 VAC and 220 VAC are shown in the following tables.

Table 2-1. Efficiency Data for 120 VAC Input

V_{IN} (V)	I_{IN} (A)	V_{OUT} (V)	I_{OUT} (A)	P_{IN} (W)	P_{OUT} (W)	Efficiency (%)	PF
119.68	0.6862	381.24	0.2	81.1	74.3	91.615	0.6987
119.64	1.1555	381.38	0.4	163.5	154.9	94.74	0.8864
119.5	1.657	381.25	0.6	239	230.2	96.318	0.94
119.36	2.172	381.25	0.8	315.5	305.1	96.704	0.9614
119.03	3.4627	381.1	1.3	507.1	493.8	97.377	0.983
118.91	4.282	380.9	1.6	626.2	611.2	97.605	0.9881
118.6	5.33	381.1	2	779.8	762.2	97.743	0.9919
118.42	6.1278	381.06	2.3	895.2	875.6	97.811	0.9935
118.24	6.932	381.88	2.8	1007.4	987.6	98.035	0.9946
118	7.755	380.24	3	1127.4	1102.7	97.809	0.9953
117.82	8.805	381	3.3	1282	1253.5	97.77	0.9958
117.6	9.638	380.0556	3.6	1402.4	1368.2	97.561	0.9961

Table 2-2. Efficiency Data for 220 VAC Input

V_{IN} (V)	I_{IN} (A)	V_{OUT} (V)	I_{OUT} (A)	P_{IN} (W)	P_{OUT} (W)	Efficiency (%)	PF
219.84	0.6595	381.23	0.2	80.8	74.2	91.832	0.4043
219.78	0.7936	381.21	0.4	161.7	154.8	95.733	0.6623
219.7	1.0114	381.23	0.6	237.2	229.9	96.922	0.791
219.62	1.2627	381.23	0.8	312.7	305	97.538	0.8615
219.48	1.795	381.23	1.2	464.2	455.4	98.104	0.9277
219.34	2.3594	381.23	1.6	621.1	611.2	98.406	0.9563
219.2	2.91	381.22	2	772.5	761.5	98.576	0.9703
219.13	3.463	381.2	2.4	924.1	912	98.691	0.9786
218.99	4.021	381.11	2.8	1075.7	1062.2	98.745	0.9837
218.88	4.322	381.1	3	1156.8	1143	98.807	0.9857
218.79	4.743	380.9	3.3	1271.3	1255.4	98.749	0.9879
218.68	5.1625	381	3.6	1385.3	1367.6	98.722	0.9896

2.3 Thermal Images

The thermal images are shown in Figure 2-3 and Figure 2-4.

The thermal images were collected under the following conditions:

- Input: 230 VAC
- Output: 380 V, 1.3 kW
- Fan: FFB0412EN-00
- Ambient temperature: 25°C
- Time: 30 minutes

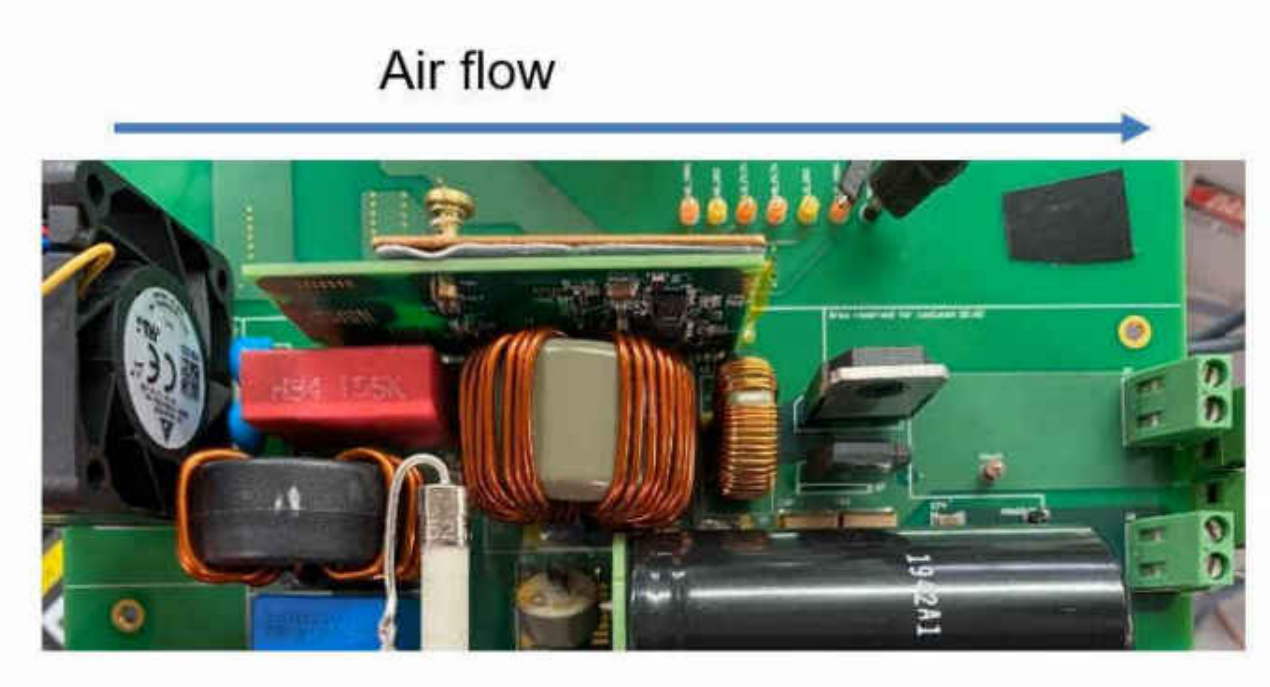


Figure 2-2. Test Setup With Air Flow

Figure 2-3. Backside of GaN FET Daughter Card

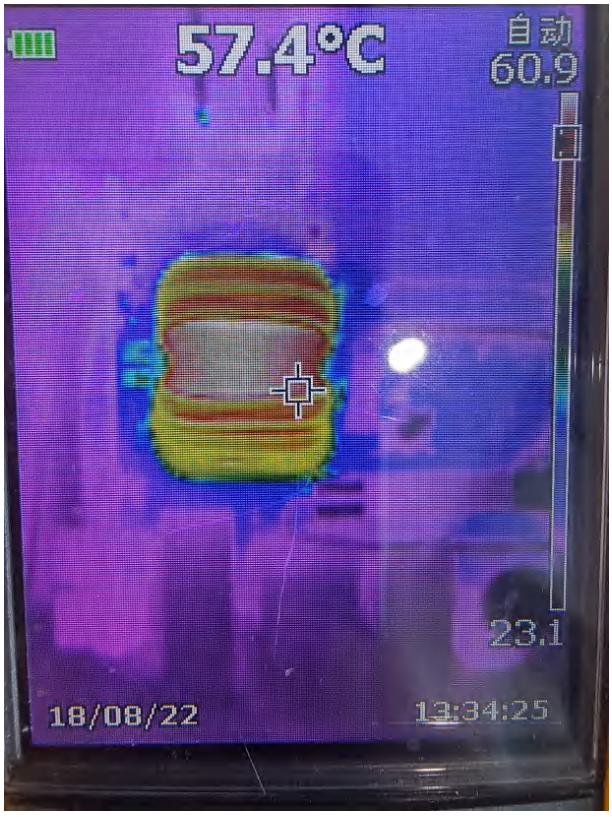


Figure 2-4. PFC Inductor

The thermal simulation conditions and results are shown in Table 2-3, Figure 2-5, and Table 2-4.

Table 2-3. Conditions

FET | Package (× 2)	LMG3522R030-Q1 | 12 × 12 mm
System Power	3-kW PFC
Power loss per GaN FET	13.9 W [target $R_{\theta JA}$ = (125°C – 55°C) / 13.9 W = < 5°C/W]
Total power loss into heat sink	27.8 W (2 × GaN)
PCB size	40 mm × 37 mm
Heat sink size	35 mm × 26 mm × 9.2 mm

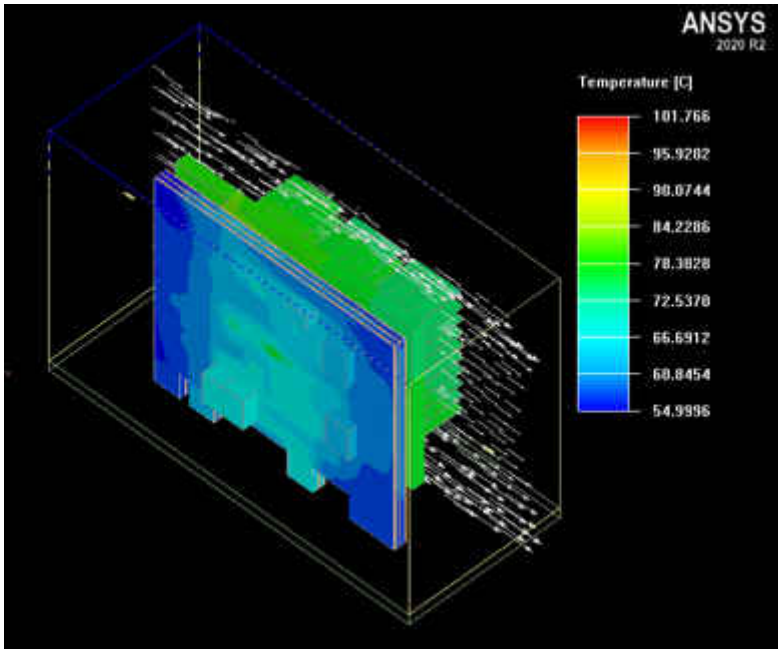


Figure 2-5. Thermal Simulation Result

Table 2-4. Simulation Results

Air Speed (m/s)	TIM k W/mK (0.5-mm Thick)	$T_{A\ (°C)}$	P (W)	GaN 1 (°C)	GaN 2 (°C)	GaN 1 $R_{\theta JA}$ (C/W)	GaN2 $R_{\theta JA}$ (C/W)
12	13	55	13.9	97.7	101.8	3.07	3.37

Figure 2-6 shows the heat sink specification.

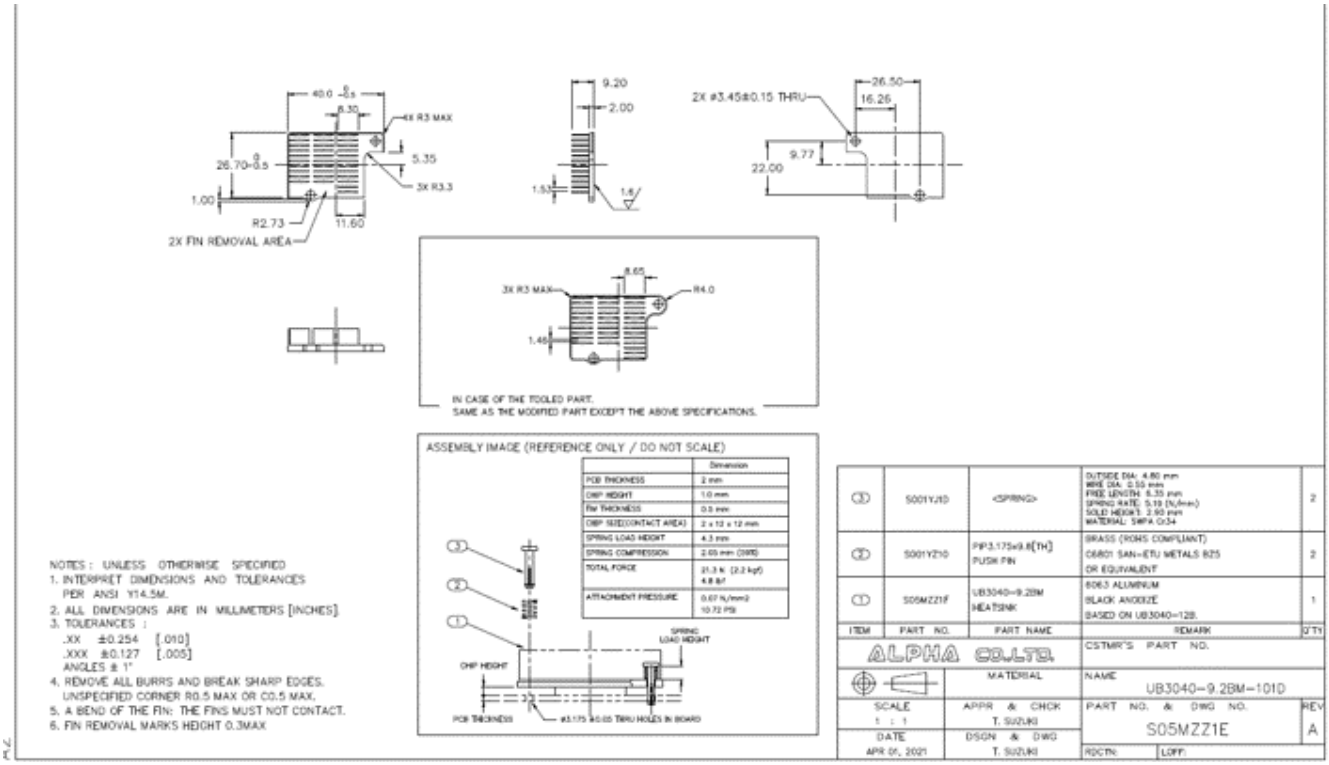
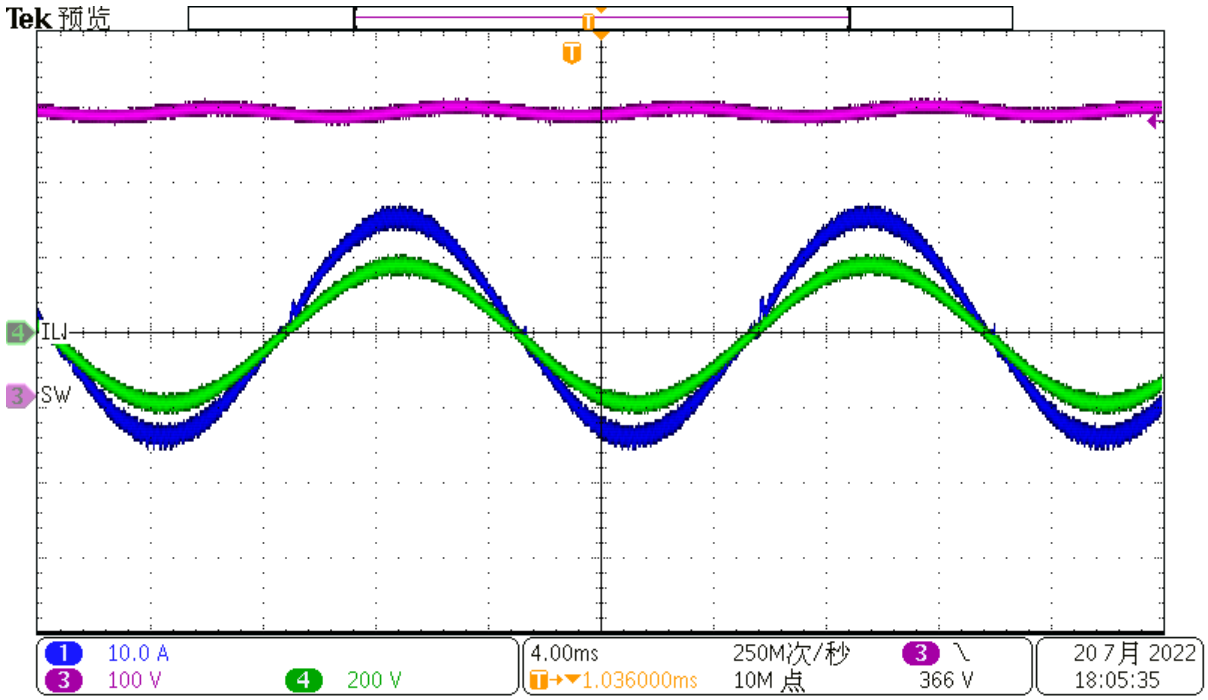


Figure 2-6. Heat Sink Specification

3 Waveforms

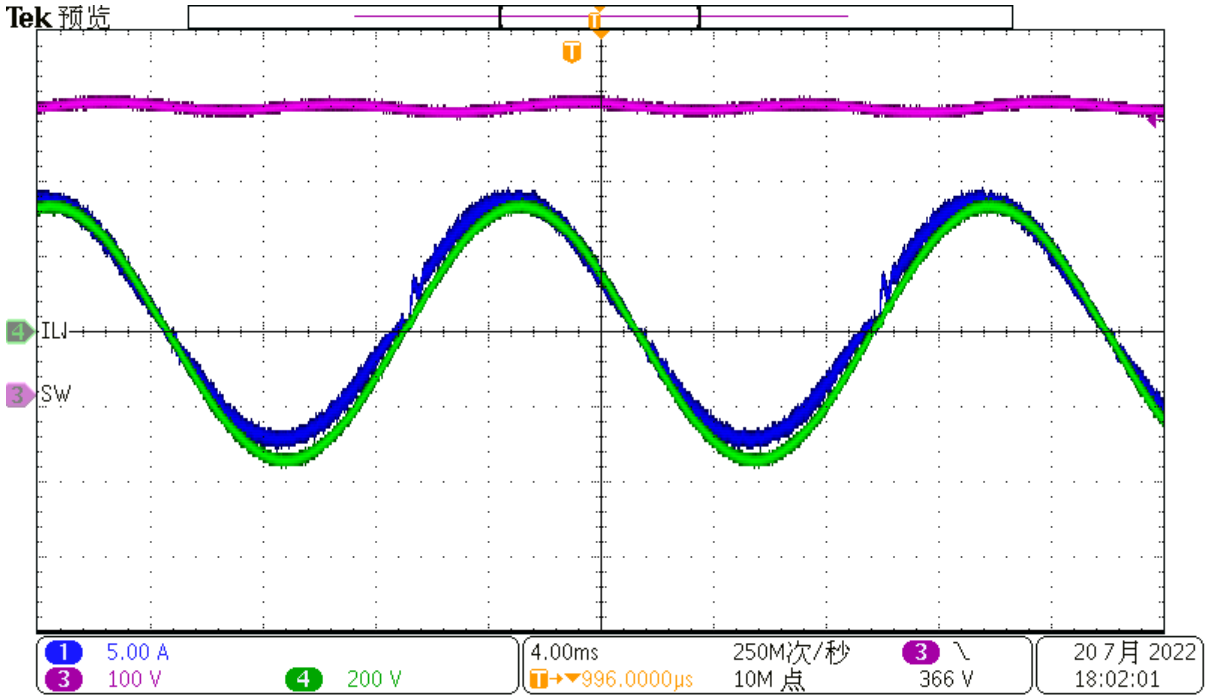
3.1 Steady State

Steady state waveforms are shown in the following images.



CH1: Input Current, CH3: Output Voltage, CH4: Input Voltage

Figure 3-1. 110 VAC, 1.3 kW



CH1: Input Current, CH3: Output Voltage, CH4: Input Voltage

Figure 3-2. 220 VAC, 1.3 kW

3.2 Switching

Switching behavior is shown in the following figures.

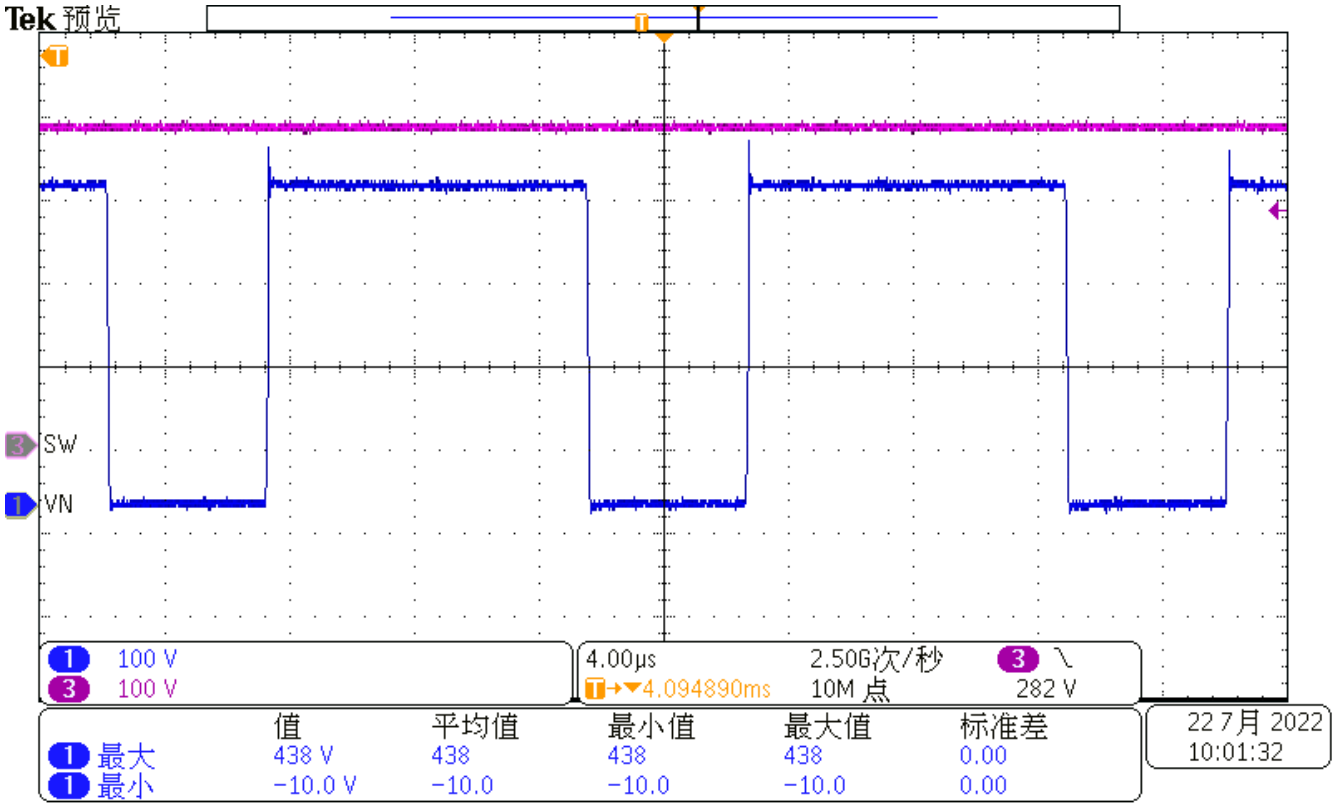


Figure 3-3. CH1: VDS Voltage CH3: Output Voltage

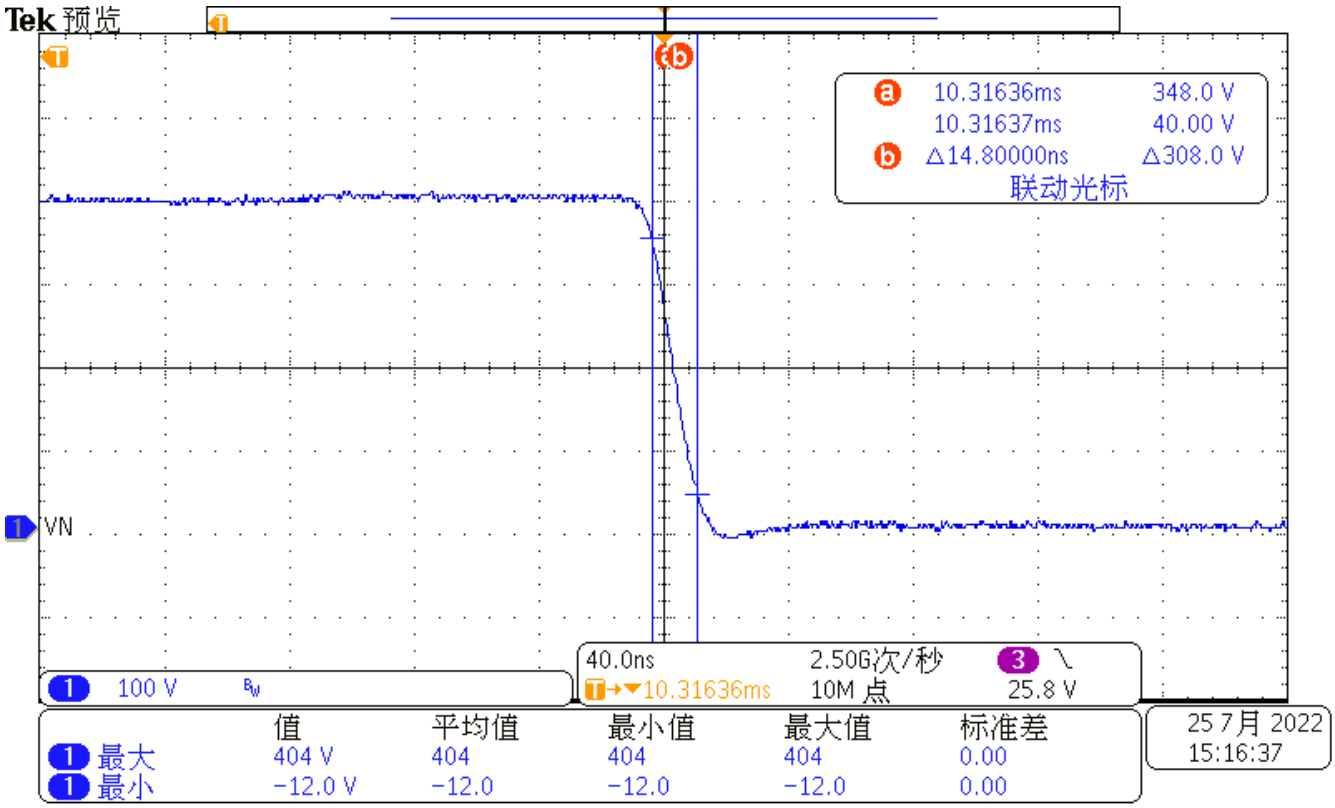


Figure 3-4. Falling Edge of VDS

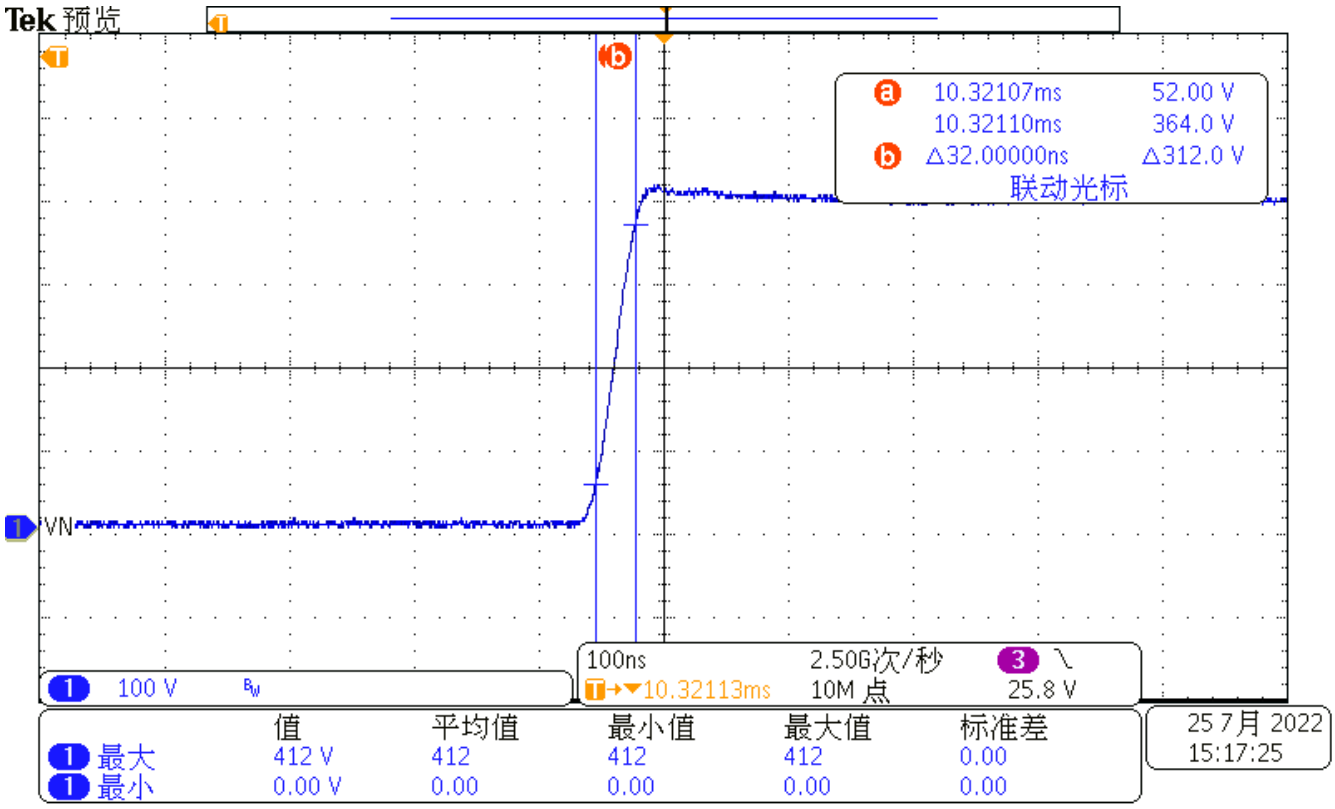


Figure 3-5. Rising Edge of VDS

3.3 Load Transients

The load transients waveforms were captured at 220 VAC with slew rate = 1 A/µs, CH1: Input current, CH3: Output voltage.

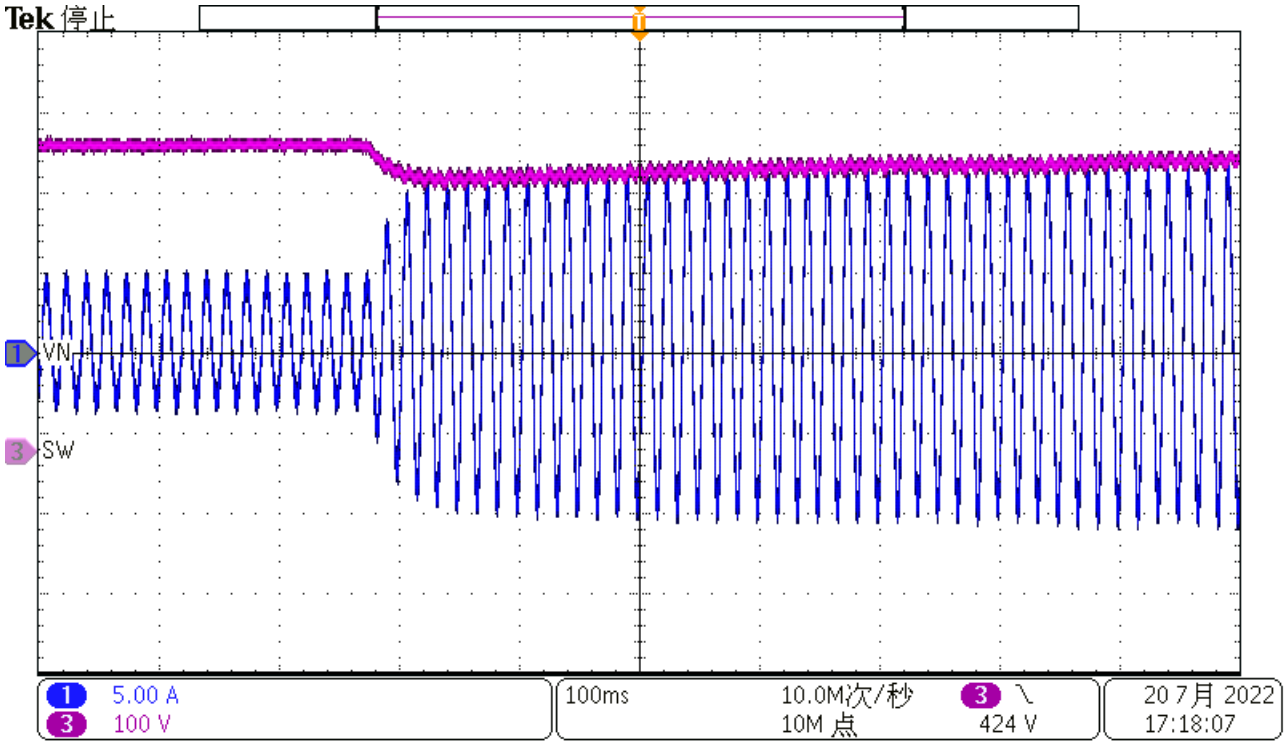


Figure 3-6. 220 VAC, 50% Load to 100% Load Transient

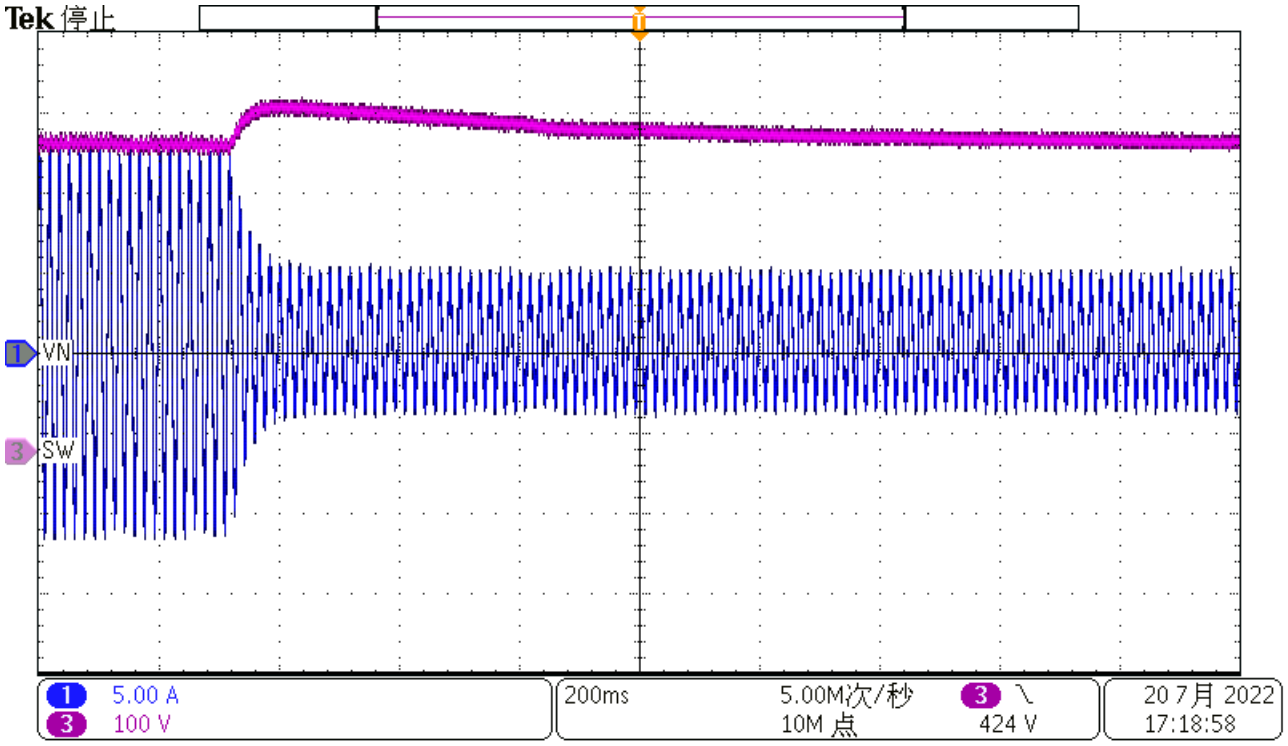


Figure 3-7. 220 VAC, 100% Load to 50% Load Transient

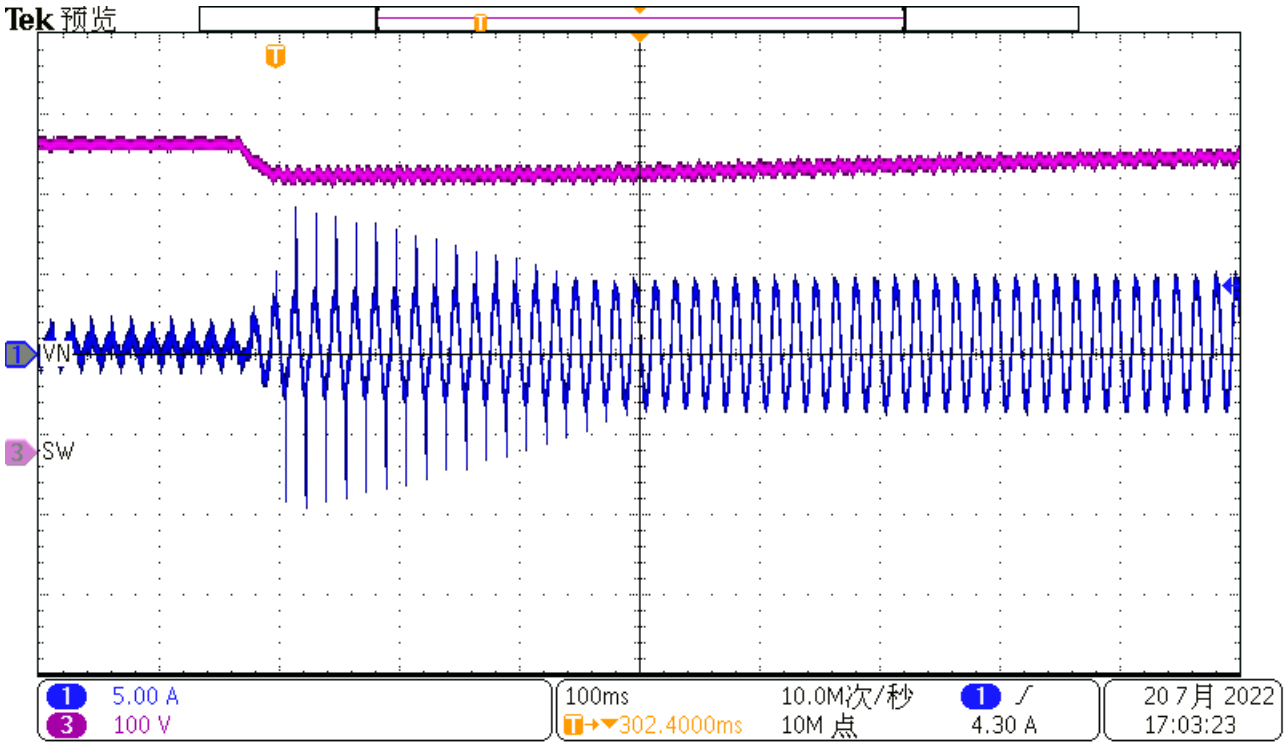


Figure 3-8. 220 VAC, 0% Load to 50% Load Transient

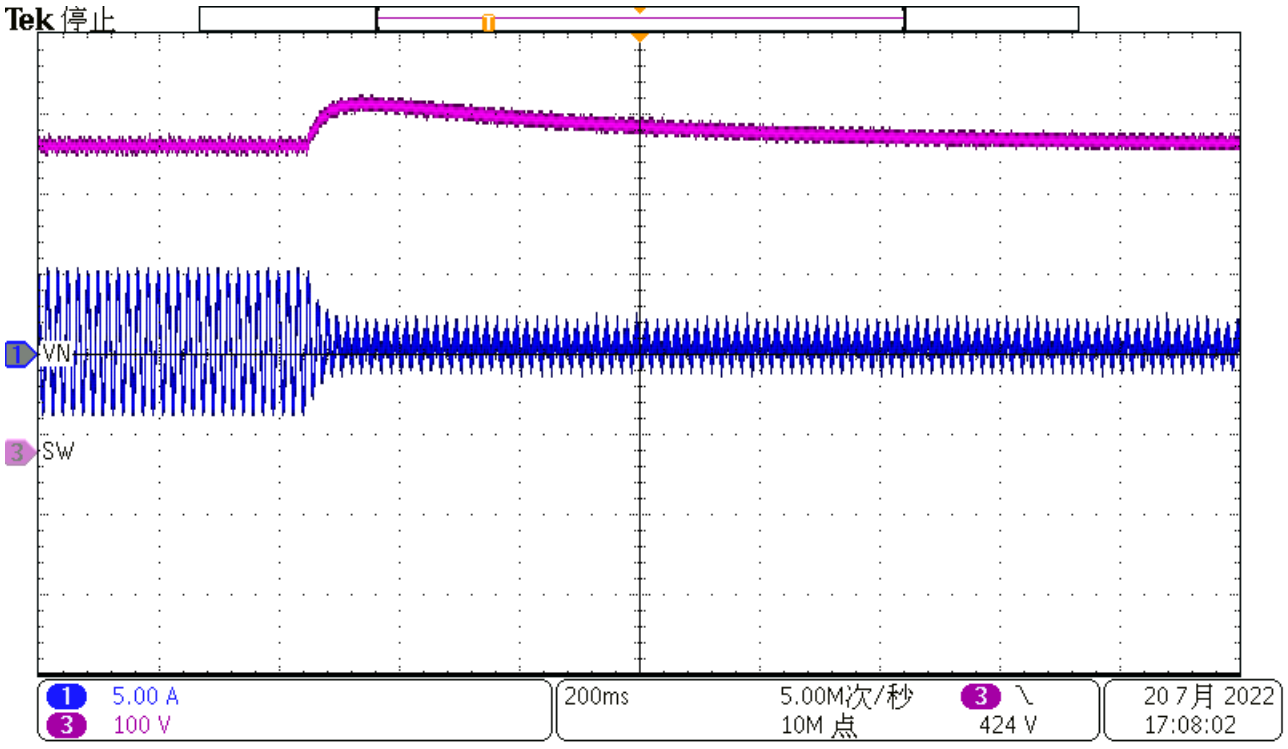


Figure 3-9. 220 VAC, 50% Load to 0% Load Transient

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