



**PRE**

**Feedback-type Programmable  
AC Power & Load  
Integrated Machine**

## Overview

In 2022, ACTIONPOWER launched the second-generation PRE20 Feedback-type Programmable AC Power & Load Integrated Machine, which has both AC source and AC load functions. The unique design of AC source/load integrated machine once again leads the development direction of the new generation of AC source. The matrix parallel function of the PRE20 series products can be expanded to 200kW in parallel, while meeting the needs of small volume (3U/20kW) and large capacity.

The PRE20 series products have four-quadrant working capability. As a power supply, they can meet the requirements of general grid adaptability regulations, and as an RLC load, they can meet the test requirements of anti-islanding protection performance and off-grid load requirements in the new energy industry. One machine can be used for both purposes without any optional accessories, which can recover 100% current to the grid with a feedback efficiency of up to 91%. It reduces the input and energy consumption cost of user equipment and better meets the requirements of "dual carbon".

源 + 载  
Source + Load



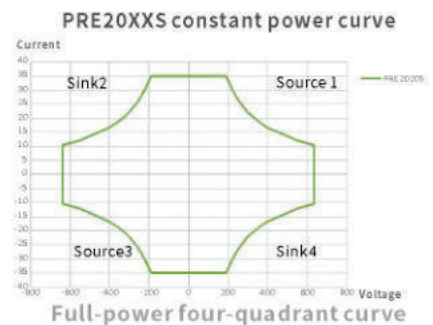
## Product selection

Product model	Rated power (kVA)	Voltage range (V <sub>rms</sub> )	Frequency range (Hz)	Maximum three-phase current		Maximum single-phase current		Voltage range (V <sub>DC</sub> )	Current range (A <sub>DC</sub> )	Appearance
				(A <sub>rms</sub> )	(A <sub>peak</sub> )	(A <sub>rms</sub> )	(A <sub>peak</sub> )			
PRE2006S	6	0~450	0.001~200	30	90	90	270	±636	±90	3U
PRE2007S	7.5	0~450	0.001~200	30	90	90	270	±636	±90	3U
PRE2009S	9	0~450	0.001~200	35	105	105	315	±636	±105	3U
PRE2012S	12	0~450	0.001~200	35	105	105	315	±636	±105	3U
PRE2015S	15	0~450	0.001~200	35	105	105	315	±636	±105	3U
PRE2020S	20	0~450	0.001~200	35	105	105	315	±636	±105	3U

## Advantages and functions of AC load

### Source/load integration, full-power four-quadrant

The PRE20 series products combine bi-directional programmable AC power source and feedback programmable AC electronic load into one, and can realize dual-purpose without purchasing any optional accessories. When operating in the feedback programmable AC electronic load mode, 100% current can be recovered to the grid, with a feedback efficiency of up to 91%.



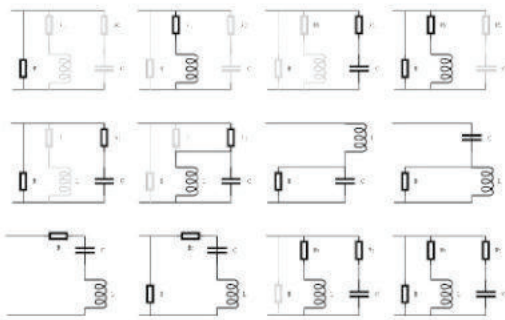
## Introduction to product functions

### RLC network simulation function

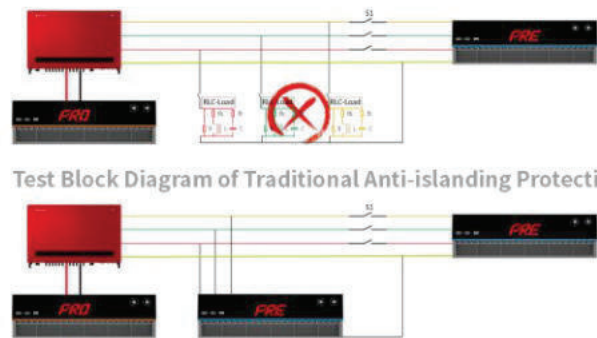
In new energy-related industries, such as: PV inverter, ESS, PCS, microgrid, OBC/BOBC, UPS, etc. need to be tested for linear load, anti-islanding protection, off-grid operation and other test requirements. All RRE20 series products can realize linear load test and feed related electric energy back to the grid, so as to improve the customer's test ability without increasing the customer's power distribution capacity.

The PRE20 series products have up to 12 built-in RLC network models, which can flexibly adjust parameters to simulate linear load characteristics, fully verify the product performance test of the test object under different impedance, three-phase balanced and unbalanced load modes, and can also test the anti-islanding protection characteristics of inverters or converters.

For products with off-grid test requirements, such as BOBC, UPS and PCS, the RLC load function of PRE20 series products can be used to realize the source-load function conversion of one device, greatly simplifying the ATE hardware configuration and realizing V2G, V2L, V2H and other tests at the same time.



RLC Load Network Topology



Test Block Diagram of PRE20 Anti-islanding Protection

### Power hardware-in-the-loop simulation (PHIL)

The PRE20 series products have extremely high dynamic response and bandwidth, with small signal bandwidth of 10kHz, large signal bandwidth of 2000Hz and delay of 60 $\mu$ s. They can amplify and output the signals of simulation system, signal source or control board to the test object, and realize the PHIL function.



Schematic Diagram of PHIL

## Accurate measurement function

### Accurate measurement function

The PRE20 series products have a voltage measurement accuracy of up to  $0.01\% \pm 0.05\% \text{F.S.}$  and a current measurement accuracy of  $0.1\% \pm 0.1\% \text{F.S.}$  The built-in harmonic analysis function has the analysis capability of 100 times @50Hz/60Hz, and the data accuracy and reliability are far better than similar products. Under the production line ATE or some R&D test conditions, it helps users save more measuring instruments.

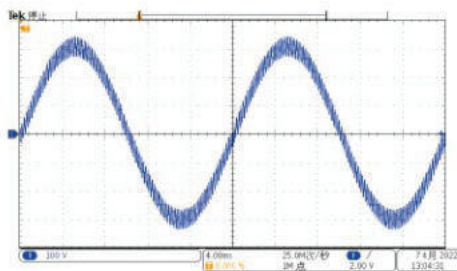


PRE20 measured voltage accuracy: 0.04% F.S.

序	幅值	相位	THD	THN	THD%	THN%	THD%	THN%
1	100.00	21.00	0.00	41.00	0.00	41.00	0.00	0.00
2	0.00	22.00	0.00	42.00	0.00	42.00	0.00	0.00
3	0.00	23.00	0.00	43.00	0.00	43.00	0.00	0.00
4	0.00	24.00	0.00	44.00	0.00	44.00	0.00	0.00
5	0.00	25.00	0.00	45.00	0.00	45.00	0.00	0.00
6	0.00	26.00	0.00	46.00	0.00	46.00	0.00	0.00
7	0.00	27.00	0.00	47.00	0.00	47.00	0.00	0.00
8	0.00	28.00	0.00	48.00	0.00	48.00	0.00	0.00
9	0.00	29.00	0.00	49.00	0.00	49.00	0.00	0.00
10	0.00	30.00	0.00	50.00	0.00	50.00	0.00	0.00
11	0.00	31.00	0.00	51.00	0.00	51.00	0.00	0.00
12	0.00	32.00	0.00	52.00	0.00	52.00	0.00	0.00
13	0.00	33.00	0.00	53.00	0.00	53.00	0.00	0.00
14	0.00	34.00	0.00	54.00	0.00	54.00	0.00	0.00
15	0.00	35.00	0.00	55.00	0.00	55.00	0.00	0.00
16	0.00	36.00	0.00	56.00	0.00	56.00	0.00	0.00
17	0.00	37.00	0.00	57.00	0.00	57.00	0.00	0.00
18	0.00	38.00	0.00	58.00	0.00	58.00	0.00	0.00
19	0.00	39.00	0.00	59.00	0.00	59.00	0.00	0.00
20	0.00	40.00	0.00	60.00	0.00	60.00	0.00	0.00

10% amplitude of 100th harmonic @220V/50Hz output accuracy

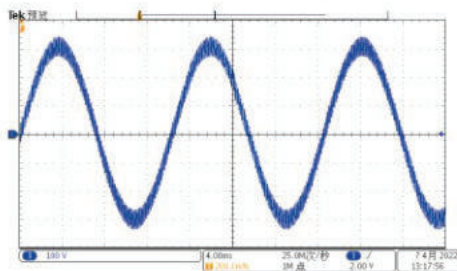
The harmonics of PRE20 series products are extended to 100 times @40Hz~70Hz, and have good output accuracy.



100th harmonic @50Hz waveform

序	幅值	相位	THD	THN	THD%	THN%	THD%	THN%
1	100.00	21.00	0.00	41.00	0.00	41.00	0.00	0.00
2	0.00	22.00	0.00	42.00	0.00	42.00	0.00	0.00
3	0.00	23.00	0.00	43.00	0.00	43.00	0.00	0.00
4	0.00	24.00	0.00	44.00	0.00	44.00	0.00	0.00
5	0.00	25.00	0.00	45.00	0.00	45.00	0.00	0.00
6	0.00	26.00	0.00	46.00	0.00	46.00	0.00	0.00
7	0.00	27.00	0.00	47.00	0.00	47.00	0.00	0.00
8	0.00	28.00	0.00	48.00	0.00	48.00	0.00	0.00
9	0.00	29.00	0.00	49.00	0.00	49.00	0.00	0.00
10	0.00	30.00	0.00	50.00	0.00	50.00	0.00	0.00
11	0.00	31.00	0.00	51.00	0.00	51.00	0.00	0.00
12	0.00	32.00	0.00	52.00	0.00	52.00	0.00	0.00
13	0.00	33.00	0.00	53.00	0.00	53.00	0.00	0.00
14	0.00	34.00	0.00	54.00	0.00	54.00	0.00	0.00
15	0.00	35.00	0.00	55.00	0.00	55.00	0.00	0.00
16	0.00	36.00	0.00	56.00	0.00	56.00	0.00	0.00
17	0.00	37.00	0.00	57.00	0.00	57.00	0.00	0.00
18	0.00	38.00	0.00	58.00	0.00	58.00	0.00	0.00
19	0.00	39.00	0.00	59.00	0.00	59.00	0.00	0.00
20	0.00	40.00	0.00	60.00	0.00	60.00	0.00	0.00

100th harmonic @50Hz data



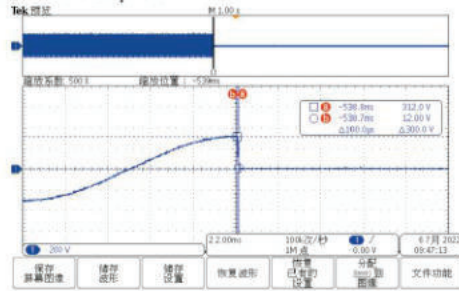
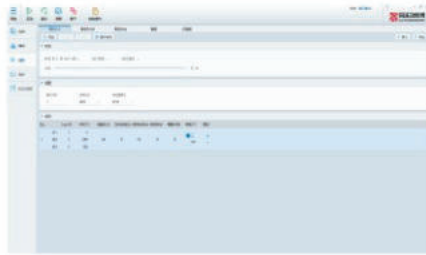
100th harmonic @70Hz waveform

序	幅值	相位	THD	THN	THD%	THN%	THD%	THN%
1	100.00	21.00	0.00	41.00	0.00	41.00	0.00	0.00
2	0.00	22.00	0.00	42.00	0.00	42.00	0.00	0.00
3	0.00	23.00	0.00	43.00	0.00	43.00	0.00	0.00
4	0.00	24.00	0.00	44.00	0.00	44.00	0.00	0.00
5	0.00	25.00	0.00	45.00	0.00	45.00	0.00	0.00
6	0.00	26.00	0.00	46.00	0.00	46.00	0.00	0.00
7	0.00	27.00	0.00	47.00	0.00	47.00	0.00	0.00
8	0.00	28.00	0.00	48.00	0.00	48.00	0.00	0.00
9	0.00	29.00	0.00	49.00	0.00	49.00	0.00	0.00
10	0.00	30.00	0.00	50.00	0.00	50.00	0.00	0.00
11	0.00	31.00	0.00	51.00	0.00	51.00	0.00	0.00
12	0.00	32.00	0.00	52.00	0.00	52.00	0.00	0.00
13	0.00	33.00	0.00	53.00	0.00	53.00	0.00	0.00
14	0.00	34.00	0.00	54.00	0.00	54.00	0.00	0.00
15	0.00	35.00	0.00	55.00	0.00	55.00	0.00	0.00
16	0.00	36.00	0.00	56.00	0.00	56.00	0.00	0.00
17	0.00	37.00	0.00	57.00	0.00	57.00	0.00	0.00
18	0.00	38.00	0.00	58.00	0.00	58.00	0.00	0.00
19	0.00	39.00	0.00	59.00	0.00	59.00	0.00	0.00
20	0.00	40.00	0.00	60.00	0.00	60.00	0.00	0.00

100th harmonic @70Hz data

■ High dynamic

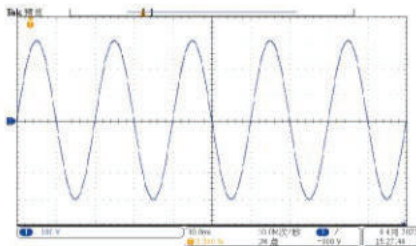
The PRE20 series products have high dynamic output characteristics, and the voltage slew rate is greater than 3.0V/us, meeting the requirements of high dynamic output.



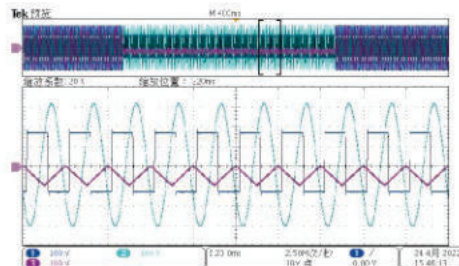
Fundamental wave: AC220V/50Hz 90° voltage drop, drop time 100µs@90%~10%

■ Multiple output modes

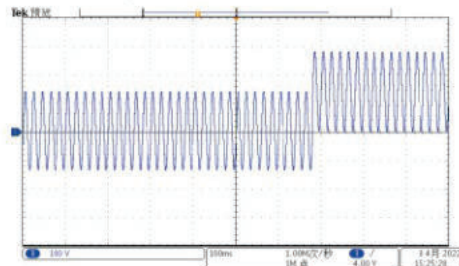
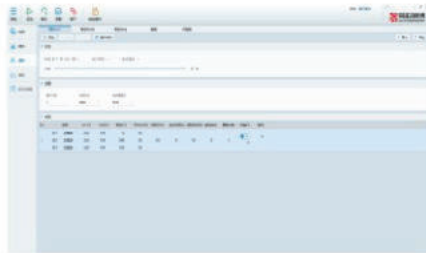
The PRE20 series products have four output modes: AC, DC, AC+DC and DC+AC, and the output power in each mode can reach full power. The fundamental frequency range of AC output is 0.01~200Hz, which is superior to various types of AC power sources;



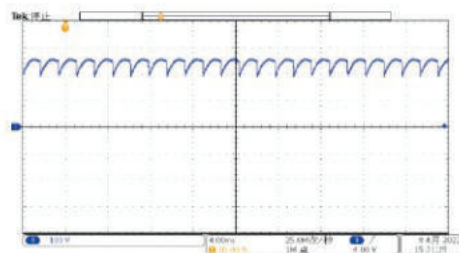
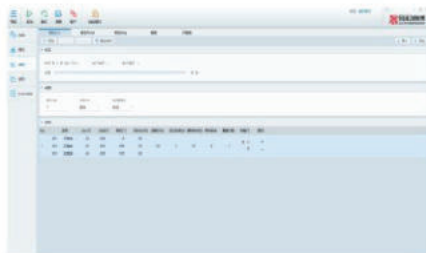
Standard 220V@50Hz waveform



Three-phase different waveforms



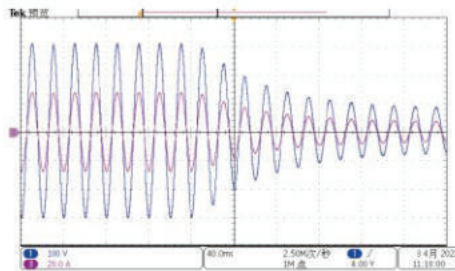
AC+DC: 220V/50Hz, superimposed 100Vdc, 0° trigger



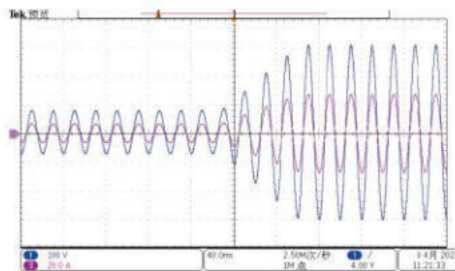
DC+AC: DC200V superimposed AC20V

■ Current and power limit function

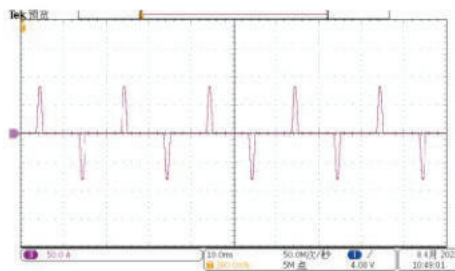
The PRE20 series products are designed with current and power limit function for R&D and testing. When this function is enabled, the output voltage of the product will be pulled down after the current or power exceeds the limit value, thus ensuring the safety of the R&D test object. After this function is disabled, the power supply can still output a peak value up to 3 times the rated current and can continue this state. In conjunction with the effective value overcurrent protection delay setting, the real impulse current value of the product can be obtained and recorded.



Normal to current limiting process



Process of current limiting returning to normal



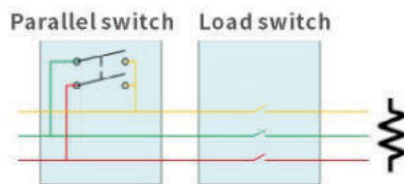
CF=4/4 times peak waveform

$U_{rms1}$	: 179.89	V	CH1 Range	U40mV/60V	1.0k	1.0kA
$I_{rms1}$	: 21.16	A	CH2 Range	U40mV/60V	1.0k	1.0kA
$I_{pk1+}$	: 81.50	A	CH3 Range	U40mV/60V	1.0k	1.0kA
$I_{pk1-}$	: -80.89	A	CH4 Range	U40mV/60V	1.0k	1.0kA

CF = 4/4 times peak data

- **Three-phase-single-phase automatic conversion**

In the space and power density of 3U/20kW, two sets of parallel switch and load switch are designed for PRE20 series products. The parallel switch is associated with the single-phase mode, which can realize the automatic conversion between the three-phase output and the single-phase output ①, reduce the operation complexity, and solve the possible faults caused by forgetting to remove the external short circuit. The load switch is associated with the OUT function, realizing the output and load isolation ②, making the R&D test and production line ATE conversion of the test object safer.



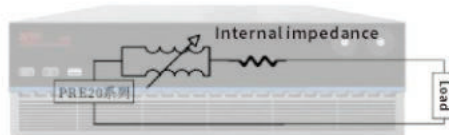
Schematic diagram of Automatic Three-phase-single-phase Conversion Function

①The output terminal supports the maximum effective value current of 70A<sub>rms</sub>/Port. If it exceeds 70A<sub>rms</sub>, external short circuit is required, and the N line needs to be short circuited.

②Only the outputs of phase lines A, B and C are isolated from the load, and the N line is not isolated from the load.

- **RL internal impedance regulation**

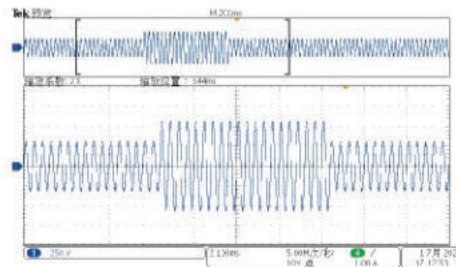
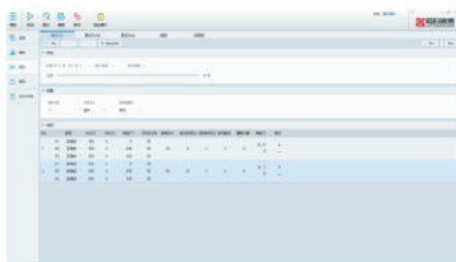
The PRE20 series products are internally integrated with R and L impedance adjustment functions, so that the output voltage and current are related to R and L parameters, and the cable impedance functions in IEC61000-3-2 and 3-3 standards are simulated.



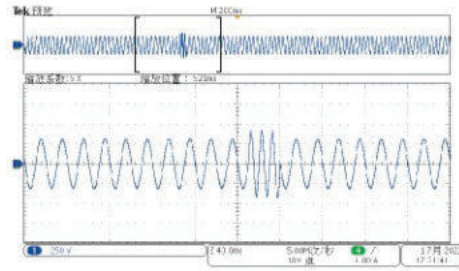
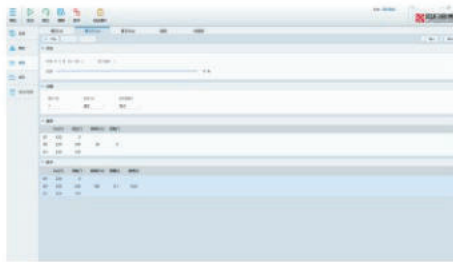
Schematic Diagram of RL Internal Impedance Circuit

- **Rich programming functions**

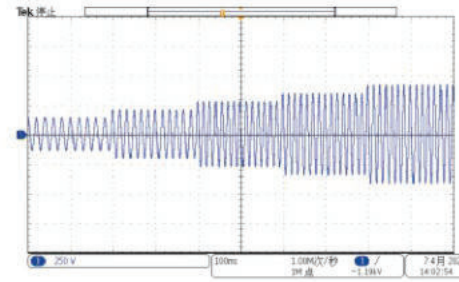
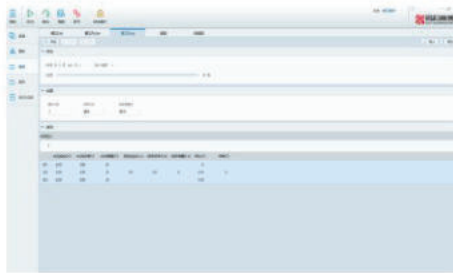
The PRE20 series products support LIST, PULSE, STEP and Advance programming functions, as well as analog programming of harmonics and inter-harmonics; support 100 groups of custom waveform programming.



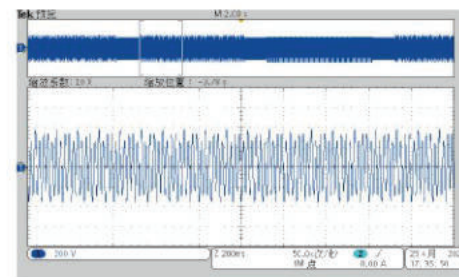
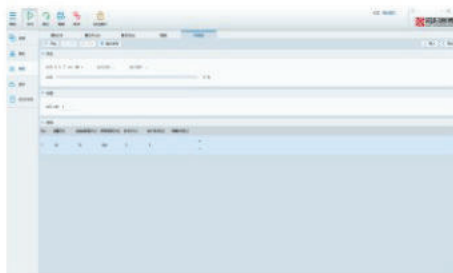
LIST programming waveform



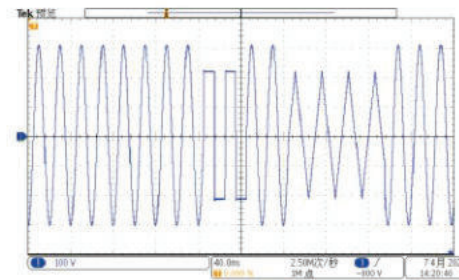
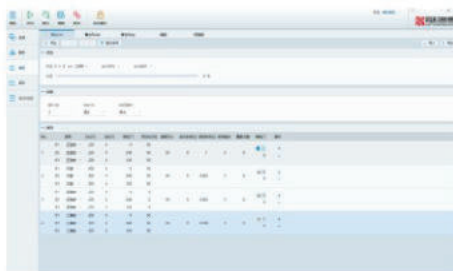
PULSE programming waveform



STEP programming waveform



Interharmonic sweep

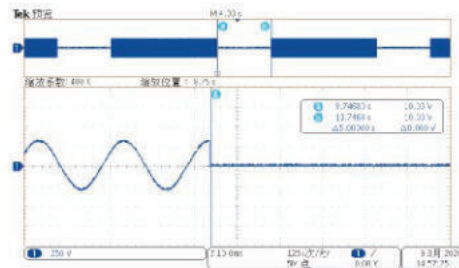
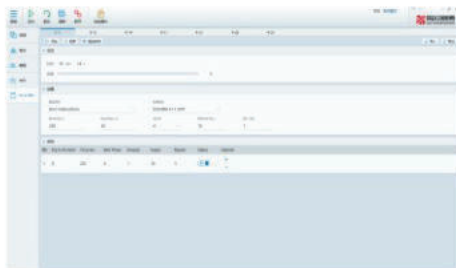


Custom waveform

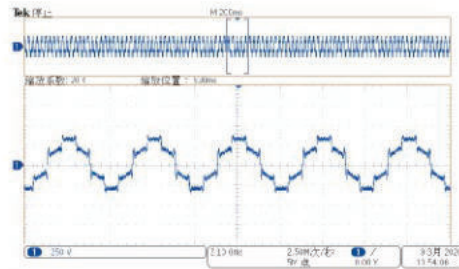
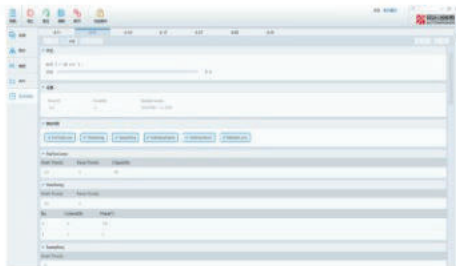


■ **Powerful standard waveform library**

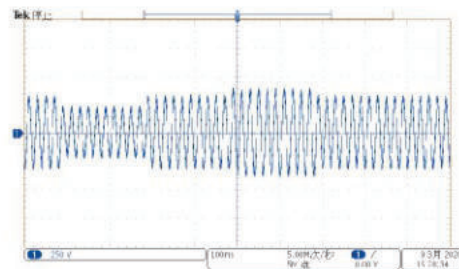
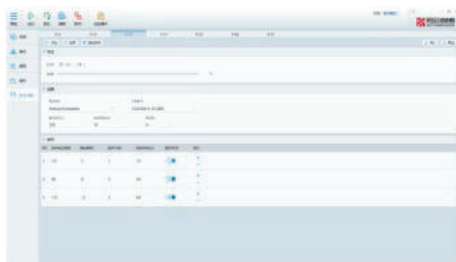
The PRE20 series products have the testing capability of UL1741SA, IEEE1547, IEC62116 and NB/T32004 distributed energy related standards; with built-in IEC61000-4 standards, the upper computer can be called with one click. It is in line with most ATS integration development requirements. Specific test items: IEC61000-4-11, 4-13, 4-14, 4-27, 4-28, T/CPSS1007-2020 AC standard; support IEC61000-4-17 and 4-29 DC standards; with 30 groups of built-in DST waveforms, it can be called with one click to carry out harmonic injection test of relevant standards.



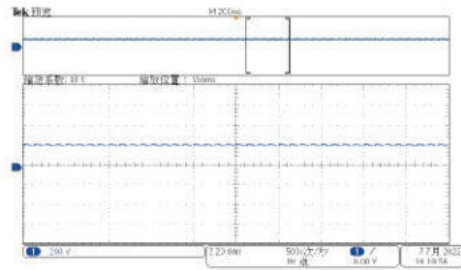
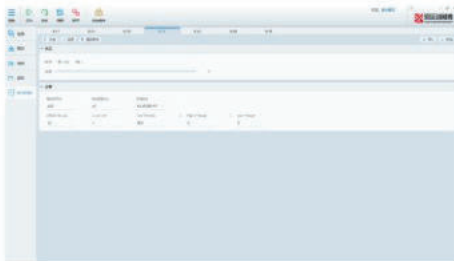
IEC61000-4-11 interruption 90°@Class2/50Hz



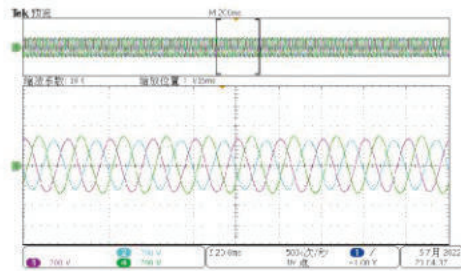
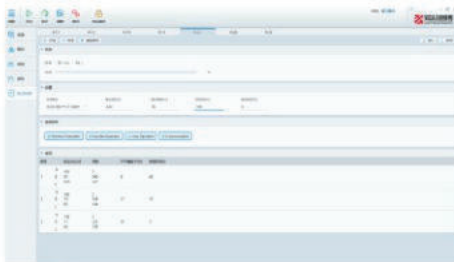
IEC61000-4-13 odd harmonics that are not multiples of 3 @Class3/50Hz



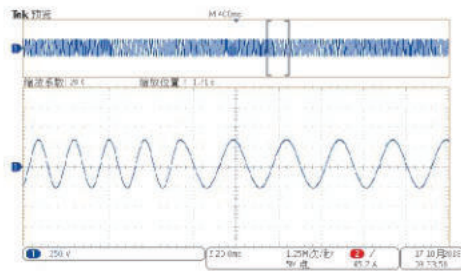
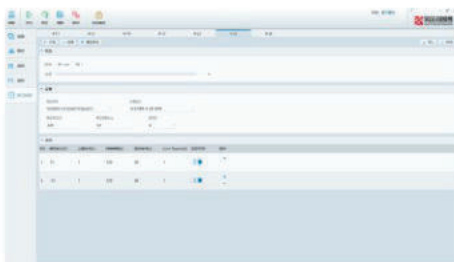
IEC61000-4-14 + 20%-30% voltage fluctuation time interval 0.2s@Class3/50Hz



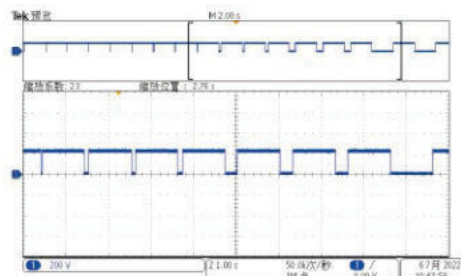
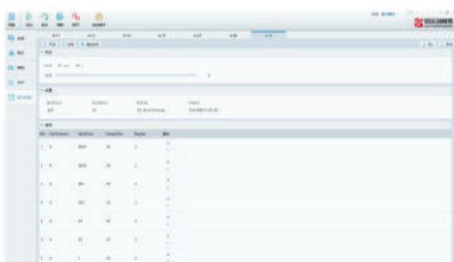
IEC61000-4-17 DC ripple voltage @Class3



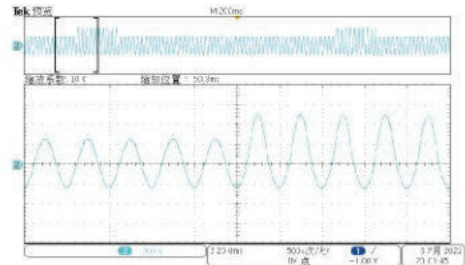
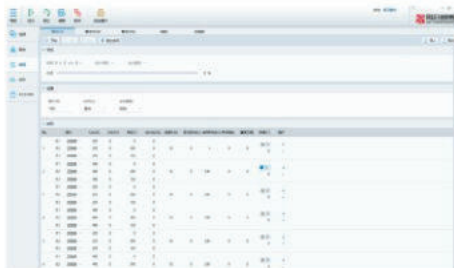
IEC61000-4-27 voltage unbalance @Class3



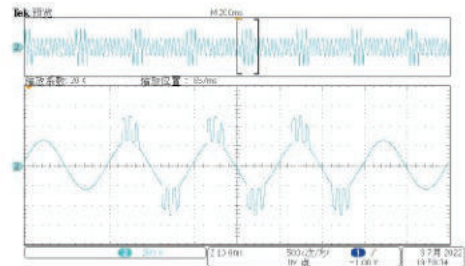
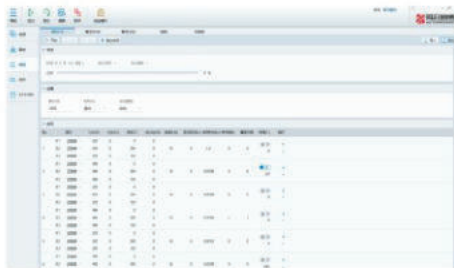
IEC61000-4-28 power frequency variation @Class4



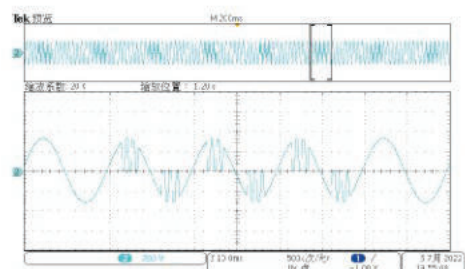
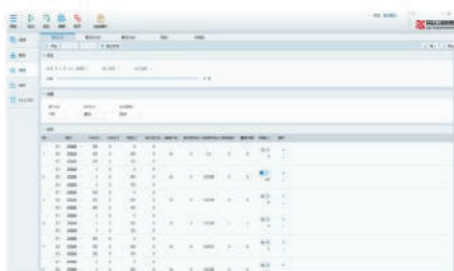
IEC61000-4-29 DC interruption



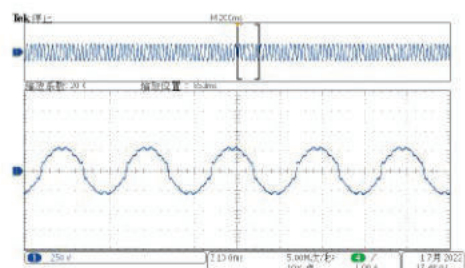
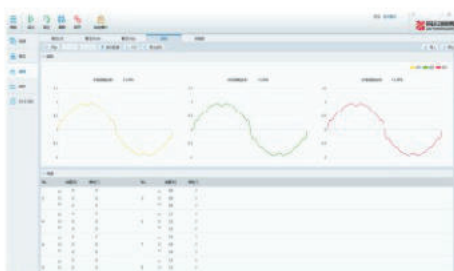
T/CPSS1007-2020 220V surge 10 cycles, half cycle voltage multiplication



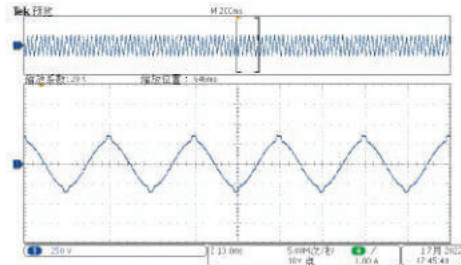
T/CPSS1007-2020 220V sudden increase to 440V, 3 cycles abnormal, 10 cycles normal



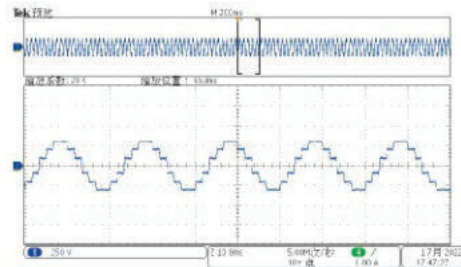
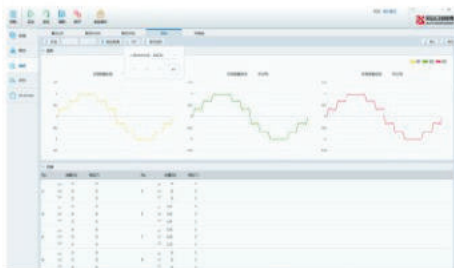
T/CPSS1007-2020 290V drop to 5V, 3 cycles abnormal, 10 cycles normal



DST10 waveform



DST23 waveform



DST26 waveform

## Applications

### PV energy storage

Simulation of grid characteristics of PV inverter and PCS, RLC load simulation of anti-islanding and off-grid test; simulation of grid characteristics of energy storage system and microgrid;

### New energy vehicle

Simulation of grid characteristics of AC and DC charging piles; Simulation of grid characteristics and load characteristics of V2X and OBC/BOBC;

### Power electronics

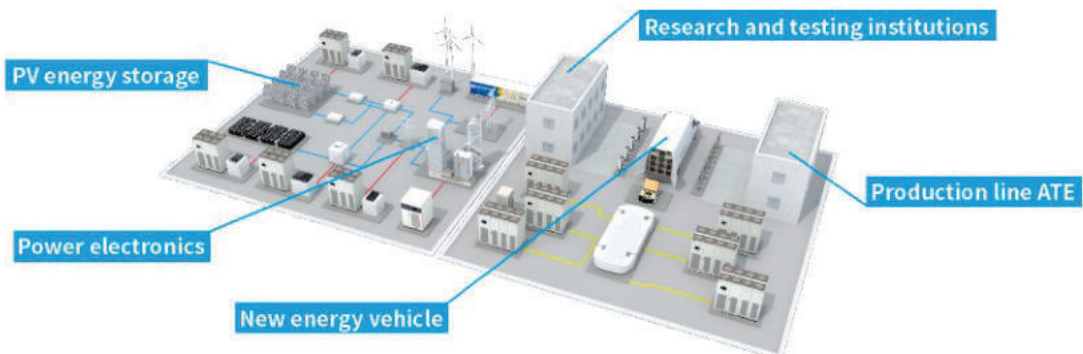
Simulation of grid characteristics and load characteristics of UPS, household appliances and electrical components;

### Colleges and research and testing institutions

Simulation of grid characteristics and load characteristics for product standard certification and testing;

### Production line ATE

Simulation of grid characteristics and load characteristics for production line product calibration and factory inspection.



## Product appearance

PRE20 products conform to the standard 19-inch chassis structure and can be integrated into the standard cabinet system or placed on the test platform in practical application.

The size of a single module is 435mm × 132mm × 680mm (W × H × D), and the appearance is as follows:



PRE20XXS reference appearance

The appearance of the cabinet system is as follows



26U cabinet

42U cabinet

Note: The optional models are 26U and 42U in height.

## Technical parameters

Indicators		Technical parameters
	Output mode	AC, DC, AC+DC, DC+AC
	Operating mode	Bi-directional feedback source
	Output phase number	Three-phase, single-phase, three-phase independent
<b>AC output</b>		
Voltage	Resolution setting (V)	0.01
	Accuracy ①	0.01%±0.05% F.S.
	Waveform type	Sine wave, triangular wave, square wave, 1% clipping, 2% clipping, 5% clipping, 10% clipping, custom wave, etc., totaling 100 types
	DC component (mV) ②	<20
	Voltage distortion ③	<0.3%@50Hz/60Hz
		<1%@0.001Hz~200Hz
	Load regulation	±0.05% F.S.
	Source regulation	±0.01% F.S.@10% variation
	Remote compensation	Adaptive
Voltage slew rate	AC>3.0V/μs	
Frequency	Resolution (Hz) ④	0.001
	Accuracy	±0.01%
Phase	Range	A = 0°, B = 240°, C = 120° (default); programmable range 0°~359.9°
	Accuracy ⑤	±0.1°@0.001~200Hz
	Resolution setting	±0.1°
Harmonic	Times	100times@40~70Hz;
	Content ⑥	40%
	Amplitude error	±5%@ set value or 0.1% of fundamental value @ less than 39 times
	Range of phase angle	0°~359.9°
Current	Resolution setting (A)	0.01
	Peak factor ⑦	1~6
	Accuracy ⑧	0.1%+0.1%F.S.@15~200Hz

## Technical parameters

Indicators		Technical parameters
<b>DC output</b>		
Voltage	Resolution setting (V)	0.01
	Output accuracy <sup>⑩</sup>	0.01%±0.05%F.S.
	Output ripple (V <sub>rms</sub> ) <sup>⑪</sup>	<0.35@(DC-300kHz)
	Load regulation	±0.05%F.S.
	Source regulation	±0.01% F.S.@10% variation
	Output slew rate	DC>3.0V/μs
Current	Resolution setting (A)	0.01
	Accuracy	0.1%+0.1% F.S.
<b>Transient state</b>		
Programming	Mode	LIST、WAVE、STEP、PULSE、Advance、Harmonic、Interharmonic、30 groups of built-in DST waveforms
	Minimum programming time step size	100μs
	Number of programming waveforms	100
	Synchronization source /trigger source	Internal, external
	Data source	Edit, import, export
	Analog programming	Effective value, amplitude and instantaneous value (power amplifier mode)
Built-in standard	AC IEC61000	4-11、4-13、4-14、4-27、4-28、3-2、3-3、3-11、3-12
	DC IEC61000	4-17、4-29
Internal resistance mode	R range (Ω) <sup>⑨</sup>	0.1~1000
	L range (mH)	0.1~1000
	Resolution setting	0.1
	Accuracy	0.1%+0.2% F.S.
<b>RLC load</b>		
Resistance	Range(Ω)	0.1~1000
	Resolution setting(Ω)	0.1
	Accuracy	±0.1% F.S.

## Technical parameters

Indicators		Technical parameters
Inductance	Range(mH)	0.1~5000
	Resolution setting(mH)	0.5
	Accuracy	±0.1% F.S.
Capacitance	Range(mF)	0.001~5
	Resolution setting(mF)	0.1
	Accuracy	±0.1% F.S.
<b>Measurement parameters</b>		
AC voltage	Resolution(V <sub>rms</sub> )	0.01
	Accuracy	0.01%+0.05% F.S.
Frequency	Resolution(Hz)	0.001
	Accuracy	±0.01%
AC current	Resolution	0.01
	Accuracy	0.1%+0.2% F.S.
Peak current	Resolution(A)	0.01
	Accuracy	±2% F.S.
Peak factor	Resolution	0.01
	Accuracy	±2.0% F.S.
Active power	Resolution(W)	1
	Accuracy <sup>②</sup>	±0.2% F.S.
Apparent power	Resolution(VA)	1
	Accuracy <sup>②</sup>	±0.1% F.S.
Power factor	Resolution	0.01
DC voltage	Resolution(V)	0.01
	Accuracy	±0.1% F.S.
DC current	Resolution(A)	0.01
	Accuracy	0.1%+0.2% F.S.



## Technical parameters

Indicators	Technical parameters
<b>Input and protection</b>	
Wiring mode	Three-phase four-wire ABC+PE
Frequency (Hz)	47~63
Voltage range (V) <sup>⑬</sup>	304~480
Input peak current (A)	< 1.5x rated
Power factor <sup>⑭</sup>	> 0.99
Efficiency <sup>⑭</sup>	> 0.91
<b>Interface</b>	
Universal interface	Type-B USB, LAN
<b>Environment</b>	
Operating range (°C)	0~50
Storage range (°C)	-20~70
Humidity	≤80%
<b>Dimension and weight</b>	
Dimension (W×H×D)	435mm×132mm×680mm (including circuit breaker 781mm)
Weight	35kg

### Note:

- ①: In the parameters table, the FS related to AC output voltage refers to the maximum AC voltage of 450V;
- ②: The DC component is set as output voltage 220VAC and frequency 50Hz, tested under no load;
- ③: When the output frequency is ≤200Hz, the maximum distortion is tested under 250VAC and the pure resistive load to the rated output power;
- ④: When the resolution is 0.001 or 0.01% of the current setting value, whichever is greater;
- ⑤: The phase precision is set to 220V for the three-phase output voltage, and the three-phase phase is set to the default phase. The test is conducted under no load;
- ⑥: 40% of the amplitude of 300V<sub>rms</sub> refers to the total content of superimposed harmonics;
- ⑦: Peak factor refers to the ratio of peak current to effective value. The typical value of standard sine wave is 1.414, and the maximum allowable value is 6, but the peak value does not exceed the maximum current value of a single machine, and does not refer to the peak factor under rated values;
- ⑧: In the parameters table, the FS of AC current parameters refers to the rated effective value current of the machine of corresponding model;
- ⑨: Output impedance refers to the steady-state output impedance, and does not exceed the maximum output;
- ⑩: In the parameters table, the FS related to DC output voltage refers to the maximum DC voltage of 636V;
- ⑪: The output ripple voltage is 500V for the output DC voltage, and the output is under no load. The oscilloscope is AC coupled with 20MHz bandwidth limit;
- ⑫: The FS of active power and apparent power precision refers to the maximum measured power value of the machine of the corresponding model;
- ⑬: The input voltage 304~323V needs to be derated by 60%, and the input voltage 323~342V needs to be derated by 80%. See "Input Voltage Derating Curve" for detailed derating requirements;
- ⑭: Power factor and efficiency index are tested under the three-phase input voltage of 380V, the set output of 220V, pure resistive load to the rated output power.

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