Test Report of Bidirectional DC source

TEST DATE: 26 May, 2023

TESTER: Shawn Qiu

SERIAL NO: B22450100.01

MODEL: BSL 200-1000-800

Specification: P_{RATED}= 200 kW, V_{RATED}= 5~1000 V, I_{RATED}= ±800 A

No.	Instruments	Model
1	Power Analyzer	ZIMMER LMG670
2	Oscilloscope	Tektronix MSO44
3	Voltage Probe	RIGOL RP1050D
4	Current Probe	PINTECH PT740-3A
5	Noise Detector	SOUND LEVEL METER
6	Temperature scanner	FLUKE MT4 MAX
7	Multichannel data recorder	TOPRIE TP700

Schematic diagram of the test system

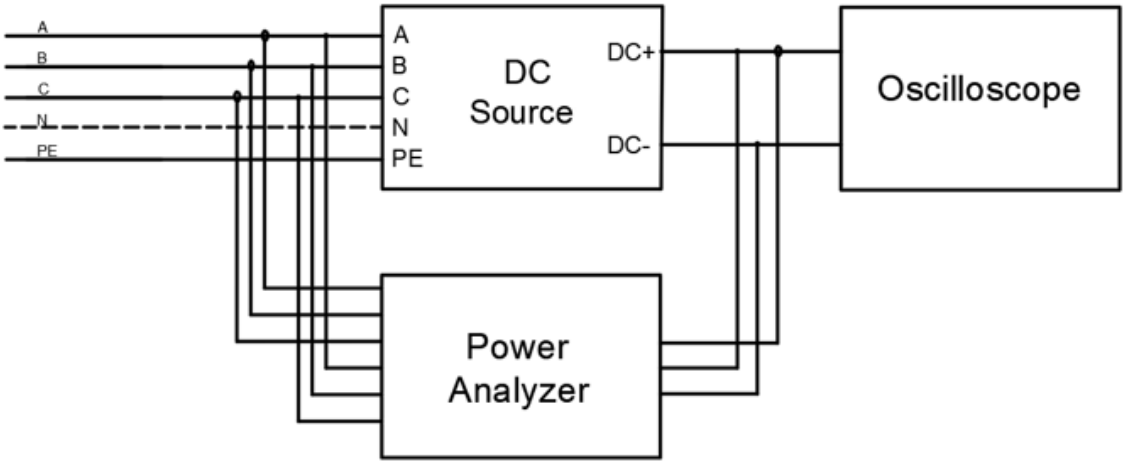

Figure 1 Test with No-Load

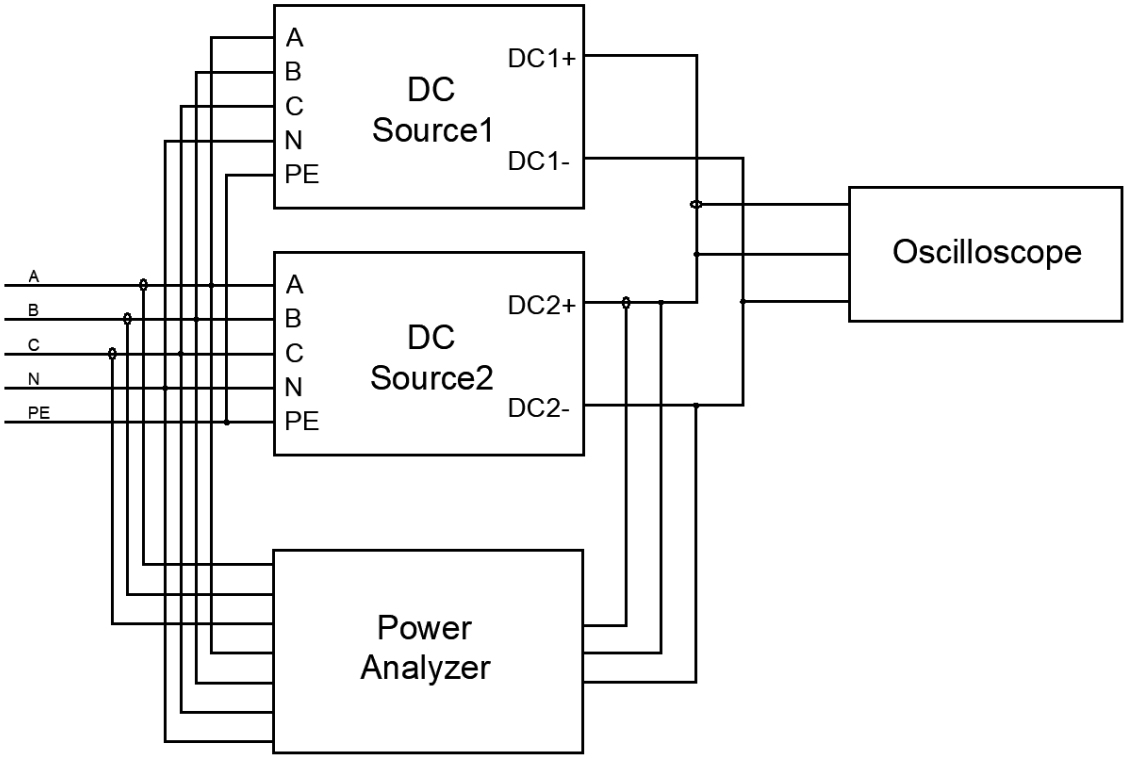

Figure 2 Test with Electronic Load

CONTENT

1. Appearance and Structural Inspection

When the power supply is power off, thorough appearance inspection checks should be conducted using either the visual inspection method or the hand feel method to ensure that there are no serious appearance defects such as scratches, indentations, color difference, paint drops, etc., caused by product assembly or bad assembly seams and breakages that exceed the specifications. Relevant safety labels should meet the corresponding requirements of the GB2894-2008 standard.

No.	Inspection contents	Confirmation（√or×）
1	No serious appearance defects were caused by product assembly, such as assembly seams and breaks beyond specifications, etc.	√
2	No serious defects affect product appearance e.g. scratches, indentations, color differences, and paint dropping.	√
3	Relevant safety labels should meet the GB2894-2008 requirement.	√
4	Complete certificates, instructions and warranty cards, and no misuse of packaging materials, or multiple accessories.	√

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2. Voltage Range

Connect the input of the BSL to the GRID to keep the input voltage within the operating voltage range of the power supply. Adjust the output voltage value within the rated voltage range. Read and record the measured value(s) on the power analyzer.

Facilities and instruments: Power analyzer

No.	Setting Voltage（V）	Voltage Measured by Power analyzer（V）
1	100	100.02
2	200	200.00
3	300	300.01
4	400	400.07
5	500	500.03

6	600	600.09
7	700	700.06
8	800	800.01
9	900	899.99
10	1000	999.96

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3. Current Range

Connect the input of two BSL units in parallel and connect them to the GRID to keep the input voltage within the operating voltage range of the power supply, and connect the output of the two BSL units in parallel. Set the first BSL unit (CV mode) to stabilize the output voltage of 250V, and adjust the output current value of the second BSL unit (CC mode) within the rated output power range to reach the maximum output. (The test connection diagram as shown in Figure 2). Read and record the measured values on the power analyzer.

Facilities and instruments: Power analyzer

No.	Setting Voltage (V)	Current Measured by Power analyzer (A)
1	80	79.79
2	160	158.97
3	240	238.97
4	320	318.88
5	400	398.90
6	480	478.88
7	560	558.61
8	640	638.66
9	720	718.63
10	800	798.72

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4. Voltage Accuracy

Connect the input of BSL to the GRID to keep the input voltage within the operating voltage range of the power supply. Set the output voltage value to ensure that the power supply works within the rated output voltage range, read and record the output voltage measurement value on the power analyzer and the power supply, and take the largest error for calculation. (The test connection diagram as shown in Figure 1). The voltage accuracy is obtained using the following formula:

$$\delta_U = \frac{|U_0 - U_1|}{U_N} \times 100\%$$

where:

δ_U——Voltage accuracy;

U_1——Voltage value measured via power analyzer, V;

U_0——Voltage value displayed on the power supply, V;

U_N——Rated voltage, V.

Facilities and instruments: Power analyzer

No.	Setting Voltage (V)		Measured by DC Source (V)	Measured by Power analyzer (V)	Voltage Accuracy
1	10% V_{RATED}	100	99.9	100.02	0.01%
2	20% V_{RATED}	200	200.0	200.00	0.00%
3	30% V_{RATED}	300	300.0	300.01	0.00%
4	40% V_{RATED}	400	399.9	400.07	0.02%
5	50% V_{RATED}	500	500.0	500.03	0.00%
6	60% V_{RATED}	600	600.0	600.09	0.01%
7	70% V_{RATED}	700	700.0	700.06	0.01%
8	80% V_{RATED}	800	799.9	800.01	0.01%
9	90% V_{RATED}	900	900.0	899.99	0.00%
10	100% V_{RATED}	1000	1000.0	999.96	0.00%

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5. Current Accuracy

Connect the input of two BSL units in parallel and connect them to the GRID to keep the input voltage within the operating voltage range of the power supply, and connect the output of the two BSL units in parallel. Set the first BSL unit (CV mode) to stabilize the output voltage of 250V, and adjust the output current value of the second BSL unit (CC mode) within the rated output power range to reach the maximum output. Record the output current measurement value of the power analyzer and power supply, and take the largest error for calculation. (The test connection diagram as shown in Figure 2). The current accuracy is obtained by the following formula:

$$\delta_I = \frac{|I_0 - I_1|}{I_N} \times 100\%$$

where:

δ_I——Current accuracy;

I_1——Current value measured via power analyzer, A;

I_0——Current value displayed on power supply, A;

I_N——Rated current, A.

Facilities and instruments: Power analyzer

No.	Setting Current (A)		Measured by DC Source (A)	Measured by Power analyzer (A)	Current Accuracy
1	10% V_{RATED}	80	79.9	79.79	0.01%
2	20% V_{RATED}	160	159.9	158.97	0.12%
3	30% V_{RATED}	240	239.9	238.97	0.12%
4	40% V_{RATED}	320	320.0	318.88	0.14%
5	50% V_{RATED}	400	400.0	398.90	0.14%
6	60% V_{RATED}	480	480.0	478.88	0.14%

7	70% V_{RATED}	560	560.0	558.61	0.17%
8	80% V_{RATED}	640	640.0	638.66	0.17%
9	90% V_{RATED}	720	720.0	718.63	0.17%
10	100% V_{RATED}	800	800.0	798.72	0.16%

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6. Power Accuracy

Connect the input of two BSL units in parallel and connect them to the GRID to keep the input voltage within the operating voltage range of the power supply, and connect the output of the two BSL units in parallel. Set the first BSL unit (CV mode) to stabilize the output voltage of 250V, and adjust the output current value of the second BSL unit (CC mode) within the rated output power range to reach the maximum output. Record the output power measurement value of the power analyzer and power supply, and take the largest error for calculation. (The test connection diagram as shown in Figure 2). The power accuracy is obtained using the following formula:

$$\delta_P = \frac{|P_0 - P_1|}{P_N} \times 100\%$$

where:

δ_P——Power accuracy;

P_1——Power value measured via power analyzer, KW;

P_0——Power value displayed on power supply, KW;

P_N——Rated power, KW.

Facilities and instruments: Power analyzer

No.	Setting Current (A)		Measured by DC Source (KW)	Measured by Power analyzer (KW)	Current Accuracy
1	10% V_{RATED}	80	19.95	19.95	0.00%

2	20% V_{RATED}	160	39.95	39.76	0.10%
3	30% V_{RATED}	240	59.95	59.77	0.09%
4	40% V_{RATED}	320	80.00	79.76	0.12%
5	50% V_{RATED}	400	100.00	99.77	0.12%
6	60% V_{RATED}	480	120.00	119.77	0.12%
7	70% V_{RATED}	560	140.00	139.71	0.14%
8	80% V_{RATED}	640	160.00	159.73	0.14%
9	90% V_{RATED}	720	180.00	179.73	0.14%
10	100% V_{RATED}	800	200.00	199.76	0.12%

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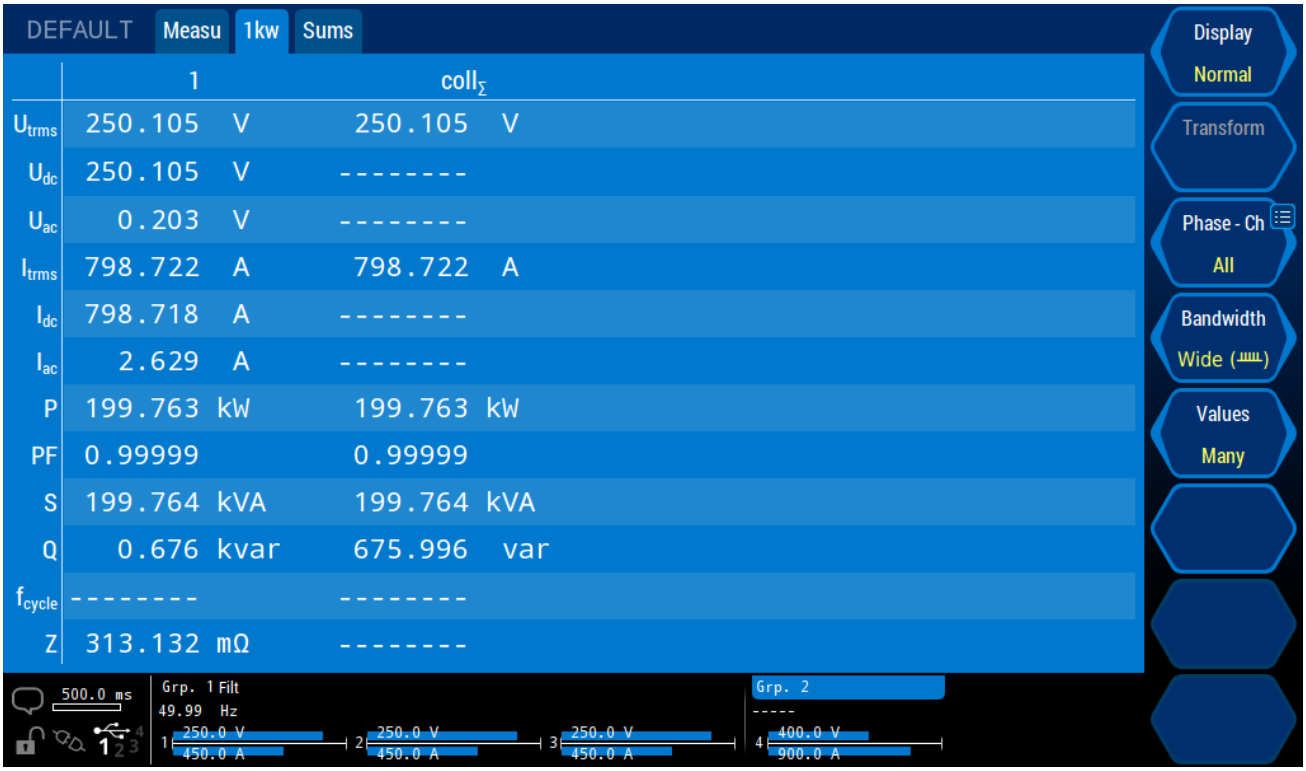
7. Efficiency

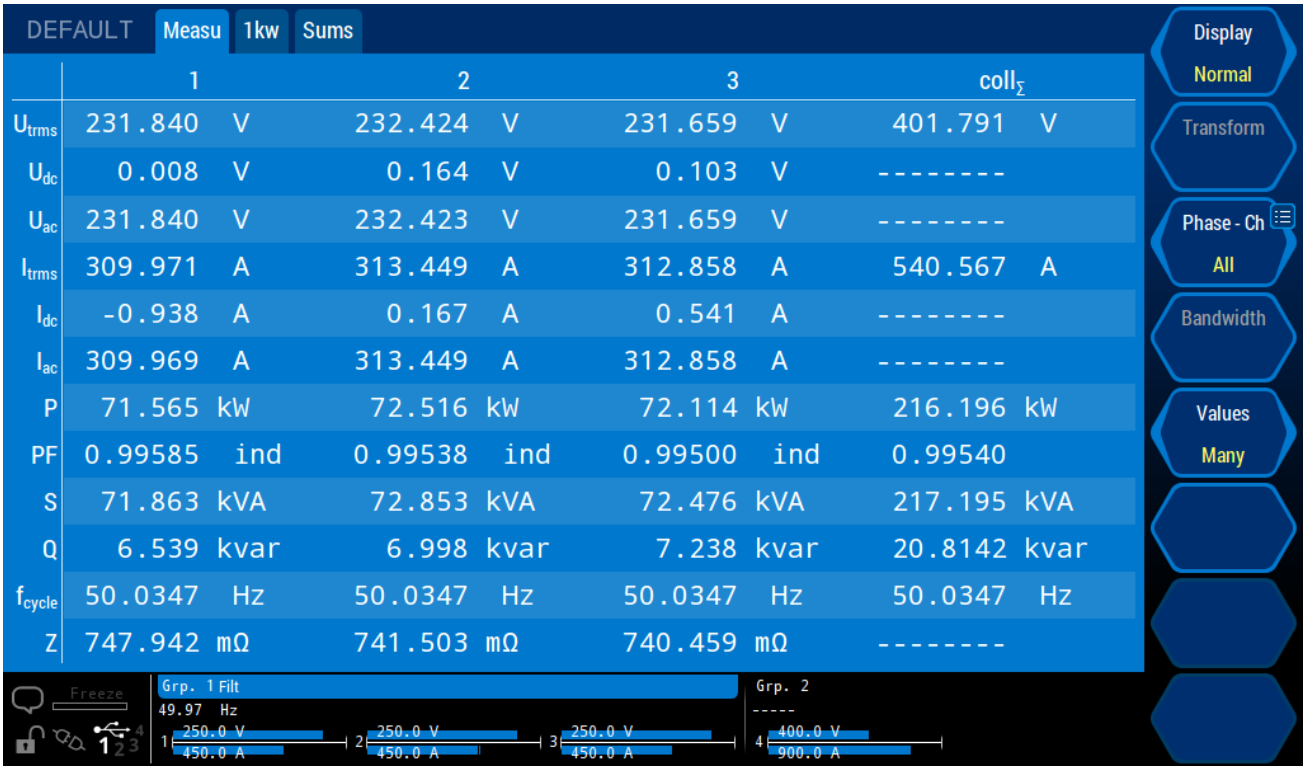
Connect the input of two BSL units in parallel and connect them to the GRID to keep the input voltage within the operating voltage range of the power supply, and connect the output of the two BSL units in parallel. Set the first BSL unit (CV mode) to stabilize the output voltage of 250V, and adjust the output current value of the second BSL unit (CC mode) within the rated output power range to reach the maximum output. (The test connection diagram as shown in Figure 2). Read and record the measured value(s) of the input side on the power analyzer.

Facilities and instruments: Power analyzer

Output	**Setting Current (A)**	**Input**			**Efficiency**	**Power Factor**
ΣP_O		**ΣP_A**	**ΣP_B**	**ΣP_C**		
199.76	800	71.56	72.51	72.11	92.4%	0.99



Measured value of the output (@full-load)



Measured value of the input (@full-load)

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8. Current THD Test

Connect the input of two BSL units in parallel and connect them to the GRID to keep the input voltage within the operating voltage range of the power supply, and connect the output of the two BSL units in parallel. Set the first BSL unit (CV mode) to stabilize the output voltage of 250V, and adjust the output current value of the second BSL unit (CC mode) within the rated output power range to reach the maximum output. (The test connection diagram as shown in Figure 2). Read and record the measured value(s) of the three-phase current THD on the GRID side on the power analyzer.

Facilities and instruments: Power analyzer

No.	Setting Current (A)	IA_{THD}	IB_{THD}	IC_{THD}
1	80	21.47%	23.25%	22.39%
2	160	12.01%	12.65%	12.57%
3	240	8.10%	9.82%	8.87%
4	320	6.35%	7.05%	6.48%
5	400	4.89%	5.79%	5.35%
6	480	4.18%	4.66%	4.42%
7	560	3.39%	4.00%	3.54%
8	640	3.31%	3.63%	3.44%
9	720	2.54%	3.07%	2.82%
10	800	2.35%	2.65%	2.57%

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9. Load Regulation

Connect the input of two BSL units in parallel and connect them to the GRID to keep the input voltage within the operating voltage range of the power supply, and connect the output of the two BSL units in parallel. Set the first BSL unit (CV mode) to stabilize the output voltage of 250V,

and adjust the output current value of the second BSL unit (CC mode) within the rated output power range to reach the maximum output. (The test connection diagram as shown in Figure 2). Read and record the output voltage measurement value on the power analyzer at no-load and full-load conditions. The Load Regulation can be obtained using the following formula:

$$L = \frac{|U_0 - U_1|}{U_1} \times 100\%$$

where:

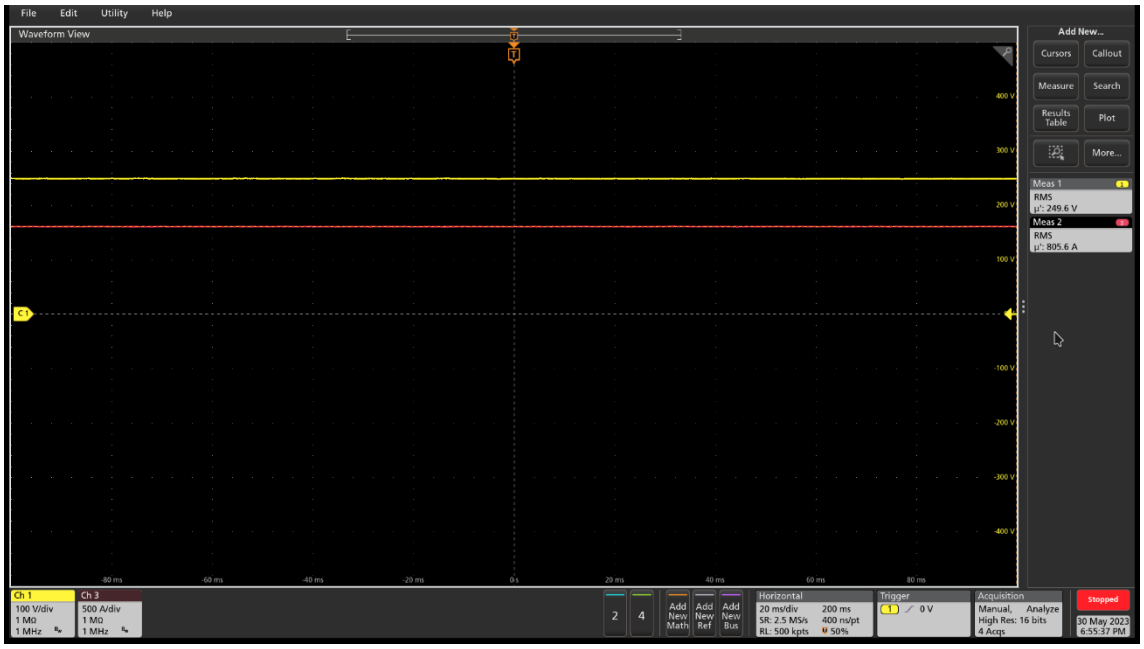
L —— Load Regulation;

U_1——Full-load voltage, V;

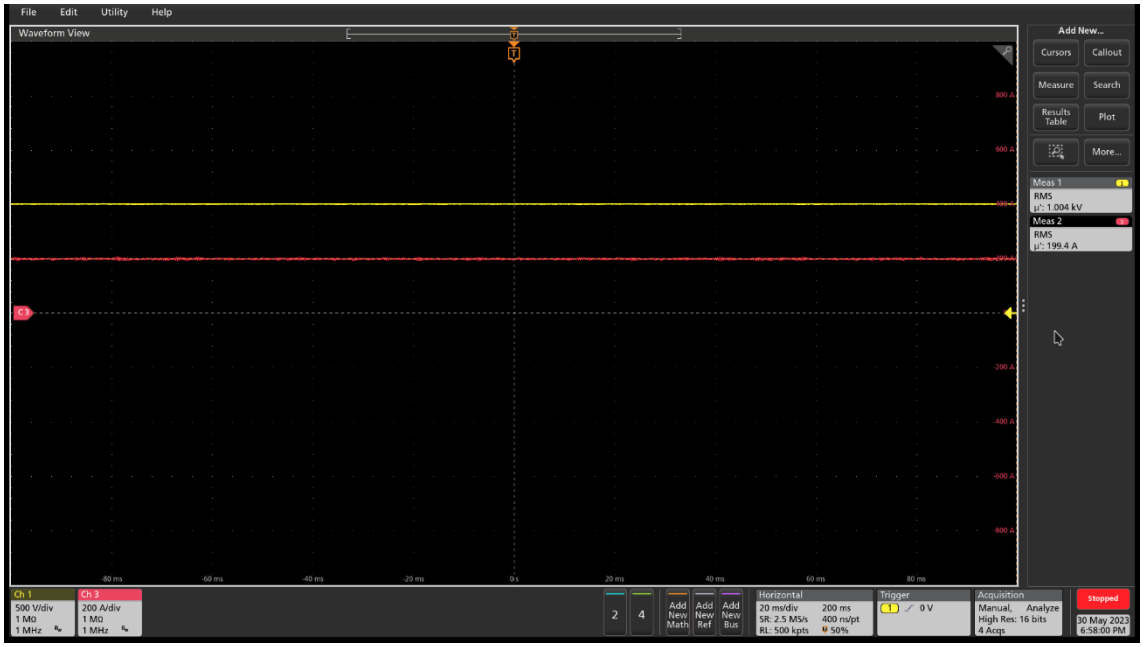
U_0——No-load voltage, V;

Facilities and instruments: Power analyzer, Oscilloscope

No.	Setting Voltage (V)	Setting current (A)	No-load Voltage Measured (V)	Full-load Voltage Measured (V)	Load Regulation
1	250	0	250.03		0.01%
2	250	800		250.01	
3	1000	0	1000.20		0.01%
4	1000	200		1000.14	



250V-800A (Channel 1 is voltage output and channel 3 is current output)



1000V-200A (Channel 1 is voltage output and channel 3 is current output)

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10. Ripple Test

Connect the input of the BSL to the GRID to keep the input voltage within the working voltage range of the power supply. Set the output voltage value to keep the power supply output within the rated voltage range, read the superposition indication value of all AC voltage components at the output end of the power supply, and take the maximum value in the test. The ripple coefficient is obtained from the following formula:

$$Y = \frac{U_{rms}}{U_N} \times 100\%$$

And:

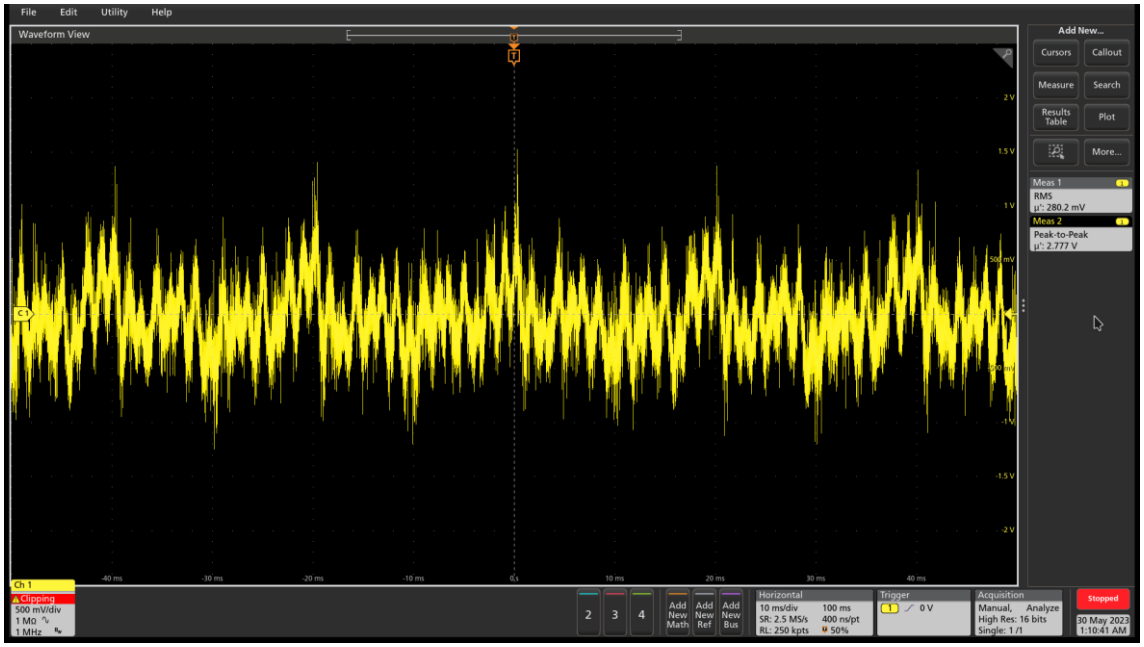
Y ———Ripple coefficient;

U_{RMS}———RMS of voltage ripple, V;

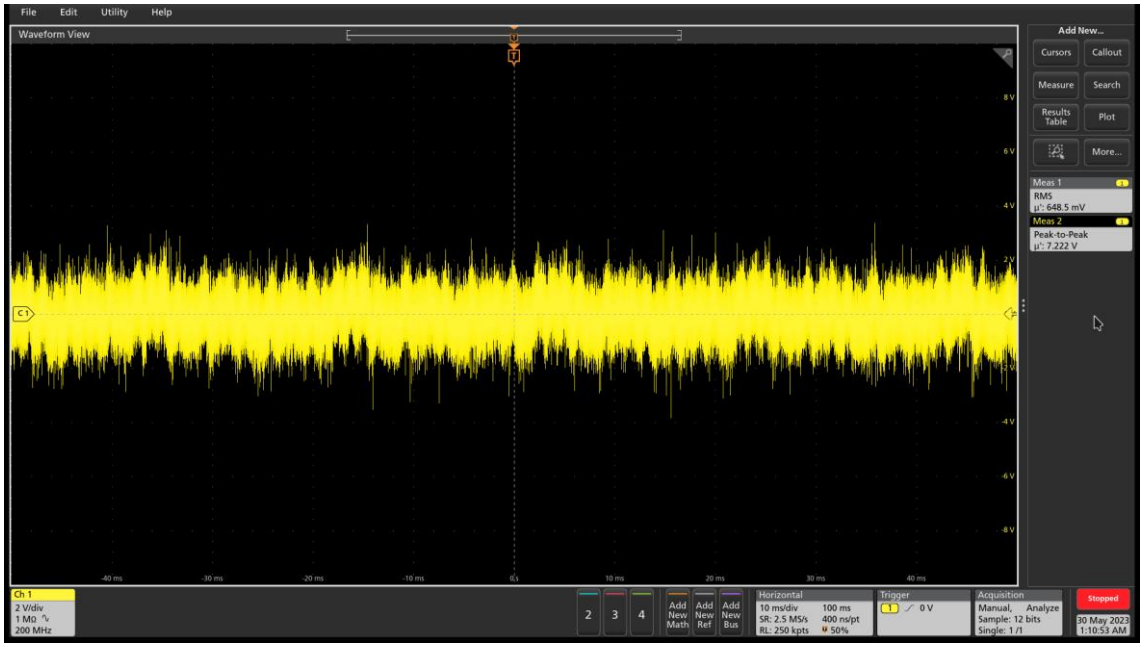
U_N ———Rated Voltage, V;

Facilities and instruments: Power analyzer, Oscilloscope

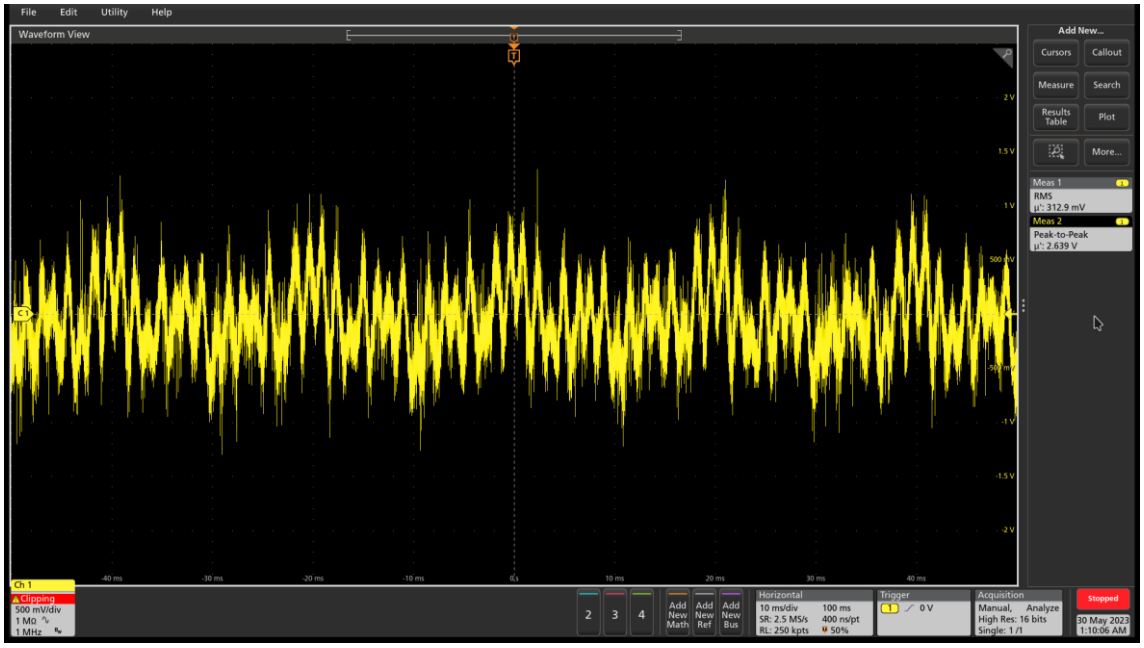
No.	Setting Voltage (V)	Noise filter on				Noise filter off				Waveform Recording
		U_{rms}	Ripple coefficient	U_{pp}	Ripple coefficient	U_{rms}	Ripple coefficient	U_{pp}	Ripple coefficient	
1	500	0.28	0.06%	2.77	0.55%	0.65	0.13%	7.22	1.44%	①-②
2	1000	0.31	0.03%	2.64	0.26%	0.65	0.07%	8.60	0.86%	③-④



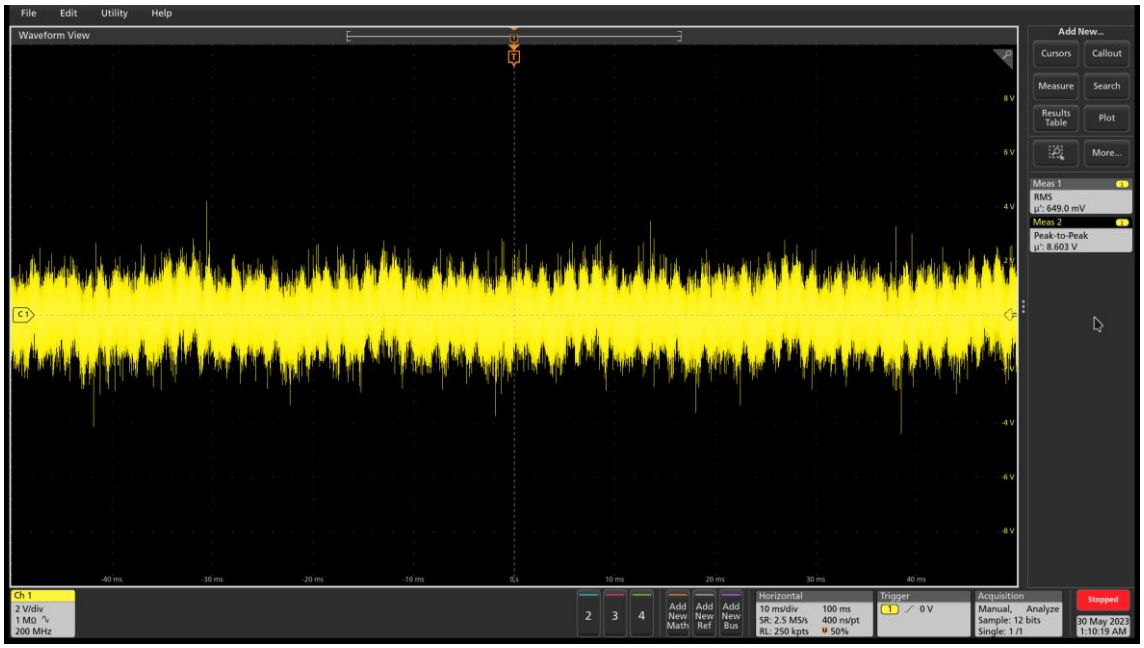
Waveform① (500V filtered voltage ripple waveform)



Waveform② (500V unfiltered voltage ripple waveform)



Waveform③ (1000V filtered voltage ripple waveform)



Waveform④ (1000V unfiltered voltage ripple waveform)

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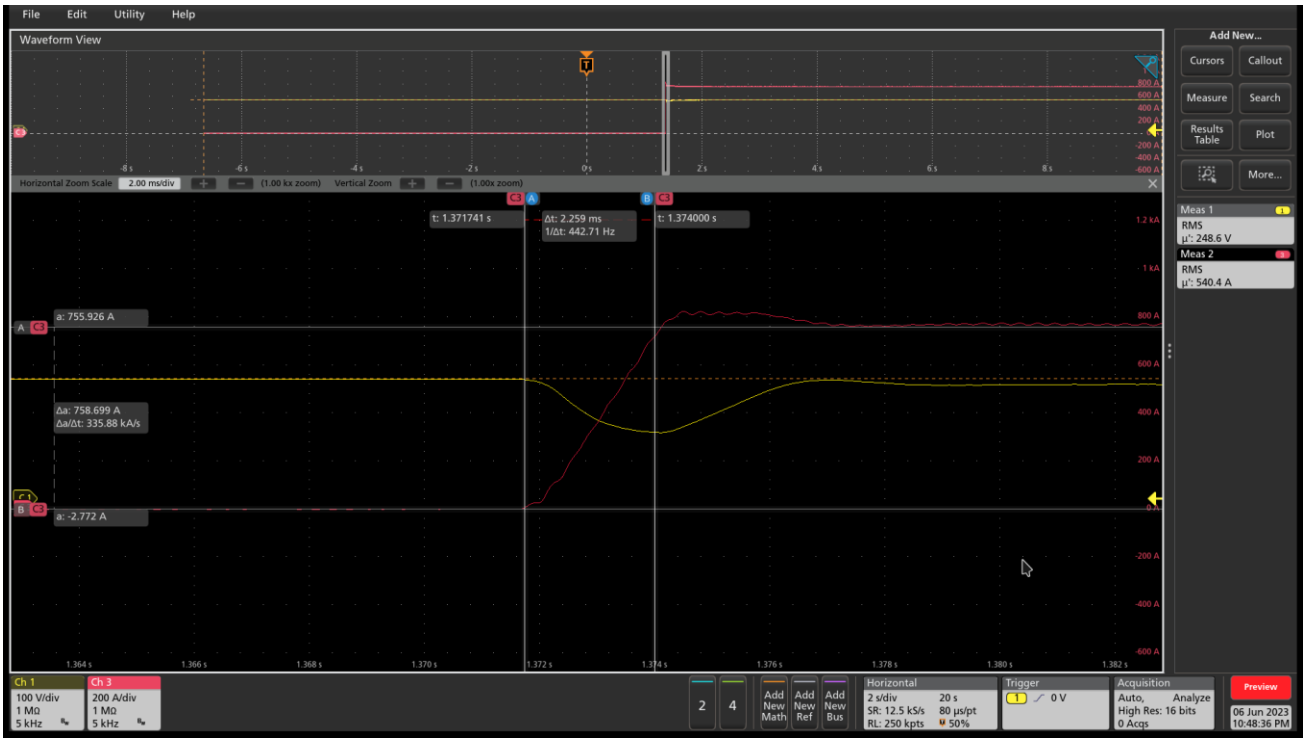
11. Current Rise Time

Connect the input of two BSL units in parallel and connect them to the GRID to keep the input voltage within the operating voltage range of the power supply, and connect the output of the

two BSL units in parallel. Set the first BSL unit (CV mode) to stabilize the output voltage of 250V, and adjust the output current value of the second BSL unit (CC mode) within the rated output power range to reach the maximum output. (The test connection diagram as shown in Figure 2). Change the current of the second BSL unit (CC mode) between -90 ~ +90%. Record the measured waveform with oscilloscope.

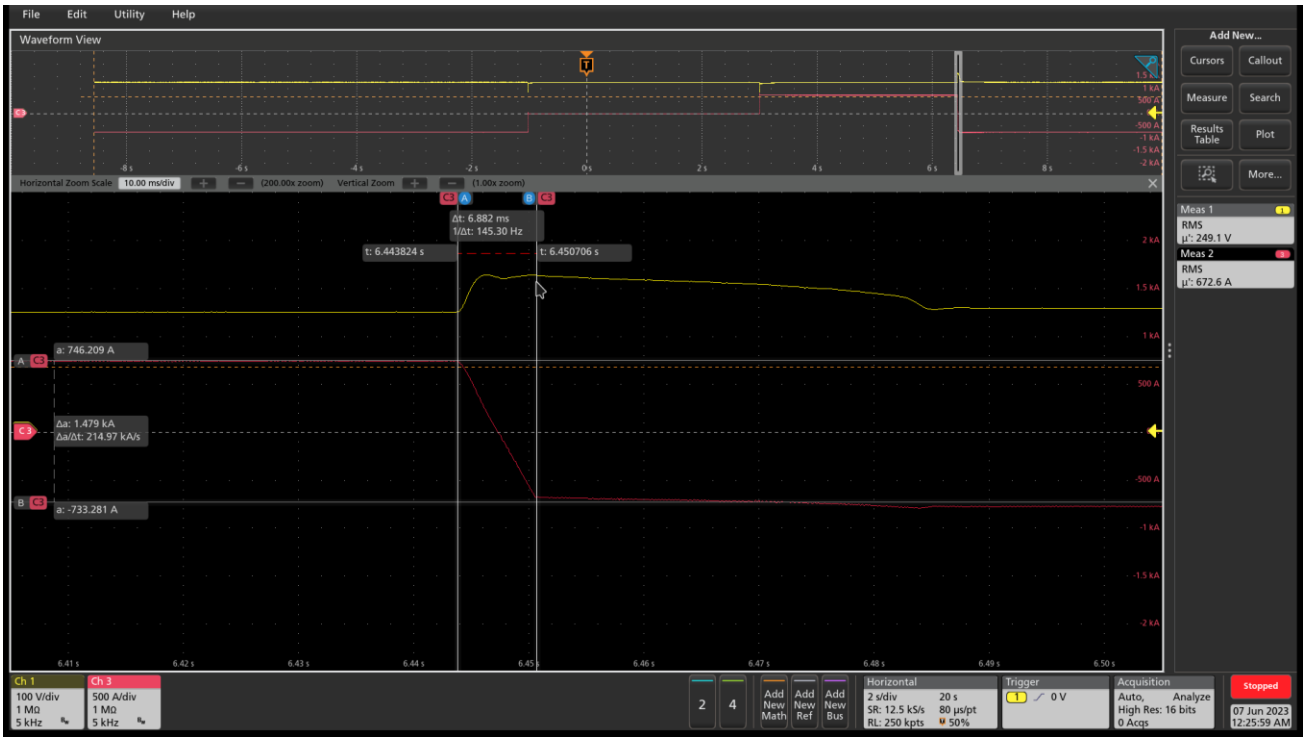
Facilities and instruments: Oscilloscope

Initial voltage (V)	Current Rise Time	Climb Time (ms)	Adjusting Amplitude (V)	Waveform Recording
250	0~90%	2.25	109.19	Waveform 1, 3
	90~-90%	6.88	76.66	Waveform 2, 4



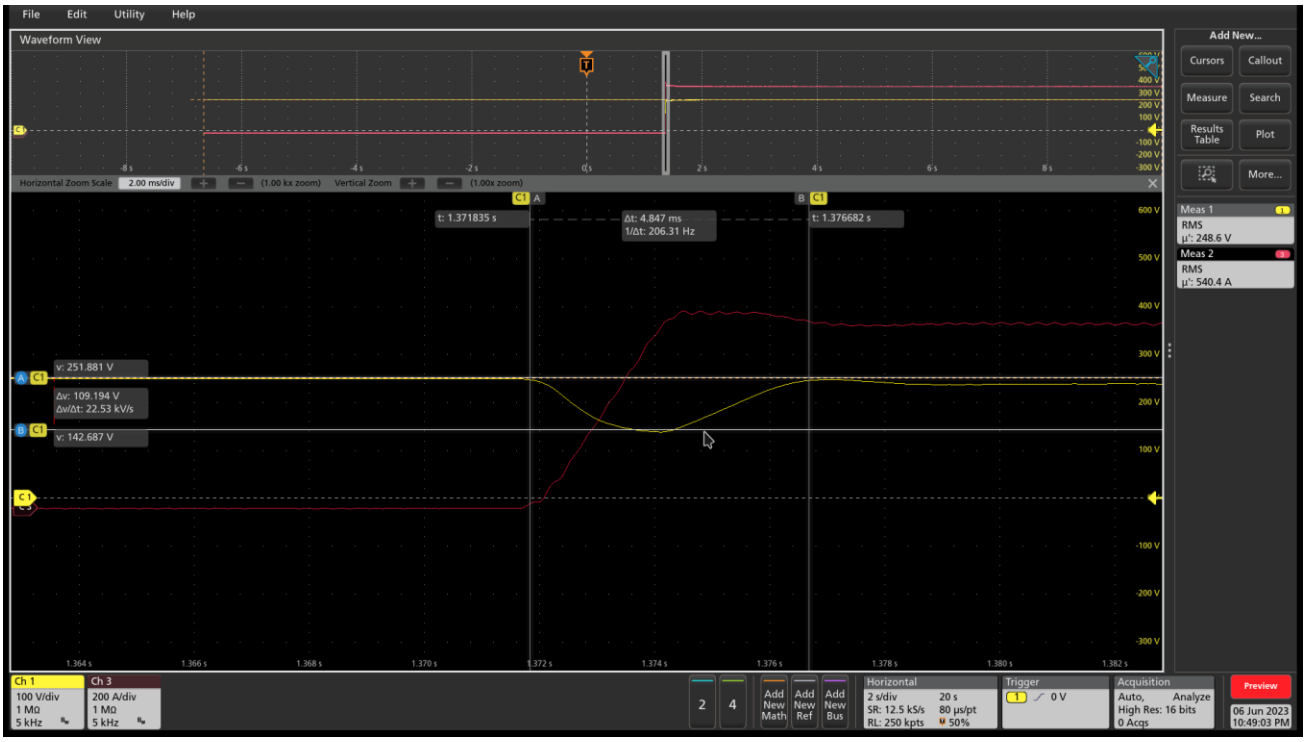
Waveform.1 Current rise time (0 ~ 90% load change)

(Channel 1 is voltage output and channel 3 is current output)



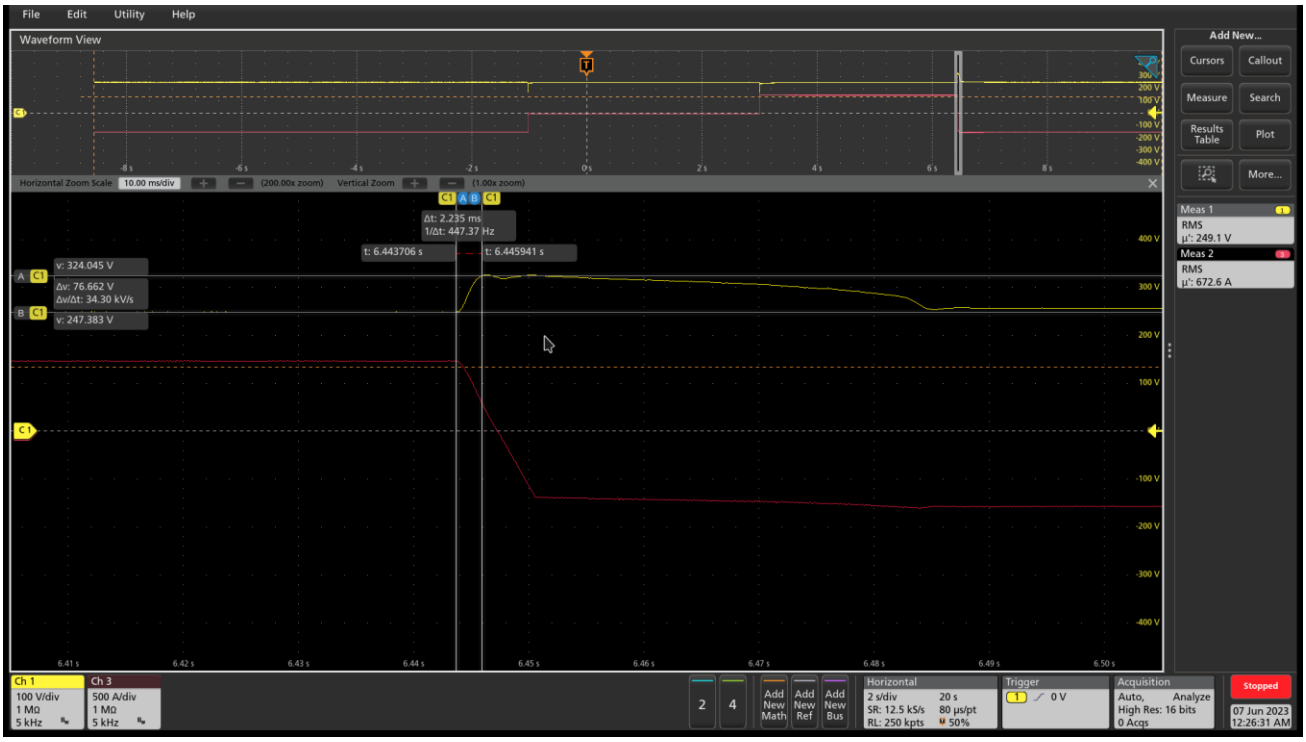
Waveform.2 Current rise time (90 ~ -90% load change)

(Channel 1 is voltage output and channel 3 is current output)



Waveform.3 Voltage regulation waveform during current rise (0 ~ 90% load change)

(Channel 1 is voltage output and channel 3 is current output)



Waveform.4 Voltage regulation waveform during current switching (90 ~ -90% load change)

(Channel 1 is voltage output and channel 3 is current output)

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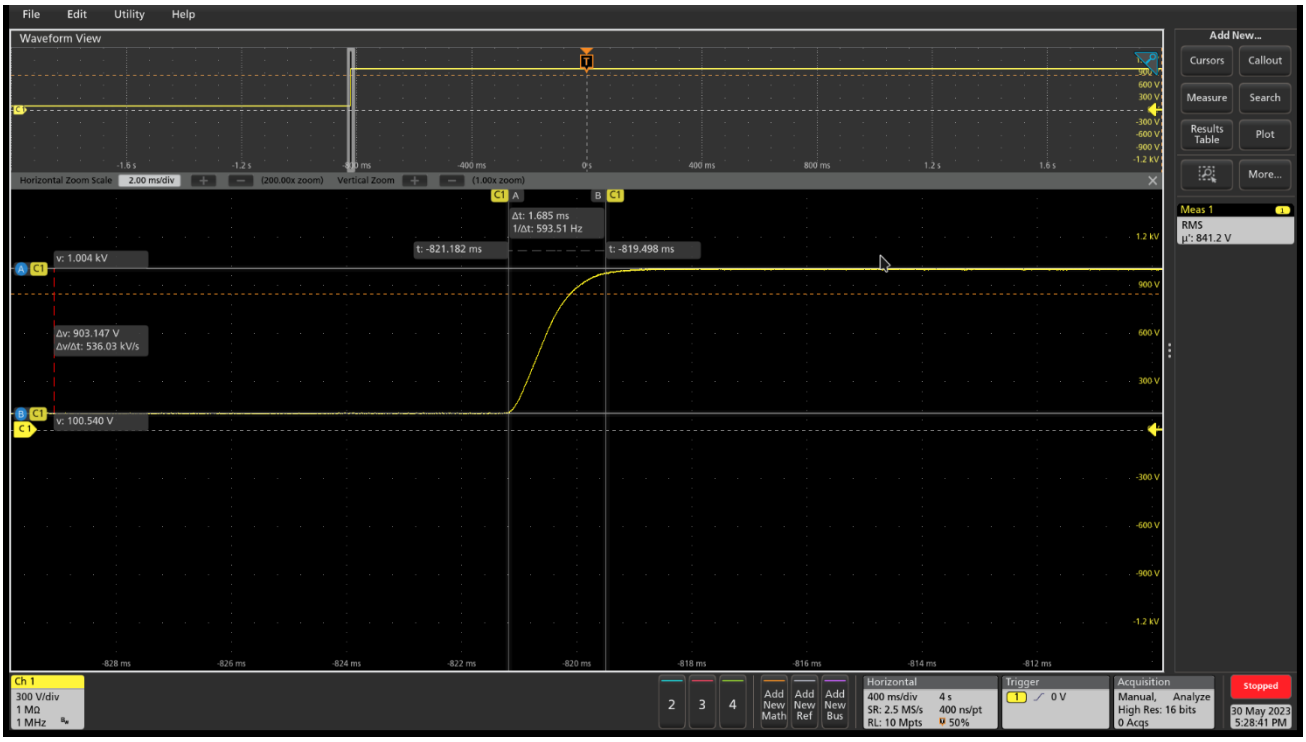
12. Voltage Rise Time

Connect the input of the BSL unit to the GRID to keep the input voltage within the working voltage range of the power supply. Set the output voltage value and change from 10% to 100% of the rated voltage. Record the measured waveform with an oscilloscope.

Facilities and instruments: Oscilloscope

Initial voltage	Final voltage	Climb time (ms)	Waveform Recording
10%V_{RATED}	100%V_{RATED}	<1.68	Waveform 1



Waveform.1 Voltage rise time

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13. Temperature Test

Connect the input of two BSL units in parallel and connect them to the GRID to keep the input voltage within the operating voltage range of the power supply, and connect the output of the two BSL units in parallel. Set the first BSL unit (CV mode) to stabilize the output voltage of 250V, and adjust the output current value of the second BSL unit (CC mode) within the rated output power range to reach the maximum output. (The test connection diagram as shown in Figure 2). Read and record the temperature measurement values of internal reactors, transformer, IGBT and other components when the power supply is running at full load.

Facilities and instruments: Temperature scanner, Electronic Load.

Test point \ No.	1	2	3	4	5	6	7	8	9	10	11
	Transf.1	Reactor-1	Reactor-2	Reactor-3	Reactor-4	IGBT 1	IGBT 2	IGBT 3	IGBT 4	IGBT 5	IGBT 6

Measured	0min	31.5	30.1	29.7	30.4	31.0	30.3	31.1	30.7	31.4	31.6	31.5
	30 min	48.5	44.4	41.8	43.2	46.7	59.4	61.8	60.5	62.7	65.1	70.2
	60 min	53.1	47.9	44.8	46.6	51.0	67.8	70.1	69.7	73.7	75.3	82.3
	90 min	62.3	51.2	48.1	50.7	56.2	69.3	71.7	71.1	74.3	76.3	84.1
	120 min	68.5	52.9	55.5	56.2	62.2	69.7	72.2	72.2	75.2	77.1	85.4
	180 min	72.9	57.4	64.5	64.5	69.3	71.0	72.7	72.8	76.2	77.9	86.2

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14. Noise Test

Connect the input of the BSL unit to the GRID to keep the input voltage within the working voltage range of the power supply. Adjust the output voltage within the rated voltage range, read and record the noise measurement within 1m around the power supply.

Facilities and instruments: Noise Detector

No.	Measured	Equivalent calculation value
1	74.8db	75.52
2	74.6db	
3	75.4db	
4	76.0db	
5	74.1db	
6	74.3db	
7	80.9db	
8	78.3db	
9	73.7db	
10	73.1db	

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15. Protection

No.	Test Items	Confirmation (√or×)
1	Adjust the output voltage to be slightly above the rated voltage specified by the power supply. The power supply will limit the voltage output.	√
2	Adjust the input voltage to be slightly above the rated voltage specified by the power supply. The power supply will promptly disconnect the output and trigger the alarm system.	√
3	Adjust the load or output voltage for the output current to be 1.2 times greater than the rated value. The power supply will trigger the protection mechanism and cut off the output.	√
4	Adjust the temperature setting value of the software program. When the current measured temperature exceeds 10% of the software setting temperature, the power supply will promptly disconnect the output and trigger the alarm system.	√

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16. Clock Function

Enter the settings interface to view and set the current time, year, month, day, hour, and minute.

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17. LCD Display Test

In the setting and running state, no screen flickers and flower appear on the LCD screen.

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