

# ***TrueWave AC Power Source***

Models TW5250 • TW3500 • TW1750

## **Operation Manual**



### **Contact Information**

Telephone: 800 733 5427 (toll free in North America)

858 450 0085 (direct)

Fax: 858 458 0267

Email:

Domestic Sales: [domorders.sd@ametek.com](mailto:domorders.sd@ametek.com)

International Sales: [intlorders.sd@ametek.com](mailto:intlorders.sd@ametek.com)

Customer Service: [service.ppd@ametek.com](mailto:service.ppd@ametek.com)

Web: [www.programmablepower.com](http://www.programmablepower.com)



## About AMETEK

AMETEK Programmable Power, Inc., a Division of AMETEK, Inc., is a global leader in the design and manufacture of precision, programmable power supplies for R&D, test and measurement, process control, power bus simulation and power conditioning applications across diverse industrial segments. From bench top supplies to rack-mounted industrial power subsystems, AMETEK Programmable Power is the proud manufacturer of Elgar, Sorensen, California Instruments and Power Ten brand power supplies.

AMETEK, Inc. is a leading global manufacturer of electronic instruments and electromechanical devices with annualized sales of \$2.5 billion. The Company has over 11,000 colleagues working at more than 80 manufacturing facilities and more than 80 sales and service centers in the United States and around the world.

## Trademarks

AMETEK is a registered trademark of AMETEK, Inc.

Other trademarks, registered trademarks, and product names are the property of their respective owners and are used herein for identification purposes only.

## Notice of Copyright

*TrueWave AC Power Source* © 2010 AMETEK Programmable Power, Inc. All rights reserved.

## Exclusion for Documentation

UNLESS SPECIFICALLY AGREED TO IN WRITING, AMETEK PROGRAMMABLE POWER, INC. ("AMETEK"):

- (a) MAKES NO WARRANTY AS TO THE ACCURACY, SUFFICIENCY OR SUITABILITY OF ANY TECHNICAL OR OTHER INFORMATION PROVIDED IN ITS MANUALS OR OTHER DOCUMENTATION.
- (b) ASSUMES NO RESPONSIBILITY OR LIABILITY FOR LOSSES, DAMAGES, COSTS OR EXPENSES, WHETHER SPECIAL, DIRECT, INDIRECT, CONSEQUENTIAL OR INCIDENTAL, WHICH MIGHT ARISE OUT OF THE USE OF SUCH INFORMATION. THE USE OF ANY SUCH INFORMATION WILL BE ENTIRELY AT THE USER'S RISK, AND
- (c) REMINDS YOU THAT IF THIS MANUAL IS IN ANY LANGUAGE OTHER THAN ENGLISH, ALTHOUGH STEPS HAVE BEEN TAKEN TO MAINTAIN THE ACCURACY OF THE TRANSLATION, THE ACCURACY CANNOT BE GUARANTEED. APPROVED AMETEK CONTENT IS CONTAINED WITH THE ENGLISH LANGUAGE VERSION, WHICH IS POSTED AT [WWW.PROGRAMMABLEPOWER.COM](http://WWW.PROGRAMMABLEPOWER.COM).

## Date and Revision

March 2011 Revision H

## Part Number

M161469-01



## Contact Information

Telephone: 800 733 5427 (toll free in North America)  
858 450 0085 (direct)  
Fax: 858 458 0267  
Email: [sales@programmablepower.com](mailto:sales@programmablepower.com)  
[service@programmablepower.com](mailto:service@programmablepower.com)  
Web: [www.programmablepower.com](http://www.programmablepower.com)

This page intentionally left blank.

# Important Safety Instructions

Before applying power to the system, verify that your product is configured properly for your particular application.

 <b>WARNING</b>	<b>Hazardous voltages may be present when covers are removed. Qualified personnel must use extreme caution when servicing this equipment. Circuit boards, test points, and output voltages also may be floating above (below) chassis ground.</b>
 <b>WARNING</b>	<b>The equipment used contains ESD sensitive ports. When installing equipment, follow ESD Safety Procedures. Electrostatic discharges might cause damage to the equipment.</b>

Only *qualified personnel* who deal with attendant hazards in power supplies, are allowed to perform installation and servicing.

Ensure that the AC power line ground is connected properly to the Power Rack input connector or chassis. Similarly, other power ground lines including those to application and maintenance equipment *must* be grounded properly for both personnel and equipment safety.

Always ensure that facility AC input power is de-energized prior to connecting or disconnecting any cable.

In normal operation, the operator does not have access to hazardous voltages within the chassis. However, depending on the user's application configuration, **HIGH VOLTAGES HAZARDOUS TO HUMAN SAFETY** may be normally generated on the output terminals. The customer/user must ensure that the output power lines are labeled properly as to the safety hazards and that any inadvertent contact with hazardous voltages is eliminated.

Guard against risks of electrical shock during open cover checks by not touching any portion of the electrical circuits. Even when power is off, capacitors may retain an electrical charge. Use safety glasses during open cover checks to avoid personal injury by any sudden component failure.

Neither AMETEK Programmable Power Inc., San Diego, California, USA, nor any of the subsidiary sales organizations can accept any responsibility for personnel, material or inconsequential injury, loss or damage that results from improper use of the equipment and accessories.

## SAFETY SYMBOLS



**WARNING**  
Risk of Electrical Shock



**CAUTION**  
Refer to Accompanying Documents



Off (Supply)



Direct Current (DC)



Standby (Supply)



Alternating Current (AC)



On (Supply)



Three-Phase Alternating Current



Protective Conductor Terminal



Earth (Ground) Terminal



Fuse



Chassis Ground

## **Product Family: Models TW5250, TW3500, TW1750**

### **Warranty Period: One Year**

#### **WARRANTY TERMS**

AMETEK Programmable Power, Inc. ("AMETEK"), provides this written warranty covering the Product stated above, and if the Buyer discovers and notifies AMETEK in writing of any defect in material or workmanship within the applicable warranty period stated above, then AMETEK may, at its option: repair or replace the Product; or issue a credit note for the defective Product; or provide the Buyer with replacement parts for the Product.

The Buyer will, at its expense, return the defective Product or parts thereof to AMETEK in accordance with the return procedure specified below. AMETEK will, at its expense, deliver the repaired or replaced Product or parts to the Buyer. Any warranty of AMETEK will not apply if the Buyer is in default under the Purchase Order Agreement or where the Product or any part thereof:

- is damaged by misuse, accident, negligence or failure to maintain the same as specified or required by AMETEK;
- is damaged by modifications, alterations or attachments thereto which are not authorized by AMETEK;
- is installed or operated contrary to the instructions of AMETEK;
- is opened, modified or disassembled in any way without AMETEK's consent; or
- is used in combination with items, articles or materials not authorized by AMETEK.

The Buyer may not assert any claim that the Products are not in conformity with any warranty until the Buyer has made all payments to AMETEK provided for in the Purchase Order Agreement.

#### **PRODUCT RETURN PROCEDURE**

1. Request a Return Material Authorization (RMA) number from the repair facility (**must be done in the country in which it was purchased**):
  - **In the USA**, contact the AMETEK Repair Department prior to the return of the product to AMETEK for repair:  
Telephone: 800-733-5427, ext. 2295 or ext. 2463 (toll free North America)  
858-450-0085, ext. 2295 or ext. 2463 (direct)
  - **Outside the United States**, contact the nearest Authorized Service Center (ASC). A full listing can be found either through your local distributor or our website, [www.programmablepower.com](http://www.programmablepower.com), by clicking Support and going to the Service Centers tab.
2. When requesting an RMA, have the following information ready:
  - Model number
  - Serial number
  - Description of the problem

**NOTE:** Unauthorized returns will not be accepted and will be returned at the shipper's expense.

**NOTE:** A returned product found upon inspection by AMETEK, to be in specification is subject to an evaluation fee and applicable freight charges.

## TABLE OF CONTENTS

Warranty .....	i
Safety Notice .....	iii
Safety Symbols .....	iv

### SECTION 1 – GENERAL DESCRIPTION

1.1	Introduction.....	1-1
1.2	Input Specifications .....	1-2
1.3	Output Specifications.....	1-2
1.4	Front Panel Display .....	1-4
1.5	GPIB and RS-232 Readback.....	1-5
1.6	Measurements.....	1-6
1.6.1	Parameters Measured .....	1-6
1.7	Protection and Safety .....	1-6
1.8	Agency Requirements .....	1-7
1.9	Physical Specifications .....	1-7
1.10	Environmental Data .....	1-7
1.11	Other Standard Features.....	1-8
1.12	Options .....	1-9

### SECTION 2 – INSTALLATION

2.1	Introduction.....	2-1
2.2	Unpacking.....	2-1
2.3	Pre-Installation Inspection .....	2-1
2.4	Installation .....	2-2
2.5	Air Intake and Exhaust .....	2-2
2.6	Installation/Dimensional Drawings.....	2-3
2.7	Input/Output Connectors .....	2-6
2.7.1	BNC Connectors.....	2-7
2.7.2	DFI (Discrete Fault Indicator).....	2-7
2.7.3	IEEE 488.2 .....	2-8
2.7.4	RS-232 Connector .....	2-8
2.7.5	Grounding .....	2-9

2.8	Input Power Requirements.....	2-9
2.8.1	187 to 264 VRMS 3-Phase Operation (3-Wire USA) .....	2-11
2.8.2	342 to 457 VRMS 3-Phase Operation (4-Wire INTL) .....	2-11
2.8.3	Single-Phase Input Connections .....	2-11
2.9	Output Connections to the Load .....	2-12
2.9.1	TW 5250 Output Connections.....	2-12
2.9.2	TW 3500 and TW 1750 Output Connections .....	2-14
2.9.3	Wiring of Unit.....	2-14
2.10	Wire Gauge Selection .....	2-14

## **SECTION 3 – OPERATION**

3.1	Program Parameters.....	3-1
3.2	Menu Parameters.....	3-1
3.3	Overview of TW Front Panel Operations .....	3-2
3.4	Displaying Readbacks.....	3-2
3.5	Setting Programmable Parameters.....	3-3
3.6	Menu System .....	3-5
3.7	Menu Tree.....	3-6
3.8	Menu Operations.....	3-7
3.8.1	Menu Prompts and Key Sequences.....	3-12
3.9	Password Protection .....	3-12
3.9.1	Creating the Password.....	3-12
3.9.2	Clearing the Password .....	3-13
3.10	Sample Menu Changes.....	3-13
3.10.1	Change TW GPIB Address .....	3-13
3.10.2	Set TW to Close Output Relay at Power Up .....	3-13
3.10.3	Place TW into Standby Mode After Power Up .....	3-14
3.10.4	Place Front Panel Program Keys into Disabled Mode .....	3-14
3.10.5	Place Front Panel Program Keys into Enabled Mode .....	3-15
3.10.6	Place TW into DC Mode .....	3-15
3.10.7	Place TW into ACDC Mode .....	3-16
3.10.8	Place TW into AC Mode.....	3-16
3.10.9	Set Current Foldback Mode .....	3-17
3.10.10	Set TW into Current Shutdown Mode .....	3-17
3.10.11	Set TW Shutdown Time Value.....	3-18
3.10.12	Store a Machine State .....	3-18



3.10.13	Recall a Machine State.....	3-19
3.10.14	Recall Factory Configuration .....	3-19
3.10.15	Specify LOCAL Sense.....	3-20
3.10.16	Specify REMOTE Sense .....	3-20
3.10.17	Place TW into PLL Lock Mode .....	3-21
3.10.18	Program Sync Connector to Send a Pulse at Phase A Zero Crossing .....	3-21
3.10.19	Program TW Amp Gains to Respond to Control BNC Connector .....	3-22
3.10.20	Specify TW Installed Amps Qty.....	3-22
3.10.21	Place TW into Parallel Amplifiers Mode .....	3-23
3.10.22	Set Password .....	3-23
3.10.23	Clear Password .....	3-24
3.11	Master/Slave Operation.....	3-25
3.11.1	Overview.....	3-25
3.11.2	Master/Slave: Step by Step Instructions.....	3-25
3.11.3	Return to Standalone Operation.....	3-28

## APPENDIX A

Fault Operations.....	A-1
-----------------------	-----

## LIST OF TABLES

Table 2-1	Recommended Mounting Slide.....	2-2
Table 2-2	TW Input/Output Connectors.....	2-6
Table 2-3	DFI Connector Pinout .....	2-7
Table 2-4	IEEE 488.2 Connector Pinout.....	2-8
Table 2-5	RS-232 Connector .....	2-8
Table 2-6	Input Currents for 3-Phase Input Power .....	2-10
Table 2-7	Single-Phase Input Configurations .....	2-10
Table 2-8	Recommended Wire Gauge Selection Guide.....	2-15

**LIST OF FIGURES**

Figure 1-1 Elgar TrueWave AC Power Source..... 1-1

Figure 2-1 Mounting Dimensions, Front View..... 2-3

Figure 2-2 Mounting Dimensions, Top and Side View..... 2-4

Figure 2-3 Rear Panel ..... 2-5

Figure 2-4 Parallel Connections ..... 2-13

Figure 2-5 Sense Lead Connections for 3-Phase Output..... 2-13

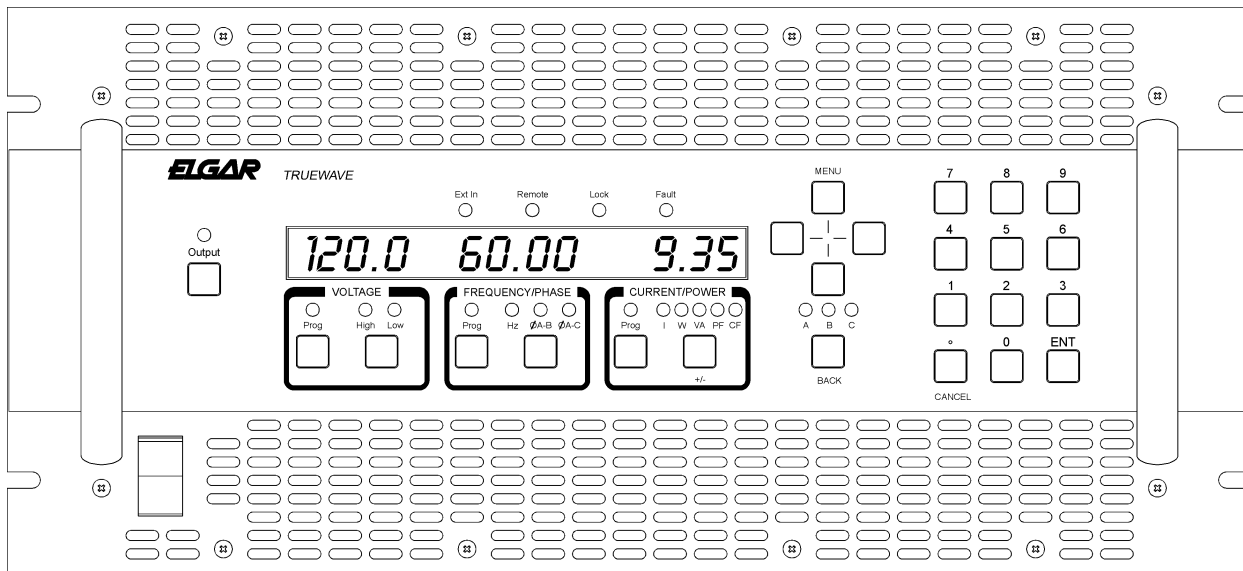
Figure 3-1 TW 5250 Three Phase Master/Slave Wiring..... 3-29

Figure 3-2 TW 5250 Single Phase Master/Slave Wiring ..... 3-30

## SECTION 1 GENERAL DESCRIPTION

### 1.1 INTRODUCTION

The Elgar TrueWave® Models TW 5250, TW 3500, and TW 1750 use transformerless, direct coupled amplifiers and a DSP-based sine wave controller for testing a variety of complex electronics.



**Figure 1-1 Elgar TrueWave AC Power Source (Rack Mount Version)**

Programming is accomplished at the front panel or with a personal computer (PC). The TrueWave communicates with the PC through a GPIB or RS-232 interface. Programming commands are defined in the TW Programming Manual, Elgar Document No. M161469-02.

One to three phase AC sine wave or DC output is specified by pushbutton/LED menu-based control. Incremental and absolute voltage and current setpoints are available at the TW front panel. The TW incorporates a hierarchical menu system to set system parameters.

The TrueWave sources are true DC as well as AC power supplies. Up to 312 VRMS are available in AC or AC+DC modes. Multi-phase models can be switched to single or three-phased operation via the front panel or the GPIB.

A wide frequency range of DC or 40 Hz to 500 Hz is available for a broad array of applications. Utilizing the latest in AC switch mode technology, the TW has less than -60 dB of noise and ripple with total harmonic distortion (THD) of <0.5%. A crest factor

of 4.0 provides high peak-to-RMS current capability. An optional input power factor correction (PFC) of .99 is also available.

## 1.2 INPUT SPECIFICATIONS

<b>Voltage</b>	187 to 264 VRMS, 3Ø L-L (3 wire), or 342 to 457 VRMS, 3Ø L-L (4 wire), or, for 1750 VA only, 187 to 264, 1Ø.
<b>Power Factor</b>	0.99 for PFC input configured units 0.6 for USA rectifier configured units 0.35 for International rectifier.
<b>Efficiency</b>	70% minimum at full load.
<b>Ride Through</b>	3 msec with rectifier input configuration, 10 msec with PFC input configuration.
<b>Frequency</b>	47 to 63 Hz minimum.

## 1.3 OUTPUT SPECIFICATIONS (at 25°C unless specified)

<b>Calibration Interval</b>	1 year.
<b>Waveshape</b>	DC and sine.
<b>Dropout</b>	Dropout of an integer number of cycles on any combination of phases, at any phase angle, and at any programmable frequency is possible via GPIB command. Sub-integer number of cycles can be achieved by varying the phase angle. Programming is referenced to phase A and all phase dropouts coincide. (Some variable propagation delay will occur.)
<b>Power, Reactive</b>	1750, 3750, or 5250 VARMS maximum as configured.
<b>Load Power Factor</b>	0 lagging to 0 leading.
<b>Voltage Programming Range</b>	Range 1: 1 minimum to 156 VRMS maximum, Range 2: 2 minimum to 312 VRMS maximum.

<b>Voltage Programming Accuracy (GPIB/Front panel) without load</b>	0.1% maximum of full scale.
<b>Voltage Programming Resolution (GPIB/Front panel)</b>	0.03% VRMS maximum (12 bits).
<b>Voltage Programming Accuracy (Analog)</b>	2% of full scale.
<b>Voltage Stability, excluding external analog control</b>	0.1% maximum with constant line, load, temperature
<b>Current Programming Range per channel</b>	Range 1: 0 to 13.0 Amps RMS maximum, Range 2: 0 to 6.5 Amps RMS maximum
<b>Current Programming Accuracy (GPIB/Front Panel)</b>	1% of full scale + 0.5% of actual
<b>Current Programming Resolution (GPIB/Front panel)</b>	0.03% maximum (12 bits)
<b>Current Stability (in constant current mode)</b>	0.5% of setting after 10 minute warmup
<b>Inductive Output Impedance (high range)</b>	104 $\mu$ h typical in low output impedance mode, 796.5 $\mu$ h $\pm$ 2% in standard reference impedance mode
<b>Resistive Output Impedance (high range)</b>	0.050 $\Omega$ typical in low output impedance mode, 0.4 $\Omega$ $\pm$ 2% in standard reference impedance mode
<b>Load Transient Recovery, Voltage mode</b>	0.5 msec maximum to within 2% of final value
<b>Noise</b>	>60 dB RMS below full scale
<b>Distortion, Output Voltage</b>	0.5% THD maximum
<b>Line Voltage Regulation, Voltage mode</b>	0.05% maximum of full scale for $\pm$ 10% line change

<b>Load Voltage Regulation</b>	0.15% maximum of full scale
<b>Lead drop</b>	5 VRMS total (sum of both lead drops)
<b>Current Crest Factor</b>	4.0 minimum
<b>Frequency Range</b>	45 to 500 Hz minimum
<b>Frequency Drift</b>	100 ppm maximum of programmed value per °C
<b>Frequency Programming Accuracy (GPIB/Front panel)</b>	0.1% maximum of programmed value
<b>Frequency Programming Resolution (GPIB/Front panel)</b>	0.1 Hz maximum
<b>Phase Programming Accuracy</b>	1° maximum
<b>Phase Programming Resolution</b>	0.1° minimum
<b>Overvoltage Protection Accuracy</b>	1% of full scale + 1% of actual maximum peak voltage
<b>Overvoltage Protection Range</b>	116% of rated output
<b>Overvoltage Protection Response Time</b>	0.1 msec maximum
<b>Overcurrent Protection Accuracy</b>	1% of full scale + 1% of reading maximum
<b>Overcurrent Protection Range</b>	115% of rated output
<b>Overcurrent Protection Response Time</b>	0.1 msec maximum
<b>Overcurrent Protection Effect</b>	Shutdown or constant current, selectable

## 1.4 FRONT PANEL DISPLAY

<b>Output Voltage Accuracy</b>	0.3% of full scale plus 0.2% of reading maximum
<b>Output Voltage Resolution</b>	0.1 VRMS maximum

<b>Output Current Accuracy</b>	0.3% of full scale + 0.5% of reading maximum
<b>Output Current Resolution</b>	0.01 Amps RMS maximum
<b>Output Power Range</b>	0 to 1900 W per phase minimum
<b>Output Power Accuracy</b>	2.5% of full scale maximum
<b>Output Power Resolution</b>	10 W maximum
<b>Crest Factor Accuracy</b>	1% of full scale maximum for output > 200VA
<b>Power Factor Accuracy</b>	4% of full scale maximum for output > 200VA
<b>Frequency Accuracy</b>	0.25% of reading
<b>Output Phase Accuracy</b>	0.5%
<b>Output Phase Resolution</b>	0.3%

## 1.5 GPIB AND RS-232 READBACK

<b>Output Voltage Accuracy</b>	0.3% of full scale + 0.2% of reading maximum
<b>Output Voltage Resolution</b>	0.1 VRMS maximum
<b>Output Current Accuracy</b>	0.3% of full scale + 0.5% of reading maximum
<b>Output Current Resolution</b>	0.01 Amps RMS maximum
<b>Output Power Range</b>	0 to 1900 W per phase minimum
<b>Output Power Accuracy</b>	2.5% of full scale maximum
<b>Output Power Resolution</b>	10 W maximum
<b>Crest Factor Accuracy</b>	1% maximum for output > 200VA
<b>Power Factor Accuracy</b>	4% maximum for output > 200VA
<b>Output Phase Accuracy</b>	0.5%
<b>Output Phase Resolution</b>	0.3%

## 1.6 MEASUREMENTS

### 1.6.1 Parameters Measured

- 1- to 3-Phase to Neutral RMS Output Voltages
- 1- to 3-Phase to Phase Voltages are Calculated
- 1- to 3-Phase RMS Output Currents
- 1- to 3-Phase Peak Current
- Output Frequency
- 1- to 3-Phase Power
- 1- to 3-Phase VA
- Power Factor of Load Calculated from 1 or 3 Phases
- Crest Factor of Load Calculated from 1 or 3 Phases
- Output Phase B and C Relative to Phase A

## 1.7 PROTECTION AND SAFETY

**Overvoltage Shutdown:** Programmable for 15V to 255V peak, 156V range; 30V to 510V peak, 312V range.

**Undervoltage Shutdown:** Automatic, not programmable.

**Programmable Current Limit Shutdown:** Can be set 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:** Can be set to 1% of range; the timeout can be set from 100 msec to 10 sec.

**Overtemperature Shutdown:** Automatic, not programmable.



## 1.8 AGENCY REQUIREMENTS

The TrueWave conforms to the following agency requirements:

- European Community CE, including:  
EN61010-1 1993  
EN55011 Group 1, Class A  
EN50082-21995
- FCC Part 15, Class A

## 1.9 PHYSICAL SPECIFICATIONS (All Models)

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

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

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

**Weight:** TW 5250 – 115 lbs. (52 kg)  
TW 3500 – 89 lbs. (40 kg)  
TW 1750 – 63 lbs. (28 kg)

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

## 1.10 ENVIRONMENTAL DATA

**Operating Temperature:** 0°C to 45°C (32°F to 113°F).

Note temperature measured at air inlet of TW. If cabinet mounted, cabinet inlet air may be rated at lower maximum temperature due to warming of inlet air.

**Storage Temperature:** -40°C to 70°C (40°F to 158°F).

**Humidity (Non-condensing):** 0 to 85% at 31°C (88°F);  
derate to 50% at 40°C (104°F).

**Operating Shock:** 10g for 11 ms.

**Operating Vibration:** 1g, 5 to 55 Hz dwell on resonances for 2 minutes maximum.

**Altitude:** Operating 6,560 ft., Non-operating 40,000 ft.

## 1.11 OTHER STANDARD FEATURES

- **1- to 3-Phase Programmable**
- **IEEE 488.2 Interface**
- **SCPI Protocol**
- **Waveform Trigger Output**  
(1 Meg $\Omega$  Load Drive; positive edge is at  $0^\circ \pm 30\mu\text{s}$ , 0 to 5V logic)
- **SYNC OUT. User programmed for:**  
Cycle Start, all cycles  
For loads  $\geq 2\text{ k}\Omega$ :  $V_{\text{out}} \leq 1\text{V}$  Low State;  $V_{\text{out}} \geq 2.4\text{V}$  High State;  
Negative edge is at  $0^\circ \pm 30\mu\text{s}$ .
- **CLOCK/LOCK**  
**CLOCK** pulses at programmed frequency for loads  $\geq 2\text{ k}\Omega$   $V_{\text{out}} \leq 1\text{V}$  Low State;  
 $V_{\text{out}} \geq 2.4\text{V}$  High State. Negative edge is at  $0^\circ \pm 30\mu\text{s}$ .  
  
**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 pull up needed. Negative edge is at  $0^\circ \pm 30\mu\text{s}$ .
- **LOCK Specifications**  
Frequency range is 40.00 Hz to 500.00 Hz.  
  
Tracking range is  $\pm 10\%$  of programmed center frequency.  
  
Duty cycle is 50%  $\pm 10\%$ .  
  
Slew rate is .02% of input frequency/second, maximum, which produces a maximum phase shift of  $5^\circ$  from the lock input falling edge to the output rising edge.  
  
The rising edge of the output will be locked to the falling edge of the lock input and will have less than a 30  $\mu\text{sec}$  propagation delay.  
  
Maximum output jitter when locked is  $< 1\%$  of lock input period.  
  
PLL lock is achieved in  $< 5$  seconds.

- **External Amplitude Modulation**  
0 to 5 VRMS provides 0 to  $\geq 20\%$  output amplitude modulation ( $\pm 2\%$  of full scale output).
- **External Direct Input**  
Normal Amplifier, 0 to 5 VRMS (DC to 500 Hz) or  $\pm 5$  VDC input for zero to full scale programmed voltage output ( $\pm 2\%$  of full scale output).
- **External Gain Control**  
0 to  $\pm 7.07$  VDC provides zero to full scale programmed voltage output ( $\pm 2\%$  of full scale output).
- **External Input Impedance**  
 $\geq 10 \text{ k}\Omega$ .
- **System Firmware**  
System firmware is stored in flash memory. This makes it possible to upgrade the firmware without disassembling or returning the unit.

## 1.12 OPTIONS

- Parallelable for Additional Power above 5250 VA requires accessory attachment cable.
- Input Power Factor Correction to 0.99

***SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.***

This page intentionally left blank.

## SECTION 2 INSTALLATION

### 2.1 INTRODUCTION

The Elgar Model TW 5250, TW 3500, or TW 1750 has been fully calibrated and tested prior to shipment. The instrument is ready for immediate use upon receipt.



**WARNING!** The TrueWave unit weighs 63–115 lbs. (28–52 kg), depending on the model. A minimum two-person lift is required!



**WARNING!** Hazardous voltages are present when operating this equipment. Please read the Safety Notice at the beginning of this manual prior to installation, operation, or maintenance.

### 2.2 UNPACKING

Perform a visual inspection of the shipping container prior to accepting the package from the carrier. If extensive damage to the shipping container is evident, a description of the damage should be noted on the carrier's receipt and signed by the driver of the carrier agent.

If damage is not apparent until the instrument is unpacked, a claim for concealed damage should be placed with the carrier. In addition, the shipping container(s) and filler material should be saved for inspection. Forward a report of damage to the Elgar Service Department. Elgar will provide instructions for repair or replacement of the instrument.

If the instrument needs to be returned to Elgar, suitable shipping containers and packing materials must be used. If proper packing material is not available, contact Elgar to provide containers and shipping instructions.

### 2.3 PRE-INSTALLATION INSPECTION

Perform a visual inspection of the instrument when it is removed from the shipping container. Check for shipping damage such as dents, scratches, distortion, and damaged connectors.

## 2.4 INSTALLATION

The TrueWave unit is 8.75" (222 mm) high and designed to be installed in a standard 19" (483 mm) RETMA rack or a transit case; pem-nuts are provided for mounting optional slides.



**CAUTION! Avoid blocking the instrument air intakes or exhaust.**

## 2.5 AIR INTAKE AND EXHAUST

The air intakes are located on the front, top, and side panels of the instrument; the exhaust is through the rear panel. No special vertical separation is required when stacking instruments. The temperature of the intake air should not exceed 113°F (45°C).

At full power, the unit dissipates over 2250W with the PFC option. It is important that the heat produced is properly vented to the exterior of the chassis. Special baffling to control air flow may be required to prevent hot exhaust air being drawn into the intakes if the unit is to be run continuously at full power.

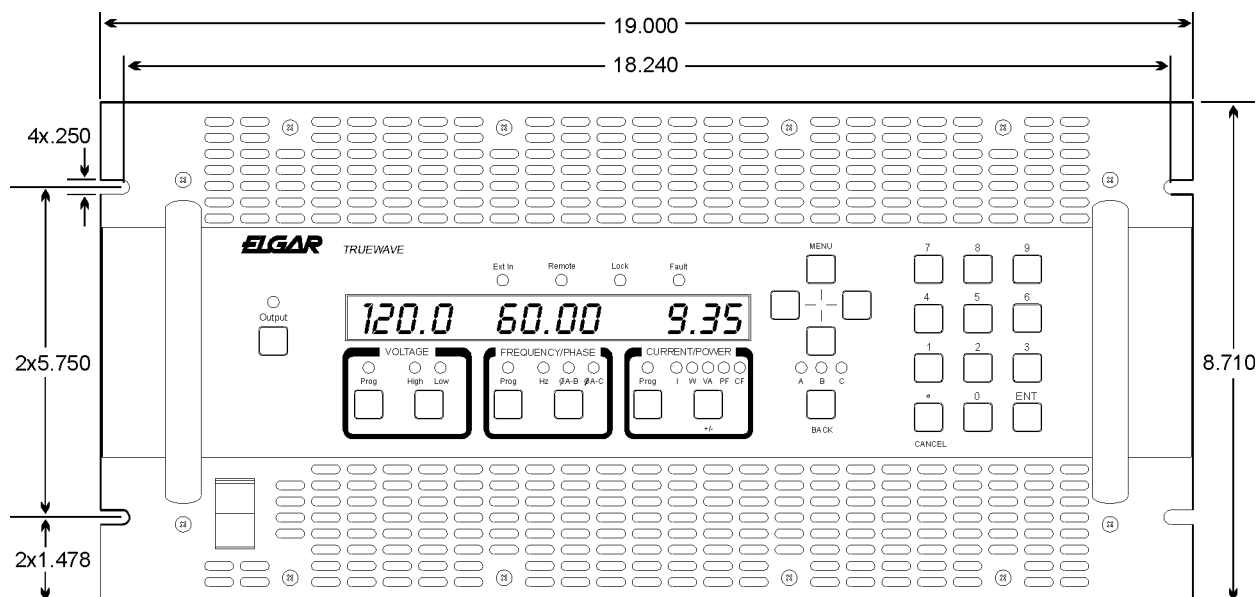
The preferred mounting method for full power operation is bottom mounting. Slide mounting may impair airflow from the side air intakes. If slides must be used, select narrow slides to minimize restrictions to airflow and select cabinets without wide rails that can block airflow. Refer to Table 2-1 for the recommended slides and Figure 2-2 for the mounting location.

TYPE	MANUFACTURER	PART NO.	ELGAR PART NO.
Mounting Kit (for slides)	Jonathan	BK-3	105-307-16
Slides	Accuride	C-3307-16D	105-370-17

***Table 2-1 Recommended Mounting Slide***

## 2.6 INSTALLATION DIMENSIONAL DRAWINGS

Refer to Figure 2-1 and Figure 2-2 for information on outline and mounting dimensions of the unit. Refer to Figure 2-3 and Table 2-2 through Table 2-5 for information on rear panel connectors. Also, refer to Figure 2-2 for customer wiring conduit details.



**Figure 2-1 Mounting Dimensions, Front View**

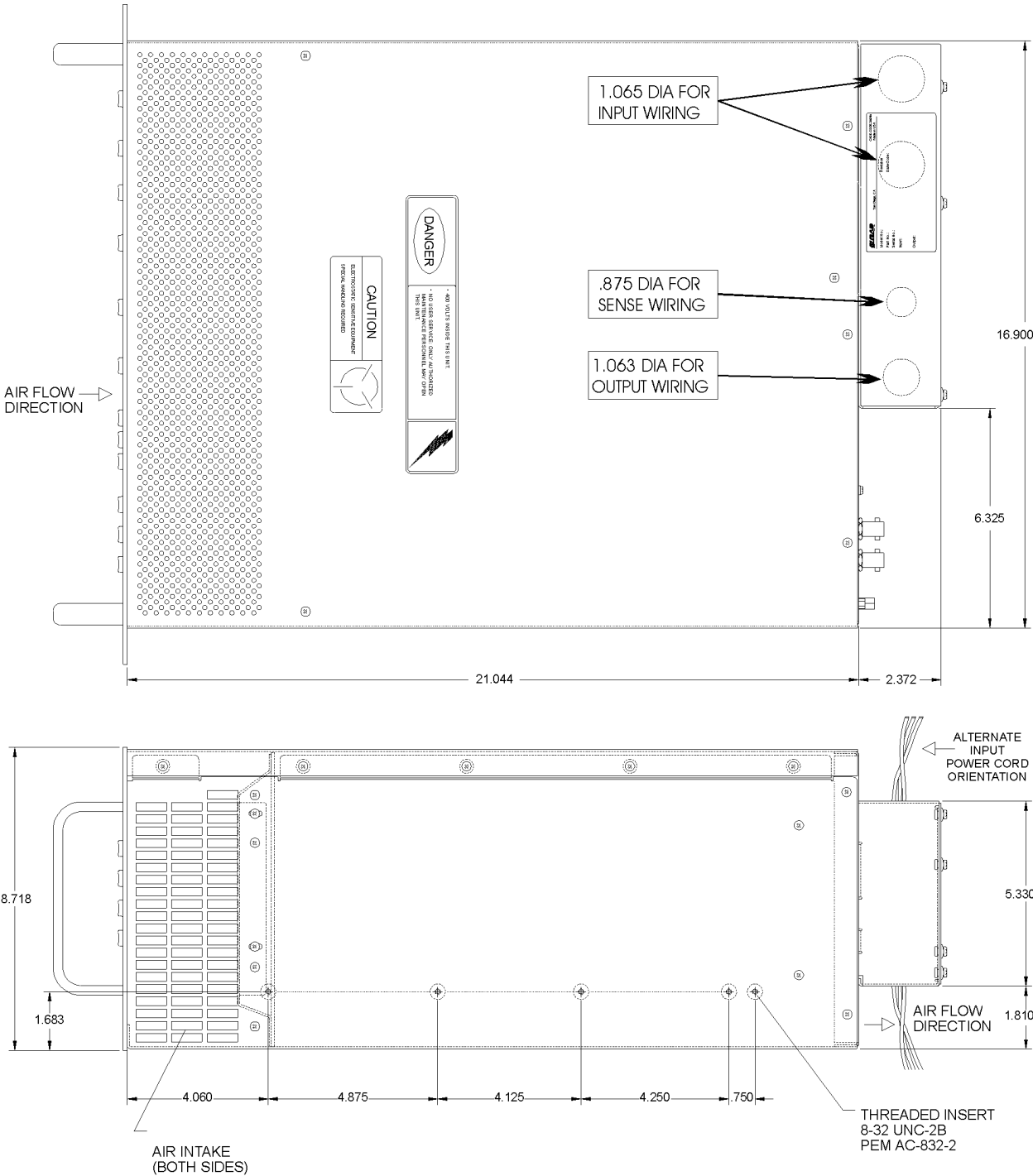
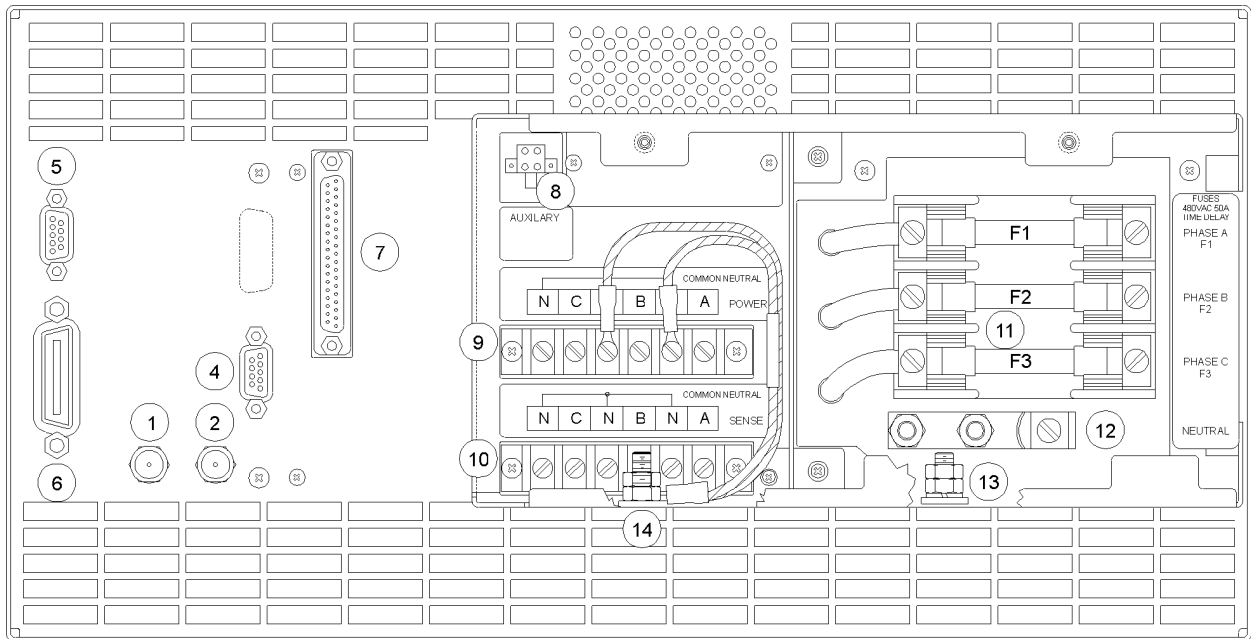


Figure 2-2 Mounting Dimensions, Top and Side View





**Figure 2-3 Rear Panel**

## 2.7 INPUT/OUTPUT CONNECTORS

Table 2-2 provides a listing of the TW input and output connectors and other data. Table 2-3 through Table 2-6 provide specific pinout information.

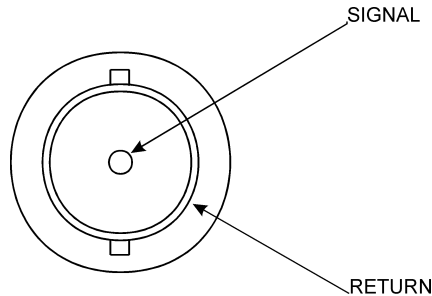
**NOTE:** The slave connection (Figure 2-3, Item 7) is not intended for user interfacing.

ITEM #	NAME	TYPE	MANUFACTURER /PART #
1	SYNC OUT	BNC	KINGS, PN KC-79-179
2	CLOCK & LOCK	BNC	KINGS, PN KC-79-179
4	RS232	9 POS SUB-D MALE (Gold Contacts)	AMP, PN 747043-4
5	DFI	9 POS SUB-D FEMALE (Gold Contacts)	AMP, PN 747052-4
6	IEEE 488.2	24 POS FEMALE (Gold Contacts)	AMP, PN 554434-1
7	SLAVE	37 POS SUB-D FEMALE	ITT CANNON, PN ADC37SOL2
8	AUX OUT	4 POS MINIFIT JR	MOLEX, PN 39-29-9045
9	OUTPUT POWER TERMINAL BARRIER	6 POS (#6 HDW)	MAGNUM, PN A304106-07-CA-MP8
10	REMOTE SENSE TERMINAL BARRIER	6 POS (#6 HDW)	MAGNUM, PN A304106-07-CA-MP8
11	<b>Refer to Table 2-6 and Table 2-7 for Fuse Ampere Rating</b>		
	PHASE A FUSE F1	480VAC 50A TIME DELAY	BUSSMAN, SC50 LITTLEFUSE, SLC50 (ELGAR PART #858-501-50)
	PHASE B FUSE F2	480VAC 50A TIME DELAY	BUSSMAN, SC40 LITTLEFUSE, SLC40 (ELGAR PART #858-480-40)
	PHASE C FUSE F3	600VAC 20A TIME DELAY	GOULD SHAWMUT ATDR20 LITTLEFUSE CCMR20 (ELGAR PART #858-300-20)
12	INPUT, NEUTRAL LUG, SINGLE BARREL	90A, 8AWG-2AWG	PANDUIT, PN C070-14-Q
13	SAFETY GROUND	STUD	#1/4-20 X .75 LG
14	CHASSIS GROUND	STUD	#1/4-20 X .75 LG

**Table 2-2 TW Input/Output Connectors (see Figure 2-3)**

### 2.7.1 BNC CONNECTORS

The diagram below illustrates the signal and return connections. Refer to Figure 2-3, Items 1 and 2.



### 2.7.2 DFI (DISCRETE FAULT INDICATOR)

The DFI connector on the rear panel has both input and output functionality.

The DFI Output Relay indicates a shutdown fault has occurred on the TW. It is a SPST reed relay with rear panel connections to the normally closed output contacts. When the TW is operating the relay is energized so that the contacts are open. When a fault occurs, or if the unit should lose power, the relay closes to indicate a fault has occurred.

The DFI Input Signal is used to command the TW to open the output relay, and close the DFI relay. It is a TTL-compatible input with a 1 k $\Omega$  input impedance, a 10 k $\Omega$  pullup to +5 VDC, and clamping diodes to \_5 VDC and ground. A signal with a negative going edge from +5 VDC to ground will trigger the DFI response.

Refer to Figure 2-3, Item 5.

PIN #	MNEMONIC	LEVEL
1	DFI RLY COMM	—
2	Not Used	—
3	DFI IN +	TTL (10 k $\Omega$ input impedance)
4 and 5	Not Used	—
6	DFI RLY N.O.	—
7	Not Used	—
8	DFI IN RTN	TTL
9	IEEE 488.2	SIGNAL GND

**Table 2-3 DFI Connector Pinout**

### 2.7.3 IEEE 488.2

Refer to Figure 2-3, Item 6.

PIN #	MNEMONIC	PIN #	MNEMONIC	PIN #	MNEMONIC
1	DIO1	9	IFC	17	REN
2	DIO2	10	SRQ	18	GND (TW PAIR W/DAV)
3	DIO3	11	ATN	19	GND (TW PAIR W/NRFD)
4	DIO4	12	SHIELD	20	GND (TW PAIR W/NDAC)
5	EOI	13	DIO5	21	GND (TW PAIR W/IFC)
6	DAV	14	DIO6	22	GND (TW PAIR W/SRQ)
7	NRFD	15	DIO7	23	GND (TW PAIR W/ATN)
8	NDAC	16	DIO8	24	SIGNAL GROUND

**Table 2-4 IEEE 488.2 Connector Pinout**

### 2.7.4 RS-232 CONNECTOR

The RS-232-C connector is a type DB-15S. The following table identifies the signals and pinout. The signal common is not attached to frame within the TW series and must be attached to the frame by the host controller.

PIN #	SIGNAL NAME	SIGNAL DESCRIPTION
1	N.C.	Not used
2	TXD	Transmit Data
3	RXD	Receive Data
4	DTR	Data Terminal Ready
5	GND	Ground
6	DSR	Data Set Ready
7	RTS	Request to Send
8	CTS	Clear to Send
9	N.C.	Not used

**Table 2-5 RS-232 Connector**

The connector is wired in such a way that the TW can be attached to a personal computer using a null modem cable.

## 2.7.5 GROUNDING



**The three waveform outputs (TRIGGER OUT, CLOCK & LOCK, SYNC OUT) share the same ground. This ground should not exceed  $\pm 20V$  Peak from chassis ground. If possible, this ground should be connected to the chassis.**

DFI, IEEE 488.2 and RS-232 share the same signal ground.

## 2.8 INPUT POWER REQUIREMENTS

Input power is connected to the TW via the rear panel connectors. See Table 2-6 and Table 2-7 for input current values. If it is required to shut the unit power off using the front panel power switch, please wait at least 30 seconds before re-applying power.



**WARNING! An overcurrent protection device (i.e., circuit breaker) is required in the building installation. The circuit breaker should be rated for continuous current as required by the TW system (see Table 2-2). Installation should comply with local safety standards.**

**A device to disconnect the TW system from the energy supply source is also required. This switch or circuit breaker must be close to the TW system, within easy reach of the operator, and clearly labeled as the disconnection device for the TW system.**

		MAXIMUM LINE CURRENT	MAXIMUM NEUTRAL CURRENT	F1-F3 FUSE RATING	RECOMMENDED CIRCUIT BREAKER RATING (MAX.)
<b>TW 5250</b>					
PFC	USA	25A RMS	Not Required	40A	40A RMS
PFC	INTL	13A RMS	13A RMS	20A	20A RMS
RECT	USA	39A RMS	Not Required	50A	50A RMS
RECT	INTL	39A RMS	68A RMS	50A	50A RMS
<b>TW 3500</b>					
PFC	USA	25A RMS	Not Required	40A	40A RMS
PFC	INTL	13A RMS	13A RMS	20A	20A RMS
RECT	USA	26A RMS	Not Required	40A	40A RMS
RECT	INTL	26A RMS	45A RMS	40A	40A RMS
<b>TW 1750</b>					
PFC	USA	14A RMS	Not Required	20A	20A RMS
PFC	INTL	13A RMS	13A RMS	20A	20A RMS
RECT	USA	13A RMS	Not Required	20A	20A RMS
RECT	INTL	13A RMS	23A RMS	20A	20A RMS

**Table 2-6 Input Currents for 3-Phase Input Power**

		REQ'D INPUT TERMINAL JUMPER CONNECTIONS	CONNECT 1-PHASE INPUT POWER TO	VOLTAGE	MAXIMUM INPUT CURRENT	F1-F3 FUSE RATING	RECOMMENDED CIRCUIT BREAKER RATING (MAX.)
<b>TW 5250</b>							
PFC*	USA	F1 to F2	F1, F3	187-264 VRMS, L-L	28A RMS	40A	40A RMS
PFC	INTL	F1 to F2, F2 to F3	F1, Neutral	187-264 VRMS, L-N	42A RMS	20A	40A RMS
<b>TW 3500</b>							
PFC	USA	F1 & F2	F1, F3	187-264 VRMS L-L	28A RMS	40A	40A RMS
PFC	INTL	F1 to F2, F2 to F3	F1, Neutral	187-264 VRMS L-N	28A RMS	20A	40A RMS
<b>TW 1750</b>							
PFC	USA	None	F1, F3	187-264 VRMS L-L	14A RMS	20A	20A RMS
PFC	INTL	None	F1, Neutral	187-264 VRMS L-N	14A RMS	20A	20A RMS

\* Only Phase A and Phase B are present at the output.

**Table 2-7 Single-Phase Input Configurations**

### 2.8.1 187 TO 264 VRMS 3-PHASE OPERATION (3-WIRE USA)

Connect the input wires to the phase A (F1), B (F2), and C (F3) input fuse terminals (no Neutral is required). **Ensure that the chassis safety ground is also connected.** Use cables with ratings equal to or greater than the current rating listed on the unit or in Table 2-6. Any phase sequence of wiring can be used.

### 2.8.2 342 TO 457 VRMS 3-PHASE OPERATION (4-WIRE INTL)

It is essential that the Neutral connection is present when using the unit. An external circuit breaker is required for the 3-phase voltages. Only units factory set at this voltage will operate at this voltage.



**CAUTION! For units built before June 2004, the Neutral must not be broken by an external switch. Severe damage to the unit may occur if Neutral is broken and phase voltage is present.**

Connect the input wires to phases A (F1), B (F2), C (F3) and Neutral. **Ensure that the chassis safety ground is also connected.** Use cables with ratings equal to or greater than the current rating listed on the unit or in Table 2-6.

### 2.8.3 SINGLE-PHASE INPUT CONNECTIONS

The TW system is designed for three-phase input power operation, either 3-wire (USA) or 4-wire (EUR) plus a chassis safety ground. However, if only single-phase input power is available, the configurations listed in Table 2-7 are possible.

An overcurrent protection device and a device for disconnecting the single-phase energy supply source are required as indicated in Section 2.8 above.

## 2.9 OUTPUT CONNECTIONS TO THE LOAD

### 2.9.1 TW 5250 OUTPUT CONNECTIONS

The Model TW 5250 can power 1-phase, 2-phase and 3-phase loads. Local or remote sensing can be used. If local sense is desired, for best regulation, jumper Sense A to Output A, Sense B to Output B, etc. Outputs may be directly paralleled for greater power. If the outputs are paralleled it is important to program the unit to the parallel mode before shorting the outputs together (refer to Figure 2-4). Outputs cannot be placed in series since the Neutral is common. However, by programming two phases 180° apart, double voltage, single phase is achieved.

Any phase sequence of wiring can be used.

The sense Neutral is also common. Thus, it is important to wire the sense wires properly (refer to Figure 2-5). If remote sense is used:

- Sense A is connected to Power A;
- Sense B is connected to Power B;
- Sense C is connected to Power C; and
- Neutral Sense is connected to Neutral Power.

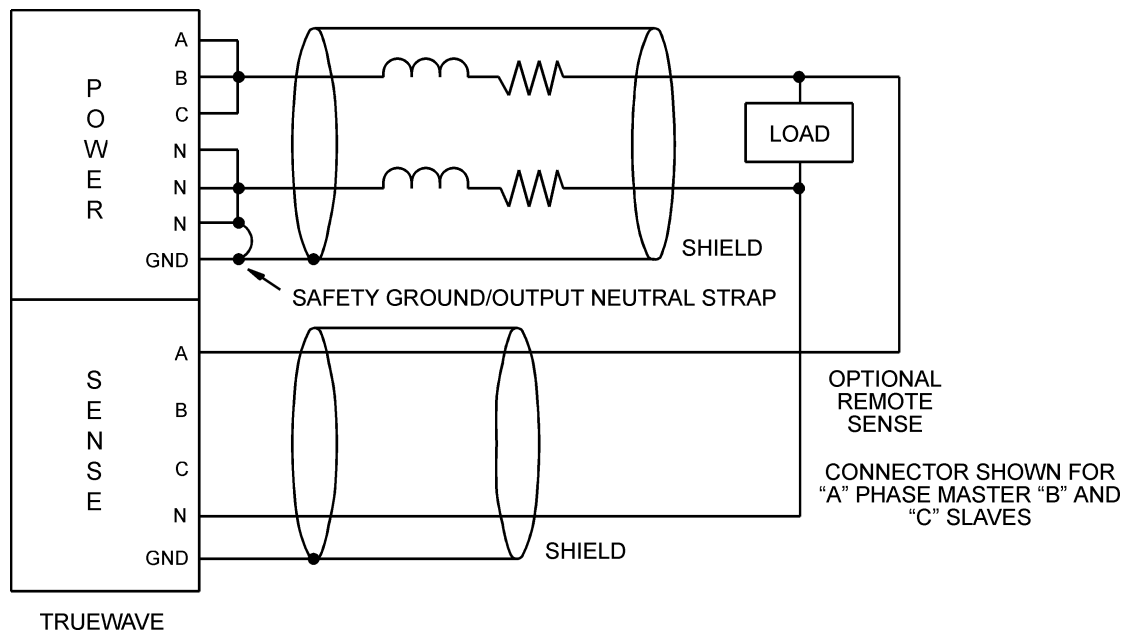


**Output power neutral must be connected to chassis ground for safe operation. The TW system is shipped with a green/yellow wire connected from output power neutral to chassis ground. It is important that the Neutral not be > 20V away from the chassis potential; the unit will shut down if this voltage is exceeded. For -101 units, the Green/Yellow wire can be removed and the neutral can float up to 156V away from chassis potential.**

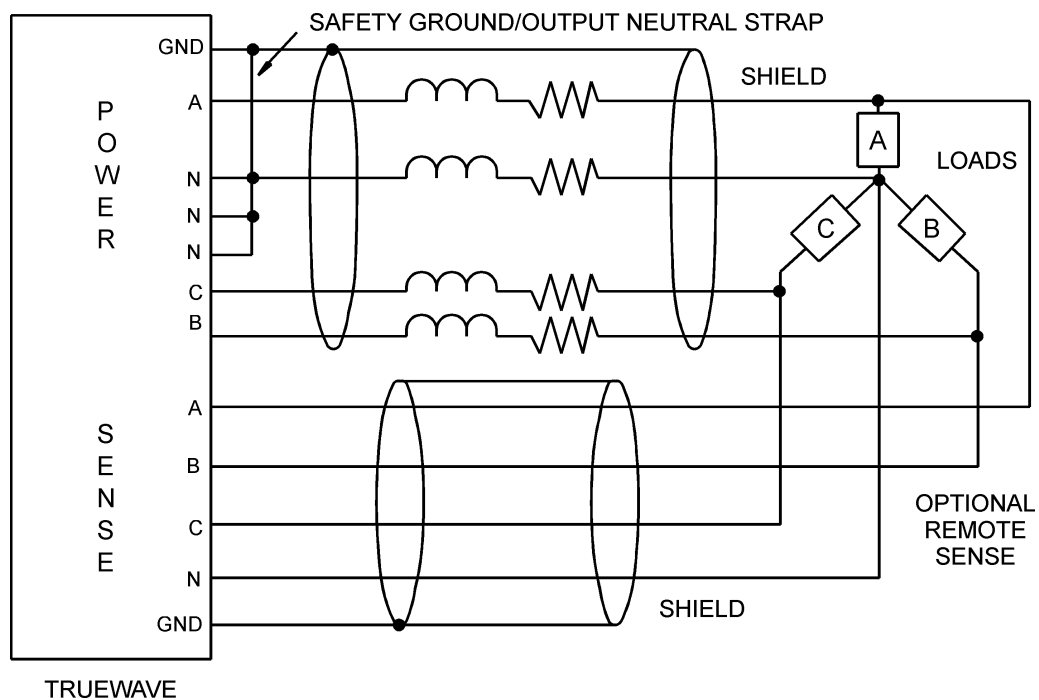
If a transformer or inductive load is present, the unit should be programmed to AC. This prevents small amounts of DC being generated which may saturate the magnetics.

For best performance, the sense leads should be connected and output neutral should be connected to chassis ground.





**Figure 2-4 Parallel Connections**



**Figure 2-5 Sense Lead Connections for 3-Phase Output**

The output power and sense leads should be shielded and the shield connected to the chassis to prevent noise pickup (or radiation to sensitive circuits in the vicinity). Again, the shield should be connected to chassis ground.

Due to the high voltages present, 312 VRMS line-to-neutral and 437 VRMS line-to-line cables rated to these voltages must be used for both the Power and Sense leads.

### **2.9.2 TW 3500 AND TW 1750 OUTPUT CONNECTIONS**

The Model TW 3500 has phase A and phase B present; phase C is an open circuit. Make connections as for the TW 5250 but with phase C missing.

The Model TW 1750 has only phase A present; phases B and C are open circuits.

### **2.9.3 WIRING OF UNIT**

Due to the high voltages and frequencies involved, it is recommended that all input and output wiring be protected with flexible conduit. Holes for this purpose are made in the terminal box (see Figure 2-2). All wiring must meet local standards for safety.

## **2.10 WIRE GAUGE SELECTION**

The following guidelines assist in determining the optimum cable specification for your power applications. These guidelines are equally applicable to both DC and low frequency AC (up to 450 Hz) power cabling. The same engineering rules apply whether going into or out of an electrical device. Thus, this guide applies equally to the input cable and output cable for this Elgar instrument and application loads.

Power cables must be able to safely carry maximum load current without overheating or causing insulation destruction. It is important to everyday performance to minimize IR (voltage drop) loss within the cable. These losses have a direct effect on the quality of power delivered to and from instruments and corresponding loads.

When specifying wire gauge, the operating temperature needs to be considered. Wire gauge current capability and insulation performance drops with the increased temperature developed within a cable bundle and with increased environmental temperature. Thus, short cables with generously derated gauge and insulation properties are recommended for power source applications.

Avoid using published commercial utility wiring codes. These codes are designed for the internal wiring of homes and buildings and accommodate the safety factors of wiring loss, heat, breakdown insulation, aging, etc. However, these codes consider that up to 5% voltage drop is acceptable. Such a loss directly detracts from the quality performance specifications of this Elgar instrument. Frequently, these codes do not consider bundles of wire within a cable arrangement.

In high performance applications, as in motor start-up and associated inrush/ transient currents, additional consideration is required. The cable wire gauge must consider peak voltages and currents that may be up to ten times the average values. An underrated wire gauge adds losses that alter the inrush characteristics of the application and thus the expected performance.

Table 2-8 identifies ratings for popular DC and AC power source cable wire gauges.

<b>COLUMN 1: SIZE (AWG)</b>	<b>COLUMN 2: AMPERES (MAXIMUM)</b>	<b>COLUMN 3: OHMS/100 FEET (ONE WAY)</b>	<b>COLUMN 4: IR DROP/100 FEET (COL. 2 X COL. 3)</b>
14	15	0.257	3.85
12	20	0.162	3.24
10	30	0.102	3.06
8	40	0.064	2.56
6	55	0.043	2.36
4	70	0.025	1.75
2	95	0.015	1.42
1/0	125	0.010	1.25
3/0	165	0.006	1.04

**Table 2-8 Recommended Wire Gauge Selection Guide**

The following notes apply to Table 2-8 and to the power cable definition:

1. The above figures are based upon insulated copper conductors at 25°C (77°F), two current carrying conductors in the cable plus a safety (chassis) ground.

Columns 3 and 4 refer to “one way” ohms and IR drop of current carrying conductors (e.g., a 50-foot cable contains 100 feet of current carrying conductor).

2. Determine which wire gauge for the application by knowing the expected peak load current ( $I_{\text{peak}}$ ), the maximum tolerated voltage loss ( $V_{\text{loss}}$ ) within the cable, and the one way cable length.

The formula below determines which ohms/100 feet entry is required from Column 3. Read the corresponding wire gauge from Column 1.

(Column 3 value) =

$$V_{\text{loss}} / [I_{\text{peak}} \times 0.02 \times (\text{cable length})]$$

Where:

Column 3 value =

Entry of the table above.

Cable length =

One way cable length in feet.

$V_{\text{loss}}$  =

Maximum loss, in volts, permitted within cable.

Special case: Should the  $V_{\text{loss}}$  requirement be very loose,  $I_{\text{peak}}$  may exceed the maximum amperes (Column 2). In this case, the correct wire gauge is selected directly from the first two columns of the table.

Example: A 20 ampere ( $I_{\text{peak}}$ ) circuit which may have a maximum 0.5 volt drop ( $V_{\text{loss}}$ ) along its 15-foot cable (one way cable length) requires (by formula) a Column 3 resistance value of 0.083. This corresponds to wire gauge size 8 AWG.

If the cable length was 10 feet, the Column 3 value would be 0.125 and the corresponding wire gauge would be 10 AWG.

3. Aluminum wire is not recommended due to soft metal migration at the terminals that may cause long term (on the order of years) poor connections and oxidation. If used, increase the wire gauge by two sizes (e.g., specify 10 gauge aluminum instead of 14 gauge aluminum).
4. Derate the above wire gauge (use a heavier gauge) for higher environmental temperatures since conductor resistance increases with temperature.

<u>Temperature</u>		<u>Current</u>
<u>Degrees</u>		<u>Capability</u>

<u>C</u>	<u>F</u>	
40	104	80%

5. Derate the above wire gauge (use a heavier gauge) for an increased number of current carrying conductors. This offsets the thermal rise of bundled conductors.

<u>Number of Conductors</u>	<u>Current Capability</u>
3 to 6	80%
Above 6	70%

6. The preferred insulation material is application dependent. Elgar's recommendation is any flame retardant, heat resistant, moisture resistant thermoplastic insulation rated to a nominal 75°C (167°F). Voltage breakdown must exceed the combined effects of:
- The rated output voltage;
  - Transient voltages induced onto the conductors from any source;
  - The differential voltage to other nearby conductors; and,
  - Safety margins to accommodate degradations due to age, mechanical abrasion and insulation migration caused by bending and temperature.
7. As frequency increases, the magnetic field of the current carrying conductors becomes more significant in terms of adverse coupling to adjacent electrical circuits. Use twisted pairs to help cancel these effects. Shielded twisted pairs are even better. Avoid close coupling with nearby cables by using separate cable runs for high power and low power cables.
8. The above general values and recommendations should be reviewed, modified and amended as necessary, for each application. Cables should be marked with appropriate safety WARNING decals, as hazardous voltages may be present.

This page intentionally left blank.

## **SECTION 3    OPERATION**

The TrueWave is programmable via the front panel and through the GPIB/ RS-232 command interface system. The unit is factory configured to power up in standby mode (output relay open) and it will operate in this manner unless it is programmed otherwise.

### **3.1   PROGRAM PARAMETERS**

The following parameters are set by quick key combinations on the front panel:

- Voltage setpoint of phases ABC, phase A alone, phase B, or phase C
- Current Limit of phases ABC, phase A alone, phase B, or phase C
- Phase angle of A-B
- Phase angle of A-C
- Frequency setpoint of TW (all phases)
- Present voltage range (0..156V, 0..312V)
- Output relay state (the output relay must be closed to source current)

### **3.2   MENU PARAMETERS**

The following parameters are programmed by means of the optionally password protected front panel menu system:

- GPIB address
- Over-current Foldback/Shutdown/Timeout modes
- Coupling to AC,DC or AC-DC
- Parallel mode On/Off
- EXT connector to Direct, Gain, or no control of the power amplifiers
- SYNC connector to Sync Out, Phase A Out, or Phase A In, or Trig In
- Voltage sense point to Local or Remote
- Chassis quantity (master-slave mode)
- IEC output impedance On/Off
- Store or Recall system state to/from 99 non-volatile memory locations
- Specify at power-up that the output relay will automatically close or not.
- Set or clear menu protection password.

The TW is controlled through the GPIB interface using the SCPI compatible command language. The RS-232 interface at the rear panel interprets the exact same syntax as the GPIB interface. The RS-232 communication parameters are fixed at:

- 9600 baud
- Parity NONE
- Data bits 8
- Stop bits 1.

Any command sent to the GPIB interface will be answered to the GPIB. Any command sent through the RS-232 interface will be answered back to the RS-232 interface.

Concurrent attachment to both GPIB and RS-232 is not supported.

The factory set GPIB address is 25.

### **3.3 OVERVIEW OF TW FRONT PANEL OPERATIONS**

The displays typically show the volts, frequency, and current read back from the output lines. The program parameters are adjusted by pressing one of three program keys, then either entering a number or using the arrow keys to ramp a given parameter up or down in variable step sizes. For instance, you can step the voltage in units of 100's, 10's, 1's, or tenths of a volt using the arrow keys. The longer the arrow is held, the faster the specified value increases or decreases. To quickly source voltage to the TW output terminals: set phase A current limit and set phase A voltage to a given value by entering these values on the keypad, press the Output key to source to the load on A phase and then rapidly scan the voltage to the load up or down with the arrow keys if desired.

### **3.4 DISPLAYING READBACKS**

When initially powered up, the TW display shows the present output voltage on the left, the present frequency in the center, and the present current being sourced on the right-most position. The display responds to several readback keys:

- A : B : C key
- Hz : Phase A-B : Phase A-C key
- I : W : VA : PF : CF key

When the A LED is lit, phase A readbacks appear on the display. Press the ABC key repeatedly to cycle through each of the phases on the display.



When the Hz key is pressed and the Phase A-B LED lights up, the phase angle between phase A and phase B appears in the center display.

When the Hz key is pressed and the Phase A-C LED lights up, the phase angle between phase A and phase C appears in the center display.

When the Hz key is pressed and the Hz LED lights up, the frequency at the output appears in the center display.

When the I key is pressed and the W LED lights up, the Watts calculated on the presently displayed phase appears in the right position of the display. If the TW is not in parallel mode and there is more than one amplifier installed, the ABC spinner can be set to AB (On a TW 3500 unit) or ABC and the total Watts is displayed on the right readout.

When the I key is pressed and the VA LED lights up, the Volt-Amps calculated on the presently displayed phase appears in the right position of the display. If the TW is not in parallel mode and there is more than one amplifier installed, the ABC spinner can be set to AB or ABC and the total Current is displayed on the right readout.

When the I key is pressed and the PF LED lights up, the Power Factor calculated on the presently displayed phase appears in the right position of the display. If the TW is not in parallel mode and there is more than one amplifier installed, the ABC spinner can be set to AB or ABC and the total Power Factor is displayed on the right readout.

When the I key is pressed and the CF LED lights up, the Crest Factor calculated on the presently displayed phase appears in the right position of the display. If the TW is not in parallel mode and there is more than one amplifier installed, the ABC spinner can be set to AB or ABC and the Crest Factor of phase A is displayed on the right readout.

### 3.5 SETTING PROGRAMMABLE PARAMETERS

The TW power supply reads the last setpoints saved to storage address 0. This way, at power up, the TW returns to the last saved state. If the power supply is to be in a preferred state at power up, ensure that this preferred state is saved to memory location 0 using either the front panel menu system, GPIB, or RS-232.

**NOTE:** *The last setpoints saved to storage location 0 are read in and applied when the TW powers up.*

Press the key labeled ABC until ABC are all lit at once (if the TW is not in parallel mode). This way, any programming changes are made to all three phases in parallel.

If the TW is in Parallel Amplifiers Mode the ABC spinner will remain in A, and all programming will be made to the A phase.

Use the Prog keys (VOLTAGE, FREQUENCY/PHASE, and CURRENT/POWER) to enter program mode. Any time during programming one parameter type, press one of the other program keys to save the results of the present program operation and shift over to a new program type.

While programming a value, press the ENT (Enter) key or the presently lit program key to save the present program value and terminate the programming operation. When programming in DC or ACDC modes, the number entered on the keypad can be sign adjusted by pressing the I/W/VA/PF/CF key. After pressing the +/- key, the display will show the '-' sign at the start of the displayed number to indicate a negative voltage value. The sign is not toggled. Press ENT without the +/- key to enter a positive number.

The programming process incorporates a timeout feature. If a key is not pressed within 10 seconds after entering program mode, the program operation is aborted and the system reverts to readback mode.

In program mode, use the arrow keys to adjust a number displayed. The digit being adjusted will be brighter than the other numbers displayed. The Up arrow will increment the number if the change doesn't push the number out of range. The setpoint will be changed and the output will be affected immediately.

**NOTE:** *When using arrow keys to adjust a programming value up or down, the change made is immediate and final. The output will reflect the changes.*

In program mode, use the number keys to specify an absolute value. If any program key is pressed after entering numbers to the display, the value entered will be range checked and applied to the output. Note that the only way to abandon a keyboard entry is to let the program sequence time out or to press the CANCEL key twice.

If a program value entered at the keyboard is out of range, the display flashes the maximum allowable value. After flashing, the program operation will be aborted.

The program keys can be disabled or "locked" using the menu system or GPIB/RS-232. Once the program keys are locked, the Lock LED is illuminated and the TW cannot be programmed via the front panel keys. The programming keys can be unlocked by means of the GPIB/RS-232 command interface or by the menu system described later in this manual.

The TW will source to its output when the Output LED is lit. The output is toggled on and off with the Output key or through SCPI.

The Remote LED lights as soon as a GPIB/RS-232 command has been received and processed.

If the TW system senses a system fault, the Fault LED lights and the specific fault appears on the TW display. Refer to Appendix A for information on resolving a fault condition.

When programming voltage, the High/Low key is active. Press this key to toggle the voltage range of the TW (all phases) from high to low or vice-versa. When the range is toggled, all voltages are set to 0, the output relay opens, and current limits are reset to 5 amps.

### **3.6 MENU SYSTEM**

Changing many TW operational parameters is performed through the Menu system.

To facilitate TW system changes, a step-by-step guide of the menu system is presented here.

The menu operations are executed by pressing either the Up arrow or the Down arrow from a front panel readback state (the Program LEDs must not be lit). It is assumed here that the password is not set.

If you hesitate too long in a given menu display without pressing a key, the menu system will time out and the readback display will re-appear.

Typically, where a Right arrow is specified, a Left arrow also will work with the reverse order of sub-items selected. Similarly, where an Up arrow is specified, a Down arrow will work as well, with the same order of items reversal.

Use the ABC/BACK key to back out of the menu system, and to back out one or more levels within the menus. Any values changed in the menu system will be written out to the hardware when the menu system is backed out by the BACK key. If the menu system is allowed to time out, no changes will be made to the TW.

### 3.7 MENU TREE

**SYST**

*(Use this menu to set the GPIB address and re-specify a system self-test)*

**SELF TEST**

PASSED or FAILED

**PORT**

GPIB ADDR 25

**CONFIG**

*(Use this menu to configure the power-generation parameters of the TW)*

**CURRENT**

TYPE [SHUT, FOLD]

CURR SHUT

CURR FOLD

SET DELAY 200

**COUPLING [AC, DC, AC-DC]**

COUP AC

COUP DC

COUP AC-DC

**PARALLEL [OFF, ON]**

PAR OFF

PAR ON

**BNC**

SYNC [TRIG O, PH A I, PH A O, TRIG I]

TRIG OUT

PHASE A OUT

PHASE A IN

TRIG IN

CONTROL [OFF, DIR, GAIN]

CONT OFF

CONT DIRECT

CONT GAIN

**SENSE [LOCAL,DIST]**

SENSE LOCAL

SENSE DISTANT

**CHASSIS**

CHAS QTY 1

**CHAIN**

CHAIN QTY 1

**IEC SETTING [ON,OFF]**

IEC ON

IEC OFF

**INSTALLED**

INST QTY 3

**STORAGE***(Use this menu to save/recall specific setpoint values to/from non-volatile storage)*

STORE 0

RECALL 0

**STARTUP [AUTO,STBY]***(Use this menu to specify if the TW will automatically source voltage at power up)*

INIT RUN

INIT STANDBY

**ACCESS***(Use this menu to set/clear password protection of the TW)*

CODE [SET, NOT SET]

CLEAR

ENTER TO CLEAR

SET

CODE 0000

REPEAT 0000

PROG FRT [ENA, DIS]

PROG FRT ENA

PROG FRT DIS

**3.8 MENU OPERATIONS****SYST**

SELF TEST

Press ENT to perform a self-diagnostic test; the result is displayed as:  
PASSED or FAILED

PORT

The communications parameters are set here.

GPIO ADDR (FACTORY: 25)

The GPIO address can be set here to address 1-31

**CONFIG**

CURRENT

The over-current mode and timing are set here.

TYPE

The current limit mode is set here

CURR SHUT (factory default)

The TW will foldback for the amount of delay set below (in milliseconds), and then will shutdown in an over-current situation.

**CURR FOLD**

The TW will lower the output voltage (“foldback”) to maintain the current limit set in this mode.

**SET DELAY** (default 100mS)

In Current Shutdown mode, this delay specifies how long the TW will foldback before shutdown

**COUPLING**

The amplifier(s) utilize AC,DC or AC/DC coupling to specify the TW output voltage mode. The TW can output DC, AC or AC with a DC offset.

**COUP AC** (factory default)

Specify that the amp(s) will source AC voltage.

**COUP DC**

Specify that the amp(s) will source DC voltage.

**COUP AC-DC**

Specify that the amp(s) will source AC with a bi-polar DC offset.

**PARALLEL** (default Off)

The TW is capable of operating all installed amplifiers in parallel, thereby increasing the single phase VA of the box. The TW is controlled by the A phase alone when in parallel mode.

**PAR OFF**

Set parallel off mode (independently controllable amps, front panel ABC spinner operational)

**PAR ON**

Set parallel on mode (no ABC spinner, TW is a single phase box)

**BNC**

The TW uses two BNC connectors to incorporate external control capabilities

**SYNC**

The BNC connector labeled “SYNC” is set up here.

**PHASE A IN**

Lock A Phase to incoming signal

**TRIG OUT**

This specifies that the BNC will provide trigger pulses on any waveform change

**PHASE A OUT (default)**

This specifies that the BNC will provide a pulse on each 0 crossing of Phase A

**TRIG IN**

This mode provides for the external synchronization of specific events (disturbance).

**CONTROL**

The BNC connector labeled “EXT” is configured here

**CONT OFF (default)**

The amplifiers are not externally controlled when this setting is specified.

**CONT DIRECT**

This setting allows a control voltage of 5Vrms (+/- 7.07 Vpeak) to directly control the amplifiers.

**CONT GAIN**

This setting allows a control voltage of 5Vrms (+/- 7.07 Vpeak) to scale the output waveform. (0 - +/- Full Scale Output)

**SENSE**

The amplifier sense point is either external (remote,distant) or internal (local) and is adjustable here

**LOCAL**

The amplifiers are controlled independent of the external sense lines.

**DISTANT (default)**

The amplifiers are controlled via the external sense lines feedback.

**CHASSIS**

The chassis quantity is set here (for Master/Slave TW application)

**CHAS QTY**

Set the number of chassis (factory default 1)

**IEC SETTING**

Sets the reference impedance of the output to support IEC hardware

**IEC ON**

Sets output to support IEC reference impedance mode of operation

**IEC OFF**

Sets output to normal impedance

**INSTALLED**

Specify the quantity of installed amplifiers here

**INST QTY**

Sets the quantity of installed amplifiers.

**STORAGE**

The setpoints that are specified via the front panel or the command interface (GPIB/serial) are saved and retrieved to EEROM non-volatile memory using the following menu commands:

**STORE**

You can save the present TW setup to locations 0-98. The following program data are saved and restored:

- A,B,C volt setpoints
- A,B,C current limit setpoints
- A,B,C offset volt setpoints
- Voltage Range (High, Low)
- B phase angle, C phase angle setpoints
- Frequency setpoint
- Current type (Shut, Fold)
- Current limit timeout
- Coupling type (AC, DC, ACDC)
- Parallel mode (On, Off) of internal amplifiers
- Clock/Lock Sync mode (SyncOut, RefOut, RefIn, TrigIn)
- Aux Input mode (Off, Direct, Gain)
- Sense mode (Local, Remote)
- Chassis Quantity
- IEC Output impedance (On, Off)

**NOTE:** *Parameters previously saved to location 0 are automatically read in at power-up time.*



**RECALL**

Read in from locations 0-99. The 99<sup>th</sup> location is factory defaults:

1. A Volts: 0.0
2. B Volts: 0.0
3. C Volts: 0.0
4. A Volts Offset 0.0
5. B Volts Offset 0.0
6. C Volts Offset 0.0
7. Frequency: 60.0
8. A Current Limit: 5.0
9. B Current Limit: 5.0
10. C Current Limit: 5.0
11. Current Limit Type Shutdown
12. Current Limit Timeout 200 ms.
13. Coupling Type: AC
14. Sense Remote
15. Internal Amplifiers Parallel Mode Off
16. Voltage Range Low
17. Chassis Quantity 1
18. A Volt Limit: 156.0
19. B Volt Limit: 156.0
20. C Volt Limit: 156.0
21. Phase Angle A : 0.0
22. Phase Angle AB: 120.0
23. Phase Angle AC: 240.0
24. Clk Lock/Sync: Phase A Out
25. Aux Input: Off
26. IEC Load State: Normal

**STARTUP**

At power up, the TW either will automatically source voltage to the output or it will wait in standby mode.

**INIT RUN**

Choose this setting to specify that the TW will automatically source voltage at start-up.

**INIT STANDBY**

Choose this setting to specify that TW will begin in standby mode.

**ACCESS**

The TW provides passcode protection to the menu interface. A passcode either can be set or not set. If the code is not set, then the menu can be manipulated and the passcode can be set or cleared. If the passcode is set, then the passcode must be entered properly to gain access to the menu system. Once the correct passcode is entered into a TW that presently requires passcode entry, the TW remains “unlocked” for 10 minutes. After the 10 minutes, the passcode will need to be entered again.

```
CODE
  CLEAR
    ENTER TO CLEAR

  SET
    CODE
```

See end of this section for more passcode information.

### **3.8.1 MENU PROMPTS AND KEY SEQUENCES**

To move vertically among major categories, use the Up arrow and Down arrow keys.

To move from a given category to a lower category, use the ENT key.

To move from a sub-category to its parent category, use the ABC/BACK key.

To change the assignment of a category that supports various forms (e.g., see Config category), use the Left and Right arrow keys to quickly change the possible modes without dropping to the sub-categories.

After making any changes inside the menu system, repeatedly press the ABC/BACK key to back out of the menu and save your changes. If the menu system is allowed to time out, the changes made will be lost.

## **3.9 PASSWORD PROTECTION**

### **3.9.1 CREATING THE PASSWORD**

Use the Up and Down arrow keys to get to the ACCESS menu command. Press the ENT key to get to the CODE sub-menu. Either the SET or NOT SET modes can be in effect at this time. Press ENT once to get to CLEAR. Use the Up or Down arrow key to get to the SET sub-menu. Press ENT once to get to the CODE sub-menu. Enter four digits at the keypad, then press ENT. When you are prompted for the REPEAT passcode, enter the same four digits and press ENT. If the codes are not identical, the BAD-RE-ENTER screen appears and you must type the two passcode entries again. If the numbers matched, the passcode has been successfully entered and you can leave the menu system by repeatedly pressing the ABC/BACK key.

### **3.9.2    CLEARING THE PASSWORD**

Use the Up and Down arrow keys to get to the ACCESS menu command. Press the ENT key to get to the CODE sub-menu. If the NOT SET mode is in effect at this time, the passcode is already cleared. Assuming the NOT SET mode is not presently in effect, press ENT once to get to CLEAR. If you wish to clear the passcode, press ENT once. Press ENT once more at the ENTER TO CLEAR prompt. The password is now cleared.

## **3.10    SAMPLE MENU CHANGES**

### **3.10.1    CHANGE TW GPIB ADDRESS**

Press the Up arrow key until the display reads:

SYST

Press the ENT key

Press the Up arrow key. The display will read:

PORT

Press the ENT key. If the present GPIB address is 25 the display will read:

GPIB ADDR 25

Either enter the new address using the 0-9 keys and press ENT, or press the Left arrow or the Right arrow key to specify the new value for the GPIB address.

Press ABC/BACK repeatedly to back out of menus and return to readback display mode.

### **3.10.2    SET TW TO CLOSE OUTPUT RELAY AT POWER UP**

Press the Up arrow key until the display reads:

STARTUP STBY

Press the Right arrow key. The display will read:

STARTUP AUTO

Press the ENT key. The display will read:

INIT RUN

Press ABC/BACK repeatedly to back out of menus and return to readback display mode.

### **3.10.3 PLACE TW INTO STANDBY MODE AFTER POWER UP**

Press the Up arrow key until the display reads:

STARTUP AUTO

Press the Right arrow key. The display will read:

STARTUP STBY

Press the ENT key. The display will read:

INIT STANDBY

Press ABC/BACK repeatedly to back out of menus and return to readback display mode.

### **3.10.4 PLACE FRONT PANEL PROGRAM KEYS INTO DISABLED MODE**

When the TW program keys are disabled, the Output key and Prog keys (VOLTAGE, FREQUENCY/PHASE, and CURRENT/POWER) are all non-operable. In this mode the TW will perform as last saved to system memory 0 and also can be controlled via the SCPI interface.

Press the Up arrow key until the display reads:

ACCESS

Press the ENT key. Assuming the password is not set, the display will read:

CODE NOT SET

Press the Up arrow key. The display will read:

PROG FRT ENA

Press the Right arrow key. The display will read:

PROG FRT DIS

Press the ENT key. The display will read:

PROG FRT DIS

Press ABC/BACK repeatedly to back out of menus and return to readback display mode.

### **3.10.5 PLACE FRONT PANEL PROGRAM KEYS INTO ENABLED MODE**

Press the Up arrow key until the display reads:

ACCESS

Press the ENT key. Assuming the password is not set, the display will read:

CODE NOT SET

Press the Up arrow key. The display will read:

PROG FRT DIS

Press the Right arrow key. The display will read:

PROG FRT ENA

Press the ENT key. The display will read:

PROG FRT ENA

Press ABC/BACK repeatedly to back out of menus and return to readback display mode. The Output and Prog keys are again operable.

### **3.10.6 PLACE TW INTO DC MODE**

Press the Up arrow key until the display reads:

CONFIG

Press the ENT key.

Press the Up arrow key until the display reads:

COUPLING AC or

COUPLING AC-DC

Press the Right arrow key until the display reads:

COUPLING DC

Press the ENT key. The display will read:

COUP DC

Press ABC/BACK repeatedly to back out of menus and return to readback display mode.

### **3.10.7 PLACE TW INTO ACDC MODE**

Press the Up arrow key until the display reads:

CONFIG

Press the ENT key.

Press the Up arrow key until the display reads:

COUPLING DC or

COUPLING AC

Press the Right arrow key until the display reads:

COUPLING AC-DC

Press the ENT key. The display will read:

COUP AC-DC

Press ABC/BACK repeatedly to back out of menus and return to readback display mode.

### **3.10.8 PLACE TW INTO AC MODE**

Press the Up arrow key until the display reads:

CONFIG

Press the ENT key.

Press the Up arrow key until the display reads:

COUPLING DC or

COUPLING ACDC

Press the Right arrow key until the display reads:

COUPLING AC

Press the ENT key. The display will read:

COUP AC

Press ABC/BACK repeatedly to back out of menus and return to readback display mode.

### **3.10.9 SET CURRENT FOLDBACK MODE**

Press the Up arrow key until the display reads:

CONFIG

Press the ENT key.

Press the Up arrow key until the display reads:

CURRENT

Press the ENT key. The display will read:

TYPE SHUT

Press the Right arrow key. The display will read:

TYPE FOLD

Press the ENT key. The display will read:

CURR FOLD

Press ABC/BACK repeatedly to back out of menus and return to readback display mode.

### **3.10.10 SET TW INTO CURRENT SHUTDOWN MODE**

Press the Up arrow key until the display reads:

CONFIG

Press the ENT key.

Press the Up arrow key until the display reads:

CURRENT

Press the ENT key. The display will read:

TYPE FOLD

Press the Right arrow key. The display will read:

TYPE SHUT

Press the ENT key. The display will read:

CURR SHUT

Press ABC/BACK repeatedly to back out of menus and return to readback display mode.

### **3.10.11 SET TW SHUTDOWN TIME VALUE**

Press the Up arrow key until the display reads:

CONFIG

Press the ENT key.

Press the Up arrow key until the display reads:

CURRENT

Press the ENT key. The display will read:

TYPE FOLD or

TYPE SHUT

Press the Up arrow key. Assuming the present timeout value is 200 milliseconds, the display will read:

SET DELAY 200

Either enter a new value in the 0-9 keys followed by the ENT key, or use the Left arrow or Right arrow key to decrement/increment the timeout value followed by the ENT key.

Press ABC/BACK repeatedly to back out of menus and return to readback display mode.

### **3.10.12 STORE A MACHINE STATE**

Press the Up arrow key until the display reads:

STORAGE

Press the ENT key.

The display reads:

STORE 0

Either enter a new value in the 0-9 keys followed by the ENT key, or use the Left arrow or Right arrow key to decrement/increment the value followed by the ENT key.

Press ABC/BACK repeatedly to back out of menus and return to readback display mode.



### **3.10.13 RECALL A MACHINE STATE**

Press the Up arrow key until the display reads:

STORAGE

Press the ENT key.

The display reads:

STORE 0

Press the Up arrow key. The display reads:

RECALL 0

Either enter a new value in the 0-9 keys followed by the ENT key, or use the Left arrow or Right arrow key to decrement/increment the value followed by the ENT key.

Press ABC/BACK repeatedly to back out of menus and return to readback display mode.

### **3.10.14 RECALL FACTORY CONFIGURATION**

Press the Up arrow key until the display reads:

STORAGE

Press the ENT key.

The display reads:

STORE 0

Press the Up arrow key. The display reads:

RECALL 0

Enter key 9 twice (99) followed by the ENT key. The display will read:

Press ABC/BACK repeatedly to back out of menus and return to readback display mode.

### **3.10.15 SPECIFY LOCAL SENSE**

Press the Up arrow key until the display reads:

CONFIG

Press the ENT key.

Press the Up arrow key until the display reads:

SENSE     DIST

Press the Right arrow key. The display will read:

SENSE   LOCAL

Press the ENT key. The display reads:

SENSE   LOCAL

Press ABC/BACK repeatedly to back out of menus and return to readback display mode.

### **3.10.16 SPECIFY REMOTE SENSE**

Press the Up arrow key until the display reads:

CONFIG

Press the ENT key.

Press the Up arrow key until the display reads:

SENSE     LOCAL

Press the Right arrow key. The display will read:

SENSE   DIST

Press the ENT key. The display reads:

SENSE   DISTANT

Press ABC/BACK repeatedly to back out of menus and return to readback display mode.

**3.10.17 PLACE TW INTO PLL LOCK MODE**

Press the Up arrow key until the display reads:

CONFIG

Press the ENT key.

Press the Up arrow key until the display reads:

BNC

Press the ENT key. Assuming the TW is in Trigger pulse out mode, the display reads:

SYNC TRIG O

Press the Right arrow key until the display reads:

SYNC PHASE A IN

Press the ENT key. The display reads:

PHASE A IN

Press ABC/BACK repeatedly to back out of menus and return to readback display mode.

**3.10.18 PROGRAM SYNC CONNECTOR TO SEND A PULSE AT PHASE A ZERO CROSSING**

Press the Up arrow key until the display reads:

CONFIG

Press the ENT key.

Press the Up arrow key until the display reads:

BNC

Press the ENT key. Assuming the TW is in Trigger pulse out mode, the display reads:

SYNC TRIG O

Press the Right arrow key until the display reads:

SYNC PHASE A O

Press the ENT key. The display reads:

PHASE A OUT

Press ABC/BACK repeatedly to back out of menus and return to readback display mode.

### **3.10.19 PROGRAM TW AMP GAINS TO RESPOND TO CONTROL BNC CONNECTOR**

Press the Up arrow key until the display reads:

CONFIG

Press the ENT key.

Press the Up arrow key until the display reads:

BNC

Press the ENT key. Assuming the control is presently in the OFF state, press the Up arrow key until the display reads:

CONTROL OFF

Press the Right arrow key until the display reads:

CONTROL GAIN

Press the ENT key. The display reads:

CONT GAIN

Press ABC/BACK repeatedly to back out of menus and return to readback display mode.

### **3.10.20 SPECIFY TW INSTALLED AMPS QTY**

Press the Up arrow key until the display reads:

CONFIG

Press the ENT key.

Press the Down arrow key until the display reads:

INSTALLED

Press the ENT key. Assuming that 1 amplifier is presently installed, the display reads:

INST QTY 1

Press the Right arrow key once to specify 2 amps, twice to specify 3 amps. Press the ENT key. The display will read:

INSTALLED

Press ABC/BACK repeatedly to back out of menus and return to readback display mode.

**3.10.21 PLACE TW INTO PARALLEL AMPLIFIERS MODE**

Press the Up arrow key until the display reads:

CONFIG

Press the ENT key.

Press the Up arrow key until the display reads:

PARALLEL

Press the right arrow KEY. The display will read:

PARALLEL ON

Press the ENT key. The display will read:

PAR ON

Press ABC/BACK repeatedly to back out of menus and return to readback display mode.

**3.10.22 SET PASSWORD**

Press the Up arrow key until the display reads:

ACCESS

Press the ENT key. Display will read:

CODE NOT SET

Press the ENT key. Display will read:

CLEAR

Press the Up arrow key The display will read:

SET NOT SET

Press the ENT key. The display will read:

CODE 0000

Press your desired four-digit code in the 0-9 keys. The display will read:

CODE - - - -

Press the ENT key. The display will read:

REPEAT 0000

Re-enter the four-digit code into the 0-9 keys. The display will read:

REPEAT - - - -

Press the ENT key. The display will read:

CODE SET

Press ABC/BACK repeatedly to back out of menus and return to readback display mode.

### **3.10.23 CLEAR PASSWORD**

Press the Up arrow key until the display reads:

ACCESS

Press the ENT key. Display will read:

CODE SET

Press the ENT key. Display will read:

CLEAR

Press the ENT key The display will read:

ENTER TO CLEAR

Press the ENT key. The display will read:

CLEAR

Press ABC/BACK repeatedly to back out of menus and return to readback display mode.

## **3.11 MASTER/SLAVE OPERATION**

### **3.11.1 OVERVIEW**

The TW series power supply provides the capability of being paralleled at the chassis level. If two TW supplies are “chained” (multiple TW units connected in a Master/Slave configuration), the system ampacities are multiplied. The TW units must be the same model number (the same power capability) and the outputs of the TWs must be connected properly. See Figures 3-1 and 3-2.

Example: Three TW 5250 models are chained (1 master, 2 slaves) and operated in 3 phase low voltage range mode (see Figure 3-1), the three phases will each support 39 amps. In high range, these three phases will each support 19.5 amps.

If the TW 5250 master is configured to operate in the parallel mode (see Figure 3-2) with the three chassis configuration, the low range sourcing capability is 117 amps. In high range this configuration will source 58.5 amps.

### **3.11.2 MASTER/SLAVE: STEP BY STEP INSTRUCTIONS**

The accessory master/slave kit (Elgar p/n 5161608-01) contains one slave cable and one breakout box together with attachment hardware.

To setup the TW system into chained mode:

1. If less than three units are being chained, proceed to step 3.
2. Install one slave cable breakout box onto each slave (elgar p/n 5161583-01). Do not attach the slave cable(s) at this time.
3. Connect the power input wiring to the master and slave(s).
4. At this time the slave cable(s) (Elgar p/n 5161586-01) should not be installed and the load wiring should not be connected to the A,B, and C phase output terminals.
5. Choose a TW unit to be the “Master” and power it on.
6. If the TW units are to be operated in Parallel mode (see Figure 3-2) it is imperative that the TW master unit be placed in Parallel mode and the Memory 0 location is updated to place the Master into parallel mode every time the units are powered. Perform section: 3.10.21 and then perform section 3.10.12 on this master TW.

7. Place the master TW into master mode by either setting the mode up in the menu system or through the SCPI system.

**SCPI:**

- If there are two slaves, GPIB Send to the master: SYST:CHASSIS 3

The chassis number counts the master chassis as one of the chassis. If there is one slave, the message will be SYST:CHASSIS 2

**Front Panel Menu:**

- Press Up Arrow to get into the menu system.
  - Press the Up Arrow enough times to get to CONFIG and press the ENT key.
  - Press the Up Arrow enough times to get to CHASSIS and press the ENT key.
  - Press the Left or Right Arrow keys to increment or decrement the chassis number, then press the ENT key. For two slaves, set chassis number to 3.
  - Press the ABC/Back key until the TW reads “SYS RESTART” and the TW will automatically reboot.
8. Now turn off the master TW while it reads “Sys Restart” or while it is searching for slaves.
  9. Turn on the next (slave) TW.
  10. Place the first slave TW into slave mode by either setting the chain address in the menu system or through the SCPI system.

**SCPI:**

- GPIB Send to the slave: SYST:CHAIN 1

The chain address number specifies the address of this slave TW.

**Front Panel Menu:**

- Press Up Arrow to get into the menu system.
- Press the Up Arrow enough times to get to CONFIG and press the ENT key.
- Press the Up Arrow enough times to get to CHAIN and press the ENT key.
- Press the Left or Right Arrow keys to increment or decrement the slave address (chain address), then press the ENT key.
- Press the ABC/Back key until the TW reads “SYS RESTART” and automatically reboots.



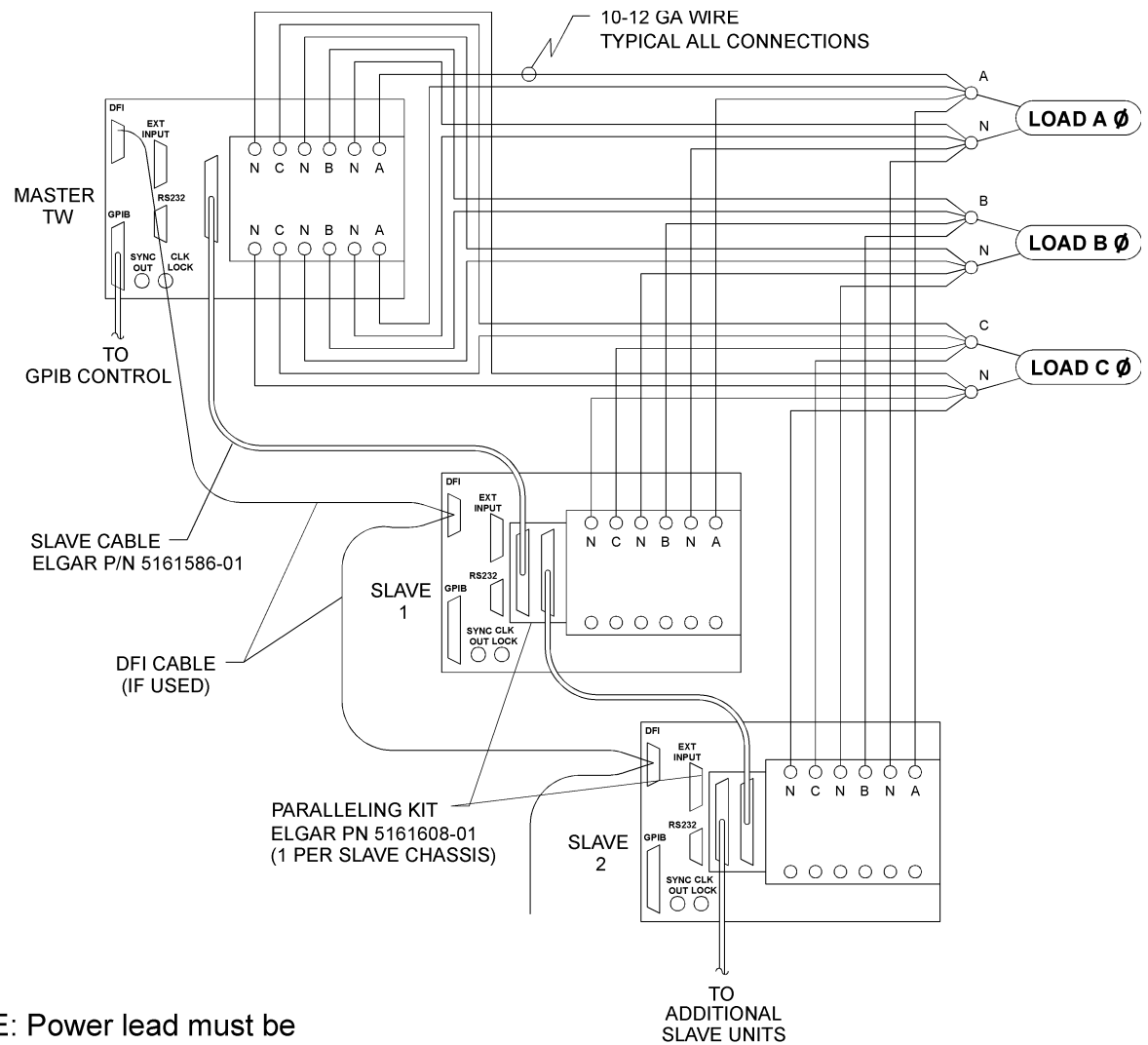
11. Now turn off the TW while it reads “Sys Restart” or after the display reads “Chained n”.
12. Re-run steps 7 through 9 for each slave, incrementing the slave address each time.
13. The TW unit output and master sense conductors need to junction in one spot at the “load junction terminal strip”. This power strip should be sized to support the wire gauge and ampacity for the number of TW units Master/Slaving.
14. Attach the output wiring between each TW (master and slave(s)) and the load junction terminal strip. All power wiring shall be of the same gauge (12,10,8 gauge, etc.) and the same length to facilitate current sharing among the TW amplifier modules.
15. Connect the sense wires between the TW master unit and the load junction terminal strip. Take care to attach all phases and phase neutral leads to the same junctions as per the drawings supplied here.
16. Attach the slave cables between all TW units. There is no need to enforce daisy-chaining or pay attention to the order or placement of the slave cables as long as the slave(s) and the master are ultimately all connected together in some manner.
17. Connect the GPIB or RS232 control line to the master. As soon as a slave is connected and talking with it's master, there will be no menu, RS232, or GPIB operations available on the slave.
18. If DFI connectors are being used for systems protection, connect the DFI daisy chain through the master and all slaves.
19. For model 5250 TWs all outputs will be bussed A to A , B to B, C to C, and the respective neutrals will be bussed AN, BN, CN to the load junction terminal strip. The six sense lines from the master will also be connected to the same six nodes on the junction strip. The load should be connected to the load junction terminal strip with a wire gauge ample enough to obviate any voltage drop considerations.
20. Of course, if the TW is a 3500, the C phase may be left disconnected and if the TW is a 1750 the B and C phases can all be disconnected here.
21. Apply power to all TW units. The slave(s) will self test and the fans will settle down with the “Chained n” display on each slave front panel.
22. The master TW will search for its slaves until all of the specified chassis are found. If the chassis number specified was 3 then the master will search for slave #1 and slave #2.

23. If the output phases are jumpered together as in Figure 3-2, the master must be placed in parallel mode through the SCPI system or through the menu system before the output key is pressed.
24. The TW units are now all controlled via the master SCPI or front panel in the usual manner. The maximum values calculated by the master will reflect the raised VA of the paralleled system by allowing larger current limits to be specified at current program time.

### 3.11.3 RETURN TO STANDALONE OPERATION

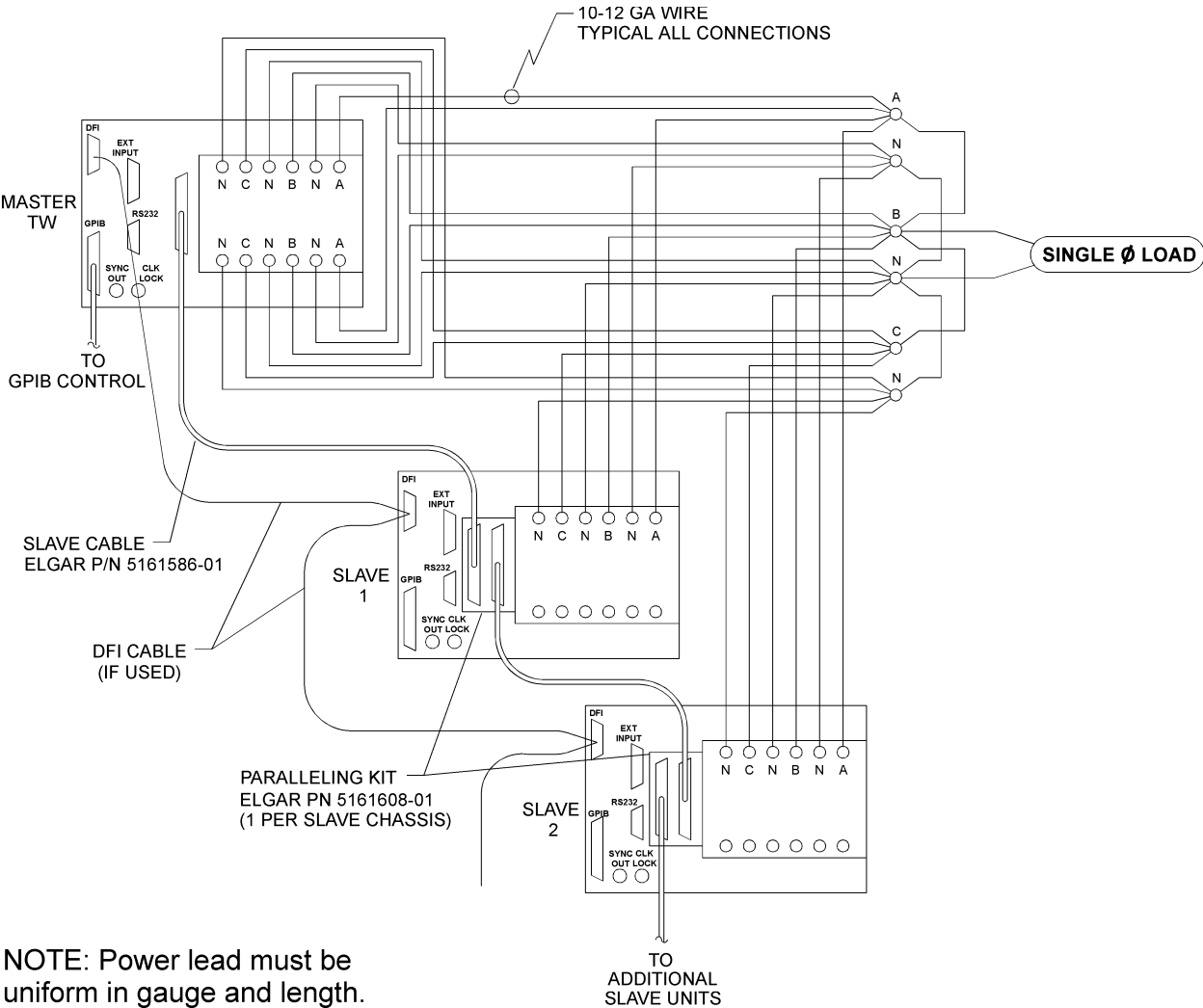
To return the TW system to standalone mode:

1. Power down all connected units
2. Remove Master/Slave cables. The steel housings may remain on the back of the slave TW units, if they were originally installed.
3. Disconnect any bussed power wiring from the TW outputs.
4. Power up TW units.
5. If the message “**Rcl Curr High**” appears on the display of any of the units, this is merely to notify the user that the previously legal current setpoint cannot apply in a standalone use. The current is automatically set to 5 Amps at this time.
6. If a unit was previously a slave: In SCPI set:  
  
SYST:CHAIN 0
7. If a unit was previously the master: In SCPI set:  
  
SYST:CHASSIS 1
8. The units will self reboot and return as individual TW configured units.



NOTE: Power lead must be uniform in gauge and length.

**Figure 3-1 TW 5250 Three Phase Master/Slave Wiring**



NOTE: Power lead must be uniform in gauge and length.

**Figure 3-2 TW 5250 Single Phase Master/Slave Wiring**

## **APPENDIX A FAULT OPERATIONS**

The TW Power Supply may experience various fault states during operation. The possible fault states can be generated by accidental overloading of the TW supply, or system failures within the TW.

### **DSP FAULT 0**

#### **DSP INITIALIZATION ERROR**

This error is reported when the DSP sub-processing system does not boot up. This error is not a recoverable error. The TW power should be cycled. If this error appears excessively, consult the Elgar technical support staff.

### **DSP FAULT 1**

#### **DSP TIMEOUT ERROR**

This error is reported when the DSP sub-processing system ceases to communicate with the main processor in the TW. This error is not a run-time recoverable error. The TW power should be cycled. If this error appears excessively, consult the Elgar technical support staff.

### **PS A FAULT 0**

#### **PHASE OVER VOLTAGE ERROR**

This error is reported when a given Phase experiences an over voltage condition. This error is a run-time recoverable error. From the front panel press the ENTER key. Through SCPI, send the \*RST command.

### **PS A FAULT 1**

#### **PHASE OVER CURRENT TRIP ERROR**

This error is reported when a given Phase experiences an over current condition. This error is a run-time recoverable error. From the front panel press the ENTER key. Through SCPI, send the \*RST command.

### **PS A FAULT 2**

#### **PHASE OVER TEMPERATURE ERROR**

This error is reported when a given Phase experiences an over temperature condition. This error is a run-time recoverable error. From the front panel press the ENTER key. Through SCPI, send the \*RST command.

**PS A FAULT 3****PHASE 350 V DC BUS OVERVOLT ERROR**

This error is reported when a given Phase DC internal bus experiences an 350V threshold voltage condition. This error is a run-time recoverable error. From the front panel press the ENTER key. Through SCPI, send the \*RST command.

**PS A FAULT 4****PHASE 380 V DC BUS OVERVOLT ERROR**

This error is reported when a given Phase DC internal bus experiences a 380V threshold over voltage condition. This error is not a run-time recoverable error. The TW power should be cycled. If this error appears excessively, consult the Elgar technical support staff.

**SELF TEST FAULT**

This error will occur if:

1. The amplifier installed quantity is incorrect in the Menu system. Perform section 3.10.20. CONFIG/INSTALLED should be set to:
  - 1 if the TW has one amplifier installed (1750)
  - 2 if the TW has two amplifiers installed (3500)
  - 3 if the TW has 3 amplifiers installed (5250)
2. On rare occasions th TW will fail power on self test due to erroneous data transmitted to the microprocessor. To correct this condition simply turn off power, wait 30 seconds and re-power the TW.
3. The TW has failed and will require service if this fault cannot be cleared by cycling the power