

# SW Series

## 1.75-21KVA PROGRAMMABLE AC POWER SERIES

### Features

- **Powerful wave shape and waveform creation**
- **Graphic LCD Display**
- **Powerful DSP2 waveform programming**
- **Flexibility in power ranges**
- **Large wave shape library**



### Product Overview

The Smart Wave (SW) series of AC power sources offers powerful waveform creation for ATE and power line disturbance simulation testing. Three separate arbitrary waveform generators enable the Smart Wave to create independent, complex waveforms on all three phases simultaneously. The Smart Wave is designed to meet waveform requirements including DC contents (up to 312V), low distortion (THD 0.25% to 100Hz), low noise and ripple, plus full compliance testing to EMC standards. At only 8-3/4 inches high for the SW 5250A, the Smart Wave delivers the most power in the smallest package. It weighs only 127 pounds, and offers the highest power density in the industry. The SW Series is expandable from 1.75kVA to 21kVA. Unlike other AC power sources, the Smart Wave delivers full rated power to 45°C.

### Features and Benefits

**Powerful Wave Shape and Waveform Creation** The Smart Wave can easily create fractional or multi-cycle dropouts, spikes, surges, sags and distorted waveforms from the front panel. To simulate these complex real-world power occurrences, the Smart Wave comes with a library of 50 built-in wave shapes of their own design. Output voltages are created by adding amplitude, frequency and other parameters to the wave shapes. The user can also create over 50 custom front panel setups with all parameters included and store them for quick recall, making the Smart Wave ideal for manual testing.

### SEQUENCE PROGRAMMING

Complex sequence or event programming is easy with time or cycle based transient segments. The sequence library is made up of a total of 1000 segments stored as labeled sequences. A sequences of up to 100 segments using up to 32 different wave shapes, arranged in any combination, can be run at any one time. The 32 wave shapes can be selected from the 50 factory supplied and 50 user created wave shapes. By setting the time or number of cycles for each segments, the user can create waveform sequences that allow automatic testing for most any standards.

### AC AND/OR DC

A direct coupled, transformerless design allows AC and DC on separate phases or on the same phase. The Smart Wave can be used as a true DC power supply. High DC content waveforms (up to 312 volts) can be created with no de-rating of output power, even with 100% reactive loads. This can eliminate the need for a separate DC supply.

### GRAPHIC LCD DISPLAY

**Display** The Smart Wave has a graphic LCD display for previewing and confirming the waveforms before connecting the output to the load. The menus are easy to follow with the overlay paging format. Users can select menus, slew voltage and frequency with a handy knob on the front panel. Front panel signal and sync outputs allow three phase scope viewing.

### POWERFUL DSP2 WAVEFORM PROGRAMMING

Waveform programming is easily accomplished using the optional DSP PC software. The software allows freehand creation of waveforms, using a mouse or mathematical expressions. Real-world waveforms can be uploaded and modified when using a digital scope. The waveforms can then be downloaded to the Smart Wave via GPIB and output to exactly simulate real-world conditions.

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### More Features and Benefits

#### FLEXIBILITY IN POWER RANGES

The Smart Wave series includes the SW 1750 (single phase only), SW 3500 (single or dual phase), and SW 5250A. The 5250A three phase unit can be switched to single phase or vice versa, simply by menu selection (and appropriate output wiring changes). The SW Series is factory upgradeable from 1750 VA to 3500 VA or 5250 VA. Utilizing a master/slave arrangement, SW 5250A can be paralleled for incrementally higher power requirements, e.g. one master/one slave = SW 10500 (10.5 kVA). As many as 3 slave chassis may be paralleled with a master to form a 21 kVA system. Options include input power factor correction, measurement capability, plus 5 and 26 VAC auxiliary outputs.

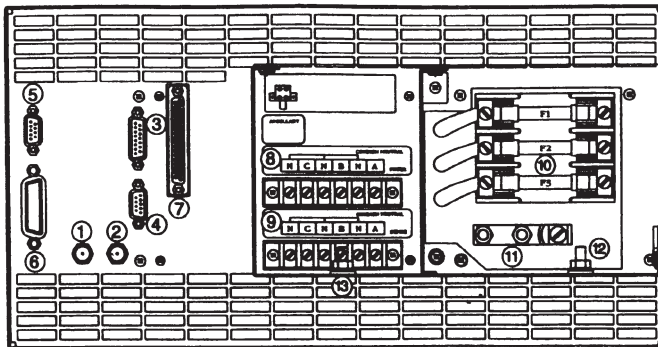
#### WAVESHAPES LIBRARY

There are 50 factory-supplied wave shapes in the Smart Wave. Following are examples of the types of wave shapes in the library:

- Sine wave
- Square wave
- Triangle wave
- Clipped sine waves
- Sine waves with spikes
- Fractional dropouts
- Sine wave with dropout (0V from 0° to 90°)
- Sine waves with  $\pm 1$ -50% DC offset
- $\pm$ DC with 3% and 10% ripple
- Fourier square waves with harmonics
- Taylor series waves
- Sine wave with noise at zero crossing

### Applications

### Technical Illustrations



Rear Panel		
1. Sync out	6. IEEE-488.2	10. Fuse F1, Fuse F2, Fuse F3
2. Clock and lock	7. Slave I/O	11. Input, neutral lug, single barrel
3. Ext. in +/-7.5V max	8. Output power terminal barrier	12. Safety ground
4. RS 232*	9. Remote sense terminal barrier	13. Chassis ground
5. DFI		

\* Can also be used to upgraded firmware in flash-ROM

The Smart Wave is designed for testing today's complex electronics, including telecommunications and commercial electronics requiring low profile, light weight power supplies.

#### OTHER APPLICATIONS INCLUDE:

- Testing for real world power conditions using different waveforms on all 3 phases (including DC)
- Load susceptibility testing with sequence or event programming and multiple voltage harmonics
- Power line disturbance simulation testing
- MIL-STD-704, DO-160 and ABD100 avionics testing
- Power supply testing for AC-DC, DC-DC converters and UPS's
- Fluorescent lighting characteristics testing (IES LM-41-1985)
- Transients on 12 & 24 VDC for automotive applications

### Smart Wave Control Suite (SWCS)

SWCS is a Windows based software package for computer control of the Smart Wave Series and SWAE AC power sources. With the SWCS you have complete control of the instrument including programming, waveform selection, creation and sequencing. SWCS enhances the standard Smart Wave features with an additional harmonic waveform analysis capability with data logging features for all measurements.

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### Specifications

#### OUTPUT

**Power Factor of Load:** 0 lagging to 0 leading

**AC or DC Output Voltage:** 0 to 156 VRMS L-N range 1; 0-312 VRMS L-N, range 2

**Output Current Per Phase:** 13A to 135V in 156V range; 6.5A to 270V in 312V range (per 1750 VA module) Note: Higher currents may be achieved in 10.5-21 kVA systems.

**Crest Factor:** 4.0 (peak output current to RMS output current)

**Output Frequency Range:** DC or 40 Hz to 5 kHz. For output frequencies greater than 1 kHz, the max slew rate allowed is 1 kHz per second.

**Output Power:** 1750 VA: 1 $\phi$ , 3500 VA: 1 $\phi$  or 2 $\phi$ , 5250 VA: 1 $\phi$  or 3 $\phi$  (systems up to 21,000 VA)

**Max Total Harmonic Distortion (Full Linear Load or No Load):** 0.25% max, 40 to 100 Hz; 0.5% max to 500 Hz; and 1% max to 1 kHz plus 1%/kHz to 5 kHz

**AC Noise Level:** >60 dB RMS below full output voltage

Amplitude Stability With Remote Sense:  $\pm 0.1\%$  of full scale over 24 hours at constant line, load and temperature

**Load Regulation:**  $\pm 0.025\%$  of full scale voltage for a full resistive load to no load; above 1 kHz, add  $\pm 0.01\%/kHz$

**Line Regulation (DC, or 40 Hz to 5 kHz):**  $\pm 0.025\%$  of full scale for a  $\pm 10\%$  input line change

**Voltage Accuracy:**  $\pm 0.1\%$  of range. Above 1 kHz, add 0.2%/kHz. Add  $\pm 0.1\%$  of full scale for "AC PLUS DC" mode. Valid for 5 to 156 VRMS and 10 to 312 VRMS at 25°C

**Voltage Resolution:** 0.05% of full scale

**Frequency Resolution:** 0.01 Hz: 40 Hz to 99.99 Hz, 0.05 Hz: 100 Hz to 999.9 Hz, 0.5 Hz: 1000 Hz to 5000 Hz

**Frequency Accuracy:**  $\pm 0.01\%$  at 25°C  $\pm 0.001\%/^{\circ}C$

**Phase Accuracy, Phase-to-Phase Balanced Linear Resistive Load:**

$\pm 1^{\circ}$ , 40 Hz to 1 kHz, plus  $\pm 1^{\circ}/kHz$  above 1 kHz

**Phase Angle Resolution:** 0.1°

**Remote Output Voltage Sense:** 5 VRMS total lead drop, max

#### WAVEFORM SPECIFICATIONS

**Wave shape Libraries:** 50 factory supplied in ROM; storage available for up to 50 user created in non volatile RAM

**Front Panel Setups:** A total of 50 user created steady-state waveforms, with amplitude, frequency, phase angle and current limit parameters

**Sequencing Library:** 1000 user created segments stored in non-volatile RAM. Segments include wave shape, amplitude, frequency, phase angle, time (from 1ms to 1000 seconds), or number of cycles.

**MIL-STD-704 Transient Library**

#### MEASUREMENTS (OPTIONAL)

- Phase to Neutral RMS Output Voltages

- Phase to Phase Voltages

- 1 $\phi$  to 3 $\phi$  RMS Output Currents.

- Peak Current

- Output Frequency

- 1 $\phi$  to 3 $\phi$  Power

- 1 $\phi$  to 3 $\phi$  VA

- Power Factor of 1 $\phi$  or 3 $\phi$  Loads

- Output Phase Angles Relative to Phase A

**Measurement Capability:** 4.5 Digit Analog to Digital Measurement System with 0.01% of full scale resolution unless otherwise noted. All accuracies 25°  $\pm 5^{\circ}C$

**Calibration Interval:** 12 months

**Operating/Accuracy Temperature Range:** 0°C to 45°C (32°F to 113°F)

**Temperature Coefficient:**  $\pm 500$  ppm/°C outside specified range

**PHASE TO NEUTRAL RMS VOLTAGE MEASUREMENT:** Valid for phases A, B and C (use phase A for Parallel Mode)

**Range:** 0V to 350V plus sign bit for DC range

**Accuracy:**  $\pm 0.3\%$  of range, DC or 47 Hz to 1 kHz;  $\pm 0.5\%$  of range, 40 to 47 Hz and for 1 kHz to 5 kHz

**Phase to Phase RMS Voltage:** Calculated from Phase to Neutral voltages and phase angle

**Range:** 0V to 700V

**Accuracy and Temperature Coefficient:** The same as the Phase to Neutral voltage

#### RMS CURRENT MEASUREMENT

Valid for phases A, B, and C (use phase A for Parallel Mode)

**Range 1:** 0A to 7.5A plus sign bit for DC range; 3 $\phi$  mode, 312V range

**Range 2:** 0A to 15A plus sign bit for DC range; 3 $\phi$  mode, 156V range

**Range 3:** 0A to 22.5A plus sign bit for DC range; parallel mode, 312V range

**Range 4:** 0A to 45A plus sign bit for DC range; parallel mode, 156V range

**Accuracy:**  $\pm 1.0\%$  of range, DC or 40 Hz to 500 Hz; add  $\pm 1.5\%/kHz$  above 500 Hz. Accuracies are specified for a max crest factor of 4.0.

Temperature Coefficient:  $\pm 500$  ppm/°C outside specified range Note: Contact Powerbox for measurement range on 10.5 to 21 kVA system.

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### PEAK CURRENT MEASUREMENT

Valid for phases A, B, and C (use phase A for Parallel Mode)

**Range 1:** 0A to 28A; 3 $\emptyset$  mode, 312V range

**Range 2:** 0A to 56A; 3 $\emptyset$  mode, 156V range

**Range 3:** 0A to 84A; parallel mode, 312V range

**Range 4:** 0A to 168A; parallel mode, 156V range

**Accuracy:**  $\pm 5\%$  of range, 40 to 500 Hz; add  $\pm 1\%/kHz$  above 500 Hz

**Power Measurement:** Valid for phases A, B, and C. Up to 3 $\emptyset$  total power and parallel mode (use phase A for parallel mode)

**Range 1:** 0 kW to 1.8 kW; 3 $\emptyset$  mode

**Range 2:** 0 kW to 5.6 kW; parallel mode and total 3 $\emptyset$  power

**Accuracy:**  $\pm 2.5\%$  of range, DC or 40 to 500 Hz for crest factors  $< 2.0$ .

Add  $\pm 1\%$  for crest factors up to 4.0. Add  $\pm 1\%/kHz$  above 500 Hz

**VA Measurement:** Valid for phases A, B, and C. Up to 3 $\emptyset$  total VA and parallel mode (use phase A for parallel mode)

**Range 1:** 0 kW to 1.8 kVA; 3 $\emptyset$  mode

**Range 2:** 0 kW to 5.6 kVA; parallel mode and total 3 $\emptyset$  power

**Accuracy:**  $\pm 2.5\%$  of range, DC or 40 to 500 Hz for crest factors  $< 2.0$ .

Add  $\pm 1\%$  for crest factors up to 4.0. Add  $\pm 1\%/kHz$  above 500 Hz.

**Power Factor:** Valid for phases A, B, and C (use phase A for Parallel Mode). The PowerFactor is calculated from the Power and VA measurements.

**Range:** 0 to 1.00

**Accuracy:**  $\pm 5\%$  of range at full power, DC or 40 to 500 Hz for crest

factors  $< 2.0$ . Add  $\pm 2\%$  for crest factors up to 4.0. Add  $\pm 1\%/kHz$  above 500 Hz.

**Frequency Measurement:** Frequencies are calculated based on output zero crossing time measurements.

**Resolution:** Frequency is displayed to 5 digits max; leading zeros are blanked. Displayed resolution is 0.01 Hz.

**Accuracy:**  $\pm 0.5\%$  of reading, at 10% to full output voltage, 0°C to 45°C

**Phase Measurement:** Valid for phases A, B, and C relative to each other

**Resolution:**  $\pm 1^\circ$

**Accuracy:**  $\pm 2^\circ$ , 40 to 500 Hz; add  $\pm 2^\circ/kHz$  above 500 Hz. For sine wave, balanced resistive load, 10% to 100% of voltage measurement range, 0°C to 45°C

### INPUT

**Input Voltage Ranges:** Factory configured 187 to 264 VRMS, 3 $\emptyset$  L-L (3 wire), or 342 to 457 VRMS, 3 $\emptyset$  L-L (4 wire). A chassis ground is also required. 115 or 230 VAC single-phase is required for PDU in 10.5-21 kVA systems. (400 Hz input allowed with PFC option)

**Input Power Factor:** 0.6 (.35 for Intl. Rectifier; 0.99 with PFC option) Note: With PFC option the inputs may be paralleled and wired for single phase input. Consult Powerbox.

**Input Frequency Range:** 47 to 63 Hz

**Efficiency:** 70% min., at full load

**Ride Through:** 3 ms min.; 10 ms min., with PFC option

### PROTECTION AND SAFETY

**Over-voltage Shutdown:** Programmable for 15V to 255V peak, 156V range; 30V to 510V peak, 312V range

**Programmable Current Limit Shutdown:** Settable to 1% of range (0.5A to 13A for 156V range; 0.5A to 6.5A for 312V range)

**Programmable Current Limit with Timed Shutdown:** Settable to 1% of range: the time out is settable from 10 ms to 10s.

**Programmable Constant Current:** Settable to 1% of range (0.5A to 13A for 156V range; 0.5A to 6.5A for 312V range). For all current accuracies  $\pm 1\%$ , add  $\pm 1.5\%/kHz$  above 500 Hz. For paralleled amplifiers, add  $\pm 1\%$ .

**Over-temperature Shutdown:** (automatic, not programmable)

**Designed to Meet the Following:**

- EN 61010 • EN 55011
- UL 3111 • EN 50082-2
- 61000-4-3, 61000-4-4

- FCC Part 15, Class A • CE Mark

### PHYSICAL SPECIFICATIONS

**Height:** 8.75 in (222 mm)

**Width:** 19 in (483 mm)

**Depth:** 23.5 in (597 mm)

**Weight:**

- SW 1750A - 73 lbs (33.1 kg)
- SW 3500A - 100 lbs (45.4 kg)
- SW 5250A - 127 lbs (57.5 kg)

**Shipping Weight:**

- SW 1750A - 160 lbs (73 kg)
- SW 3500A - 180 lbs (82 kg)
- SW 5250A - 200 lbs (91 kg)

**Note:** 10.5, 15.75 and 21 kVA systems, dimension and weight are approximately x2, x3 and x4 SW 5250A specifications

**Cooling:** Air is drawn in from the top, bottom, and sides and exhausted through the rear.

### ENVIRONMENTAL DATA

**Operating Temperature:** 0°C to 45°C

**Storage Temperature:** -40°C to 70°C

**Humidity (Non-condensing):** 0 to 85% at 25°C (77°F); de-rate to 50% at 40°C (104°F)

**Altitude:** Operating 10,000 ft, non operating 40,000 ft

### OTHER STANDARD FEATURES

- 1 $\emptyset$  to 3 $\emptyset$  programmable
- IEEE-488.2 interface
- SCPI protocol
- Wave Form trigger output: (1 M $\Omega$  Load Drive)
- BNC outputs for scope viewing of waveforms (1 M $\Omega$  Load Drive)
- SYNC OUT. User programmed for: Cycle start, all cycles. Segment start, all or selected segments. For loads  $\geq 2\text{ k}\Omega$ : V out  $\leq 1\text{V}$  low state; V out  $\geq 2.4\text{V}$  high state
- External Amplitude Modulation 0 to 5 VRMS provides 0 to  $\geq 20\%$  output amplitude modulation.
- Clock/lock:
- Clock pulses at programmed frequency. For loads  $\geq 2\text{ k}\Omega$ : V out:  $\leq 1\text{V}$  low state; V out  $\geq 2.4\text{V}$  high state
- Lock locks output to input 'TTL' frequency; signal needs to supply pull down current of 15 mA with voltage drop of  $\leq 0.6\text{V}$ ; no pullup needed.
- External Drive: Normal amplifier, 0 to 5 VRMS (DC to 5 kHz) or  $\pm 5\text{VDC}$  input for zero to full voltage output
- External Gain Control 0 to  $\pm 7.07\text{VDC}$  provides zero to full output
- External Input Impedance  $\geq 30\text{ k}\Omega$

### OPTIONS

- Measurement capability
- Input power factor correction to 0.99
- Parallelable for additional power from 10.5 kVA to 21 kVA
- External waveform creation software DSP2
- 5V or 26V, 0.25A auxiliary AC outputs
- Custom cabinets for 10.5, 15.75 & 21 kVA systems
- Interharmonic waveform generator
- Low speed fan option
- 16A/phase output

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### Selection Tables

#### SW ORDERING INFORMATION

MODEL NUMBER	OUTPUT POWER RATING	AC INPUT	POWER FACTOR CORRECTION
SW 1750A-1	1750 VA (1)	187-264 VRMS (L-L), 3 wire	No
SW 1750A-2	1750 VA (1)	342-457 VRMS (L-L), 4 wire	No
SW 1750A-3	1750 VA (1)	187-264 VRMS (L-L), 3 wire	Yes
SW 1750A-4	1750 VA (1)	342-457 VRMS (L-L), 4 wire	Yes
SW 3500A-1	3500 VA (2)	187-264 VRMS (L-L), 3 wire	No
SW 3500A-2	3500 VA (2)	342-457 VRMS (L-L), 4 wire	No
SW 3500A-3	3500 VA (2)	187-264 VRMS (L-L), 3 wire	Yes
SW 3500A-4	3500 VA (2)	342-457 VRMS (L-L), 4 wire	Yes
SW 5250A-1	5250 VA (3)	187-264 VRMS (L-L), 3 wire	No
SW 5250A-2	5250 VA (3)	342-457 VRMS (L-L), 4 wire	No
SW 5250A-3	5250 VA (3)	187-264 VRMS (L-L), 3 wire	Yes
SW 5250A-4	5250 VA (3)	342-457 VRMS (L-L), 4 wire	Yes

1. 1495 VA at 115V or 230V output 2. 2990 VA at 115V or 230V output 3. 4485 VA at 115V or 230V output

MODEL NUMBER	OUTPUT POWER	5250 MASTER/SLAVE CONFIGURATION
SW 10500	10.5 kVA	1 master SW 5250 & 1 slave SW 5250
SW 15750	15.75 kVA	1 master SW 5250 & 2 slave SW 5250
SW 21000	21.00 kVA	1 master SW 5250 & 3 slave SW 5250

### SW Model Number

