AMETEK®
PROGRAMMABLE POWER

CalPower technical note

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AMETEK's Elgar SW and California Instruments CSW Form, Fit and Functions Comparison

Introduction

The purpose of this technical note is to compare the differences between the discontinued Elgar SW Series and the ***New!*** California Instruments CSW. The Elgar SW was a flag ship product for AMETEK Programmable Power and unfortunately has come to the end of its feasible design life due to several obsolete components.

The SW featured high performance power amplifiers offering low Vthd and high frequency output. California Instruments products' lines include some of the most advanced DSP controllers available. The natural path for AMETEK Programmable Power to integrate the best of both worlds!

Front Panel Display and Data Entry

Display

The CSW display features a LED back-light with a very high contrast ratio in comparison to the SW. The CSW allows adjustment of the viewing angle so whether used on a bench or mounted in a cabinet, the display is clear and easy to read.

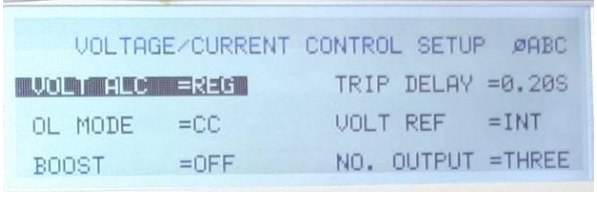

Figure 1: Display

Data Entry

Intuitive programming structure. Source programming available via key pad entry or shuttle knob.

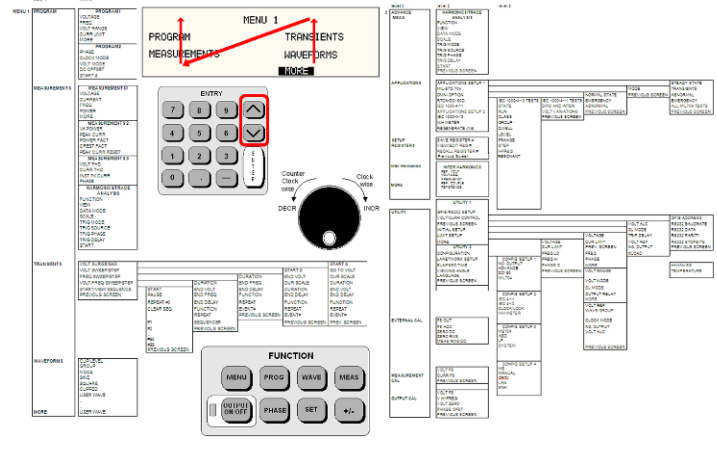

Figure 2: Menu Tree Structure and Entry

Mechanical

The CSW chassis utilizes the same chassis as the SW. Several improvements have been made to the rear panel.

The SW uses rear fuses to as protection against input line faults. The CSW includes an input circuit breaker located on the front panel so no more rear panel fuses are required. The CSW CB also helps to protect against over voltage conditions which the fuses do not.

Another benefit of this improvement is that the CSW is truly disconnected from the utility supply when turned OFF from the front panel.

Input power connections are made using a terminal block instead of the fuses mounted block.

Figure 3: SW Rear Panel

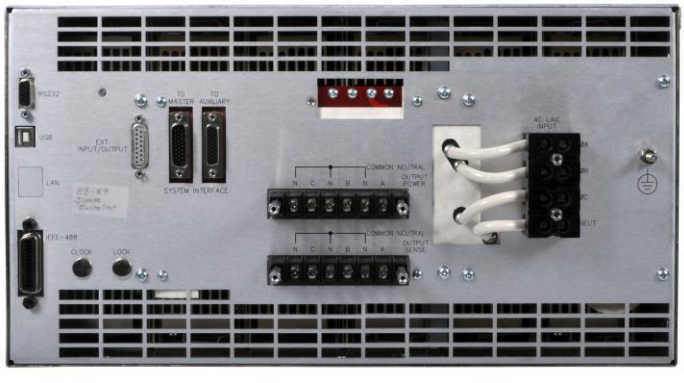

Figure 4: CSW Rear Panel

Power Input

	SW Series		CSW Series		
	Std.	Opt.	Std.	Opt.	Comments
Voltage Input	187-264Vrms	187-264Vrms	187-264Vrms		Three phase, three wire
	187-457Vrms	187-457Vrms	187-457Vrms		
Input PF	0.35-0.6	0.99	0.99		CSW PFC Input Standard
Efficiency	70%	70%	70%		
Ride Through	3msec	10msec	10msec		

Table 1

Power Output

	SW Series		CSW Series		
	Std.	**Opt.**	**Std.**	**Opt.**	**Comments**
AC/DC Voltage Range	156/312		156/312		
DC Offset Resolution	N/A	N/A	0.1V		
Frequency Range	DC / 40-5kHz	DC / 2-8kHz	DC / 40-5kHz	DC / 16-8kHz	-HF Option
Output Current	16A to 115V in 156V range; 8.0A to 230V in 312V range		16A at 115V in 156V range; 8.0A at 230V in 312V range		Constant Power Mode
Crest Factor	4:1		4:1		
% THD	0.25% 100Hz .5% 500Hz 1% 1kHz + 1% to 5khz		0.25% 100Hz .5% 500Hz 1% 1kHz + 1% to 5khz		
AC Noise	>60db rms 40-500Hz		>60db rms 40-500Hz		Load dependant Variable Fan Speed
Amplitude Stability	±0.1%		±0.1%		
Load Regulation	0.025% Above 1kHz add 0.015%/kHz		0.025% Above 1kHz add 0.015%/kHz		
Line Regulation	±0.025% of full scale for a ±10% input line change		±0.025% of full scale for a ±10% input line change		
Voltage Accuracy	0.1% of range. Above 1Khz .2%/Khz		0.1% of range. Above 1Khz .2%/Khz		
Voltage Resolution	0.050%		Front Panel: 0.1 voltRemote: 0.0025 volts (156 range) 0.005 volts (312 range)		
Frequency Resolution	0.01Hz 40-99.99Hz 0.05Hz 100-999.9Hz .5Hz - 1kHz-5kHz		0.01 Hz: 40.00 to 81.91Hz 0.1Hz: 82.0Hz to 819.1Hz 1 Hz: 820Hz to 5kHz		

Frequency Accuracy	0.01%	±0.01% at 25°C ±0.001%/°C	
Phase Angle Accuracy	1° 40-1Khz plus 1%/kHz above 1kHz	±1°, 40Hz to 1kHz, plus ±1°/kHz above 1 kHz.	
Programmable Phase Angle Res.	0.1°	0.1°	

Table 2

Measurements

	SW Series		CSW Series		
	Std.	**Opt.**	**Std.**	**Opt.**	**Comments**
Voltage L-N	0V to 350.0V plus sign bit for DC mode		0V to 312V		
Accuracy	±0.3% of range, DC or 47 Hz to 1kHz; ±0.5% of range, 40 to 47 Hz and for 1 kHz to 5kHz		±0.1% of range from 5 to 156V or 10 to 312V Above 1kHz add 0.2%/kHz		
Voltage L-L	0V to 700V				
Accuracy	±0.3% of range, DC or 47 Hz to 1 kHz; ±0.5% of range, 40 to 47 Hz and for 1kHz to 5kHz		N/A		
RMS Current					
Range 1	0A to 7.5A, plus sign bit for DC mode; 3-phase mode, 312V range				

Range 2	0A to 15A, plus sign bit for DC mode; 3-phase mode, 156V range	±1% of range add ±1.5%/kHz above 500 Hz Ranges: 0.5 to 16A: 156V range 0.5 to 8A: 312V range Multiply by 3 for 1-phase mode	
Range 3	0A to 22.5A, plus sign bit for DC mode; parallel mode, 312V range		
Range 4	0A to 45A, plus sign bit for DC mode; parallel mode, 156V range		
Accuracy	±1.0% of range, DC or 40 Hz to 500 Hz; add ±1.5%/kHz above 500 Hz. Accuracies are specified for a maximum crest factor of 4.0		
Resolution		0.001A	
Peak Current			
Range 1	0A to 28A; 3-phase mode, 312V range	±5% of range, 40 to 500Hz; add ±1%/kHz 500Hz to 5kHz Ranges: 0 to 56A; 156V range 0 to 28A; 312V range Multiply by 3 for 1-phase mode	
Range 2	0A to 56A; 3-phase mode, 156V range		
Range 3	0A to 84A; parallel mode, 312V range		
Range 4	0A to 168A; parallel mode, 156V range		
Accuracy	±5% of range, 40 to 500 Hz; add ±1%/kHz, 500 to 5kHz		
Resolution	XXXX	0.01A	

Power			
Range 1	0 kW to 1.8 kW; 3-phase mode	±2.5% of range, DC or 40 to 500. Add ±1%/kHz above 500 Hz. Ranges: 1.8kW; 3-phase mode 5.6kW; 1-phase mode	
Range 2	0 kW to 5.6 kW; parallel mode and total 3-phase power		
Accuracy	±2.5% of range, DC or 40 to 500 Hz for crest factors <2.0. Add ±1% for crest factors up to 4.0. Add ±1%/kHz above 500 Hz		
Resolution	1W	1W	
VA			
Range 1	0 kW to 1.8 kVA; 3-phase mode	±2.5% of range, DC or 40 to 500. Add ±1%/kHz above 500 Hz. Ranges: 1.8kVA; 3-phase mode 5.6kVA; 1-phase mode	
Range 2	0 kW to 5.6 kVA; parallel mode and total 3-phase power		
Accuracy	±2.5% of range, DC or 40 to 500 Hz for crest factors <2.0. Add ±1% for crest factors up to 4.0. Add ±1%/kHz above 500 Hz		
Resolution		1W	
Power Factor			
Range		0.00-1.0	
Accuracy		1 Phase Mode 0.03%, 3 Phase Mode 0.01%	
Frequency			
Resolution		0.01 Hz to 81.91Hz 0.1Hz to	

		819.1Hz 1Hz > 819.1Hz	
Accuracy		0.01Hz to 81.91Hz 0.1 Hz to 819.1Hz 1Hz > 819.1Hz	
Phase Angle			
Resolution	±1° (for outputs above 20 VRMS)	0. 1°	
Accuracy	±2°, 40 to 500 Hz; add ±2°/kHz above 500 Hz. For sine wave, balanced resistive load, 10% to 100% of voltage measurement range	±2˚, 40 to 500Hz, add ±2˚/kHz above 500Hz. (0 to 45˚C)	
Crest Factor	N/A		
Range		1.0-10	
Accuracy		1.5%	
Resolution		0.01	

Table 4

Remote Programming

SW Series	CSW Series
GPIB - Conforms to all specifications for devices as defined in IEEE 488.2, and complies with SCPI command syntax version 1995	GPIB - All AC source functions are programmable over the GPIB interface. ANSI/IEEE Std. 488.2-1987 IEEE Standard Codes, Formats, Protocols, and Common Commands. USB - All AC source functions are programmable over the USB interface. The USB interface operates internally at a fixed baudrate of 460800 baud but USB 2.0 burst transfer rates are supported. RS232- All AC source functions are programmable over the RS232C interface. Baudrates from 9600 to 115200 are supported. LAN - All AC source functions are programmable over the

	LAN (Ethernet) interface if the –LAN option is installed. The LAN interface operates internally at a fixed baudrate of 460800 baud but autodetection of 10Base-T, 100Base-T and 1000Base-T is supported.

Graphical Users Interface (control software suite)

The CSW features a new Graphical Users Interface (GUI) based on the popular California Instruments platform. The software operates in SIMULATION MODE and can be downloaded at:

http://www.elgar.com/products/Ls-Lx/Ls-Lx_Series_Downloads.htm

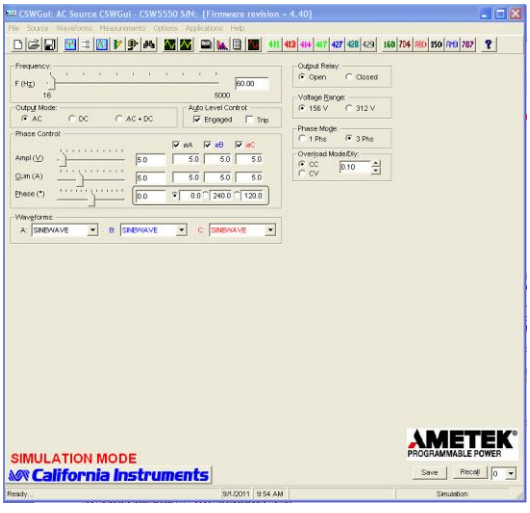

Figure 5: GUI in Simulation Mode

Calibration

The CSW can be calibrated for all functions by using the front panel or GUI. Those functions are the Voltage, Current, Phase Angle and all External Signal inputs. Only the Voltage and Current measurements must be calibrated for both the programmed and measured values.

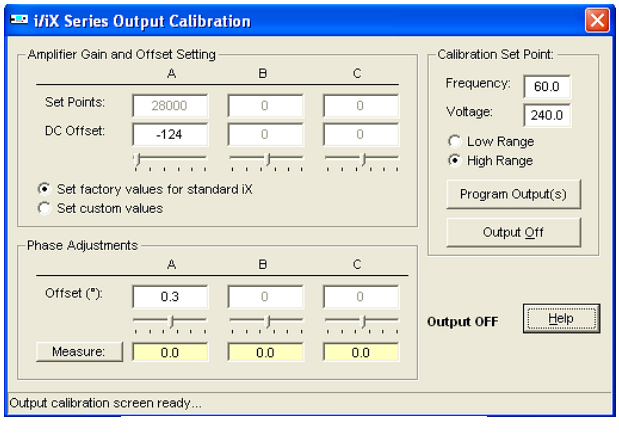

Figure 6: GUI Calibration

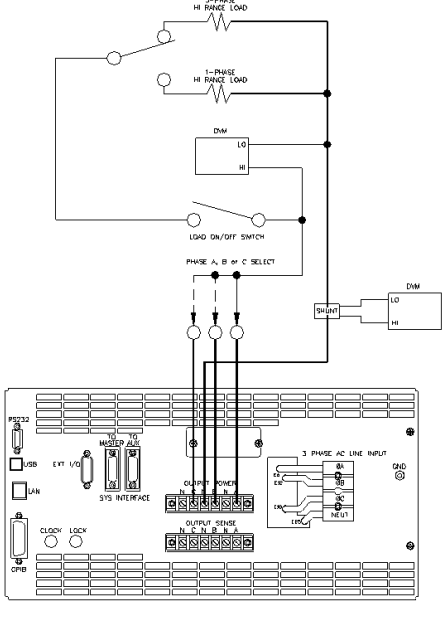

Figure 7: Calibration Setup

Unique SW and CSW Features

External Modulation

Like the SW the CSW includes an External Modulation function. A 0 to 5Vrms provides 0 to ≥20% modulation to each of the three output phases (±2% of full scale output).

An added benefit of the CSW is the ability to separate inputs from the other External Inputs. This allows the modulation function to be performed for any programmed function, Internal or External.

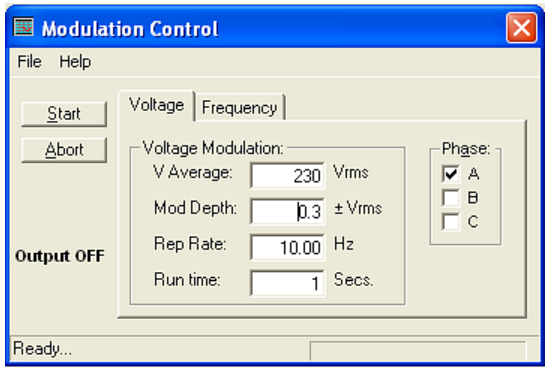

Figure 8: Modulation Entry via GUI

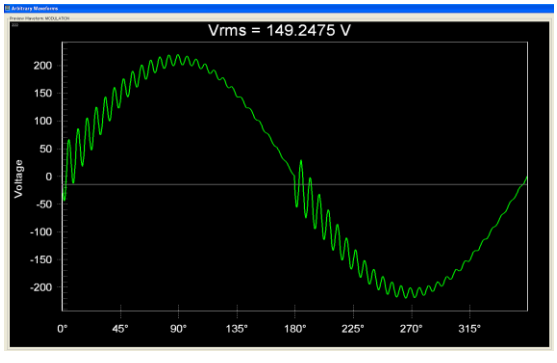

Figure 9: Modulated Waveform

External Sync Input

Elgar SW	California Instruments CSW
A TTL input to frequency synchronize the outputs. The Phase A output can be programmed relative to the external input. For this function the SW uses a Phase Locked Loop. This requires that the frequency to which the power source is to be synched must first be programmed ±10%. When the Synch is then enabled the frequency will be tracked. There is phase jitter between the external input and the output voltages.	The tracked frequency does not have to be programmed. When this function is enabled the output frequency will be tracked and the Phase A output will be phase locked to the TTL input. Unlike the SW the output phase angle of Phase A output can be programmed relative to the edge of the external TTL input. There is no jitter between the outputs and the external TTL input. (demonstration)

External Direct Input

Elgar SW	California Instruments CSW
Normal Amplifier, 0 to 5 VRMS (DC to 5kHz) or ±5 VDC input for zero to full scale programmed voltage output (±2% of full scale output). All outputs must be programmed to the same External Direct Input function.	**Significant benefit of the CSW allows any number of output phases programmed to the External Direct Input.** For example Phase A and B could be programmed for the Internal signal generator while phase C could be programmed for the External Direct Input. The CSW also sets the output voltage from 0 to a full-scale output instead of 0 to the programmed value like the SW

External Gain Control

Elgar SW	California Instruments CSW
0 to ±7.07 VDC provides zero to full scale programmed voltage output (±2% of full scale output). The input pins are the same as those used for the other external input functions. This function is not independent. In other words all phases must be programmed to the External Gain Control function.	**Significant benefit of the CSW allows any number of output phases programmed to the External Gain Control.** For example Phase A and B could be programmed for the Internal signal generator while phase C could be programmed for the External Gain Control input.

Multi-Chassis Configurations

Elgar SW	California Instruments CSW
For systems with more than one power source all SW systems required an external Power Distribution Unit. The external PDU has some electronics for combining the current measurement signals. In addition there were modifications required to the SW Analog board for both the Master and Auxiliary power sources. Up to **4** power sources can be connected in the system.	For systems the **only requirement is to use a System Interface cable**. One cable is required for each Auxiliary power source. Up to **6** power sources may be connected in the system. There are no changes required for either the Master or Auxiliary power sources. Multi-Chassis system can be separated into individual stand alone sources by simply removing the interface cable. No internal jumpers or firmware reconfiguration is required! The CSW features auto detect and will automatically configure for Master / Auxiliary

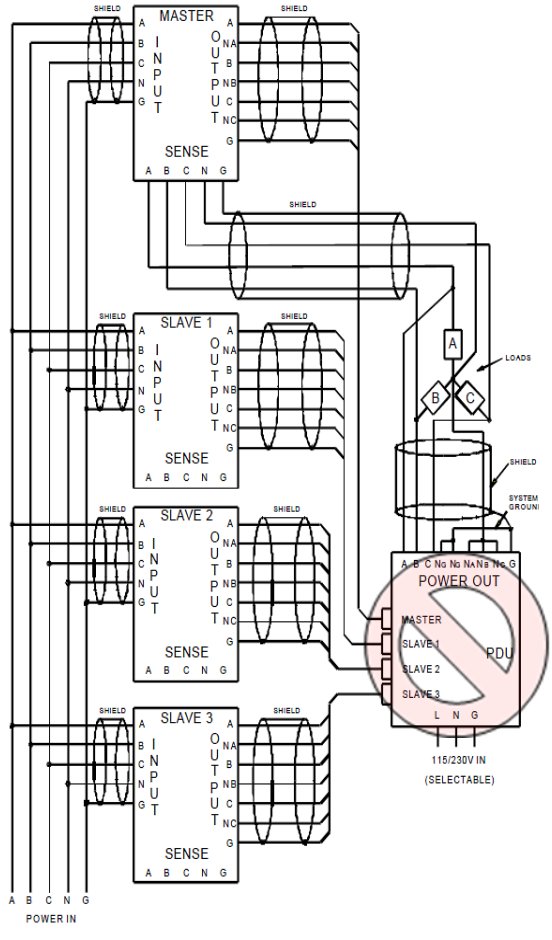

Figure 10: Elgar SW with PDU

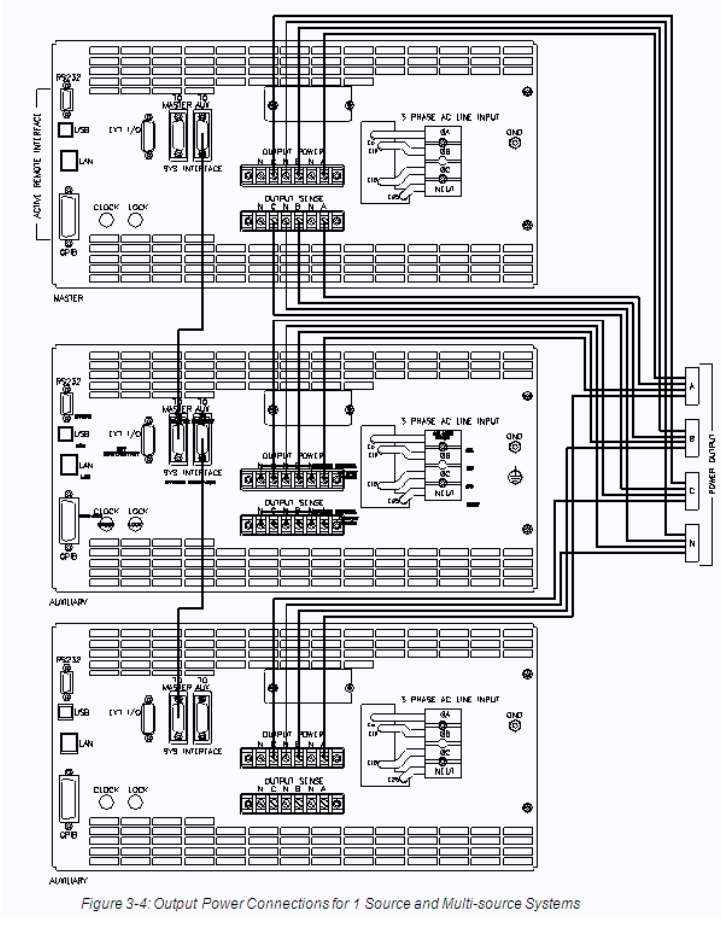

Figure 3-4: Output Power Connections for 1 Source and Multi-source Systems

Figure 11: California Instruments CSW

Clock and Lock

Elgar SW	California Instruments CSW
Programmed to the **CLOCK mode;** configures BNC to output pulses at programmed frequency for loads 2 kW. Vout 1V Low State; Vout 2.4V High State. Negative edge is at 0° ±30ms. **LOCK** configures BNC to input 'TTL' frequency; signal needs to supply pull down current of 15 mA with voltage drop of 0.6V; no pull up needed. Negative edge is at 0° ±30 ms. This is used for the PLL input and a similar function as the California Instruments External Synch function. See above for more complete comparison	There will be the California Instrument version of the Clock/ Lock function. What was called the CLOCK will be available as an output from the LOCK BNC connector when the Clock/ Lock option is ordered. What the SW called the LOCK function will be the same as the CSW External Synch feature as described above for the PLL Specification. The CSW CLOCK/LOCK will be available as **an option**.

Sync Output

Elgar SW	California Instruments CSW
An input to trigger a function. For loads ≥2kΩ: Vout ≤1V Low State; Vout ≥2.4V High State; Negative edge is at 0° ±30µsec	**Sync Out BNC connector:** Rear panel BNC connector the same function as the front panel Trigger BNC connector. An input to trigger a function. A TTL input to frequency synchronize the outputs. The Phase A output can be programmed relative to the external input