

IGBT and SiC Gate Drive Auxiliary PSU Reference Design with Planar Transformer



Description

This reference design introduces a tiny auxiliary power supply unit (PSU) used to supply automotive insulated-gate bipolar transistor (IGBT) or automotive silicon carbide (SiC) drive. The isolated outputs support three gate controls, each supplied with +21.2V, 2W output. This design uses the planar transformer to reduce the board height and cost. The LM25184-Q1 controller supports primary-side regulation by controlling the flyback voltage from secondary side. There is no need for an additional auxiliary winding. The board maximum efficiency is 89.2%. The design uses six PCB layers, and the temperature rise is just 16°C with full load 6W.

Features

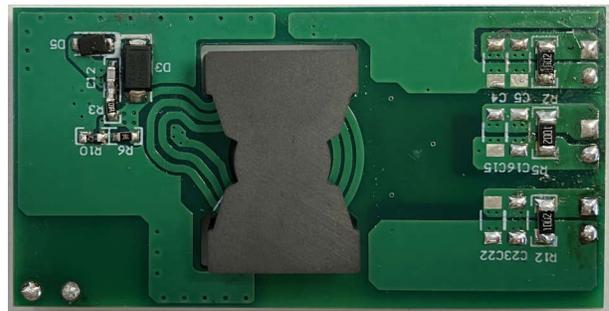
- Primary-side regulation flyback for three outputs (+21.2V, 2W) with planar transformer
- Peak efficiency 89.2% at 6W full load
- Temperature rise only 16°C at full load
- Compact size in 57mm × 29mm × 9mm

Applications

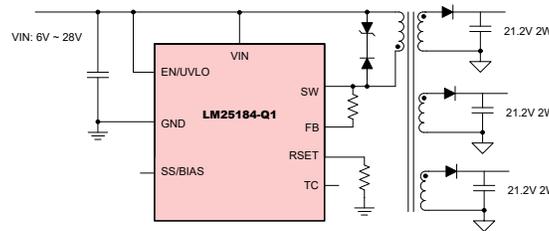
- [DC/DC converter system](#)



Top of Board



Bottom of Board



Block Diagram

1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1-1. Voltage and Current Requirements

PARAMETER	SPECIFICATIONS
Input Voltage	6VDC - 28VDC
Output voltage	21.2V, three rails
Output power	2W for each rail
IC	LM25184QNGURQ1

1.2 Required Equipment

- Multimeter: Fluke 287C
- DC Source: Chroma 62006P-100-50
- E-Load: Chroma 63103A module
- Oscilloscope: Tektronix DPO4104B
- Electrical thermography: Fluke TIS55

1.3 Dimensions

The board dimensions are 57mm (length) by 29mm (width) by 9mm (height).

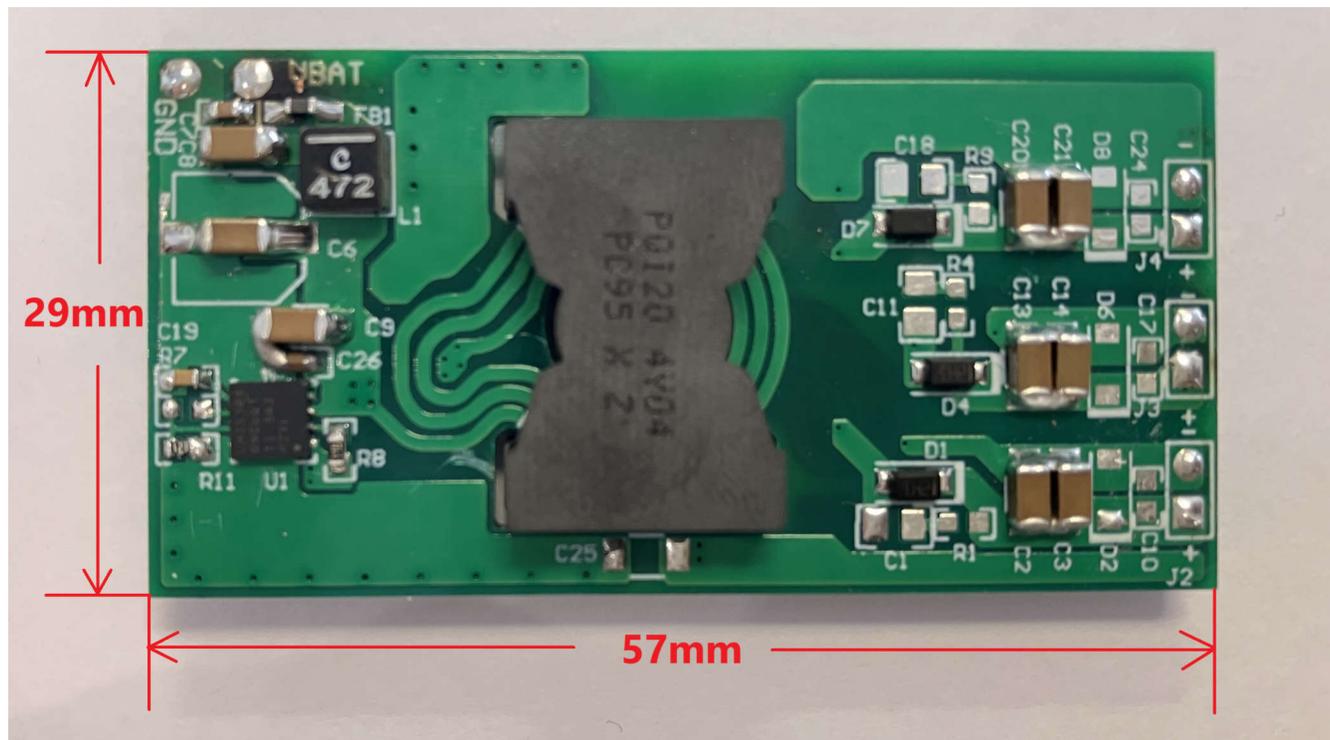


Figure 1-1. Board Dimensions

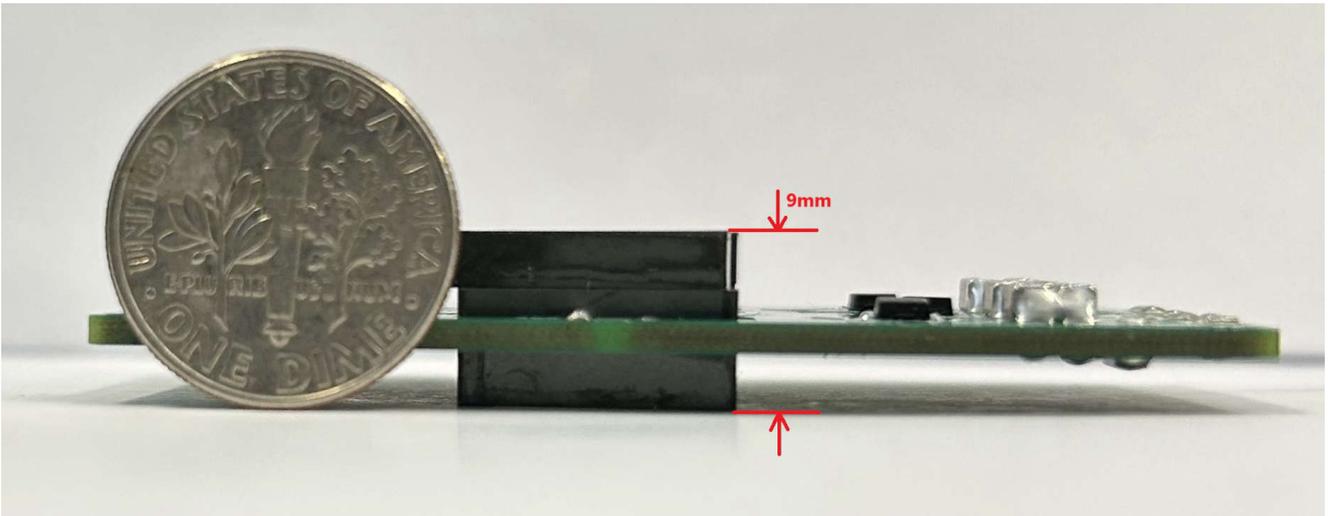


Figure 1-2. Board Dimensions

2 Testing and Results

2.1 Efficiency Graphs

Efficiency is shown in [Figure 2-1](#).

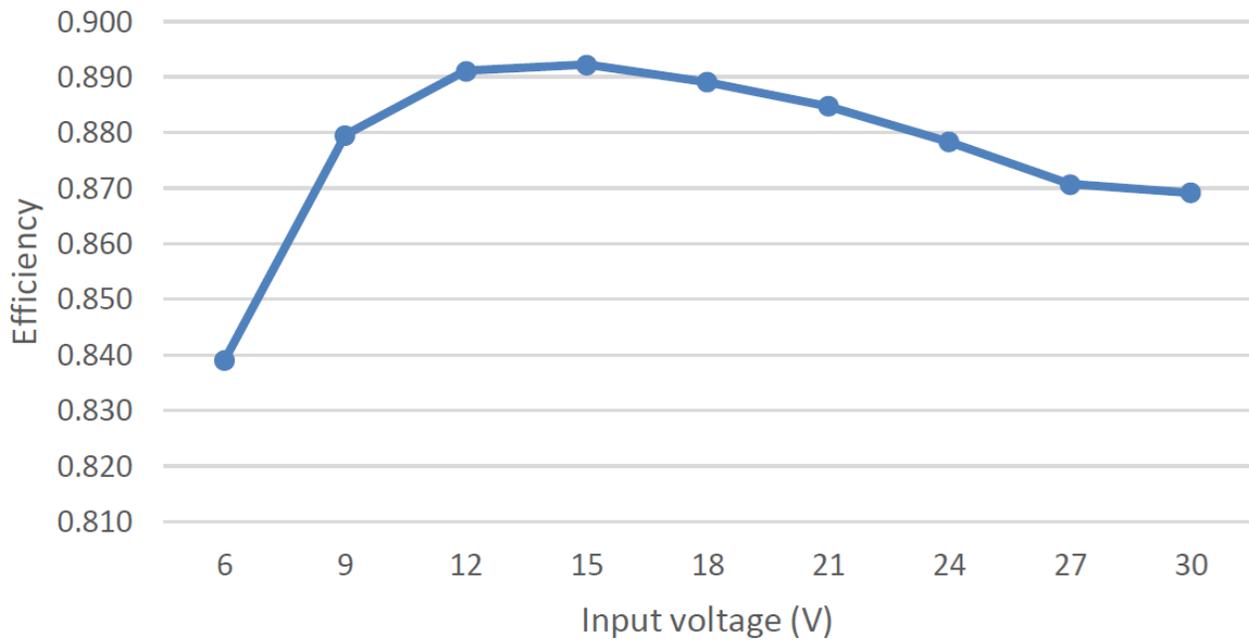


Figure 2-1. Efficiency Graph

2.2 Efficiency Data

Table 2-1. Efficiency Data

V_{in} (V)	I_{in} (A)	V_{o1} (V)	I_{o1} (A)	V_{o2} (V)	I_{o2} (A)	V_{o3} (V)	I_{o3} (A)	EFFICIENCY
6.062	1.242	21.219	0.0995	21.203	0.0984	21.19	0.1	0.839
9.063	0.7929	21.234	0.0997	21.219	0.0984	21.2	0.0998	0.880
12	0.5912	21.233	0.0995	21.234	0.0986	21.2	0.0998	0.891
15.005	0.4723	21.235	0.0995	21.234	0.0984	21.21	0.1	0.892
18.053	0.3939	21.24	0.0995	21.242	0.0984	21.21	0.0999	0.889
21.014	0.34	21.24	0.0995	21.242	0.0984	21.22	0.0998	0.885
23.994	0.3	21.244	0.0995	21.25	0.0984	21.22	0.0998	0.878
27.061	0.2685	21.244	0.0995	21.25	0.0986	21.22	0.0998	0.871
28.084	0.259	21.243	0.0995	21.25	0.0984	21.22	0.0998	0.869

2.3 Load Regulation

Table 2-2. Load Regulation

V_{o1} (V)	I_{o1} (A)	V_{o2} (V)	I_{o2} (A)	V_{o3} (V)	I_{o3} (A)
21.51	0	21.5	0	21.49	0
23.049	0	22.742	0	21.33	0.1
22.908	0	21.367	0.1	22.81	0
21.33	0.1	22.688	0	22.9	0
23.124	0	21.258	0.1	21.22	0.1
21.229	0.1	22.406	0	21.2	0.1
21.238	0.1	21.25	0.1	22.83	0
21.233	0.1	21.234	0.1	21.2	0.1

2.4 Thermal Images

Thermal image is shown in [Figure 2-2](#) through [Figure 2-4](#).

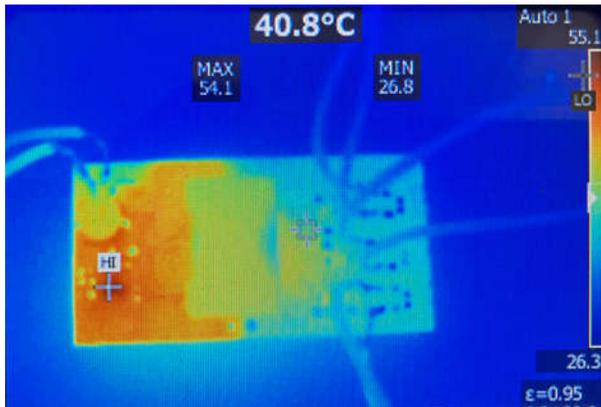


Figure 2-2. Thermal Image, 6V Input, Full Load

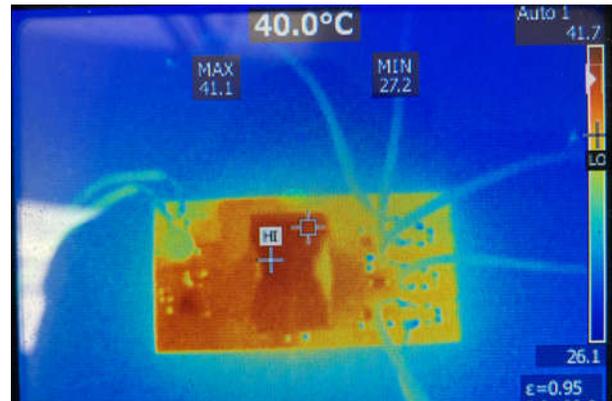


Figure 2-3. Thermal Image, 12V Input, Full Load

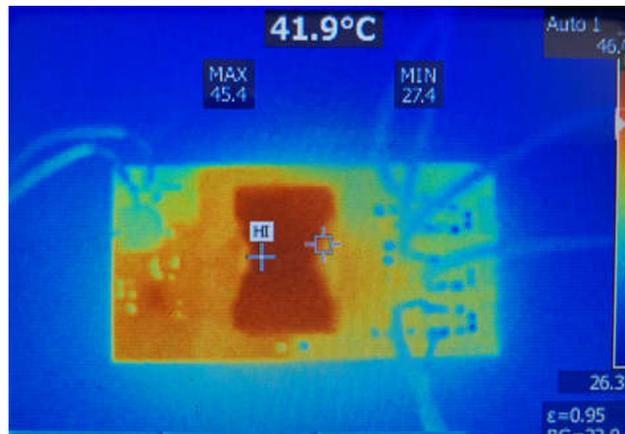


Figure 2-4. Thermal Image, 28V Input, Full Load

3 Waveforms

3.1 Switching

Switching behavior is shown in [Figure 3-1](#) through [Figure 3-3](#).

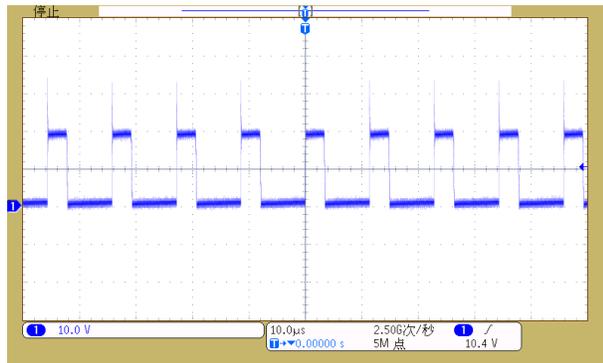


Figure 3-1. Switching, 6V Input, Full Load

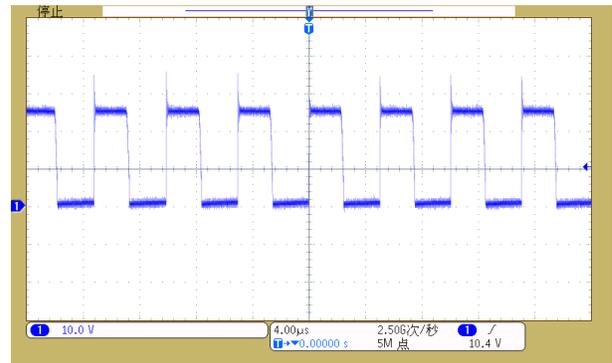


Figure 3-2. Switching, 12V Input, Full Load

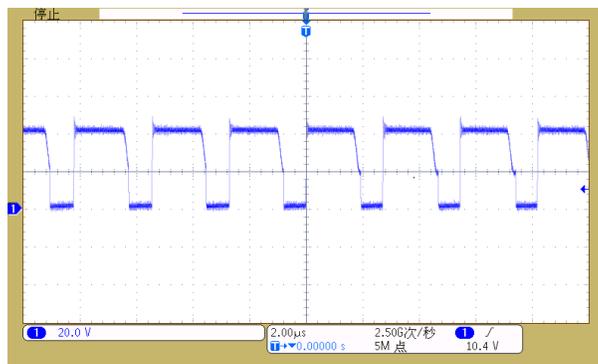


Figure 3-3. Switching, 28V Input, Full Load

3.2 Output Voltage Ripple

Output voltage ripple is shown in [Figure 3-4](#) through [Figure 3-9](#).

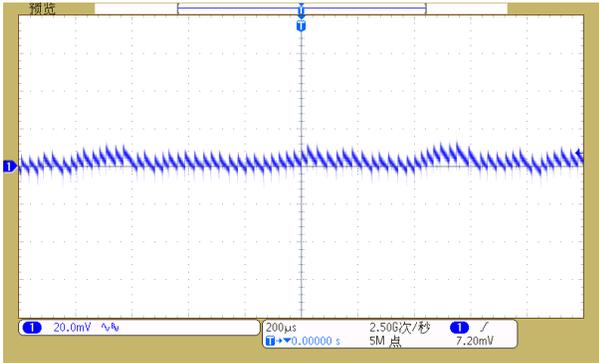


Figure 3-4. VOUT1 Output Voltage Ripple, 12V Input, No Load

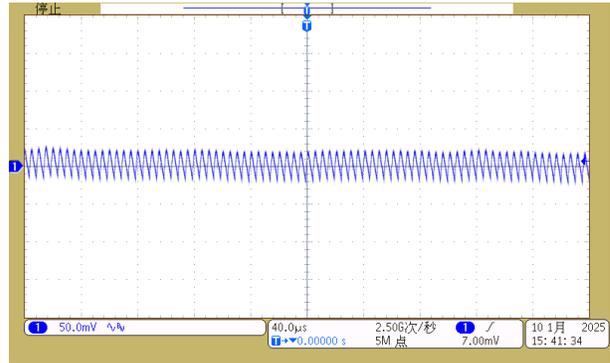


Figure 3-5. VOUT1 Output Voltage Ripple, 12V Input, Full Load

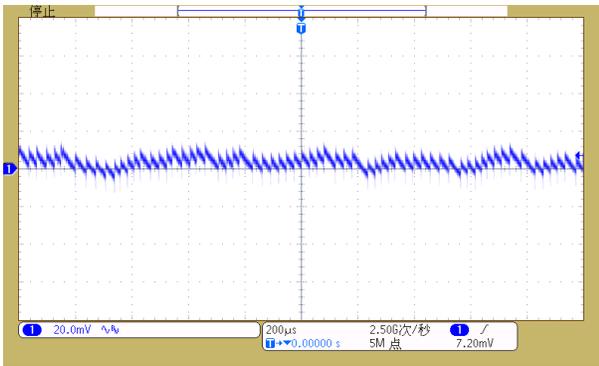


Figure 3-6. VOUT2 Output Voltage Ripple, 12V Input, No Load

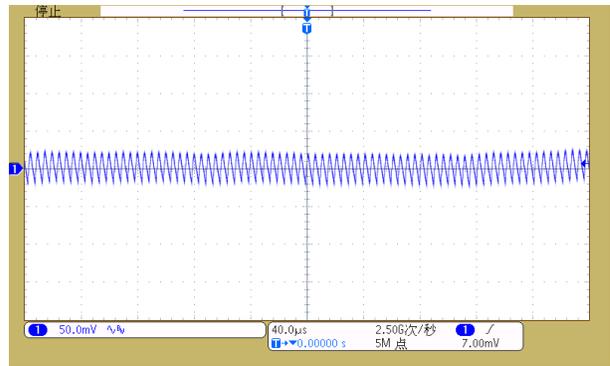


Figure 3-7. VOUT2 Output Voltage Ripple, 12V Input, Full Load

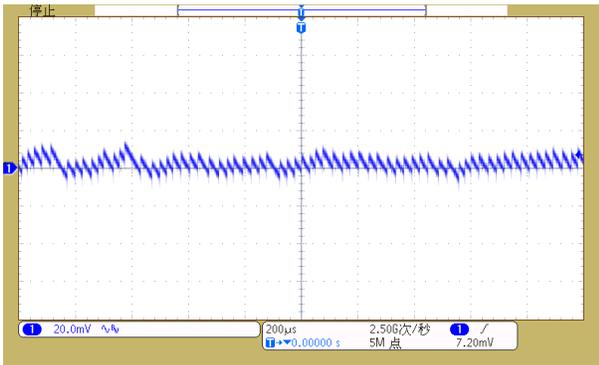


Figure 3-8. VOUT3 Output Voltage Ripple, 12V Input, No Load

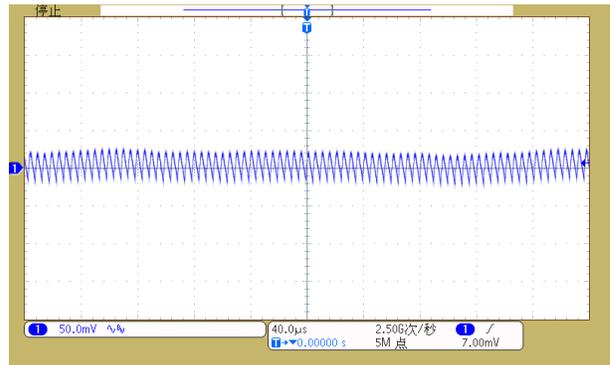


Figure 3-9. VOUT3 Output Voltage Ripple, 12V Input, Full Load

3.3 Load Transients

Load transient response is shown in Figure 3-10 through Figure 3-12.

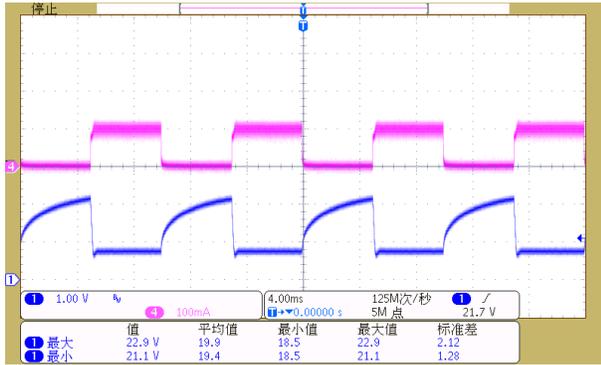


Figure 3-10. V_{out1} Load Transient, 0A to 100mA, 100mA/us, 12V Input

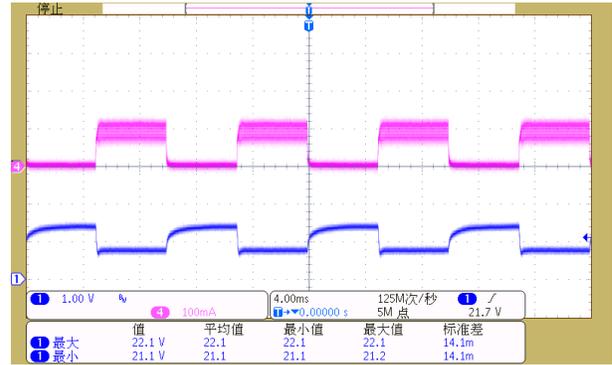


Figure 3-11. V_{out2} Load Transient, 0A to 100mA, 100mA/us, 12V Input

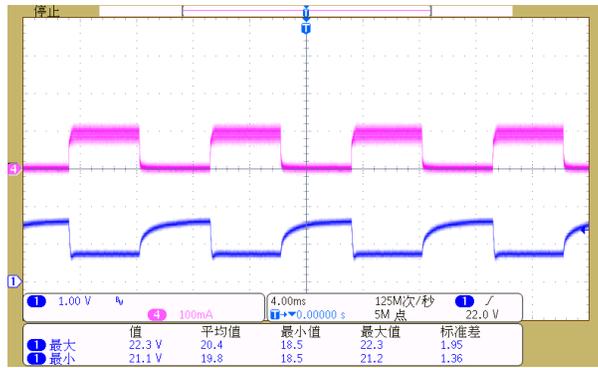


Figure 3-12. V_{out3} Load Transient, 0A to 100mA, 100mA/us, 12V Input

3.4 Start-up Sequence

Start-up behavior is shown in [Figure 3-13](#) and [Figure 3-14](#).

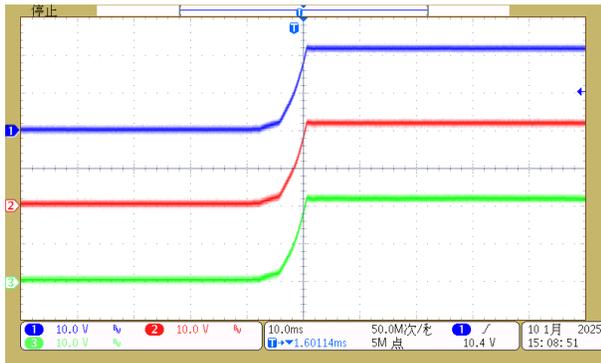


Figure 3-13. Start-Up Waveform, 12V Input, No Load

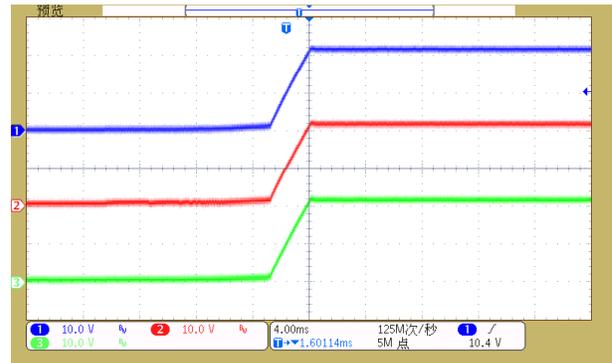


Figure 3-14. Start-Up Waveform, 12V Input, Full Load

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